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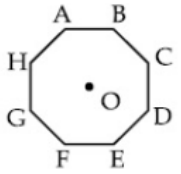
Archive - JEE Main & Advanced

Introduction to Vector and Forces	Class - XI | Physics

JEE Main 2021

1. In an octagon ABCDEFGH of equal side, what is the sum of $\overrightarrow{AB}+\overrightarrow{AC}+\overrightarrow{AD}+\overrightarrow{AE}+\overrightarrow{AF}+\overrightarrow{AG}+\overrightarrow{AH}$, if, $\overrightarrow{AO}=2\hat{i}+3\hat{j}-4\hat{k}$



(A) $16\hat{i}-24\hat{j}+32\hat{k}$

(B) $16\hat{i}+24\hat{j}-32\hat{k}$

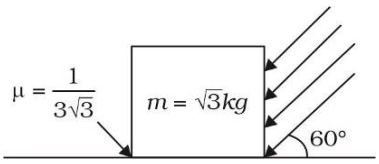
(C) $16\hat{i}+24\hat{j}+32\hat{k}$

(D) $-16\hat{i}-24\hat{j}+32\hat{k}$

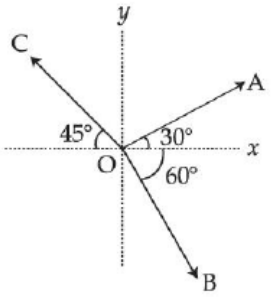
2. If $\vec{P}\times\vec{Q}=\vec{Q}\times\vec{P}$, the angle between $\vec{P}$ and $\vec{Q}$ is $\theta(0°<\theta<360°)$. The value of 'θ' will be _____°.

3. The coefficient of static friction between a wooden block of mass 0.5 kg and a vertical rough wall is 0.2. The magnitude of horizontal force that should be applied on the block to keep it adhere to the wall will be _____ *N*. $[g=10ms^{-2}]$

4. As shown in the figure, a block of mass $\sqrt{3}\,kg$ is kept on a horizontal rough surface of coefficient of friction $\frac{1}{3\sqrt{3}}$. The critical force to be applied on the vertical surface as shown at an angle 60° with horizontal such that it does not move, will be 3*x*. The value of *x* will be_____.



5. The magnitude of vectors $\overrightarrow{OA},\overrightarrow{OB}$ and $\overrightarrow{OC}$ in the given figure are equal. The direction of $\overrightarrow{OA}+\overrightarrow{OB}-\overrightarrow{OC}$ with *x*-axis will be:



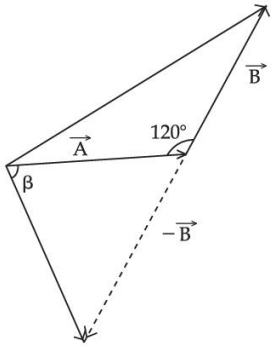
(A) $\tan^{-1}\frac{(1-\sqrt{3}-\sqrt{2})}{(1+\sqrt{3}+\sqrt{2})}$

(B) $\tan^{-1}\frac{(1+\sqrt{3}-\sqrt{2})}{(1-\sqrt{3}-\sqrt{2})}$

(C) $\tan^{-1}\frac{(\sqrt{3}-1+\sqrt{2})}{(1+\sqrt{3}-\sqrt{2})}$

(D) $\tan^{-1}\frac{(\sqrt{3}-1+\sqrt{2})}{(1-\sqrt{3}+\sqrt{2})}$

6. The angle between vector $(\vec{A})$ and $(\vec{A}-\vec{B})$ is:

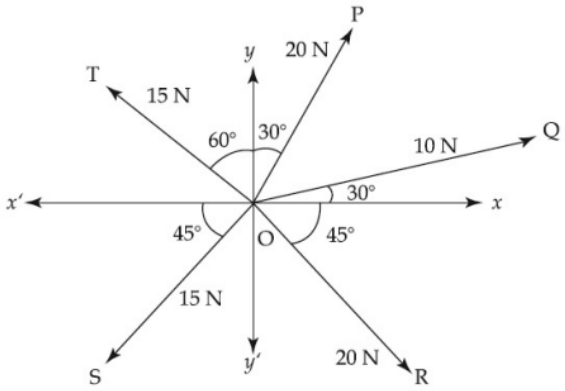


(A) $\tan^{-1}\left(\dfrac{-\frac{B}{2}}{A-B\frac{\sqrt{3}}{2}}\right)$ **(B)** $\tan^{-1}\left(\dfrac{A}{0.7B}\right)$

(C) $\tan^{-1}\left(\dfrac{\sqrt{3}B}{2A-B}\right)$ **(D)** $\tan^{-1}\left(\dfrac{B\cos\theta}{A-B\sin\theta}\right)$

7. The resultant of these force $\overrightarrow{OP},\overrightarrow{OQ},\overrightarrow{OR},\overrightarrow{OS}$ and $\overrightarrow{OT}$ is approximately_____ N.

[Take $\sqrt{3}=1.7,\sqrt{2}=1.4$ Given $\hat{i}$ and $\hat{j}$ unit vectors along x, y axis]



(A) $2.5\hat{i}-14.5\hat{j}$ **(B)** $3\hat{i}+15\hat{j}$ **(C)** $9.25\hat{i}+5\hat{j}$ **(D)** $-1.5\hat{i}-15.5\hat{j}$

8. **Statement I:**

If three forces $\vec{F}_1, \vec{F}_2$ *and* $\vec{F}_3$ are represented bv three sides of a triangle and $\vec{F}_1+\vec{F}_2=-\vec{F}_3$, then these three forces are concurrent forces and satisfy the condition for equilibrium.

Statement II:

A triangle made up of three forces $\vec{F}_1, \vec{F}_2$ *and* $\vec{F}_3$ as its sides taken in the same order, satisfy the condition for translatory equilibrium.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

(A) Both **Statement I** and **Statement II** are true.

(B) **Statement I** is true but **Statement II** is false.

(C) **Statement I** is false but **Statement II** is true.

(D) Both **Statement I** and **Statement II** are false.

9. **Statement I:**

Two forces $(\vec{P}+\vec{Q})$ *and* $(\vec{P}-\vec{Q})$ where $\vec{P}\perp\vec{Q}$, when act at an angle θ_1 to each other, the magnitude of their resultant is $\sqrt{3(P^2+Q^2)}$, when they act at an angle θ_2, the magnitude of their resultant becomes $\sqrt{2(P^2+Q^2)}$. This possible only when $\theta_1<\theta_2$.

Statement II:

In the situation given above

$\theta_1 = 60^\circ$ *and* $\theta_2 = 90^\circ$

In the light of the above statements, choose the most appropriate answer from the options given below:

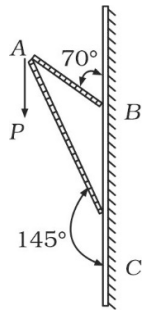
(A) **Statement I** is false but **Statement II** is true.

(B) Both **Statement I** and **Statement II** are false.

(C) Both **Statement I** and **Statement II** are true.

(D) **Statement I** is true but **Statement II** is false.

10. Consider a frame that is made up of two thin massless rods *AB* and *AC* as shown in the figure. A vertical force $\vec{P}$ -of magnitude 100 N is applied at point *A* of the frame.



Suppose the force is $\vec{P}$ resolved parallel to the arms *AB* and *AC* of the frame.

The magnitude of the resolved component along the arm *AC* is *xN*.

The value of *x*, to the nearest integer, is _____.

[Given : sin(35°) = 0.573, cos(35°) = 0.819 sin(110°) = 0.939, cos(110°) = –0.342]

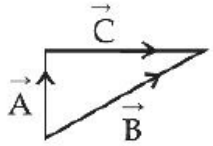
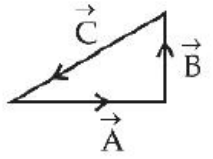
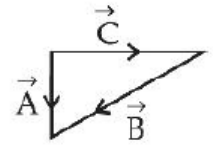
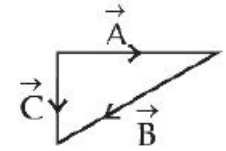
11. A person is swimming with a speed of 10 *m/s* at an angle of 120° with the flow and reaches to a point directly opposite on the other side of the river. The speed of the flow is *'x'm/s*. The value of *'x'* to the nearest integer is _____ .

12. A swimmer can swim with velocity of 12 km/h in still water. Water flowing in a river has velocity 6 km/h. The direction with respect to the direction of flow of river water he should swim in order to reach the point on the other bank just opposite to his starting point is _____°. (Round off to the Nearest Integer) (Find the angle in degrees)

13. Two vectors $\vec{P}$ and $\vec{Q}$ have equal magnitudes. If the magnitude of $\vec{P}+\vec{Q}$ is n times the magnitude of $\vec{P}-\vec{Q}$, then angle between $\vec{P}$ and $\vec{Q}$ is:

(A) $\cos^{-1}\left(\frac{n^2-1}{n^2+1}\right)$ **(B)** $\cos^{-1}\left(\frac{n-1}{n+1}\right)$ **(C)** $\sin^{-1}\left(\frac{n^2-1}{n^2+1}\right)$ **(D)** $\sin^{-1}\left(\frac{n-1}{n+1}\right)$

14. Match List I with List II.

List I		List II	
(a)	$\vec{C}-\vec{A}-\vec{B}=0$	**(i)**	
(b)	$\vec{A}-\vec{C}-\vec{B}=0$	**(ii)**	
(c)	$\vec{B}-\vec{A}-\vec{C}=0$	**(iii)**	
(d)	$\vec{A}+\vec{B}=-\vec{C}$	**(iv)**	

Choose the correct answer from the options given below:

(A) (a) → (iv), (b) → (i), (c) → (iii), (d) → (ii) **(B)** (a) → (iv), (b) → (iii), (c) → (i), (d) → (ii)

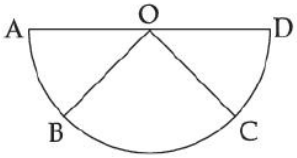
(C) (a) → (iii), (b) → (ii), (c) → (iv), (d) → (i) **(D)** (a) → (i), (b) → (iv), (c) → (ii), (d) → (iii)

15. Two vectors $\vec{X}$ *and* $\vec{Y}$ have equal magnitude. The magnitude of $\left(\vec{X}-\vec{Y}\right)$ is *n* times the magnitude of $\left(\vec{X}+\vec{Y}\right)$. The angle between $\vec{X}$ *and* $\vec{Y}$ is:

(A) $\cos^{-1}\left(\frac{n^2+1}{-n^2-1}\right)$ **(B)** $\cos^{-1}\left(\frac{-n^2-1}{n^2-1}\right)$ **(C)** $\cos^{-1}\left(\frac{n^2+1}{n^2-1}\right)$ **(D)** $\cos^{-1}\left(\frac{n^2-1}{-n^2-1}\right)$

16. **Assertion A :** If A, B, C and D are four points on a semi-circular arc with centre at '*O*' such that $\left|\overrightarrow{AB}\right|=\left|\overrightarrow{BC}\right|=\left|\overrightarrow{CD}\right|$, then $\overrightarrow{AB}+\overrightarrow{AC}+\overrightarrow{AD}=4\overrightarrow{AO}+\overrightarrow{OB}+\overrightarrow{OC}$

Reason R : Polygon law of vector addition yields $\overrightarrow{AB}+\overrightarrow{BC}+\overrightarrow{CD}=\overrightarrow{AD}=2\overrightarrow{AO}$



In the light of the above statements, choose the most appropriate answer from the options given below:

(A) A is not correct but R is correct

(B) Both A and R are correct and R is the correct explanation of A

(C) A is correct but R is not correct

(D) Both A and R are correct but R is not the correct explanation of A

17. What will be the projection of vector $\vec{A}=\hat{i}+\hat{j}+\hat{k}$ on vector $\vec{B}=\hat{i}+\hat{j}$?

(A) $\sqrt{2}(\hat{i}+\hat{j}+\hat{k})$ **(B)** $2(\hat{i}+\hat{j}+\hat{k})$ **(C)** $(\hat{i}+\hat{j})$ **(D)** $\sqrt{2}(\hat{i}+\hat{j})$

18. Three particle *P*, *Q* and *R* are moving along the vectors $\vec{A} = \hat{i} + \hat{j}$, $\vec{B} = \hat{j} + \hat{k}$ and $\vec{C} = -\hat{i} + \hat{j}$ respectively. They strike on a point and start to move in different directions. Now particle *P* is moving normal to the plane which contains vector $\vec{A}$ and $\vec{B}$. Similarly particle *Q* is moving normal to the plane which contains vector $\vec{A}$ and $\vec{C}$. The angle between the direction of motion of *P* and *Q* is $\cos^{-1}\left(\frac{1}{\sqrt{x}}\right)$. Then the value of *x* is _____.

19. A boy reaches the airport and finds that the escalator is not working. He walks up the stationary escalator in time t_1. If he remains stationary on a moving escalator then the escalator takes him up in time t_2. The time taken by him to walk up on the moving escalator will be:

(A) $t_2 - t_1$ **(B)** $\frac{t_1 t_2}{t_2 + t_1}$ **(C)** $\frac{t_1 t_2}{t_2 - t_1}$ **(D)** $\frac{t_1 + t_2}{2}$

20. If $\vec{A}$ -and $\vec{B}$ -are two vectors satisfying the relation $\vec{A}.\vec{B} = \left|\vec{A} \times \vec{B}\right|$. Then the value of $\left|\vec{A} - \vec{B}\right|$ will be:

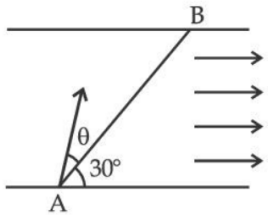
(A) $\sqrt{A^2 + B^2}$ **(B)** $\sqrt{A^2 + B^2 + \sqrt{2}AB}$

(C) $\sqrt{A^2 + B^2 + 2AB}$ **(D)** $\sqrt{A^2 + B^2 - \sqrt{2}AB}$

21. A butterfly is flying with a velocity $4\sqrt{2}\,m/s$ in North-East direction. Wind is slowly blowing at 1m/s from North to South. The resultant displacement of the butterfly in 3 second is:

(A) $12\sqrt{2}\,m$ **(B)** 20 m **(C)** 15 m **(D)** 3 m

22. A swimmer wants to cross a river from point A to point B. Line AB makes an angle of 30° with flow of river. Magnitude of velocity of the swimmer is same as that of the river. The angle θ with the line AB should be_____°, so that the swimmer reaches point B.



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Introduction to Vector and Forces	Class - XI | Physics

JEE Main 2022

1. $\vec{A}$ is a vector quantity such that $|\vec{A}|$= non-zero constant. Which of the following expression is true for $\vec{A}$?

(A) $\vec{A}\cdot\vec{A}=0$ **(B)** $\vec{A}\times\vec{A}<0$ **(C)** $\vec{A}\times\vec{A}=0$ **(D)** $\vec{A}\times\vec{A}>0$

2. Which of the following relations is true for two unit vector $\hat{A}$ and $\hat{B}$ making an angle θ to each other?

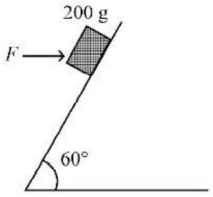
(A) $|\hat{A}+\hat{B}|=|\hat{A}-\hat{B}|\tan\frac{\theta}{2}$ **(B)** $|\hat{A}-\hat{B}|=|\hat{A}+\hat{B}|\tan\frac{\theta}{2}$

(C) $|\hat{A}+\hat{B}|=|\hat{A}-\hat{B}|\cos\frac{\theta}{2}$ **(D)** $|\hat{A}-\hat{B}|=|\hat{A}+\hat{B}|\cos\frac{\theta}{2}$

3. If force $\vec{F}=3\hat{i}+4\hat{j}-2\hat{k}$ acts on a particle having position vector $2\hat{i}+\hat{j}+2\hat{k}$ then, the torque about the origin will be:

(A) $3\hat{i}+4\hat{j}-2\hat{k}$ **(B)** $-10\hat{i}+10\hat{j}+5\hat{k}$ **(C)** $10\hat{i}+5\hat{j}-10\hat{k}$ **(D)** $10\hat{i}+\hat{j}-5\hat{k}$

4. A block of mass 200g is kept stationary on a smooth inclined plane by applying a minimum horizontal force $F=\sqrt{x}N$ as shown in figure.



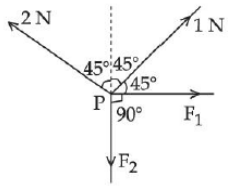
The value of x = _____.

5. A mass of 10 kg is suspended vertically by a rope of length 5 m from the roof. A force of 30 N is applied at the middle point of rope in horizontal direction. The angle made by upper half of the rope with vertical is $\theta=\tan^{-1}\left(x\times10^{-1}\right)$. The value of x is _____. (Given, $g=10m/s^2$)

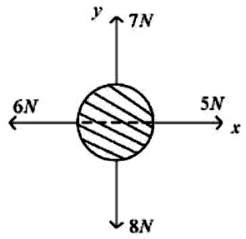
6. Two vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes. If magnitude of $\vec{A}+\vec{B}$ is equal to two times the magnitude of $\vec{A}-\vec{B}$, then the angle between $\vec{A}$ and $\vec{B}$ will be:

(A) $\sin^{-1}\left(\frac{3}{5}\right)$ **(B)** $\sin^{-1}\left(\frac{1}{3}\right)$ **(C)** $\cos^{-1}\left(\frac{3}{5}\right)$ **(D)** $\cos^{-1}\left(\frac{1}{3}\right)$

7. Four forces are acting at a point P in equilibrium as shown in figure. The ratio of force F_1 to F_2 is 1 : x where x = _____.



8. For a free body diagram shown in the figure, the four forces are applied in the '*x*' and '*y*' directions. What additional force must be applied and at what angle with positive *x*-axis so that the net acceleration of body is zero?



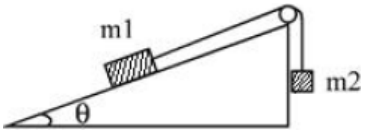
(A) $\sqrt{2}N, 45°$ **(B)** $\sqrt{2}N, 135°$

(C) $\frac{2}{\sqrt{3}}N, 30°$ **(D)** $2N, 45°$

9. If $\vec{A} = \left(2\hat{i} + 3\hat{j} - \hat{k}\right)m$ and $\vec{B} = \left(\hat{i} + 2\hat{j} + 2\hat{k}\right)m$. The magnitude of component of vector $\vec{A}$ along vector $\vec{B}$ will be _____*m*.

10. If the projection of $2\hat{i} + 4\hat{j} - 2\hat{k}$ on $\hat{i} + 2\hat{j} + \alpha\hat{k}$ is zero. Then, the value of α will be _____ .

11. Two bodies of masses $m_1 = 5kg$ and $m_2 = 3kg$ are connected by a light string going over a smooth light pulley on a smooth inclined plane as shown in the figure. The system is at rest. The force exerted by the inclined plane on the body of mass m_1 will be: [Take : $g = 10\,ms^{-2}$]



(A) 30 N **(B)** 40 N **(C)** 50 N **(D)** 60 N

12. The torque of a force $5\hat{i} + 3\hat{j} - 7\hat{k}$ about the origin is τ. If the force acts on a particle whose position vector $2\hat{i} + 2\hat{j} + \hat{k}$, then the value of τ will be :

(A) $11\hat{i} + 19\hat{j} - 4\hat{k}$ **(B)** $-11\hat{i} + 9\hat{j} - 16\hat{k}$ **(C)** $-17\hat{i} + 19\hat{j} - 4\hat{k}$ **(D)** $17\hat{i} + 9\hat{j} + 16\hat{k}$

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Kinematics of a Particle	Class - XI | Physics

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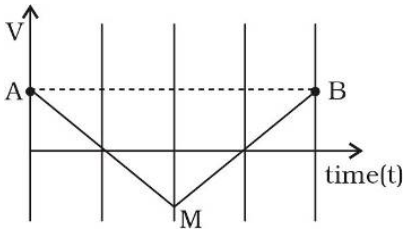
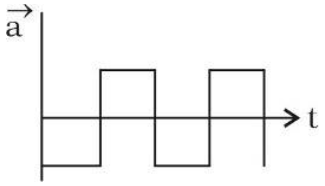
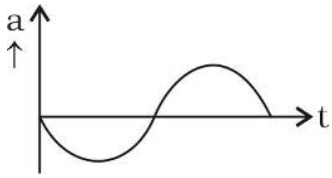
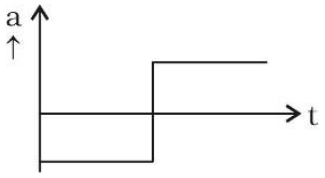
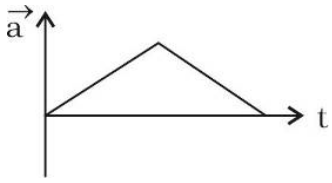
1. If the velocity-time graph has the shape AMB, what would be the shape of the corresponding acceleration-time graph?



(A)


(B)


(C)


(D)


2. An engine of a train, moving with uniform acceleration, passes the signal-post with velocity u and the last compartment with velocity v. The velocity with which middle point of the train passes the signal post is :

(A) $\sqrt{\frac{v^2-u^2}{2}}$ **(B)** $\frac{v-u}{2}$ **(C)** $\sqrt{\frac{v^2+u^2}{2}}$ **(D)** $\frac{u+v}{2}$

3. A stone is dropped from the top of a building. When it crosses a point 5m below the top, another stone starts to fall from a point 25 m below the top. Both stones reach the bottom of building simultaneously. The height of the building is:

(A) 50 m **(B)** 35 m **(C)** 45 m **(D)** 25 m

4. A scooter accelerates from rest for time t_1 at constant rate a_1 and then retards at constant rate a_2 for time t_2 and comes to rest. The correct value of $\frac{t_1}{t_2}$ will be:

(A) $\frac{a_1+a_2}{a_2}$ **(B)** $\frac{a_1+a_2}{a_1}$ **(C)** $\frac{a_1}{a_2}$ **(D)** $\frac{a_2}{a_1}$

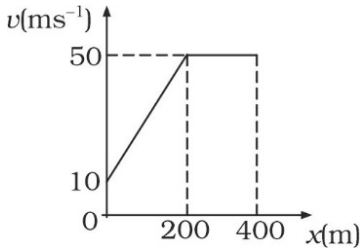
5. A particle is projected with velocity v_0 along x-axis. A damping force is acting on the particle which is proportional to the square of the distance from the origin i.e. $ma = -ax^2$. The distance at which the particle stops:

(A) $\left(\frac{2v_0^2}{3\alpha}\right)^{\frac{1}{2}}$ **(B)** $\left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{2}}$ **(C)** $\left(\frac{2v_0}{3\alpha}\right)^{\frac{1}{3}}$ **(D)** $\left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{3}}$

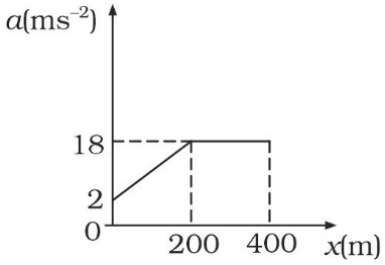
6. A car accelerates from rest at a constant rate α for some time after which it decelerates at a constant rate β to come rest. If the total time elapsed is t seconds, the total distance travelled is:

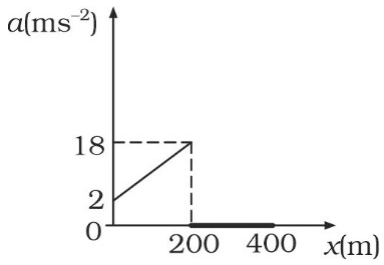
(A) $\frac{\alpha\beta}{2(\alpha+\beta)}t^2$ **(B)** $\frac{4\alpha\beta}{(\alpha+\beta)}t^2$ **(C)** $\frac{2\alpha\beta}{(\alpha+\beta)}t^2$ **(D)** $\frac{\alpha\beta}{4(\alpha+\beta)}t^2$

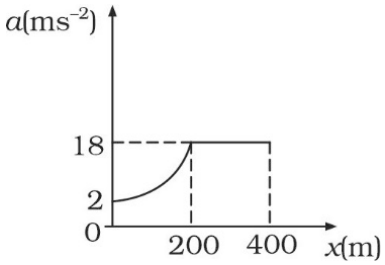
7. The velocity-displacement graph describing the motion of a bicycle is shown in the figure.

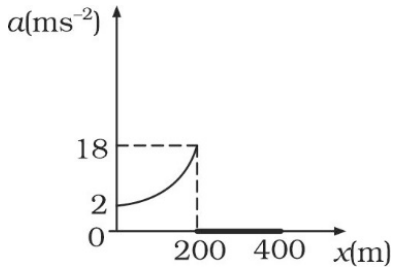


The acceleration-displacement graph of the bicycle's motion is best described by :

(A)


(B)


(C)


(D)


8. A rubber ball is released from a height of 5m above the floor. It bounces back repeatedly, always rising to $\frac{81}{100}$ of the height through which it falls. Find the average speed of the ball. (Take $g = 10 ms^{-2}$)

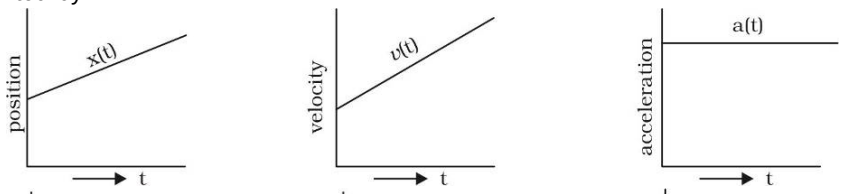
(A) $2.50 ms^{-1}$ **(B)** $2.0 ms^{-1}$ **(C)** $3.50 ms^{-1}$ **(D)** $3.0 ms^{-1}$

9. The velocity of a particle is $v = v_0 + gt + Ft^2$. Its position is $x = 0$ at $t = 0$; then its displacement after time $(t = 1)$ is :

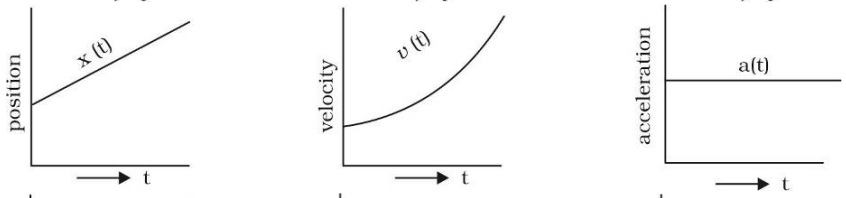
(A) $v_0 + g + F$ **(B)** $v_0 + \frac{g}{2} + F$ **(C)** $v_0 + 2g + 3F$ **(D)** $v_0 + \frac{g}{2} + \frac{F}{3}$

10. The position, velocity and acceleration of a particle moving with a constant acceleration can be represented by:

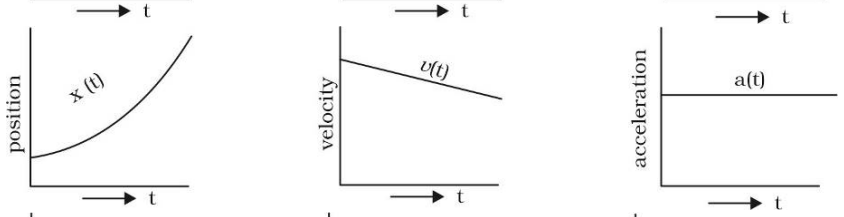
(A)



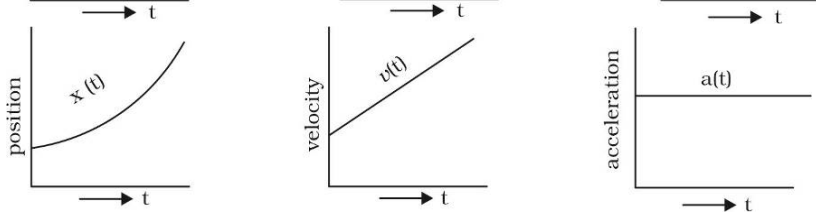
(B)



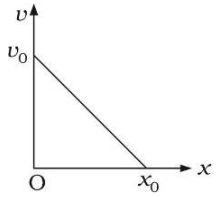
(C)



(D)

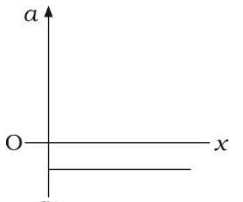


11. The velocity-displacement graph of a particle is shown in the figure.

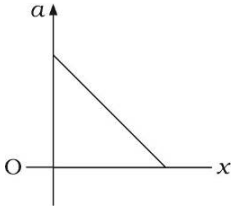


The acceleration-displacement graph of the same particle is represented by:

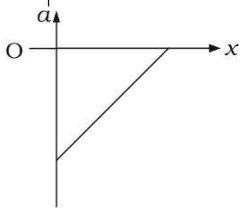
(A)



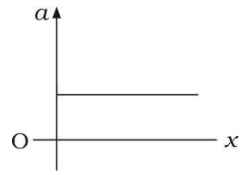
(B)



(C)



(D)



12. A mosquito is moving with a velocity $\vec{v} = 0.5t^{2}\hat{i} + 3t\,\hat{j} + 9\hat{k}$ m/s and accelerating in uniform conditions. What will be the direction of mosquito after 2 *s*?

(A) $\tan^{-1}\left(\frac{2}{3}\right)$ from *x*-axis

(B) $\tan^{-1}\left(\frac{2}{3}\right)$ from *y*-axis

(C) $\tan^{-1}\left(\frac{5}{2}\right)$ from *y*-axis

(D) $\tan^{-1}\left(\frac{5}{2}\right)$ from *x*-axis

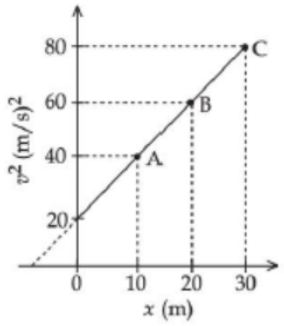
13. Two spherical balls having equal masses with radius of 5 cm each are thrown upwards along the same vertical direction at an interval of $3s$ with the same initial velocity of 35 m/s, then these balls collide at a height of _____ m. (take $g = 10\ m/s^2$)

14. If the velocity of a body related to displacement x given by $v = \sqrt{5000 + 24x}\ m/s$, then the acceleration of the body is _____ m/s^2.

15. Water drops are falling from a nozzle of a shower onto the floor, from a height of 9.8m. The drops fall at a regular interval of time. When the first drop strikes the floor, at that instant, the third drop begins to fall. Locate the position of second drop from the floor when the first drop strikes the floor.

(A) 4.18 m **(B)** 7.35 m **(C)** 2.45 m **(D)** 2.94 m

16. A particle is moving with constant acceleration 'a'. Following graph shows v^2 versus x (displacement) plot. The acceleration of the particle is _____ m/s^2.



17. Water droplets are coming from an open tap at a particular rate, The spacing between a droplet observed at 4th second after its fall to the next droplet is 34,3 m. At what rate the droplets are coming from the tap? (Take $g = 9.8m/s^2$)

(A) 3 drops/2 seconds **(B)** 1 drop/7 seconds
(C) 2 drops/second **(D)** 1 drop/second

18. The relation between time t and distance x for a moving body is given as $t = mx^2 + nx$, where m and n are constants. The retardation of the motion is: (Where v stands for velocity)

(A) $2mv^3$ **(B)** $2nv^3$ **(C)** $2n^2v^3$ **(D)** $2mnv^3$

19. A balloon was moving upwards with a uniform velocity of 10 m/s. An object of finite mass is dropped from the balloon when it was at a height of 75 m from the ground level. The height of the balloon from the ground when object strikes the ground was around: (takes the value of g as 10 m/s^2)

(A) 200 m **(B)** 250 m **(C)** 300 m **(D)** 125 m

20. The instantaneous velocity of a particle moving in a straight line is given as $v = \alpha t + \beta t^2$, where α *and* β are constants. The distance travelled by the particle between 1s and 2s is :

(A) $\frac{3}{2}\alpha + \frac{7}{3}\beta$ **(B)** $3\alpha + 7\beta$ **(C)** $\frac{\alpha}{2} + \frac{\beta}{3}$ **(D)** $\frac{3}{2}\alpha + \frac{7}{2}\beta$

21. A ball is thrown up with a certain velocity so that it reaches a height 'h'. Find the ratio of the two different times of the ball reaching $\frac{h}{3}$ in both the directions.

(A) $\frac{\sqrt{3}-1}{\sqrt{3}+1}$ **(B)** $\frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$ **(C)** $\frac{1}{3}$ **(D)** $\frac{\sqrt{2}-1}{\sqrt{2}+1}$

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Archive - JEE Main & Advanced

Kinematics of a Particle	Class - XI | Physics

JEE Main 2022

1. From the top of a tower, a ball is thrown vertically upward which reaches the ground in 6 s. A second ball thrown vertically downward from the same position with the same speed reaches the ground in 1.5s. A third ball released, from the rest from the same location, will reach the ground in _____s.

2. An object of mass 5 kg is thrown vertically upwards from the ground. The air resistance produces a constant retarding force of 10 N throughout the motion. The ratio of time of ascent to the time of descent will be equal to : [Use $g = 10\ ms^{-2}$].

(A) 1 : 1 **(B)** $\sqrt{2} : \sqrt{3}$ **(C)** $\sqrt{3} : \sqrt{2}$ **(D)** 2 : 3

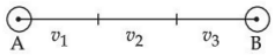
3. Two buses *P* and *Q* start from a point at the same time and move in a straight line and their positions are represented by $X_P(t) = \alpha t + \beta t^2$ and $X_Q(t) = ft - t^2$. At what time, both the buses have same velocity?

(A) $\frac{\alpha - f}{1+\beta}$ **(B)** $\frac{\alpha + f}{2(\beta - 1)}$ **(C)** $\frac{\alpha + f}{2(1+\beta)}$ **(D)** $\frac{f - \alpha}{2(1+\beta)}$

4. A ball of mass $0.5kg$ is dropped from the height of $10m$. The height, at which the magnitude of velocity becomes equal to the magnitude of acceleration due to gravity, is _____m. [Use $g = 10m/s^2$]

5. A ball is projected vertically upward with an initial velocity of $50ms^{-1}$ at $t = 0s$. At $t = 2s$, another ball is projected vertically with same velocity. At $t =$ ___s, second ball will meet the first ball ($g = 10ms^{-2}$).

6. A car covers *AB* distance with first one-third at velocity $v_1 ms^{-1}$, second one-third at $v_2\ ms^{-1}$ and last one-third at $v_3\ ms^{-1}$. If $v_3 = 3v_1, v_2 = 2v_1$ and $v_1 = 11\,ms^{-1}$ then the average velocity of the car is _____ms^{-1}.



7. Two balls A and B are placed at the top of 180 m tall tower. Ball A is released from the top at t = 0 s. Ball B is thrown vertically down with an initial velocity 'u' at t = 2 s. After a certain time, both balls meet 100 m above the ground. Find the value of 'u' in ms^{-1}. [use g = 10 ms^{-2}] :

(A) 10 **(B)** 15 **(C)** 20 **(D)** 30

8. A small toy starts moving from the position of rest under a constant acceleration. If it travels a distance of 10 *m* in *t s*, the distance travelled by the toy in the next *t s* will be:

(A) 10 *m* **(B)** 20 *m* **(C)** 30 *m* **(D)** 40 *m*

9. A car is moving with speed of 150 km/h and after applying the break it will move 27 m before it stops. If the same car is moving with a speed of one third the reported speed then it will stop after travelling _____ m distance.

10. A particle is moving in a straight line such that its velocity is increasing at 5 ms^{-1} per meter. The acceleration of the particle is _____ ms^{-2} at a point where its velocity is 20 ms^{-1}.

11. A ball is thrown vertically upwards with a velocity of $19.6 ms^{-1}$ from the top of a tower. The ball strikes the ground after 6s. The height from the ground up to which the ball can rise will be $\left(\frac{k}{5}\right)m$. The value of k is _____ (use $g = 9.8 m/s^2$)

12. A ball is thrown up vertically with a certain velocity so that, it reaches a maximum height h. Find the ratio of the times in which it is at height $\frac{h}{3}$ while going up and coming down respectively.

(A) $\frac{\sqrt{2}-1}{\sqrt{2}+1}$ **(B)** $\frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$ **(C)** $\frac{\sqrt{3}-1}{\sqrt{3}+1}$ **(D)** $\frac{1}{3}$

13. If $t = \sqrt{x} + 4$, then $\left(\frac{dx}{dt}\right)_{t=4}$ is:

(A) 4 **(B)** zero **(C)** 8 **(D)** 16

14. A juggler throws balls vertically upwards with same initial velocity in air. When the first ball reaches its highest position, he throws the next ball. Assuming the juggler throws n balls per second, the maximum height the balls can reach is:

(A) $g/2n$ **(B)** g/n **(C)** $2gn$ **(D)** $g/2n^2$

15. A ball is released from a height h. If t_1 and t_2 be the time required to complete first half and second half of the distance respectively. Then, choose the correct relation between t_1 and t_2.

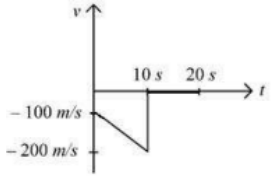
(A) $t_1 = (\sqrt{2})t_2$ **(B)** $t_1 = (\sqrt{2}-1)t_2$ **(C)** $t_2 = (\sqrt{2}+1)t_1$ **(D)** $t_2 = (\sqrt{2}-1)t_1$

16. A *NCC* parade is going with a uniform speed of 9 km/h under a mango tree on which a monkey is sitting at a height of 19.6 m. At any particular instant, the monkey drops a mango. A cadet will receive the mango whose distance form the tree at time of drop is: (Given : $g = 9.8 m/s^2$)

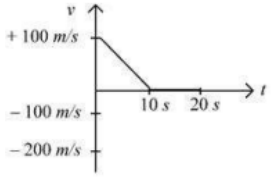
(A) 5 m **(B)** 10 m **(C)** 19.8 m **(D)** 24.5 m

17. A bullet is shot vertically downwards with an initial velocity of 100 m/s from a certain height. Within 10s, the bullet reaches the ground and instantaneously comes to rest due to the perfectly inelastic collision. The velocity-time curve for total time t = 20s will be: (Take : $g = 10\ m/s^2$).

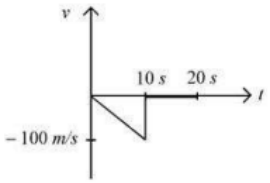
(A)



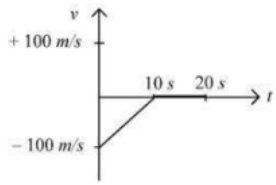
(B)



(C)



(D)



18. The velocity of the bullet becomes one third after it penetrates 4 cm in a wooden block. Assuming that bullet is facing a constant resistance during its motion in the block. The bullet stops completely after travelling at $(4 + x)$ cm inside the block. The value of x is :

(A) 2.0 **(B)** 1.0 **(C)** 0.5 **(D)** 1.5

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Archive - JEE Main & Advanced

Motion in Two Dimension	Class - XI | Physics

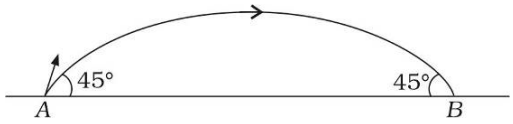
JEE Main 2021

1. The trajectory of a projectile in a vertical plane is $y = \alpha x - \beta x^2$, where α and β are constants and x & y are respectively the horizontal and vertical distances of the projectile from the point of projection. The angle of projection θ and the maximum height attained H are respectively given by:

(A) $\tan^{-1}\left(\frac{\beta}{\alpha}\right), \frac{\alpha^2}{\beta}$ **(B)** $\tan^{-1}\alpha, \frac{\alpha^2}{4\beta}$ **(C)** $\tan^{-1}\beta, \frac{\alpha^2}{2\beta}$ **(D)** $\tan^{-1}\alpha, \frac{4\alpha^2}{\beta}$

2. The angular speed of truck wheel is increased from 900 rpm to 2460 rpm in 26 seconds. The number of revolutions by the truck engine during this time is_____.
(Assuming the acceleration to be uniform).

3. The projectile motion of a particle of mass 5g is shown in the figure.
The initial velocity of the particle is $5\sqrt{2}\ ms^{-1}$ and the air resistance is assumed to be negligible. The magnitude of the change in momentum between the points A and B is $x \times 10^{-2}\ kgms^{-1}$. The value of x, to the nearest integer is:



4. A player kicks a football with an initial speed of $25ms^{-1}$ at an angle of 45° from the ground. What are the maximum height and the time taken by the football to reach at the highest point during motion?
(Take : $g = 10ms^{-2}$)

(A) $h_{max} = 15.625m, T = 3.54s$ **(B)** $h_{max} = 3.54m, T = 0.125s$
(C) $h_{max} = 15.625m, T = 1.77s$ **(D)** $h_{max} = 10m, T = 2.5s$

5. A bomb is dropped by a fighter plane flying horizontally. To an observer sitting in the plane, the trajectory of the bomb is a:

(A) Hyperbola
(B) Parabola in the direction of motion of plane
(C) Parabola in a direction opposite to the motion of plane
(D) Straight line vertically down the plane

6. A huge circular arc of length 4.4 ly subtends an angle '4s' at the centre of the circle. How long it would take for a body to complete 4 revolution if its speed is 8 AU per second?
Given: $1ly = 9.46 \times 10^{15}m$

$1AU = 1.5 \times 10^{11}m$

(A) $7.2\times10^{8}s$ **(B)** $3.5\times10^{6}s$ **(C)** $4.5\times10^{10}s$ **(D)** $4.1\times10^{8}s$

7. A helicopter is flying horizontally with a speed 'v' at an altitude 'h' has to drop a food packet for a man on the ground. What is the distance of helicopter from the man when the food packet is dropped?

(A) $\sqrt{\frac{2v^2h}{g}+h^2}$ **(B)** $\sqrt{2ghv^2+h^2}$ **(C)** $\sqrt{\frac{2gh}{v^2}+h^2}$ **(D)** $\sqrt{\frac{2ghv^2+1}{h^2}}$

8. The ranges and heights for two projectiles projected with the same initial velocity at angles 42° and 48° with the horizontal are R_1,R_2 and H_1,H_2 respectively. Choose the correct option:

(A) $R_1 < R_2$ and $H_1 < H_2$ **(B)** $R_1 > R_2$ and $H_1 = H_2$

(C) $R_1 = R_2$ and $H_1 = H_2$ **(D)** $R_1 = R_2$ and $H_1 < H_2$

9. A body rotating with an angular speed of 600 rpm is uniformly accelerated to 1800 rpm in 10 sec. The number of rotations made in the process is _____ .

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Archive - JEE Main & Advanced

Motion in Two Dimension	Class - XI | Physics

JEE Main 2022

1. A girl standing on road holds her umbrella at 45° with the vertical to keep the rain away. If she starts running without umbrella with a speed of $15\sqrt{2}\,kmh^{-1}$, the rain drops hit her head vertically. The speed of rain drops with respect to the moving girl is:

(A) $30\,kmh^{-1}$ **(B)** $\frac{25}{\sqrt{2}}kmh^{-1}$ **(C)** $\frac{30}{\sqrt{2}}kmh^{-1}$ **(D)** $25\,kmh^{-1}$

2. A ball is spun with angular acceleration $\alpha = 6t^2 - 2t$ where t is in second and α is in $rads^{-2}$. At $t = 0$, the ball has angular velocity of $10\,rads^{-1}$ and angular position of $4\,rad$. The most appropriate expression for the angular position of the ball is:

(A) $\frac{3}{2}t^4 - t^2 + 10t$ **(B)** $\frac{t^4}{2} - \frac{t^3}{3} + 10t + 4$

(C) $\frac{2t^4}{3} - \frac{t^3}{6} + 10t + 12$ **(D)** $2t^4 - \frac{t^3}{2} + 5t + 4$

3. A projectile is projected with velocity of 25 m/s at an angle θ with the horizontal. After t seconds its inclination with horizontal becomes zero. If R represents horizontal range of the projectile, the value of θ will be : [use g = 10 m/s^2]

(A) $\frac{1}{2}\sin^{-1}\left(\frac{5t^2}{4R}\right)$ **(B)** $\frac{1}{2}\sin^{-1}\left(\frac{4R}{5t^2}\right)$ **(C)** $\tan^{-1}\left(\frac{4t^2}{5R}\right)$ **(D)** $\cot^{-1}\left(\frac{R}{20\,t^2}\right)$

4. A fly wheel is accelerated uniformly from rest and rotates through 5 rad in the first second. The angle rotated by the fly wheel in the next second, will be:

(A) 7.5 rad **(B)** 15 rad **(C)** 20 rad **(D)** 30 rad

5. A body is projected from the ground at an angle of 45° with the horizontal. Its velocity after 2s is 20 ms^{-1}. The maximum height reached by the body during its motion is _____ m. (use $g = 10\ ms^{-2}$)

6. A force on an object of mass 100 g is $(10\hat{i} + 5\hat{j})N$. The position of that object at t = 2s is $(a\hat{i} + b\hat{j})m$ after starting from rest. The value of $\frac{a}{b}$ will be _____.

7. Given below are two statements. One is labeled as **Assertion A** and the other is labeled as **Reason R**.

Assertion A: two identical balls A and B thrown with same velocity 'u' at two different angles with horizontal attained the same range R. If A and B reached the maximum height h_1 and h_2 respectively, then $R = 4\sqrt{h_1 h_2}$

Reason R: Product of said height. $h_1 h_2 = \left(\frac{u^2\sin^2\theta}{2g}\right).\left(\frac{u^2\cos^2\theta}{2g}\right)$

Choose the correct answer :

(A) Both **A** and **R** are true and **R** is the correct explanation of **A**.

(B) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**.

(C) **A** is true but **R** is false.

(D) **A** is false but **R** is true.

8. For a particle in uniform circular motion, the acceleration $\vec{a}$ at any point $P(R,\theta)$ on the circular path of radius R is (when θ is measured from the positive x-axis and v is uniform speed) :

(A) $-\frac{v^2}{R}\sin\theta\hat{i}+\frac{v^2}{R}\cos\theta\hat{j}$ **(B)** $-\frac{v^2}{R}\cos\theta\hat{i}+\frac{v^2}{R}\sin\theta\hat{j}$

(C) $-\frac{v^2}{R}\cos\theta\hat{i}-\frac{v^2}{R}\sin\theta\hat{j}$ **(D)** $-\frac{v^2}{R}\hat{i}+\frac{v^2}{R}\hat{j}$

9. A fighter jet is flying horizontally at a certain altitude with a speed of $200ms^{-1}$. When it passes directly overhead an anti-aircraft gun, a bullet is fired from the gun, at an angle θ with the horizontal, to hit the jet. If the bullet speed is $400m/s$, the value of θ will be_____°.

10. A projectile is launched at an angle 'α' with the horizontal with a velocity $20ms^{-1}$. After 10s, its inclination with horizontal is 'β'. The value of $\tan\beta$ will be : $(g=10m/s^2)$

(A) $\tan\alpha+5\sec\alpha$ **(B)** $\tan\alpha-5\sec\alpha$

(C) $2\tan\alpha-5\sec\alpha$ **(D)** $2\tan\alpha+5\sec\alpha$

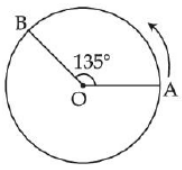
11. Motion of a particle in $x-y$ plane is described by a set of following equations $x=4\sin\left(\frac{\pi}{2}-\omega t\right)m$ and $y=4\sin(\omega t)m$. The path of the particle will be:

(A) circular **(B)** helical **(C)** parabolic **(D)** elliptical

12. A person can throw a ball upto a maximum range of 100 m. How high above the ground he can throw the same ball?

(A) 25 m **(B)** 50 m **(C)** 100 m **(D)** 200 m

13. A person moved from A to B on a circular path as shown in figure. If the distance travelled by him is 60 m, then the magnitude of displacement would be: (Given : $\cos135°=-0.7$)



(A) 42 m **(B)** 47 m

(C) 19 m **(D)** 40 m

14. A ball is projected from the ground with a speed 15 ms^{-1} at an angle θ with horizontal so that its range and maximum height are equal, then '$\tan\theta$' will be equal to:

(A) $\frac{1}{4}$ **(B)** $\frac{1}{2}$ **(C)** 2 **(D)** 4

15. Two projectiles thrown at 30° and 45° with the horizontal respectively, reach the maximum height in same time. The ratio of their initial velocities is:

(A) $1:\sqrt{2}$ **(B)** 2 : 1 **(C)** $\sqrt{2}:1$ **(D)** 1 : 2

16. If the initial velocity in horizontal direction of a projectile is unit vector $\hat{i}$ and the equation of trajectory is $y=5x(1-x)$. The y component vector of the initial velocity is _____ $\hat{j}$. (Take: $g\times10\,m/s^2$)

17. Two projectiles are thrown with same initial velocity making an angle of 45° and 30° with the horizontal respectively. The ratio of their respective ranges will be:

(A) $1:\sqrt{2}$ **(B)** $\sqrt{2}:1$ **(C)** $2:\sqrt{3}$ **(D)** $\sqrt{3}:2$

18. A ball of mass m is thrown vertically upward. Another ball of mass $2m$ is thrown at an angle θ with the vertical. Both the balls stay in air for the same period of time. The ratio of the heights attained by the two balls respectively is $1/x$. The value of x is _____.

19. At time $t = 0$ a particle starts travelling from a height $7\hat{z}\,cm$ in a plane keeping z coordinate constant. At any instant of time it's position along the $\hat{x}$ and $\hat{y}$ directions are defined as $3t$ and $5t^3$ respectively. At $t = 1s$ acceleration of the particle will be:

(A) $-30\hat{y}$ **(B)** $30\hat{y}$ **(C)** $3\hat{x} + 15\hat{y}$ **(D)** $3\hat{x} + 15\hat{y} + 7\hat{z}$

20. A ball is projected with kinetic energy E, at an angle of 60° to the horizontal. The kinetic energy of this ball at the highest point of its flight will become:

(A) Zero **(B)** $\frac{E}{2}$ **(C)** $\frac{E}{4}$ **(D)** E

21. An object projected in the air with initial velocity u at an angle θ. The projectile motion is such that the horizontal range R, is maximum. Another object is projected in the air with a horizontal range half of the range of first object. The initial velocity remains same in both the case. The value of the angle of projection, at which the second object is projected, will be _____ degree.

22. A body of mass 10 kg is projected at an angle of 45° with the horizontal. The trajectory of the body is observed to pass through a point (20, 10). If T is the time of flight, then its momentum vector, at time $t = \frac{T}{\sqrt{2}}$, is _____ . [Take $g = 10\ m/s^2$]

(A) $100\hat{i} + \left(100\sqrt{2} - 200\right)\hat{j}$ **(B)** $100\sqrt{2}\hat{i} + \left(100 - 200\sqrt{2}\right)\hat{j}$

(C) $100\hat{i} + \left(100 - 200\sqrt{2}\right)\hat{j}$ **(D)** $100\sqrt{2}\hat{i} + \left(100\sqrt{2} - 200\right)\hat{j}$

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Archive - JEE Main & Advanced

Dynamics of a Particle	Class - XI | Physics

JEE Main 2021

1. An inclined plane is bent in such a way that the vertical cross-section is given by $y = \frac{x^2}{4}$ where y is in vertical and x in horizontal direction. If the upper surface of this curved plane is rough with coefficient of friction $\mu = 0.5$, the maximum height in cm at which a stationary block will not slip downward is_____ cm.

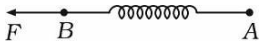
2. A particle is moving with uniform speed along the circumference of a circle of radius R under the action of a central fictitious force F which is inversely proportional to R^3. Its time period of revolution will be given by:

(A) $T \propto R^{4/3}$ **(B)** $T \propto R^{5/2}$ **(C)** $T \propto R^2$ **(D)** $T \propto R^{3/2}$

3. A person standing on a spring balance inside a stationary lift measures $60\,kg$. The weight of that person if the lift descends with uniform downward acceleration of $1.8\,m/s^2$ will be ____ N. $[g = 10\,m/s^2]$

4. A boy pushes a box of mass $2kg$ with a force $\vec{F} = (20\hat{i} + 10\hat{j})N$ on a frictionless surface. If the box was initially at rest, then _____m is displacement along the x-axis after 10 s.

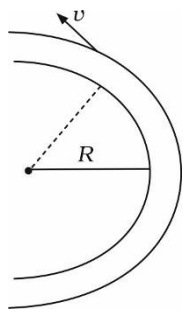
5. Two masses A and B, each of mass M are fixed together by a massless spring. A force acts on the mass B as shown in figure. If the mass A starts moving away from mass B with acceleration 'a', then the acceleration of mass B will be :



(A) $\frac{F - Ma}{M}$ **(B)** $\frac{Ma - F}{M}$ **(C)** $\frac{F + Ma}{M}$ **(D)** $\frac{MF}{F + Ma}$

6. A body of mass 2 kg moves under a force of $(2\hat{i} + 3\hat{j} + 5\hat{k})N$. It starts from rest and was at the origin initially. After 4s, its new coordinates are (8, b, 20). The value of b is _____ .
(Round off to the Nearest Integer)

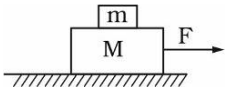
7. A modem grand – prix racing car of mass m is travelling on a flat track in a circular act of radius R with a speed v. If the coefficient of static friction between the tyres and the track is μ_s , then the magnitude of negative lift F_L acting downwards on the car is : (Assume forces on the four tyres are identical and g=acceleration due to gravity)



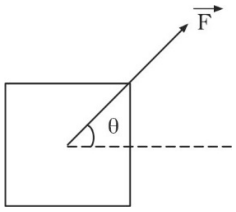
(A) $m\left(\frac{v^2}{\mu_s R} - g\right)$ **(B)** $m\left(\frac{v^2}{\mu_s R} + g\right)$

(C) $-m\left(g + \frac{v^2}{\mu_s R}\right)$ **(D)** $m\left(g - \frac{v^2}{\mu_s R}\right)$

8. Two blocks (m = 0.5 kg and M = 45 kg) are arranged on a horizontal frictionless table as shown in figure. The coefficient of static friction between the two block is $\frac{3}{7}$. Then the maximum horizontal force that can be applied on the larger block so that the blocks move together is _____ N. (Round off to the Nearest Integer) [Take g as $9.8\, ms^{-2}$]



9. A block of mass m slides along a floor while a force of magnitude F is applied to it at an angle θ as shown in figure. The coefficient of kinetic friction is μ_k. Then, the block's acceleration `a' is given by : g is acceleration due to gravity



(A) $-\frac{F}{m}\cos\theta-\mu k\left(g-\frac{F}{m}\sin\theta\right)$ **(B)** $\frac{F}{m}\cos\theta-\mu k\left(g+\frac{F}{m}\sin\theta\right)$

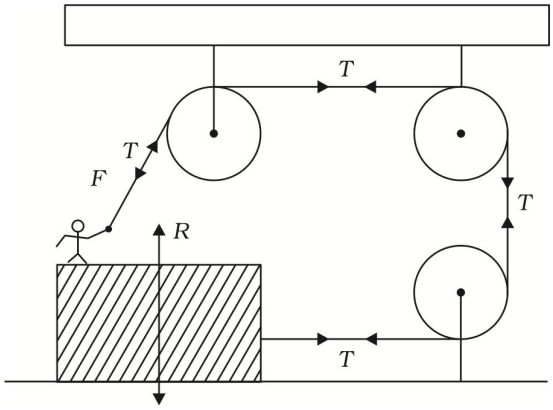
(C) $\frac{F}{m}\cos\theta+\mu k\left(g-\frac{F}{m}\sin\theta\right)$ **(D)** $\frac{F}{m}\cos\theta-\mu k\left(g-\frac{F}{m}\sin\theta\right)$

10. A block of 200 g mass moves with a uniform speed in a horizontal circular groove, with vertical side walls of radius 20 cm. If the block takes 40 s to complete one round, the normal force by the side walls of the groove is :

(A) $0.0314\ \text{N}$ **(B)** 6.28×10^{-3} N **(C)** 9.859×10^{-2} N **(D)** 9.859×10^{-4} N

11. A body of mass 1*kg* rests on a horizontal floor with which it has a coefficient of static friction $\frac{1}{\sqrt{3}}$. It is desired to make the body move by applying the minimum possible force *FN*. The value of F will be_____. (Round off to the Nearest Integer) [Take $g=10ms^{-2}$]

12. A boy of mass 4*kg* is standing on a piece of wood having mass 5*kg*. If the coefficient of friction between the wood and the floor is 0.5, the maximum force that the boy can exert on the rope so that the piece of wood does not move from its place is _____ *N*. (Round off to the Nearest Integer) [Take $g=10ms^{-2}$]



13. **Statement I :** A cyclist is moving on a unbanked road with a speed of 7 kmh^{-1} and takes a sharp circular turn along a path of radius of 2m without reducing the speed. The static friction coefficient is 0.2. The cyclist will not slip and pass the curve. ($g = 9.8\ m/s^2$)

Statement II : If the road is banked at angle of 45°, cyclist can cross the curve of 2m radius with the speed of 18.5 kmh^{-1} without slipping.

In the light of the above statements, choose the correct answer from the options given below.

(A) Statement I is correct and statement II is incorrect

(B) Statement I is incorrect and statement II is correct

(C) Both statement I and statement II are true

(D) Both statement I and statement II are false

14. The initial mass of a rocket is 1000 kg. Calculate at what rate the fuel should be burnt so that the rocket is given an acceleration of 20 ms^{-2}. The gases come out at a relative speed of 500 ms^{-1} with respect to the rocket : [Use $g = 10\ m/s^2$]

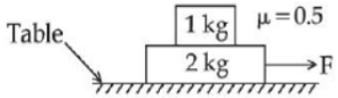
(A) 6.0×10^2 kg s^{-1} **(B)** 500 kg s^{-1}

(C) 60 kg s^{-1} **(D)** 10 kg s^{-1}

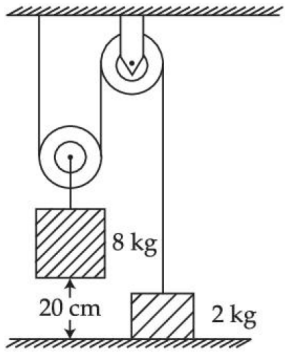
15. A particle of mass m is suspended from a ceiling through a string of length *L*. The particle moves in a horizontal circle of radius *r* such that $r = \frac{L}{\sqrt{2}}$. The speed of particle will be:

(A) $\sqrt{\frac{rg}{2}}$ **(B)** $\sqrt{rg}$ **(C)** $2\sqrt{rg}$ **(D)** $\sqrt{2rg}$

16. The coefficient of static friction between two blocks is 0.5 and the table is smooth. The maximum horizontal force that can be applied to move the blocks together is _____ N. (take $g = 10\ ms^{-2}$)



17. The boxes of masses 2*kg* and 8*kg* are connected by a massless string passing over smooth pulleys. Calculate the time taken by box of mass 8*kg* to strike the ground starting from rest. (use $g = 10m/s^2$)

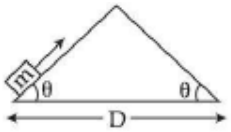


(A) 0.4*s* **(B)** 0.34*s* **(C)** 0.2*s* **(D)** 0.25*s*

18. A car is moving on a plane inclined at 30° to the horizontal with an acceleration of $10ms^{-2}$ parallel to the plane upward. A bob is suspended by a string from the roof of the car. The angle is degrees which the string makes with the vertical is _____.

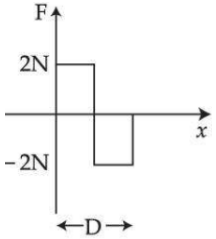
(Take $g = 10ms^{-2}$)

19. An object of mass '*m*' is being moved with a constant velocity under the action of an applied force of 2N along a frictionless surface with following surface profile.

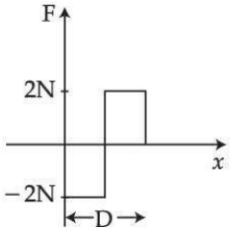


The correct applied force vs distance graph will be:

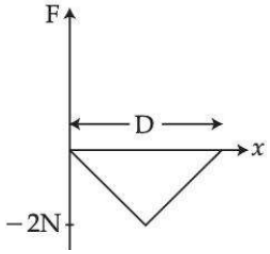
(A)



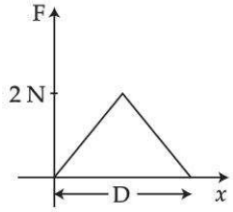
(B)



(C)



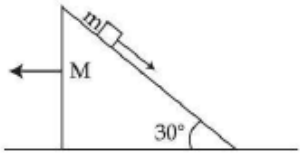
(D)



20. A block of mass m slides on the wooden wedge, which in turn slides backward on the horizontal surface. The acceleration of the block with respect to the wedge is:

Given $m = 8\,kg, M = 16kg$

Assume all the surfaces shown in the figure to be frictionless



(A) $\frac{3}{5}g$ **(B)** $\frac{2}{3}g$ **(C)** $\frac{4}{3}g$ **(D)** $\frac{6}{5}g$

21. When a body slides down from rest along a smooth inclined plane making an angle of 30° with the horizontal, it take time T. When the same body slides down from the rest along a rough inclined plane making the same angle and through the same distance, it takes time αT, where α is a constant greater than 1. The co-efficient of friction between the body and the rough plane is $\frac{1}{\sqrt{x}}\left(\frac{\alpha^2-1}{\alpha^2}\right)$ where *x* = _____

22. A particle of mass M originally at rest is subjected to a force whose direction is constant but magnitude varies with time according to the relation

$$F = F_0\left[1-\left(\frac{t-T}{T}\right)^2\right]$$

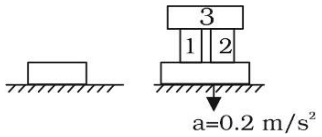
Where F_0 and T are constants. The force acts only for the time interval 2T. The velocity *v* of the particle after time 2T is :

(A) $\frac{4F_0T}{3M}$ **(B)** $\frac{2F_0T}{M}$ **(C)** $\frac{F_0T}{2M}$ **(D)** $\frac{F_0T}{3M}$

23. A body of mass '*m*' is launched up on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of friction between the body and plane is $\frac{\sqrt{x}}{5}$ if the time of ascent is half of the time of descent. The value of *x* is _____ .

24. A steel block of 10 kg rests on a horizontal floor as shown. When three iron cylinders are placed on it as shown, the block and cylinders go down with an acceleration $0.2 m/s^2$ .The normal reaction *R*' by the floor if mass of the iron cylinders are equal and of 20KG each, is _____N.

[Take g=10 m/s^2 and $\mu_s = 0.2$]



(A) 686 **(B)** 714 **(C)** 684 **(D)** 716

25. The normal reaction '*N*' for a vehicle of 800 kg mass, negotiating a turn on a 30° banked road at maximum possible speed without skidding is _____$\times 10^3 kg m/s^2$.

[Given $\cos 30° = 0.87, \mu_s = 0.2$]

(A) 6.96 **(B)** 7.2 **(C)** 12.4 **(D)** 10.2

26. A force $\vec{F}(40\hat{i} + 10\hat{j})N$ acts on a body of mass 5 kg, If the body starts from rest, its position vector $\vec{r}$ at time $t = 10s$, will be:

(A) $(400\hat{i} + 100\hat{j})m$ **(B)** $(100\hat{i} + 400\hat{j})m$

(C) $(400\hat{i} + 400\hat{j})m$ **(D)** $(100\hat{i} + 100\hat{j})m$

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Dynamics of a Particle	Class - XI | Physics

JEE Main 2022

1. One end of a massless spring of spring constant k and natural length l_0 is fixed while the other end is connected to a small object of mass m lying on a frictionless table. The spring remains horizontal on the table. If the object is made to rotate at an angular velocity ω about an axis passing trough fixed end, then the elongation of the spring will be:

(A) $\frac{k - m\omega^2 l_0}{m\omega^2}$ **(B)** $\frac{m\omega^2 l_0}{k + m\omega^2}$ **(C)** $\frac{m\omega^2 l_0}{k - m\omega^2}$ **(D)** $\frac{k + m\omega^2 l_0}{m\omega^2}$

2. A block of mass 10 kg starts sliding on a surface with an initial velocity of 9.8 ms^{-1}. The coefficient of friction between the surface and block is 0.5. The distance covered by the block before coming to rest is: [use g= 9.8 ms^{-2}]

(A) 4.9 m **(B)** 9.8 m **(C)** 12.5 m **(D)** 19.6 m

3. A boy ties a stone of mass 100 g to the end of a 2 m long string and whirls it around in a horizontal plane. The string can withstand the maximum tension of 80 N. If the maximum speed with which the stone can revolve is $\frac{K}{\pi} rev./\min$. The value of K is : (Assume the string is massless and unstretchable)

(A) 400 **(B)** 300 **(C)** 600 **(D)** 800

4. A uniform chain of 6m length is placed on a table such that a part of its length is hanging over the edge of the table. The system is at rest. The co-efficient of static friction between the chain and the surface of the table is 0.5, the maximum length of the chain hanging from the table is _____m.

5. A disc with a flat small bottom beaker placed on it at a distance R from its center is revolving about an axis passing through the center and perpendicular to its plane with an angular velocity ω. The coefficient of static friction between the bottom of the beaker and the surface of the disc is μ. The beaker will revolve with the disc if :

(A) $R \le \frac{\mu g}{2\omega^2}$ **(B)** $R \le \frac{\mu g}{\omega^2}$ **(C)** $R \ge \frac{\mu g}{2\omega^2}$ **(D)** $R \ge \frac{\mu g}{\omega^2}$

6. A curved in a level road has radius 75m. The maximum speed of a car turning this curved road can be 30m/s without skidding. If radius of curved road is changed to 48m and the coefficient of friction between the tyres and the road remains same, then maximum allowed speed would be _____ m/s.

7. A person is standing in an elevator. In which situation, he experiences weight loss?

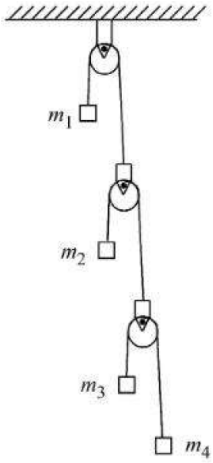
(A) When the elevator moves upward with constant acceleration

(B) When the elevator moves downward with constant acceleration

(C) When the elevator moves upward with uniform velocity

(D) When the elevator moves downward with uniform velocity

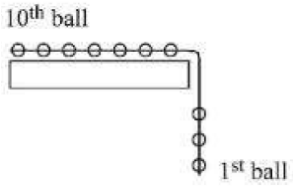
8. In the arrangement shown in figure a_1, a_2, a_3 and a_4 are the accelerations of masses m_1, m_2, m_3 and m_4 respectively. Which of the following relation is true for this arrangement?



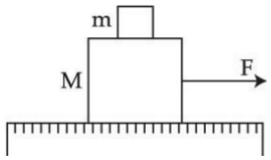
(A) $4a_1 + 2a_2 + a_3 + a_4 = 0$ **(B)** $a_1 + 4a_2 + 3a_3 + a_4 = 0$

(C) $a_1 + 4a_2 + 3a_3 + 2a_4 = 0$ **(D)** $2a_1 + 2a_2 + 3a_3 + a_4 = 0$

9. A system to 10 balls each of mass $2kg$ are connected via massless and unstretchable string. The system is allowed to slip over the edge of a smooth table as shown in figure. Tension on the string between 7^{th} and 8^{th} ball is _____ N when 6^{th} ball just leaves the table.

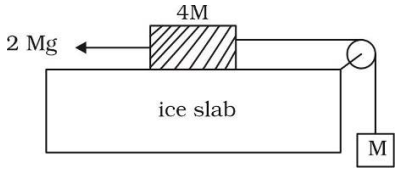


10. A system of two blocks of masses $m = 2kg$ and $M = 8kg$ is placed on a smooth table as shown in figure. The coefficient of static friction between two blocks is 0.5. The maximum horizontal force F that can be applied to the block of mass M so that the blocks move together will be:



(A) 9.8 N **(B)** 39.2 N **(C)** 49N **(D)** 78.4N

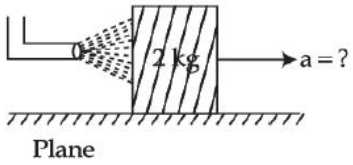
11. A hanging mass M is connected to a four times bigger mass by using a string pulley arrangement, as shown in the figure. The bigger mass is placed on a horizontal ice-slab and being pulled by 2 Mg force. In this situation, tension in the string is $\frac{x}{5}Mg$ for $x =$ _____. Neglect mass of the string and friction of the block (bigger mass) with ice slab. (Given g = acceleration due to gravity)



12. A block of mass $2kg$ moving on a horizontal surface with speed of $4\,ms^{-1}$ enters a rough surface ranging from $x = 0.5m$ to $x = 1.5m$. The retarding force in this range of rough surface is related to distance by $F = -kx$ where $k = 12\ Nm^{-1}$. The speed of the block as it just crosses the rough surface will be:

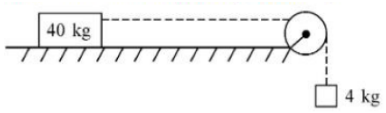
(A) zero **(B)** $1.5ms^{-1}$ **(C)** $2.0ms^{-1}$ **(D)** $2.5ms^{-1}$

13. A block of metal weighing 2 kg is resting on a frictionless plane (as shown in figure). It is struck by a jet releasing water at a rate of $1 kgs^{-1}$ and at a speed of $10 ms^{-1}$. Then, the initial acceleration of the block, in ms^{-2}, will be:



(A) 3 **(B)** 6 **(C)** 5 **(D)** 4

14. A block of mass 40 *kg* slides over a surface, when a mass of 4 *kg* is suspended through an inextensible massless string passing over frictionless pulley as shown below:
The coefficient of kinetic friction between the surface and block is 0.02. The acceleration of block is. (Given : $g = 10\ ms^{-2}$)



(A) $1\ ms^{-2}$ **(B)** $1/5\ ms^{-2}$ **(C)** $4/5\ ms^{-2}$ **(D)** $8/11\ ms^{-2}$

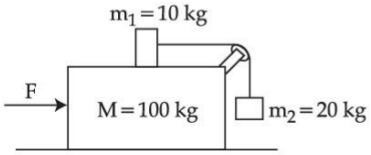
15. A block of mass *M* placed inside a box descends vertically with acceleration '*a*'. The block exerts a force equal to one-fourth of its weight on the floor of the box. The value of '*a*' will be:

(A) $\frac{g}{4}$ **(B)** $\frac{g}{2}$ **(C)** $\frac{3g}{4}$ **(D)** g

16. Two billiard balls of mass 0.05 kg each moving in opposite directions with 10 ms^{-1} collide and rebound with the same speed. If the time duration of contact is $t = 0.005s$, then what is the force exerted on the ball due to each other?

(A) 100 N **(B)** 200 N **(C)** 300 N **(D)** 400 N

17. Three masses *M* = 100 kg, $m_1 = 10\ kg$ and $m_2 = 20kg$ are arranged in a system as shown in figure. All the surfaces are frictionless and strings are inextensible and weightless. The pulleys are also weightless and frictionless. A force *F* is applied on the system so that the mass m_2 moves upward with an acceleration of $2ms^{-2}$. The value of *F* is: (Take $g = 10\ ms^{-2}$)



(A) 3360 N **(B)** 3380 N **(C)** 3120 N **(D)** 3240 N

18. A monkey of mass 50kg climbs on a rope which can withstand the tension (*T*) of 350N. If monkey initially climbs down with an acceleration of $4 m/s^2$ and then climbs up with an acceleration of $5 m/s^2$. Choose the correct option ($g = 10 m/s^2$).

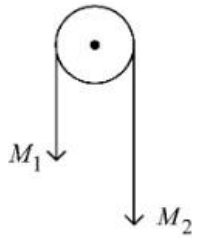
(A) *T* = 700 *N* while climbing upward **(B)** *T* = 350*N* while going downward

(C) Rope will break while climbing upward **(D)** Rope will break while going downward

19. A ball of mass 0.15 kg hits the wall with its initial speed of 12 ms^{-1} and bounces back without changing its initial speed. If the force applied by the wall on the ball during the contact is 100 N, calculate the time duration of the contact of ball with the wall:

(A) 0.018 s **(B)** 0.036 s **(C)** 0.009 s **(D)** 0.072 s

20. Two mass M_1 and M_2 are tied together at the two ends of a light inextensible string that passes over a frictionless pulley. When the mass M_2 is twice that of M_1, the acceleration of the system is a_1. When the mass M_2 is thrice that of M_1, the acceleration of the system is a_2. Then ratio $\frac{a_1}{a_2}$ will be:



(A) $\frac{1}{3}$ **(B)** $\frac{2}{3}$ **(C)** $\frac{3}{2}$ **(D)** $\frac{1}{2}$

21. A bag is gently dropped on a conveyor belt moving at a speed of 2 m/s. The coefficient of friction between the conveyor belt and bag is 0.4. initially, the bag slips on the belt before it stops due to friction. The distance travelled by the bag on the belt during slipping motion, is :

[Take : $g = 10\ m/s^{-2}$]

(A) 2*m* **(B)** 0.5 *m* **(C)** 3.2 *m* **(D)** 0.8 *ms*

22. A block of mass M slides down on a rough inclined plane with constant velocity. The angle made by the incline plane with horizontal is θ. The magnitude of the contact force will be:

(A) Mg **(B)** $Mg\cos\theta$

(C) $\sqrt{Mg\sin\theta + Mg\cos\theta}$ **(D)** $Mg\sin\theta\sqrt{1+\mu}$

23. A block '*A*' takes 2*s* to slide down a frictionless incline of 30° and length '*l*', kept inside a lift going up with uniform velocity '*v*'. If the incline is changed to 45°, the time taken by the block, to slide down the incline, will be approximately.

(A) 2.66s **(B)** 0.83s **(C)** 1.68s **(D)** 0.70s

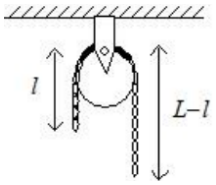
24. A balloon has mass of 10 *g* in air. The air escapes from the balloon at a uniform rate with velocity 4.5 cm/s. If the balloon shrinks in 5 *s* completely. Then, the average force acting on that balloon will be (in dyne).

(A) 3 **(B)** 9 **(C)** 12 **(D)** 18

25. A pressure-pump has a horizontal tube of cross sectional area $10 cm^2$ for the outflow of water at a speed of 20m/s. The force exerted on the vertical wall just in front of the tube which stops water horizontally flowing out of the tube, is: [Given : density of water $= 1000\ kg/m^3$]

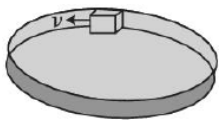
(A) 300 *N* **(B)** 500 *N* **(C)** 250 *N* **(D)** 400 *N*

26. A uniform metal chain of mass *m* and length '*L*' passes over a massless and frictionless pulley. It is released from rest with a part of its length '*l*' is hanging on one side and rest of its length '*L* – *l*' the other side of the pulley. At a certain point of time, when $l = \frac{L}{x}$, the acceleration of the chain is $\frac{g}{2}$. The value of *x* is _____.

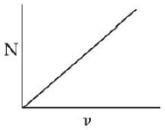


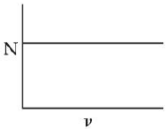
(A) 6 **(B)** 2 **(C)** 1.5 **(D)** 4

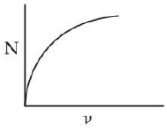
27. A smooth circular groove has a smooth vertical wall as shown in figure. A block of mass *m* moves against the wall with a speed *v*. Which of the following curve represents the correct relation between the normal reaction on the block by the wall (*N*) and speed of the block (*v*)?



(A) 

(B) 

(C) 

(D) 

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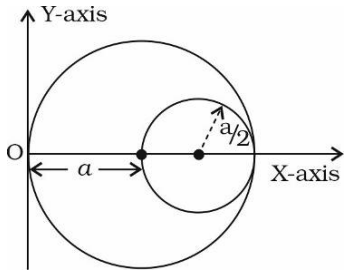
Archive - JEE Main & Advanced

Energy and Momentum	Class - XI | Physics

JEE Main 2021

1. A ball with a speed of 9 m/s collides with another identical ball at rest. After the collision, the direction of each ball makes an angle of 30° with the original direction. The ratio of velocities of the balls after collision is $x : y$, where x is_____ .

2. A circular hole of radius $\left(\frac{a}{2}\right)$ is cut out of a circular disc of radius 'a' as shown in figure. The centroid of the remaining circular portion with respect to point 'O' will be:



(A) $\frac{2}{3}a$ **(B)** $\frac{10}{11}a$ **(C)** $\frac{5}{6}a$ **(D)** $\frac{1}{6}a$

3. Two solids A and B of mass 1 kg and 2kg respectively are moving with equal linear momentum. The ratio of their kinetic energies $(K.E)_A : (K.E.)_B$ will be $\frac{A}{1}$, so the value of A will be _____.

4. The potential energy (U) of a diatomic molecule is a function dependent on r (interatomic distance) as

$$U = \frac{\alpha}{r^{10}} - \frac{\beta}{r^5} - 3$$

Where, α and β are positive constants. The equilibrium distance between two atoms will be $\left(\frac{2\alpha}{\beta}\right)^{\frac{a}{b}}$, where $a =$_____.

5. A small bob tied at one end of a thin string of length 1 m is describing a vertical circle so that the maximum and minimum tension in the string are in the ratio 5 : l. The velocity of the bob at the highest position is _____ m/s. (Take $g = 10$ m/s^2)

6. Two particles having masses 4 g and 16 g respectively are moving with equal kinetic energies. The ratio of the magnitudes of their linear momentum is n : 2. The value of n will be _____ .

7. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Body 'P' having mass M moving with speed 'u' has head-on collision elastically with another body 'Q' having mass 'm' initially at rest. If $m << M$, body 'Q' will have a maximum speed equal to '$2u$' after collision.

Reason R : During elastic collision, the momentum and kinetic energy are both conserved.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Both A and R are correct and R is the correct explanation of A.

(B) A is not correct but R is correct.

(C) A is correct but R is not correct.

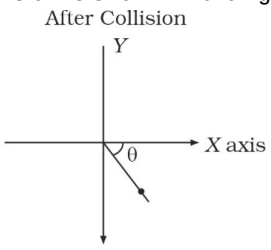
(D) Both A and R are correct but R is NOT the correct explanation of A.

8. A body is rolling a 0.5 kg ball on the frictionless floor with the speed of $20 ms^{-1}$. The ball gets deflected by an obstacle on the way. After deflection it moves with 5% of its initial kinetic energy. What is the speed of the ball now?

(A) $14.41\, ms^{-1}$ **(B)** $19.0 ms^{-1}$ **(C)** $4.47\, ms^{-1}$ **(D)** $1.00\, ms^{-1}$

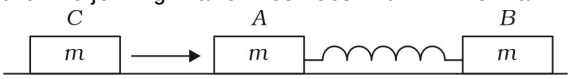
9. A ball of mass 10 kg moving with a velocity $10\sqrt{3}$ ms^{-1} along $X-$axis, hits another ball of mass 20 kg which is at rest. After collision, the first ball comes to rest and the second one disintegrates into two equal pieces. One of the pieces starts moving along Y-axis at a speed of 10 m/s. The second piece starts moving at a speed of 20 m/s at an angle θ (degree) with respect to the X-axis.

The configuration of pieces after collision is shown in the figure.



The value of θ to the nearest integer is _____ .

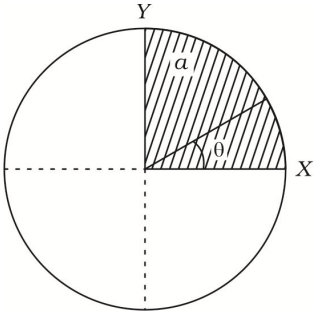
10. Two identical blocks A and B each of mass m resting on the smooth horizontal floor are connected by a light spring of natural length L and spring constant K. A third block C of mass m moving with a speed v along the line joining A and B collides with A. The maximum compression in the spring is :



(A) $v\sqrt{\frac{m}{2K}}$ **(B)** $\sqrt{\frac{mv}{K}}$ **(C)** $\sqrt{\frac{mv}{2K}}$ **(D)** $\sqrt{\frac{m}{2K}}$

11. The disc of mass M with uniform surface mass density σ is shown in the figure. The centre of mass of the quarter disc (the shaded area) is at the position $\frac{x}{3}\frac{a}{\pi}, \frac{x}{3}\frac{a}{\pi}$ where x is _____.

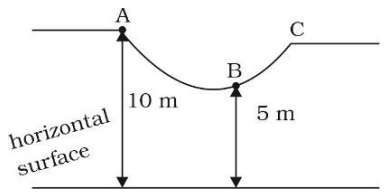
(Round off to the Nearest Integer) [a is an area as shown in the figure]



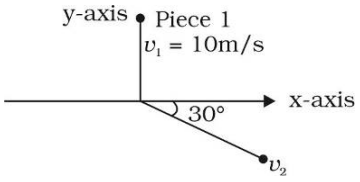
12. A constant power delivering machine has towed a box, which was initially at rest, along a horizontal straight line. The distance moved by the box in time 't' is proportional to:

(A) $t^{1/2}$ **(B)** $t^{2/3}$ **(C)** t **(D)** $t^{3/2}$

13. As shown in the figure, a particle of mass 10 kg is placed at a point A. When the particle is slightly displaced to its right, it starts moving and reaches the point B. The speed of the particle at B is x *m/s.*
(Take $g = 10\ m/s^2$)
The value of *'x'* to the nearest integer is_____ .

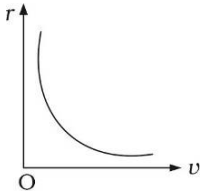


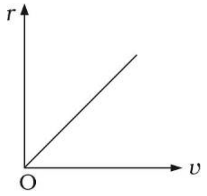
14. A ball of mass 10 *kg* moving with a velocity $10\sqrt{3}\ m/s$ along the x-axis, hits another ball of mass 20 *kg* which is at rest. After the collision, first ball comes to rest while the second ball disintegrates into two equal pieces. One piece starts moving along y-axis with a speed of 10 *m/s*. The second piece starts moving at an angle of 30° with respect to the x-axis. The velocity of the ball moving at 30° with x-axis is x *m/s*.
The configuration of pieces after collision is shown in the figure below.
The value of x to the nearest integer is _____ .

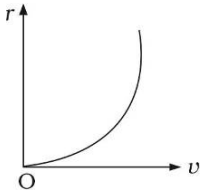


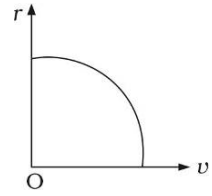
15. A bullet of mass 0.1 *kg* is fired on a wooden block to pierce through it, but it stops after moving a distance of 50 *cm* into it. If the velocity of bullet before hitting the wood is 10 *m/s* and it slows down with uniform deceleration, then the magnitude of effective retarding force on the bullet is *'x'* N.
The value of 'x' to the nearest integer is _____ .

16. A particle of mass m moves in a circular orbit under the central potential field, $U(r) = -\frac{C}{r}$, where C is a positive constant. The correct radius - velocity graph of the particle's motion is:

(A)


(B)


(C)


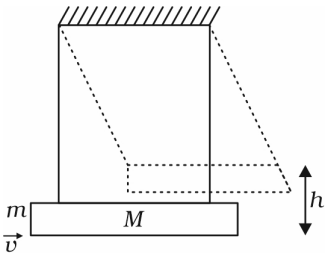
(D)


17. An object mass of m_1 collides with another object of mass m_2, which is at rest. After the collision the objects move with equal speeds in opposite direction. The ratio of the masses $m_2 : m_1$ is:

(A) 3 : 1 **(B)** 1 : 2 **(C)** 1 : 1 **(D)** 2 : 1

18. A ball of mass 4 kg, moving with a velocity of $10\ ms^{-1}$, collides with a spring of length 8 m and force constant 100 Nm^{-1}. The length of the compressed spring is x*m*. The value of x, to the nearest integer is:

19. A large block of wood of mass $M = 5.99$ kg is hanging from two long massless cords. A bullet of mass $m = 10$ g is fired into the block and gets embedded in it. The (block + bullet) then swing upwards, their centre of mass rising a vertical distance $h = 9.8$ cm before the (block + bullet) pendulum comes momentarily to rest at the end of its arc. The speed of the bullet just before collision is: (Take $g = 9.8\ ms^{-2}$)



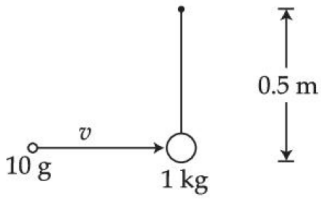
(A) 821.4 m/s **(B)** 831.4 m/s **(C)** 841.4 m/s **(D)** 811.4 m/s

20. A uniform chain of length 3 meter and mass 3 kg overhangs a smooth table with 2 meter laying on the table. If k is the kinetic energy of the chain in joule as it completely slips off the table, then the value of k is _____. (Take $g = 10\ m/s^2$)

21. Two person A and B perform same amount of work in moving a body through a certain distance d with application of forces acting at angle 45° and 60° with the direction of displacement respectively. The ratio of force applied by person A to the force applied by person B is $\frac{1}{\sqrt{x}}$. The value of x is _____.

22. A bullet of 10g, moving with velocity v, collided head-on with the stationary bob of a pendulum and recoils with velocity 100m/s. The length of the pendulum is 0.5m and mass of the bob is 1kg. The minimum value of $v =$ _____ m/s so that the pendulum describes a circle.

(Assume the string to be inextensible and $g = 10m/s^2$)



23. A body of mass M moving at speed V_0 collides elastically with a mass 'm' at rest. After the collision, the two masses move at angles θ_1 *and* θ_2 with respect to the initial direction of motion of the body of mass M. The largest possible value of the ratio M/m, for which the angles θ_1 *and* θ_2 will be equal, is:

(A) 1 **(B)** 3 **(C)** 2 **(D)** 4

24. A block moving horizontally on a smooth surface with a speed of $40ms^{-1}$ splits into two equal parts. If one of the parts moves at $60ms^{-1}$ in the same direction, then the fractional change in the kinetic energy will be $x : 4$ where $x =$ _____.

25. A block moving horizontally on a smooth surface with a speed of 40 m/s splits into two parts with masses in the ratio of I : 2. If the smaller part moves at 60 m/s in the same direction, then the fractional change in kinetic energy is :

(A) $\frac{1}{8}$ **(B)** $\frac{1}{3}$ **(C)** $\frac{2}{3}$ **(D)** $\frac{1}{4}$

26. A body of mass '*m*' dropped from a height '*h*' reaches the ground with a speed of $0.8\sqrt{gh}$. The value of work done by the air-friction is:

(A) mgh **(B)** $0.64\ mgh$ **(C)** $-0.68\ mgh$ **(D)** $1.64\ mgh$

27. An engine is attached to a wagon through a shock absorbed of length 1.5 *m*. The system with a total mass of 40, 000 kg is moving with a speed of $72\ kmh^{-1}$ when the brakes are applied to bring it to rest. In the process of the system being through to rest, the spring of the shock absorber gets compressed by 1.0 *m*. If 90% of energy of the wagon is lost due to friction, the spring constant is_____ × 105 N/*m*.

28. A 2 kg steel rod of length 0.6 m is clamped on a table vertically at its lower end and is free to rotate in vertical plane. The upper end is pushed so that the rod falls under gravity. Ignoring the friction due to clamping at its lower end, the speed of the free end of rod when it passes through its lowest position is___ms^{-1}. (Take g = 10 ms^{-2})

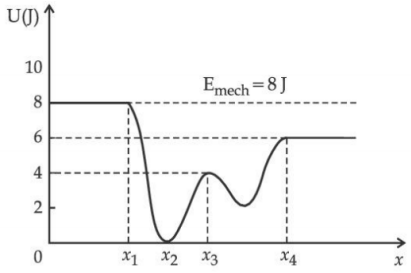
29. A pendulum bob has a speed of $3m/s$ at its lowest position. The pendulum is 50 cm long. The speed of bob, when the length makes an angle of $60°$ to the vertical will be $(g = 10m/s^2)$_____ m/s.

30. A force of $F = (5y + 20)\hat{j}\ N$ acts on a particle. The work done by this force when the particle is moved from $y = 0$ *m* to $y = 10$ *m* is _____ *J*.

31. An automobile of mass 'm' accelerates starting from origin and initially at rest, while the engine supplies constant power P. The position is given as a function of time by :

(A) $\left(\frac{9P}{8m}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$ **(B)** $\left(\frac{9m}{8P}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$ **(C)** $\left(\frac{8P}{9m}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$ **(D)** $\left(\frac{8P}{9m}\right)^{\frac{1}{2}} t^{\frac{2}{3}}$

32. Given below is the plot of a potential energy function U(x) for a system, in which a particle is in one dimensional motion, while a conservative force F(x) acts on it. Suppose that $E_{mech} = 8J$, the incorrect statement for this system is:



[where K.E. = kinetic energy]

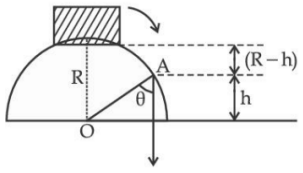
(A) At $x < x_1$, K.E. is smallest and the particle is moving at the slowest speed

(B) At $x > x_4$, K.E. is constant throughout the region

(C) At $x = x_2$, K.E. is greatest and the particle is moving at the fastest speed

(D) At $x = x_3$, K.E. = 4J

33. A small block slides down from the top of hemisphere of radius R = 3 m shown in the figure. The height 'h' at which the block will lose contact with the surface of the sphere is _____ m.
(Assume there is no friction between the block and the hemisphere)



JEE Advanced 2021

Question Stem for Question Nos. 1 and 2

Question Stem

A projectile is thrown from a point O on the ground at an angle 45° from the vertical and with a speed $5\sqrt{2}$ m/s. The projectile at the highest point of its trajectory splits into two equal parts. One part falls vertically down to the ground, 0.5 s after the splitting. The other part, t seconds after the splitting, falls to the ground at a distance x meters from the point O. The acceleration due to gravity $g = 10$ m/s^2.

1. The value of t is _____.

2. The value of x is _____.

Questions Stem for Questions Nos. 3 and 4

Question Stem

A pendulum consists of a bob of mass m = 0.1 kg and a massless inextensible string of length L = 1.0 m. It is suspended from a fixed point at height H = 0.9 m above a frictionless horizontal floor. Initially, the bob of the pendulum is lying on the floor at rest vertically below the point of suspension. A horizontal impulse P = 0.2 kg-m/s is imparted to the bob at some instant. After the bob slides for some distance, the string becomes taut and the bob lifts off the floor. The magnitude of the angular momentum of the pendulum about the point of suspension just before the bob lifts off is J kg-m^2/s. The kinetic energy of the pendulum just after the lift off is K Joules.

3. The value of J is _____.

4. The value of K is_____.

Archive - JEE Main & Advanced

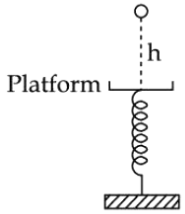
Energy and Momentum	Class - XI | Physics

JEE Main 2022

1. A particle experiences a variable force $\vec{F} = (4x\hat{i} + 3y^2\hat{j})$ in a horizontal x-y plane. Assume distance in meters and force in newton. If the particle moves from point (1, 2) to point (2, 3) in the *x*-*y* plane, then Kinetic Energy changes by :

(A) 50.0 J **(B)** 12.5 J **(C)** 25.0 J **(D)** 0 J

2. A ball of mass 100 g is dropped from a height h = 10 cm on a platform fixed at the top of a vertical spring (as shown in figure). The ball stays on the platform and the platform is depressed by a distance $\frac{h}{2}$. The spring constant is _____ Nm^{-1}. (Use g = 10 ms^{-2})



3. A stone of mass m, tied to a string is being whirled in a vertical circle with a uniform speed. The tension in the string is:

(A) The same throughout the motion

(B) Minimum at the highest position of the circular path

(C) Minimum at the lowest position of the circular path

(D) Minimum when the rope is in the horizontal position

4. Potential energy as a function of *r* is given by $U = \frac{A}{r^{10}} - \frac{B}{r^5}$, where *r* is the interatomic distance, *A* and *B* are positive constants. The equilibrium distance between the two atoms will be:

(A) $\left(\frac{A}{B}\right)^{\frac{1}{5}}$ **(B)** $\left(\frac{B}{A}\right)^{\frac{1}{5}}$ **(C)** $\left(\frac{2A}{B}\right)^{\frac{1}{5}}$ **(D)** $\left(\frac{B}{2A}\right)^{\frac{1}{5}}$

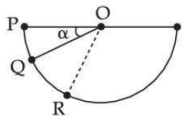
5. A 0.5 kg block moving at a speed of $12ms^{-1}$ compresses a spring through a distance 30 *cm* when its speed is halved. The spring constant of the spring will be _____ Nm^{-1}.

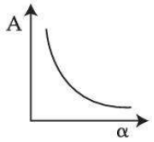
6. An object is thrown vertically upwards. At its maximum height, which of the following quantity becomes zero?

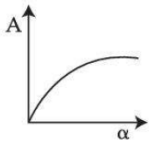
(A) Momentum **(B)** Potential energy

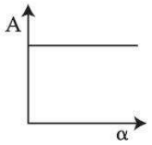
(C) Acceleration **(D)** Force

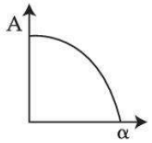
7. A ball is released from rest from point P of a smooth semi-spherical vessel as shown in figure. The ratio of the centripetal force and normal reaction on the ball at point Q is A while angular position of point Q is α with respect to point P. Which of the following graphs represent the correct relation between A and α when ball goes from Q to R?



(A) 

(B) 

(C) 

(D) 

8. Arrange the four graphs in descending order of total work done; where W_1, W_2, W_3 and W_4 are the work done corresponding to figure *a*, *b*, *c* and *d* respectively.

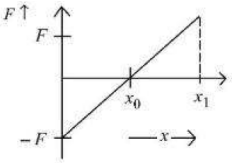
Figure-a 

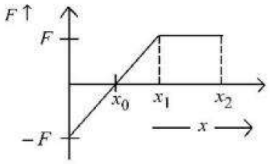
Figure-b 

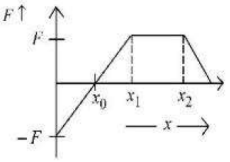
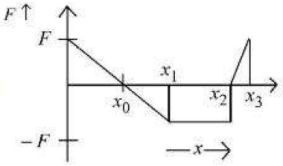
Figure-c 

Figure-d 

(A) $W_3 > W_2 > W_1 > W_4$ **(B)** $W_3 > W_2 > W_4 > W_1$

(C) $W_2 > W_3 > W_4 > W_1$ **(D)** $W_2 > W_3 > W_1 > W_4$

9. A batsmen hits back a ball of mass 0.4 *kg* straight in the direction of the bowler without changing its initial speed of $15 ms^{-1}$. The impulse imparted to the ball is _____ *Ns*.

10. Two blocks of masses 10 kg and 30 kg are placed on the same straight line with coordinates (0, 0) cm and (*x*, 0) cm respectively. The block of 10 kg is moved on the same line through a distance of 6 cm towards the other block. The distance through which the block of 30 kg must be moved to keep the position of centre of mass of the system unchanged is:

(A) 4 cm towards the 10 kg block **(B)** 2 cm away from the 10 kg block

(C) 2 cm towards the 10 kg block **(D)** 4 cm away from the 10 kg block

11. What percentage of kinetic energy of a moving particle is transferred to a stationary particle when it strikes the stationary particle of 5 times its mass?
(Assumes the collision to be head-on elastic collision)

(A) 50.0 % **(B)** 66.6 % **(C)** 55.6 % **(D)** 33.3 %

12. A pendulum of length 2 m consists of a wooden bob of mass 50 g. A bullet of mass 75 g is fired towards the stationary bob with a speed *v*. The bullet emerges out of the bob with a speed $\frac{v}{3}$ and the bob just completes the vertical circle. The value of *v* is _____ ms^{-1}. (if $g = 10 m/s^2$).

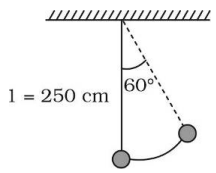
13. A stone tide to a string of length *L* is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at its lowest position and has a speed *u*. The magnitude of change in its velocity, as it reaches a position where the string is horizontal, is $\sqrt{x(u^2 - gL)}$. The value of *x* is:

(A) 3 **(B)** 2 **(C)** 1 **(D)** 5

14. A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration (a) is varying with time t as $a = k^2rt^2$, where k is a constant. The power delivered to the particle by the force acting on it is given as:

(A) zero **(B)** $mk^2r^2t^2$ **(C)** mk^2r^2t **(D)** mk^2rt

15. A pendulum is suspended by a string of length 250 cm. The mass of the bob of the pendulum is 200 g. The bob is pulled aside until the string is at 60° with Vertical as shown in the figure. After releasing the bob, the maximum velocity attained by the bob will be _____ ms^{-1}. (if $g = 10\ m/s^2$)



16. A man of 60 kg is running on the road and suddenly jumps into a stationary trolly car of mass 120 kg. Then, the trolly car starts moving with velocity $2ms^{-1}$. The velocity of the running man was _____ ms^{-1}, when he jumps into the car.

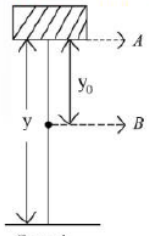
17. A body of mass M at rest explodes into three pieces, in the ratio of masses 1:1:2. Two smaller pieces fly off perpendicular to each other with velocities of 30 ms^{-1} and 40 ms^{-1} respectively. The velocity of the third piece will be:

(A) $15ms^{-1}$ **(B)** $25ms^{-1}$ **(C)** $35ms^{-1}$ **(D)** $50ms^{-1}$

18. A particle of mass 500 gm is moving in a straight line with velocity $v = bx^{5/2}$. The work done by the net force during its displacement from $x = 0$ to $x = 4m$ is: (Take $b = 0.25m^{-3/2}s^{-1}$)

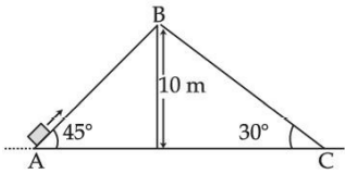
(A) 2 J **(B)** 4 J **(C)** 8 J **(D)** 16 J

19. In the given figure, the block of mass m is dropped from the point 'A'. The expression for kinetic energy of block when it reaches point 'B' is:



(A) $\frac{1}{2}mg\,y_0^2$ **(B)** $\frac{1}{2}mg\,y^2$ **(C)** $mg(y - y_0)$ **(D)** mgy_0

20. Two inclined planes are placed as shown in figure. A block is projected from the point A of inclined plane AB along its surface with a velocity just sufficient to carry it to the top point B at a height 10 m. After reaching the Point B the block slides down on inclined plane BC. Time it takes to reach to the point C from point A is $t(\sqrt{2}+1)s$. The value of t is _____. (Use : $g = 10\ m/s^2$)



21. A body of mass 0.5 kg travels on straight line path with velocity $v = (3x^2 + 4)\ m/s$. The net work done by the force during its displacement from $x = 0$ to $x = 2m$ is :

(A) 64 J **(B)** 60 J **(C)** 120 J **(D)** 128 J

22. A bag of sand of mass 9.8 kg is suspended by a rope. A bullet of 200 g travelling with speed 10 ms^{-1} gets embedded in it, then loss of kinetic energy will be:

(A) 4.9 J **(B)** 9.8 J **(C)** 14.7 J **(D)** 19.6 J

23. The identical spheres each of mass M are placed at the corners of a right angled triangle with mutually perpendicular sides equal to 3 m each. Taking point of intersection of mutually perpendicular sides as origin, the magnitude of position vector of centre of mass of the system will be $\sqrt{x}$ m. The value of the *x* is:

24. As per the given figure, two blocks each of mass 250g are connected to a spring of spring constant $2Nm^{-1}$. If both are given velocity *v* in opposite directions, then maximum elongation of the spring is:

(A) $\frac{v}{2\sqrt{2}}$ **(B)** $\frac{v}{2}$ **(C)** $\frac{v}{4}$ **(D)** $\frac{v}{\sqrt{2}}$

25. A body of mass 8 kg and another of mass 2 kg are moving with equal kinetic energy. The ratio of their respectively momenta will be:

(A) 1 : 1 **(B)** 2 : 1 **(C)** 1 : 4 **(D)** 4 : 1

26. Sand is being dropped from a stationary dropper at a rate of 0.5 kgs^{-1} on a conveyor belt moving with a velocity of 5 ms^{-1}. The power needed to keep the belt moving with the same velocity will be:

(A) 1.25 *W* **(B)** 2.5 *W* **(C)** 6.25 *W* **(D)** 12.5 *W*

27. In two different experiments, an object of mass 5 kg moving with a speed of 25 ms^{-1} hits two different walls and comes to rest within (i) 3 second, (ii) 5 seconds, respectively.
Choose the correct option out of the following:

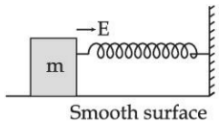
(A) Impulse and average force acting on the object will be same for both the cases.

(B) Impulse will be same for both the cases but the average force will be different.

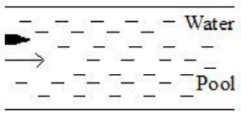
(C) Average force will be same for both the case but the impulse will be different.

(D) Average force and impulse will be different for both the cases

28. A block of mass '*m*' (as shown in figure) moving with kinetic energy *E* compresses a spring through a distance 25 cm when, its speed is halved. The value of spring constant of used spring will be $nE\ Nm^{-1}$ for $n =$ _____.



29. A bullet of mass 200 g having initial kinetic energy 90 J is shot inside a long swimming pool as shown in the figure. If it's kinetic energy reduces to 40 J within 1s, the minimum length of the pool, the bullet has to travel so that it completely comes to rest is:



(A) 45 m **(B)** 90 m **(C)** 125 m **(D)** 25 m

30. The distance of centre of mass from end *A* of a one dimensional rod (*AB*) having mass density $\rho=\rho_0\left(1-\frac{x^2}{L^2}\right)$ kg/m and length *L* (in meter) is $\frac{3L}{\alpha}m$. The value of α is _____. (Where *x* is the distance from end *A*)

31. Two bodies of mass 1 kg and 3 kg have position vectors $\hat{i}+2\hat{j}+\hat{k}$ and $-3\hat{i}-2\hat{j}+\hat{k}$ respectively. The magnitude of position vector of centre of mass of this system will be similar to the magnitude of vector:

(A) $\hat{i}+2\hat{j}+\hat{k}$ **(B)** $-3\hat{i}-2\hat{j}+\hat{k}$ **(C)** $-2\hat{i}+2\hat{k}$ **(D)** $-2\hat{i}-\hat{j}+2\hat{k}$

32. If momentum of a body is increased by 20%, then its kinetic energy increases by :

(A) 36% **(B)** 40% **(C)** 44% **(D)** 48%

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Rotational Motion	Class - XI | Physics

JEE Main 2021

1. Moment of inertia (M.I.) of four bodies, having same mass and radius, are reported as;

I_1 = M.I. of thin circular ring about its diameter,

I_2 = M.I. of circular disc about an axis perpendicular to disc and going through the centre,

I_3 = M.I. of solid cylinder about its axis and

I_4 = M.I. of solid sphere about its diameter

(A) $I_1 = I_2 = I_3 > I_4$ **(B)** $I_1 = I_2 = I_3 < I_4$

(C) $I_1 + I_2 = I_3 + \frac{5}{2} I_4$ **(D)** $I_1 + I_3 < I_2 + I_4$

2. A uniform thin bar of mass 6kg and length 2.4 meter is bent to make an equilateral hexagon. The moment of inertia about an axis passing through the centre of mass and perpendicular to the plane of hexagon is _____ $\times 10^{-1} kgm^2$

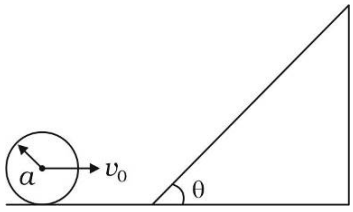
3. Four identical solid spheres each of mass 'm' and radius 'a' are placed with their centres on the four corners of a square of side 'b'. The moment of inertia of the system about one side of square where the axis of rotation is parallel to the plane of the square is :

(A) $\frac{4}{5}ma^2$ **(B)** $\frac{4}{5}ma^2 + 2mb^2$ **(C)** $\frac{8}{5}ma^2 + mb^2$ **(D)** $\frac{8}{5}ma^2 + 2mb^2$

4. A cord is wound round the circumference of wheel of radius r. The axis of the wheel is horizontal and the moment of inertia about it is I. A weight mg is attached to the cord at the end. The weight falls from rest. After falling through a distance `h', the square of angular velocity of wheel will be :

(A) $\frac{2mgh}{I + mr^2}$ **(B)** $\frac{2gh}{I + mr^2}$ **(C)** $\frac{2mgh}{I + 2mr^2}$ **(D)** $2gh$

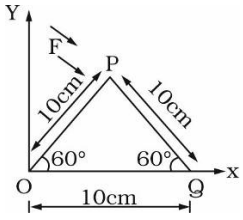
5. A sphere of radius 'a' and mass 'm' rolls along a horizontal plane with constant speed v_0. It encounters an inclined plane at angle θ and climbs upward. Assuming that it rolls without slipping, how far up the sphere will travel?



(A) $\frac{v_0^2}{5g\sin\theta}$ **(B)** $\frac{v_0^2}{2g\sin\theta}$

(C) $\frac{10v_0^2}{7g\sin\theta}$ **(D)** $\frac{2}{5}\frac{v_0^2}{g\sin\theta}$

6. A triangular plate is shown. A force $\vec{F} = 4\hat{i} - 3\hat{j}$ is applied at point P. The torque at point P with respect to point 'O' and 'Q' are :



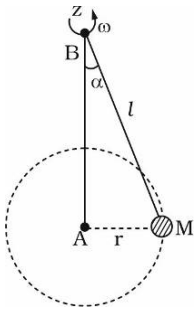
(A) $15 - 20\sqrt{3}, 15 + 20\sqrt{3}$

(B) $-15 + 20\sqrt{3}, 15 + 20\sqrt{3}$

(C) $-15 - 20\sqrt{3}, 15 - 20\sqrt{3}$

(D) $15 + 20\sqrt{3}, 15 - 20\sqrt{3}$

7. A mass M hangs on a massless rod of length ℓ which rotates at a constant angular frequency. The mass M moves with steady speed in a circular path of constant radius. Assume that the system is in steady circular motion with constant angular velocity ω . The angular momentum of M about point A is L_A which lies in the positive z direction and the angular momentum of M about point B is L_B . The correct statement for this system is :



(A) L_A and L_B are both constant in magnitude and direction

(B) L_B is constant in direction with varying magnitude

(C) L_B is constant, both in magnitude and direction

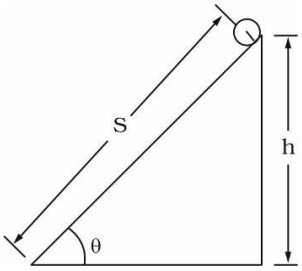
(D) L_A is constant, both in magnitude and direction

8. The following bodies,

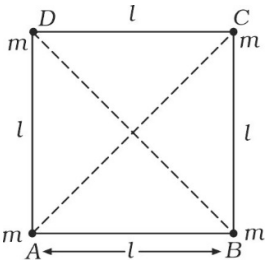
(A) a ring (B) a disc (C) a solid cylinder (D) a solid sphere

of same mass 'm' and radius 'R' are allowed to roll down without slipping simultaneously from the top of the inclined plane. The body which will reach first at the bottom of inclined plane is _____.

[Mark the body as per their respective numbering given in the question]



9. Four equal masses, m each are placed at the corners of a square of length (l) as shown in the figure. The moment of inertia of the system about an axis passing through A and parallel to DB would be :



(A) $3\,ml^2$ **(B)** $\sqrt{3}\,ml^2$

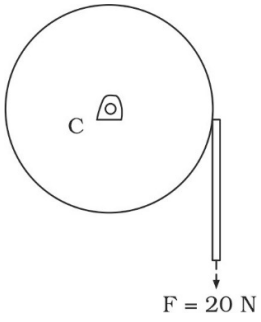
(C) $2\,ml^2$ **(D)** ml^2

10. Consider a 20 kg uniform circular disk of radius 0.2 m. It is pin supported at its center and is at rest initially. The disk is acted upon by a constant force $F = 20\ \text{N}$ through a massless string wrapped around its periphery as shown in the figure.

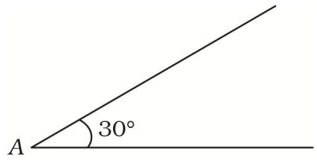
Suppose the disk makes n number of revolutions to attain an angular speed of $50\ \text{rad s}^{-1}$.

The value of n, to the nearest integer, is _____.

[Given : In one complete revolution, the disk rotates by 6.28 rad]



11. A sphere of mass $2kg$ and radius $0.5m$ is rolling with an initial speed of $1ms^{-1}$ goes up an inclined plane which makes an angle of 30° with the horizontal plane, without slipping. How long will the sphere take to return to the starting point A ?



(A) $0.52s$ **(B)** $0.60s$ **(C)** $0.80s$ **(D)** $0.57s$

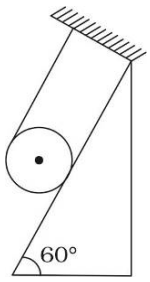
12. A thin circular ring of mass M and radius r is rotating about its axis with an angular speed ω. Two particles having mass m each are now attached at diametrically opposite points. The angular speed of the ring will become:

(A) $\omega\dfrac{M-2m}{M+2m}$ **(B)** $\omega\dfrac{M}{M+m}$ **(C)** $\omega\dfrac{M+2m}{M}$ **(D)** $\omega\dfrac{M}{M+2m}$

13. Consider a uniform wire of mass M and length L. It is bent into a semicircle. Its moment of inertia about a line perpendicular to the plane of the wire passing through the centre is:

(A) $\dfrac{ML^2}{\pi^2}$ **(B)** $\dfrac{1}{2}\dfrac{ML^2}{\pi^2}$ **(C)** $\dfrac{1}{4}\dfrac{ML^2}{\pi^2}$ **(D)** $\dfrac{2}{5}\dfrac{ML^2}{\pi^2}$

14. A solid cylinder of mass m is wrapped with an inextensible light string and, is placed on a rough inclined plane as shown in the figure. The frictional force acting between the cylinder and the inclined plane is:



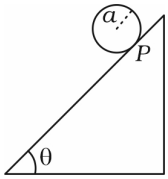
[The coefficient of static friction, μ_S, is 0.4]

(A) $\dfrac{7}{2}mg$ **(B)** $5\,mg$ **(C)** $\dfrac{mg}{5}$ **(D)** 0

15. A solid disc of radius 'a' and mass 'm' rolls down without slipping on an inclined plane making an angle θ with the horizontal. The acceleration of the disc will be $\dfrac{2}{b}g\sin\theta$ where b is _____ .

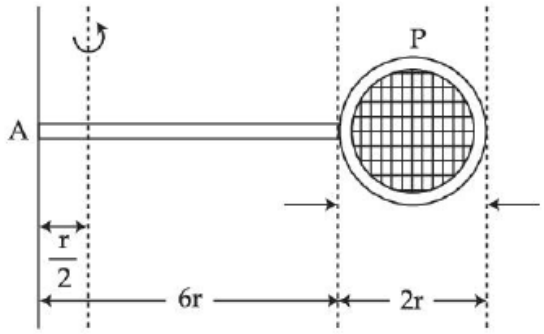
(Round off to the Nearest Integer)

(g = acceleration due to gravity $\theta =$ angle as shown in figure)



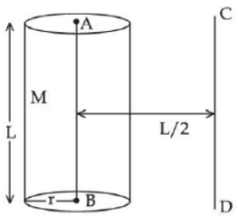
16. A force $\vec{F} = 4\hat{i} + 3\hat{j} + 4\hat{k}$ is applied on a intersection point of $x = 2$ plane and x-axis. The magnitude of torque of this force about a point (2, 3, 4) is _____. (Round off to the Nearest Integer)

17. Consider a badminton racket with length scales as shown in the figure.



If the mass of the linear and circular portions of the badminton racket are same (M) and the mass of the threads are negligible, the moment of inertia of the racket about an axis perpendicular to the handle and in the plane of the ring at, $\frac{r}{2}$ distance from the end A of the handle will be _____ Mr^2.

18. The solid cylinder of length 80 cm and mass M has a radius of 20 cm. Calculate the density of the material used if the moment of inertia of the cylinder about an axis CD parallel to AB as shown in figure is 2.7 kg m^2.



(A) 7.5×10^1 kg/m^3 **(B)** 1.49×10^2 kg/m^3

(C) 7.5×10^2 kg/m^3 **(D)** 14.9 kg/m^3

19. Moment of inertia of a square plate of side l about the axis passing through one of the corner and perpendicular to the plane of square plate is given by:

(A) $\frac{Ml^2}{6}$ **(B)** $\frac{2}{3}Ml^2$ **(C)** Ml^2 **(D)** $\frac{Ml^2}{12}$

20. Two discs have moment of intertia I_1 and I_2 about their respective axes perpendicular to the plane and passing through the centre. They are rotating with angular speeds, ω_1 and ω_2 respectively and are brought into contact face to face with their axes of rotation coaxial. The loss in kinetic energy of the system in the process is given by :

(A) $\frac{I_1I_2}{(I_1+I_2)}(\omega_1-\omega_2)^2$ **(B)** $\frac{(\omega_1-\omega_2)^2}{2(I_1+I_2)}$

(C) $\frac{I_1I_2}{2(I_1+I_2)}(\omega_1-\omega_2)^2$ **(D)** $\frac{(I_1-I_2)^2\omega_1\omega_2}{2(I_1+I_2)}$

21. Angular momentum of a single particle moving with constant speed along circular path:

(A) remains same in magnitude and direction

(B) changes is magnitude but remains same in the direction

(C) is zero

(D) remains same in magnitude but changes in the direction

22. A system consists of two identical spheres each of mass 1.5 kg and radius 50 cm at the ends of a light rod. The distance between the centres of the two spheres is 5 m. What will be the moment of inertia of the system about an axis perpendicular to the rod passing through its midpoint ?

(A) $1.875\times10^5 kgm^2$ **(B)** $18.75 kgm^2$

(C) $1.905\times10^5 kgm^2$ **(D)** $19.05 kgm^2$

23. A body rolls down an inclined plane without slipping. The kinetic energy of rotation is 50% of its translational kinetic energy. The body is:

(A) Solid sphere **(B)** Ring **(C)** Solid cylinder **(D)** Hollow cylinder

24. A solid disc of radius 20 cm and mass 10 kg is rotating with an angular velocity of 600 rpm, about an axis normal to its circular plane and passing through its centre of mass. The retarding torque required to bring the disc at rest in 10 s is _____ $\pi \times 10^{-1} Nm$.

25. Consider a situation in which a ring, a solid cylinder and a solid sphere roll down on the same inclined plane without slipping. Assume that they start rolling from rest and having identical diameter.
The correct statement for this situation is:

(A) The cylinder has the greatest and the sphere has the least velocity of the centre of mass at the bottom of the inclined plane

(B) The sphere has the greatest and the ring has the least velocity of the centre of mass at the bottom of the inclined plane

(C) All of them will have same velocity

(D) The ring has the greatest and the cylinder has the least velocity of the centre of mass at the bottom of the inclined plane

26. The centre of a wheel rolling on a plane surface moves with a speed v_0. A particle on the rim of the wheel at the same level as the centre will be moving at a speed $\sqrt{x}\, v_0$. Then the value of *x* is _____.

27. A rod of mass *M* and length *L* is lying on a horizontal frictionless surface. A particle of mass 'm' travelling along the surface hits at one end of the rod with a velocity 'u' in a direction perpendicular to the rod. The collision is completely elastic. After collision, particle comes to rest. The ratio of masses $\left(\frac{m}{M}\right)$ is $\frac{1}{x}$. The value of '*x*' will be_____.

28. Two bodies, a ring and a solid cylinder of same material are rolling down without slipping an inclined plane. The radii of the bodies are same. The ratio of velocity of the centre of mass at the bottom of the inclined plane of the ring to that of the cylinder is $\frac{\sqrt{x}}{2}$. Then, the value of *x* is _____.

29. Given below are two statements: one is labelled as **Assertion** A and the other is labelled as **Reason R.**

Assertion A: Moment of inertia of a circular disc of mass 'M' and radius 'R' about X, Y axes (passing through its plane) and Z-axis which is perpendicular to its plane were found to be I_x, I_y & I_Z respectively. The respective radii of gyration about all the three axes will be the same.

Reason R: A rigid body making rotational motion has fixed mass and shape. In the light of the above statements, choose the most appropriate answer from the options given below :

(A) Both A and R are correct and R is the correct explanation of A

(B) Both A and R are correct but R is NOT the correct explanation of A

(C) A is correct but R is not correct

(D) A is not correct but R is correct

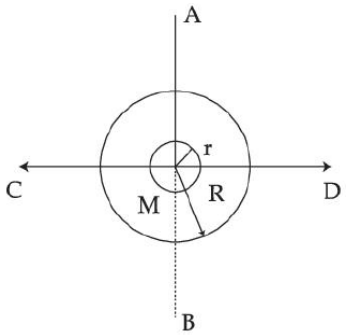
30. A particle of mass '*m*' is moving in time '*t*' on a trajectory given by

$\vec{r} = 10\alpha t^2 \hat{i} + 5\beta(t-5)\hat{j}$

Where α and β are dimensional constants.

The angular momentum of the particle becomes the same as it was for $t = 0$ at time $t =$ _____ seconds.

31. The figure shows two solid discs with radius *R* and *r* respectively. If mass per unit area is same for the both, what is the ratio of *MI* of bigger disc around *AB* (which is $\perp$ to the plane of the disc and passing through its centre) to *MI* of smaller disc around one of its diameters lying on its plane ? Given '*M*' is the mass of the larger disc. (*MI* stands for moment of inertia)



(A) $2R^4 : r^4$ **(B)** $R^2 : r^2$ **(C)** $2R^2 : r^2$ **(D)** $2r^4 : R^4$

32.

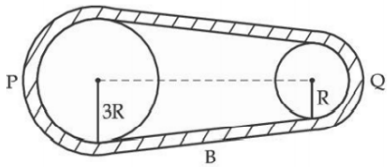
List-I		List-II	
(a)	*MI* of the rod (length L. Mass M, about an axis $\perp$ to the rod passing through the midpoint)	**(i)**	$8ML^2 / 3$
(b)	*MI* of the rod (length L. Mass 2M, about an axis $\perp$ to the rod passing through one of its end)	**(ii)**	$ML^2 / 3$
(c)	*MI* of the rod (length 2L. Mass M, about an axis $\perp$ to the rod passing through its midpoint)	**(iii)**	$ML^2 / 12$
(d)	*MI* of the rod (length 2L. Mass 2M, about an axis $\perp$ to the rod passing through one of its end)	**(iv)**	$2ML^2 / 3$

Choose the correct answer from the options given below :

(A) (a)-(iii), (b)-(iv), (c)-(ii), (d)-(i) **(B)** (a)-(ii), (b)-(iii), (c)-(i), (d)-(iv)

(C) (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii) **(D)** (a)-(ii), (b)-(i), (c)-(iii), (d)-(iv)

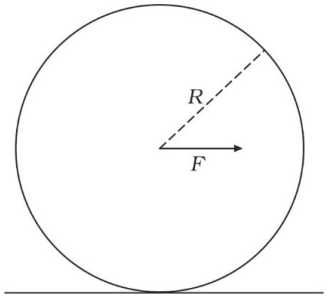
33. In the given figure, two wheels P and Q are connected by a belt B. The radius of P is three times as that of Q. In case of same rotational kinetic energy, the ratio of rotational inertias $\left(\frac{I_1}{I_2}\right)$ will be x : 1. The value of x will be_____.



34. A circular disc reaches from top to bottom of an inclined plane of length 'L'. When it slips down the plane, it takes time 't_1'. When it rolls down the plane, it takes time t_2. The value of $\frac{t_2}{t_1}$ is $\sqrt{\frac{3}{x}}$. The value of x will be _____.

JEE Advanced 2021

1. A horizontal force F is applied at the center of mass of a cylindrical object of mass m and radius R, perpendicular to its axis as shown in the figure. The coefficient of friction between the object and the ground is μ. The center of mass of the object has an acceleration a. The acceleration due to gravity is g. Given that the object rolls without slipping, which of the following statement(s) is(are) correct?



(A) For the same F, the value of a does not depend on whether the cylinder is solid or hollow

(B) For a solid cylinder, the maximum possible value of a is $2\mu g$

(C) The magnitude of the frictional force on the object due to the ground is always μmg

(D) For a thin-walled hollow cylinder, $a = \dfrac{F}{2m}$

2. A particle of mass $M = 0.2$ kg is initially at rest in the xy-plane at a point $(x = -l, y = -h)$, where $l = 10$ m and $h = 1$ m. The particle is accelerated at time $t = 0$ with a constant acceleration $a = 10$ m/s^2 along the positive x-direction. Its angular momentum and torque with respect to the origin, in SI units, are represented by $\vec{L}$-and $\vec{\tau}$-, respectively. $\hat{i}$, $\hat{j}$ and $\hat{k}$ are unit vectors along the positive x, y and z-directions, respectively. If $\hat{k} = \hat{i} \times \hat{j}$ then which of the following statement(s) is(are) correct?

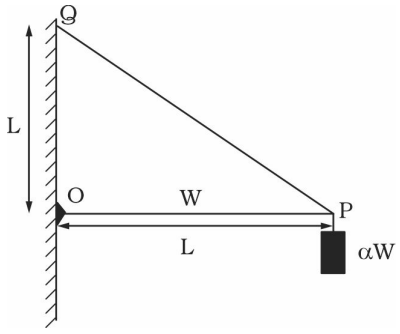
(A) The particle arrives at the point $(x = l, y = -h)$ at time $t = 2s$

(B) $\vec{\tau} = 2\hat{k}$ when the particle passes through the point $(x = l, y = -h)$

(C) $\vec{L} = 4\hat{k}$ when the particle passes through the point $(x = l, y = -h)$

(D) $\vec{\tau} = \hat{k}$ when the particle passes through the point $(x = 0, y = -h)$

3. One end of a horizontal uniform beam of weight W and length L is hinged on a vertical wall at point O and its other end is supported by a light inextensible rope. The other end of the rope is fixed at point Q, at a height L above the hinge at pint O. A block of weight αW is attached at the point P of the beam, as shown in the figure (not to scale). The rope can sustain a maximum tension of $(2\sqrt{2})W$. Which of the following statement(s) is (are correct?



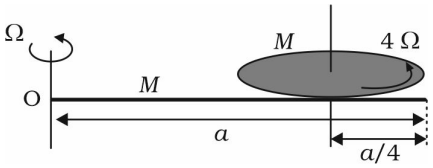
(A) The vertical component of reaction force at O does not depend on α

(B) The horizontal component of reaction force at O is equal to W for $\alpha = 0.5$

(C) The tension in the rope is $2W$ for $\alpha = 0.5$

(D) The rope breaks if $\alpha > 1.5$

4. A thin rod of mass M and length a is free to rotate in horizontal plane about a fixed vertical axis passing through point O. A thin circular disc of mass M and of radius $a/4$ is pivoted on this rod with its center at a distance $a/4$ from the free end so that it can rotate freely about its vertical axis, as shown in the figure. Assume that both the rod and the disc have uniform density and they remain horizontal during the motion. An outside stationary observer finds the rod rotating with an angular velocity Ω and the disc rotating about its vertical axis with angular velocity 4Ω. The total angular momentum of the system about the point O is $\left(\frac{Ma^2\Omega}{48}\right)n$. The value of n is _____.



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Archive - JEE Main & Advanced

Rotational Motion	Class - XI | Physics

JEE Main 2022

1. A metre scale is balanced on a knife edge at its centre. When two coins, each of mass 10 g are put one on the top of the other at the 10.0 cm mark the scale is found to be balanced at 40.0 cm mark. The mass of the metre scale is found to be $x \times 10^{-2} kg$. The value of x is _____.

2. Moment of Inertia (M.I.) of four bodies having same mass 'M' and radius '$2R$' are as follows :

I_1 = M.I. of solid sphere about its diameter

I_2 = M.I. of solid cylinder about its axis

I_3 = M.I. of solid circular disc about its diameter

I_4 = M.I. of thin circular ring about its diameter

If $2(I_2 + I_3) + I_4 = x \cdot I_1$ then the value of x will be _____.

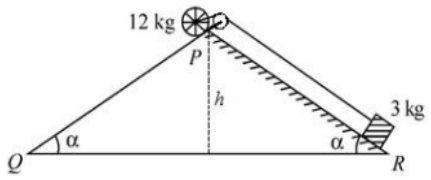
3. A thin circular ring of mass M and radius R is rotating with a constant angular velocity 2 $rads^{-1}$ in a horizontal plane about an axis vertical to its plane and passing through the center of the ring. If two objects each of mass m be attached gently to the opposite ends of a diameter of ring, the ring will then rotate with an angular velocity (in rads^{-1}).

(A) $\frac{M}{(M+m)}$ **(B)** $\frac{(M+2m)}{2M}$ **(C)** $\frac{2M}{(M+2m)}$ **(D)** $\frac{2(M+2m)}{M}$

4. A solid spherical ball is rolling on a frictionless horizontal plane surface about its axis of symmetry. The ratio of rotational kinetic energy of the ball to its total kinetic energy is:

(A) $\frac{2}{5}$ **(B)** $\frac{2}{7}$ **(C)** $\frac{1}{5}$ **(D)** $\frac{7}{10}$

5. A rolling wheel of 12 kg is on an inclined plane at position P and connected to a mass of 3 kg through a string of fixed length and pulley as shown in figure. Consider PR as friction free surface. The velocity of centre of a mass of the wheel when it reaches at the bottom Q of the inclined plane PQ will be $\frac{1}{2}\sqrt{xgh}\ m/s$. The value of x is _____.



6. Match List-I with List-II

List-I		List-II	
A	Moment of inertia of solid sphere of radius R about any tangent.	**I**	$\frac{5}{3}MR^2$
B	Moment of inertia of hollow sphere of radius (R) about any tangent.	**II**	$\frac{7}{5}MR^2$
C	Moment of inertia of circular ring of radius (R) about it diameter	**III**	$\frac{1}{4}MR^2$
D	Moment of inertia of circular disc of radius (R) about any diameter	**IV**	$\frac{1}{2}MR^2$

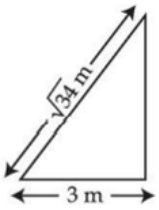
Choose the correct answer from the options given below:

(A) A-II, B-I, C-IV, D-III **(B)** A-I, B-II, C-IV, D-III

(C) A-II, B-I, C-III, D-IV **(D)** A-I, B-II, C-III, D-IV

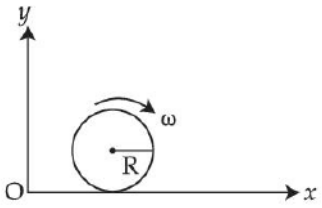
7. The position vector of 1 kg object is $\vec{r} = \left(3\hat{i} - \hat{j}\right)m$ and its velocity $\vec{v} = (3\hat{j} + \hat{k})$ ms^{-1}. The magnitude of its angular momentum is $\sqrt{x}$ Nm where x is _____.

8. A $\sqrt{34}\ m$ long ladder weighing $10\,kg$ leans on a frictionless wall. Its feet rest on the floor 3 m away form the wall as shown in the figure. If F_f and F_w are the reaction forces of the floor and the wall, then ratio of F_w / F_f will be: (Use $g = 10\ m/s^2$.)



(A) $\frac{6}{\sqrt{110}}$ **(B)** $\frac{3}{\sqrt{113}}$ **(C)** $\frac{3}{\sqrt{109}}$ **(D)** $\frac{2}{\sqrt{109}}$

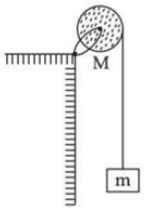
9. A spherical shell of 1 kg mass and radius R is rolling with angular speed ω on horizontal plane (as shown in figure). The magnitude of angular momentum of the shell about the origin O is $\frac{a}{3}R^2\omega$. The value of a will be:



(A) 2 **(B)** 3 **(C)** 5 **(D)** 4

10. The moment of inertia of a uniform thin rod about a perpendicular axis passing through one end is I_1. The same rod is bent into a ring and its moment of inertia about a diameter is I_2. If I_1/I_2 is $x\pi^2/3$, then the value of x will be _____.

11. A uniform disc with mass $M = 4\,kg$ and radius $R = 10\,cm$ is mounted on a fixed horizontal axle as shown in figure. A block with mass $m = 2\,kg$ hangs from a massless cord that is wrapped around the rim of the disc. During the fall of the block, the cord does not slip and there is no friction at the axle. The tension in the cord is _____ N. (Take $g = 10\,ms^{-2}$)



12. A solid cylinder and a solid sphere, having same mass M and radius R, roll down the same inclined plane from top without slipping. They start from rest. The ratio of velocity of the solid cylinder to that of the solid sphere, with which they reach the ground, will be :

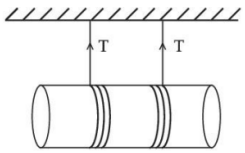
(A) $\sqrt{\frac{5}{3}}$ **(B)** $\sqrt{\frac{4}{5}}$ **(C)** $\sqrt{\frac{3}{5}}$ **(D)** $\sqrt{\frac{14}{15}}$

13. A disc of mass 1 kg and radius R is free to rotate about a horizontal axis passing through its centre and perpendicular to the plane of disc. A body of same mass as that of disc is fixed at the highest point of the disc. Now the system is released, when the body comes to the lowest position, its angular speed will be $4\sqrt{\frac{x}{3R}}$ rad s^{-1} where x = _____. (g = 10 ms^{-2})

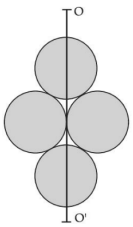
14. The radius of gyration of a cylindrical rod about an axis of rotation perpendicular to its length and passing through the center will be _____*m*. (Given, the length of the rod is $10\sqrt{3}$ m).

15. A pulley of radius 1.5 *m* is rotated about its axis by a force $F = (12t - 3t^2)N$ applied tangentially (while *t* is measured in seconds). If moment of inertia of the pulley about its axis of rotation is 4.5 kg m^2, the number of rotations made by the pulley before its direction of motion is reversed, will be K/π. The value of *K* is _____.

16. A solid cylinder length is suspended symmetrically through two massless strings, as shown in the figure. The distance from the initial rest position, the cylinder should be unbinding the strings to achieve a speed of 4 ms^{-1}, is _____ cm. (Take $g = 10\,ms^{-2}$).



17. Four identical discs each of mass '*M*' and diameter '*a*' are arranged in a small plane as shown in figure. If the moment of inertia of the system about *OO*' is $\frac{x}{4}Ma^2$. Then, the value of *x* will be ____.



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Gravitation	Class - XI | Physics

JEE Main 2021

1. Four identical particles of equal masses 1 kg made to move along the circumference of a circle of radius 1m under the action of their own mutual gravitational attraction. The speed of each particle will be:

(A) $\sqrt{G(1+2\sqrt{2})}$ **(B)** $\frac{\sqrt{(1+2\sqrt{2})G}}{2}$ **(C)** $\sqrt{\frac{G}{2}(1+2\sqrt{2})}$ **(D)** $\sqrt{\frac{G}{2}(2\sqrt{2}-1)}$

2. Two stars of masses m and $2m$ at a distance d rotate about their common centre of mass in free space. The period of revolution is:

(A) $\frac{1}{2\pi}\sqrt{\frac{d^3}{3Gm}}$ **(B)** $2\pi\sqrt{\frac{3Gm}{d^3}}$ **(C)** $2\pi\sqrt{\frac{d^3}{3Gm}}$ **(D)** $\frac{1}{2\pi}\sqrt{\frac{3Gm}{d^3}}$

3. Consider two satellites S_1 and S_2 with periods of revolution 1 hr. and 8 hr. respectively revolving around a planet in circular orbits. The ratio of angular velocity of satellite S_1 to the angular velocity of satellite S_2 is:

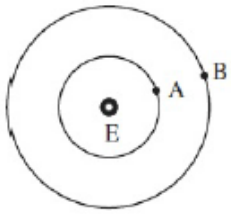
(A) 2 : 1 **(B)** 1 : 4 **(C)** 1 : 8 **(D)** 8 : 1

4. A body weighs 49 N on a spring balance at the north pole. What will be its weight recorded on the same weighing machine, if it is shifted to the equator?

[Use $g=\frac{GM}{R^2}=9.8ms^{-2}$ and radius of earth, R = 6400 km]

(A) 49.17 N **(B)** 49 N **(C)** 48.83 N **(D)** 49.83 N

5. Two satellites A and B of masses 200 kg and 400 kg are revolving round the earth at height of 600 km and 1600 km respectively. If T_A and T_B are the time periods of A and B respectively then the value of $T_B - T_A$:



[Given: radius of earth = 6400 km, mass of earth $=6.\times10^{24}kg$]

(A) $4.24\times10^2\ s$ **(B)** $4.24\times10^3\ s$

(C) $3.33\times10^2\ s$ **(D)** $1.33\times10^3\ s$

6. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.
Assertion A : The escape velocities of planet A and B are same. But A and B are of unequal mass.
Reason R : The product of their mass and radius must be same. $M_1R_1 = M_2R_2$

In the light of the above statements, choose the most appropriate answer from the options given below:

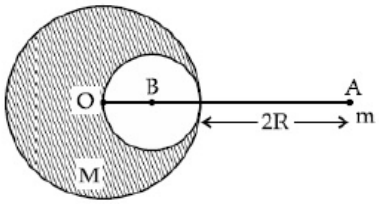
(A) A is correct but R is not correct

(B) Both A and R are correct and R is the correct explanation of A

(C) Both A and R arc correct but R is NOT the correct explanation of A

(D) A is not correct but R is correct

7. A solid sphere of radius R gravitationally attracts a particle placed at 3R from its centre with a force F_1. Now a spherical cavity of radius $\left(\frac{R}{2}\right)$ is made in the sphere (as shown in figure) and the force becomes F_2. The value of $F_1 : F_2$ is:



(A) 41 : 50 **(B)** 50 : 41 **(C)** 25 : 36 **(D)** 36 : 25

8. The initial velocity v_i required to project a body vertically upward from the surface of the earth to reach a height of 10*R*, where *R* is the radius of the earth, may be described in terms of escape velocity v_e such that $v_i = \sqrt{\frac{x}{y}} \times v_e$. The value of *x* will be _____ .

9. A planet revolving in elliptical orbit has :

A. a constant velocity of revolution.

B. has the least velocity when it is nearest to the sun.

C. its areal velocity is directly proportional to its velocity.

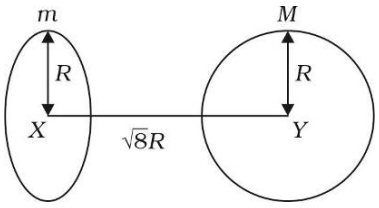
D. areal velocity is inversely proportional to its velocity.

E. to follow a trajectory such that the areal velocity is constant.

Choose the correct answer from the options given below :

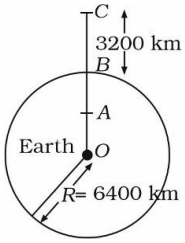
(A) C only **(B)** E only **(C)** D only **(D)** A only

10. Find the gravitational force of attraction between the ring and sphere as shown in the diagram, where the plane of the ring is perpendicular to the line joining the centres. If $\sqrt{8}R$ is the distance between the centres of a ring (of mass '*m*') and a sphere (mass '*M*') where both have equal radius '*R*'.



(A) $\frac{2\sqrt{2}}{3} \cdot \frac{GMm}{R^2}$ **(B)** $\frac{\sqrt{8}}{27} \cdot \frac{GMm}{R^2}$ **(C)** $\frac{1}{3\sqrt{8}} \cdot \frac{GMm}{R^2}$ **(D)** $\frac{\sqrt{8}}{9} \cdot \frac{GMm}{R}$

11. In the reported figure of earth, the value of acceleration due to gravity is same at point *A* and *C* but it is smaller than that of its value at point *B* (surface of the earth). The value of $OA : AB$ will be $x : y$. The value of *x* is _____.



12. The radius in kilometer to which the present radius of earth (R = 6400 km) to be compressed so that the escape velocity is increased 10 times is_____ .

13. The maximum and minimum distances of a comet from the Sun are 1.6×10^{12} m and 8.0×10^{10} m respectively. If the speed of the comet at the nearest point is 6×10^{4} ms^{-1}, the speed at the farthest point is :

(A) 1.5×10^{3} m/s **(B)** 4.5×10^{3} m/s **(C)** 6.0×10^{3} m/s **(D)** 3.0×10^{3} m/s

14. A geostationary satellite is orbiting around an arbitary planet '*P*' at a height of 11*R* above the surface of '*P*', *R* being the radius of '*P*'. The time period of another satellite in hours at a height of 2*R* from the surface of '*P*' is _____. '*P*' has the time period of 24 hours.

(A) $\frac{6}{\sqrt{2}}$ **(B)** 3 **(C)** $6\sqrt{2}$ **(D)** 5

15. The time period of a satellite in a circular orbit of radius R is T. The period of another satellite in a circular orbit of radius 9R is:

(A) 9T **(B)** 12T **(C)** 3T **(D)** 27T

16. The angular momentum of a planet of mass M moving around the sun in an elliptical orbit is $\vec{L}$. The magnitude of the areal velocity of the planet is:

(A) $\frac{4L}{M}$ **(B)** $\frac{2L}{M}$ **(C)** $\frac{L}{2M}$ **(D)** $\frac{L}{M}$

17. If the angular velocity of earth's spin is increased such that the bodies at the equator start floating, the duration of the day would be approximately:

[Take $g=10\,ms^{-2}$, the radius of earth, $R=6400\times10^{3}m$, Take $\pi=3.14$]

(A) 84 minutes **(B)** 60 minutes

(C) does not change **(D)** 1200 minutes

18. If one wants to remove all the mass of the earth to infinity in order to break it up completely. The amount of energy that needs to be supplied will be $\frac{x}{5}\frac{GM^2}{R}$ where *x* is _____.

(Round off to the Nearest Integer)

(*M* is the mass of earth, *R* is the radius of earth, *G* is the gravitational constant)

19. Inside a uniform spherical shell:

(a) The gravitational field is zero.

(b) The gravitational potential is zero.

(c) The gravitational field is same everywhere.

(d) The gravitation potential is same everywhere.

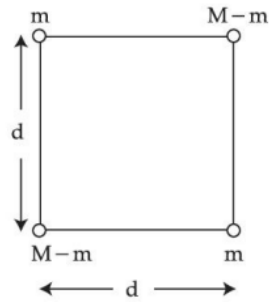
(e) All of the above

Choose the **most appropriate** answer from the options given below:

(A) (*a*), (*c*) and (*d*) only **(B)** (*a*), (*b*) and (*c*) only

(C) (*e*) only **(D)** (*b*), (*c*) and (*d*) only

20. A body of mass (2M) splits into four masses {m, M – m, m, M–m}, which are rearranged to form a square as shown in the figure. The ratio of $\frac{M}{m}$ for which, the gravitational potential energy of the system becomes maximum is *x* : 1. The value of *x* is_____.



21. A mass of 50kg is placed at the centre of a uniform spherical shell of mass 100kg and radius 50m. If the gravitational potential at a point, 25m from the centre is $V\ kg/m$. The value of V is :

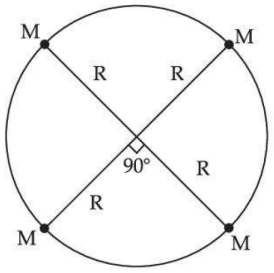
(A) $-20G$ **(B)** $-4G$ **(C)** $-60G$ **(D)** $+2G$

22. The masses and radii of the earth and moon are $(M_1,R_1)\ and\ (M_2,R_2)$ respectively. Their centres are at a distance 'r' apart. Find the minimum escape velocity for a particle of mass 'm' to be projected from the middle of these two masses:

(A) $V=\frac{1}{2}\sqrt{\frac{2G(M_1+M_2)}{r}}$ **(B)** $V=\sqrt{\frac{4G(M_1+M_2)}{r}}$

(C) $V=\frac{1}{2}\sqrt{\frac{4G(M_1+M_2)}{r}}$ **(D)** $V=\frac{\sqrt{2G}(M_1+M_2)}{r}$

23. Four particles each of mass M, move along a circle of radius R under the action of their mutual gravitational attraction as shown in figure. The speed of each particle is:



(A) $\frac{1}{2}\sqrt{\frac{GM}{R}(2\sqrt{2}-1)}$ **(B)** $\frac{1}{2}\sqrt{\frac{GM}{M}(2\sqrt{2}+1)}$

(C) $\frac{1}{2}\sqrt{\frac{GM}{R(2\sqrt{2}+1)}}$ **(D)** $\sqrt{\frac{GM}{R}}$

24. Two satellites revolved around a plane in coplanar circular orbits in anticlockwise direction. Their period of revolutions are 1 hour and 8 hours respectively. The radius of the orbit of nearer satellite is $2\times10^3 km$. The angular speed of the farther satellite as observed from the nearer satellite at the instant when both the satellites are closet if $\frac{\pi}{x} rad\ h^{-1}$ where x is:

25. If R_E be the radius of Earth, then the ratio between the acceleration due to gravity at a depth 'r' below and a height 'r' above the earth surface is : (Given : $r<R_E$)

(A) $1+\frac{r}{R_E}-\frac{r^2}{R_E^2}-\frac{r^3}{R_E^3}$ **(B)** $1+\frac{r}{R_E}-\frac{r^2}{R_E^2}+\frac{r^3}{R_E^3}$

(C) $1+\frac{r}{R_E}+\frac{r^2}{R_E^2}+\frac{r^3}{R_E^3}$ **(D)** $1-\frac{r}{R_E}-\frac{r^2}{R_E^2}-\frac{r^3}{R_E^3}$

26. Consider a binary star system of star A and star B with masses m_A and m_B revolving in a circular orbit of radii r_A and r_B, respectively. If T_A and T_B are the time period of star A and star B, respectively, then:

(A) $T_A>T_B\ (\text{if } r_A>r_B)$ **(B)** $T_A=T_B$

(C) $T_A=T_B\ (\text{if } m_A>m_B)$ **(D)** $\frac{T_A}{T_B}=\left(\frac{r_A}{r_B}\right)^{\frac{3}{2}}$

27. A satellite is launched into a circular orbit of radius R around earth, while a second satellite is launched into a circular orbit of radius 1.02R. The percentage difference in the time periods of the two satellites is:

(A) 2.0 **(B)** 0.7 **(C)** 1.5 **(D)** 3.0

28. The minimum and maximum distances of a planet revolving around the Sun are x_1 and x_2. If the minimum speed of the planet on its trajectory is V_o then its maximum speed will be

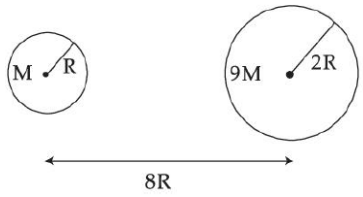
(A) $\frac{V_o x_1^2}{x_2^2}$ **(B)** $\frac{V_o x_1}{x_2}$ **(C)** $\frac{V_o x_2}{x_1}$ **(D)** $\frac{V_o x_2^2}{x_1^2}$

29. Consider a planet in some solar system which has a mass double the mass of earth and density equal to the average density of earth. If the weight of an object on earth is W, the weight of the same object on that planet will be :

(A) $2W$ **(B)** $\sqrt{2}W$ **(C)** W **(D)** $2^{\frac{1}{3}}W$

30. Suppose two plants (spherical in shape) of radii R and $2R$, but mass M and $9M$ respectively have a centre to centre separation $8R$ as shown in the figure. A satellite of mass 'm' is projected from the surface of the planet of mass 'M' directly towards the centre of the second planet. The minimum speed 'v' required for the satellite to reach the surface of the second planet is $\sqrt{\frac{a}{7}\frac{GM}{R}}$ then the value of 'a' is _____.

[Given : The two planets are fixed in their position]



31. Two identical particles of mass 1 kg each go round a circle of radius R, under the action of their mutual gravitational attraction. The angular speed of each particle is:

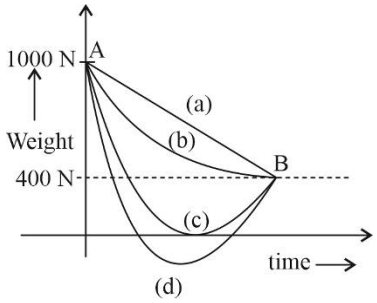
(A) $\frac{1}{2R}\sqrt{\frac{1}{G}}$ **(B)** $\sqrt{\frac{2G}{R^3}}$ **(C)** $\frac{1}{2}\sqrt{\frac{G}{R^3}}$ **(D)** $\sqrt{\frac{G}{2R^3}}$

32. The planet Mars has two moons, if one of them has a period 7 hours, 30 minutes and an orbital radius of $9.0\times10^3 km$. Find the mass of Mars.

$\left\{Given\ \frac{4\pi^2}{G}=6\times10^{11}N^{-1}m^{-2}kg^2\right\}$

(A) $3.25\times10^{21}kg$ **(B)** $6.00\times10^{23}kg$ **(C)** $7.02\times10^{25}kg$ **(D)** $5.96\times10^{19}kg$

33. A person whose mass is 100 kg travels Earth to Mars in a spaceship. Neglect all other objects in sky and take acceleration due to gravity on the surface of the Earth and Mars as $10 m/s^2$ and $4 m/s^2$ respectively. Identify from the below figure, the curve that fits best for the weight of the passenger as a function of time:



(A) (a) **(B)** (b) **(C)** (c) **(D)** (d)

34. A body is projected vertically upwards from the surface of earth with a velocity sufficient enough to carry it to infinity. The time taken by it to reach height h is _____s.

(A) $\sqrt{\frac{R_e}{2g}}\left[\left(1+\frac{h}{R_e}\right)^{3/2}-1\right]$ **(B)** $\frac{1}{3}\sqrt{\frac{2R_e}{g}}\left[\left(1+\frac{h}{R_e}\right)^{3/2}-1\right]$

(C) $\sqrt{\frac{2R_e}{g}}\left[\left(1+\frac{h}{R_e}\right)^{3/2}-1\right]$ **(D)** $\frac{1}{3}\sqrt{\frac{R_e}{2g}}\left[\left(1+\frac{h}{R_e}\right)^{3/2}-1\right]$

JEE Advanced 2021

1. The distance between two stars of masses $3M_S$ and $6M_S$ is $9R$. Here R is the mean distance between the centers of the Earth and the Sun, and M_S is the mass of the Sun. The two stars orbit around their common center of mass in circular orbits with period nT, where T is the period of Earth's revolution around the Sun. The value of n is _____.

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Archive - JEE Main & Advanced

Gravitation	Class - XI | Physics

JEE Main 2022

1. The approximate height from the surface of earth at which the weight of they body becomes $\frac{1}{3}$ of its weight on the surface of earth is: [Radius of earth R = 6400 km and $\sqrt{3} = 1.732$]

(A) 3840 km **(B)** 4685 km **(C)** 2133 km **(D)** 4267 km

2. The distance between Sun and Earth is *R*. The duration of year if the distance between Sun and Earth becomes 3*R* will be:

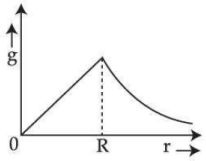
(A) $\sqrt{3}$ years **(B)** 3 years **(C)** 9 years **(D)** $3\sqrt{3}$ years

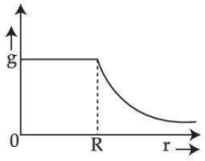
3. The height of any point P above the surface of earth is equal to diameter of earth. The value of acceleration due to gravity at point P will be: (Given g = acceleration due to gravity at the surface of earth).

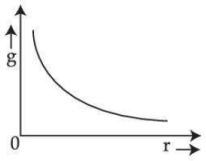
(A) *g* / 2 **(B)** *g* / 4 **(C)** *g* / 3 **(D)** *g* / 9

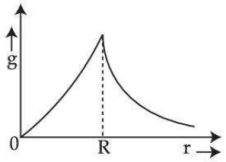
4. Two satellites S_1 and S_2 are revolving in circular orbits around a planet with radius $R_1 = 3200km$ and $R_2 = 800km$ respectively. The ratio of speed of satellite S_1 to the speed of satellite S_2 in their respective orbits would be $\frac{1}{x}$ where x = _____.

5. The variation of acceleration due to gravity (*g*) with distance (*r*) from the center of the earth is correctly represented by: (Given R = radius of earth)

(A)


(B)


(C)


(D)


6. Given below are two statements : One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : If we move from poles to equator, the direction of acceleration due to gravity of earth always points towards the center of earth without any variation in its magnitude.

Reason R : At equator, the direction of acceleration due to the gravity is towards the center of earth.

In the light of above statements, choose the correct answer from the options given below.

(A) Both A and R are true and R is the correct explanation of A

(B) Both A and R are true but R is NOT the correct explanation of A

(C) A is true but R is false

(D) A is false but R is true

7. Given below are two statements:

Statement I : The law of gravitation holds good for any pair of bodies in the universe.

Statement II : The weight of any person becomes zero when the person is at the centre of the earth.

In the light of the above statements, choose the correct answer from the options given below.

(A) Both Statement I and Statement II are true

(B) Both Statement I and Statement II are false

(C) Statement I is true but Statement II is false

(D) Statement I is false but Statement II is true

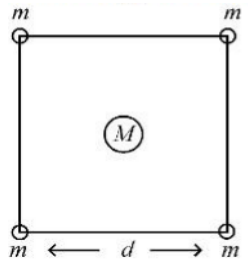
8. Four spheres each of mass m form a square of side d (as shown in figure). A fifth sphere of mass M is situated at the centre of square. The total gravitational potential energy of the system is:

(A) $-\frac{Gm}{d}\left[\left(4+\sqrt{2}\right)m+4\sqrt{2}M\right]$

(B) $-\frac{Gm}{d}\left[\left(4+\sqrt{2}\right)M+4\sqrt{2}m\right]$

(C) $-\frac{Gm}{d}\left[3m^2+4\sqrt{2}M\right]$

(D) $-\frac{Gm}{d}\left[6m^2+4\sqrt{2}M\right]$



9. Two planets A and B of equal mass are having their period of revolutions T_A and T_B such that $T_A = 2T_B$. These planets are revolving in the circular orbits of radii r_A and r_B respectively. Which out of the following would be the correct relationship of their orbits?

(A) $2r_A^2 = r_B^3$ **(B)** $r_A^3 = 2r_B^3$

(C) $r_A^3 = 4r_B^3$ **(D)** $T_A^2 - T_B^2 = \frac{\pi^2}{GM}\left(r_B^3 - 4r_A^3\right)$

10. Two objects of equal masses placed at certain distance from each other attracts each other with a force of F. If one-third mass of one object is transferred to the other object, then the new force will be:

(A) $\frac{2}{9}F$ **(B)** $\frac{16}{9}F$ **(C)** $\frac{8}{9}F$ **(D)** F

11. The escape velocity of a body on a planet 'A' is 12 kms^{-1}. The escape velocity of the body on another planet 'B', whose density is four times and radius is half of the planet 'A', is:

(A) $12\,kms^{-1}$ **(B)** $24\,kms^{-1}$ **(C)** $36\,kms^{-1}$ **(D)** $6\,kms^{-1}$

12. The time period of a satellite revolving around earth in a given orbit is 7 hours. If the radius of orbit is increased to three times its previous value, then approximate new time period of the satellite will be:

(A) 40 hours **(B)** 36 hours **(C)** 30 hours **(D)** 25 hours

13. Three identical particle A, B and C of mass 100 kg each are placed in a straight line with $AB = BC = 13$ m. The gravitational force on a fourth particle P of the same mass is F, when placed at a distance 13 m from the particle B on the perpendicular bisector of the line AC. The value of F will be approximately:

(A) 21 G **(B)** 100 G **(C)** 59 G **(D)** 42 G

14. An object is taken to a height above the surface of earth at a distance $\frac{5}{4}R$ from the centre of the earth. Where radius of earth, $R = 6400$ km. The percentage decrease in the weight of the object will be:

(A) 36% **(B)** 50% **(C)** 64% **(D)** 25%

15. The percentage decrease in the weight of a rocket, when taken to a height of 32 km above the surface of earth will be: (Radius of earth = 6400 km)

(A) 1% **(B)** 3% **(C)** 4% **(D)** 0.5%

16. A body is projected vertically upwards from the surface of earth with a velocity equal to one third of escape velocity. The maximum height attained by the body will be: (Take radius of earth = 6400 km and $g = 10\ ms^{-2}$)

(A) 800 km **(B)** 1600 km **(C)** 2133 km **(D)** 4800 km

17. Two satellites *A* and *B*, having masses in the ratio 4 : 3, are revolving in circular orbits of radii 3*r* and 4*r* respectively around the earth. The ratio of total mechanical energy of *A* to *B* is:

(A) 9 : 16 **(B)** 16 : 9 **(C)** 1 : 1 **(D)** 4 : 3

18. A body of mass *m* is projected with velocity λv_e in vertically upward direction from the surface of the earth into space. It is given that v_e is escape velocity and $\lambda < 1$. If air resistance is considered to be negligible, the maximum height from the centre of earth, to which the body can go, will be: (R: radius of earth)

(A) $\frac{R}{1+\lambda^2}$ **(B)** $\frac{R}{1-\lambda^2}$ **(C)** $\frac{R}{1-\lambda}$ **(D)** $\frac{\lambda^2 R}{1-\lambda^2}$

19. If the radius of earth shrinks by 2% while its mass remains same. The acceleration due to gravity on the earth's surface will approximately.

(A) Decrease by 2% **(B)** Decrease by 4%

(C) Increase by 2% **(D)** Increases by 4%

20. If the acceleration due to gravity experienced by a point mass at a height h above the surface of earth is same as that of the acceleration due to gravity at a depth αh ($h << R_e$) from the earth surface. The value of α will be _____. (Use : $R_e = 6400$ km)

21. An object of mass 1 kg is taken to a height from the surface of earth which is equal to three times the radius of earth. The gain in potential energy of the object will be: [If, $g = 10 ms^{-2}$ and radius of earth $= 6400 km$]

(A) $48 MJ$ **(B)** $24 MJ$ **(C)** $36 MJ$ **(D)** $12 MJ$

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Liquids	Class - XI | Physics

JEE Main 2021

1. A hydraulic press can lift 100 kg when a mass 'm' is placed on the smaller piston. It can lift _____ kg when the diameter of the larger piston is increased by 4 times and that of the smaller piston is decreased by 4 times keeping the same mass 'm' on the smaller piston.

2. A larger number of water drops, each of radius r, combine to have a drop of radius R. If the surface tension is T and mechanical equivalent of heat is J, the rise in heat energy per unit volume will be:

(A) $\frac{2T}{rJ}$ **(B)** $\frac{3T}{J}\left(\frac{1}{r}-\frac{1}{R}\right)$ **(C)** $\frac{2T}{J}\left(\frac{1}{r}-\frac{1}{R}\right)$ **(D)** $\frac{3T}{rJ}$

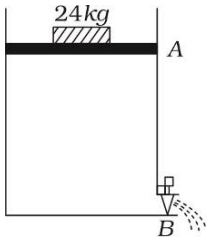
3. When two soap bubbles of radii a and b $(b>a)$ coalesce, the radius of curvature of common surface is:

(A) $\frac{ab}{a+b}$ **(B)** $\frac{b-a}{ab}$ **(C)** $\frac{ab}{b-a}$ **(D)** $\frac{a+b}{ab}$

4. Suppose you have taken a dilute solution of oleic acid in such a way that its concentration becomes $0.01 cm^3$ of oleic acid per cm^3 of the solution. Then you make a thin film of this solution (monomolecular thickness) of area $4 cm^2$ by considering 100 spherical drops of radius $\left(\frac{3}{40\pi}\right)^{1/3}\times 10^{-3} cm$. Then the thickness of oleic acid layer will be $x\times 10^{-14} m$. Where x is _____.

5. Consider a water tank as shown in the figure. Its cross-sectional area is $0.4\, m^2$. The tank has an opening B near the bottom whose cross-section area is 1 cm^2. A load of 24 kg is applied on the water at the top when the height of the water level is 40 cm above the bottom, the velocity of water coming out the opening B is $v\, ms^{-1}$. The value of v, to the nearest integer, is:

[Take value of g to be 10 ms^{-2}]



6. What will be the nature of flow of water from a circular tap, when its flow rate increased from 0.18L/min to 0.48 L/min? The radius of the tap and viscosity of water are 0.5 cm and 10^{-3} Pa s, respectively.

(Density of water : 10^3 kg/m^3)

(A) Steady flow to unsteady flow **(B)** Remains turbulent flow

(C) Unsteady to steady flow **(D)** Remains steady flow

7. The pressure acting on a submarine is $3\times10^5\ Pa$ at a certain depth. If the depth is doubled, the percentage increase in the pressure acting on the submarine would be :
(Assume that atmospheric pressure is $1\times10^5\ Pa$ density of water is 10^3 kg m^{-3}, $g = 10\ ms^{-2}$)

(A) $\frac{5}{200}\%$ **(B)** $\frac{200}{3}\%$ **(C)** $\frac{200}{5}\%$ **(D)** $\frac{3}{200}\%$

8. Two narrow bores of diameter 5.0 mm and 8.0 mm are joined together to form a U-shaped tube open at both ends. If this U-tube contains water, what is the difference in the level of two limbs of the tube.
[Take surface tension of water $T = 7.3\times10^{-2}$ Nm^{-1}, angle of contact = 0, $g = 10\ ms^{-2}$ and density of water $= 1.0\times10^3$ kg m^{-3}].

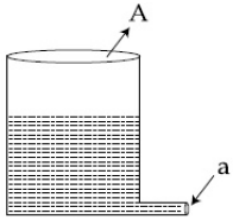
(A) 2.19 mm **(B)** 3.62 mm **(C)** 4.97 mm **(D)** 5.34 mm

9. A soap bubble of radius 3 cm is formed inside the another soap bubble of radius 6 cm. The radius of an equivalent soap bubble which has the same excess pressure as inside the smaller bubble with respect to the atmospheric pressure is _____ cm.

10. Two small drops of mercury each of radius R coalesce to form a single large drop. The ratio of total surface energy before and after the change is:

(A) $2^{\frac{1}{3}}:1$ **(B)** $1:2^{\frac{1}{3}}$ **(C)** 2 : 1 **(D)** 1 : 2

11. A light cylindrical vessel is kept on a horizontal surface. Area of base is A. A hole of cross-sectional area 'a' is made just at its bottom side. The minimum coefficient of friction necessary to prevent sliding the vessel due to the impart force of the emerging liquid is ($a << A$) :



(A) $\frac{a}{A}$ **(B)** $\frac{A}{2a}$ **(C)** None of these **(D)** $\frac{2a}{A}$

12. Two spherical soap bubbles of radii r_1 and r_2 in vacuum combine under isothermal conditions.
The resulting bubble has a radius equal to :

(A) $\sqrt{r_1^2+r_2^2}$ **(B)** $\frac{r_1r_2}{r_1+r_2}$ **(C)** $\sqrt{r_1r_2}$ **(D)** $\frac{r_1+r_2}{2}$

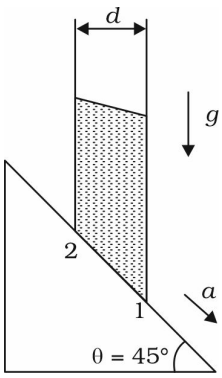
13. A raindrop with radius R = 0.2 *mm* falls from a cloud at a height h = 2000 m above ground. Assume that the drop is spherical throughout its fall and the force of buoyance may be neglected, then the terminal speed attained by the raindrop is :
[Density of water f_w = 1000 kg m^{-3}, and Density of air f_a = 1.2 kg m^{-3}, g = 10 m/s^2
Coefficient of viscosity of air = 1.8×10^{-5} Nsm^{-2}]

(A) 4.94 ms^{-1} **(B)** 250.6 ms^{-1} **(C)** 43.56 ms^{-1} **(D)** 14.4 ms^{-1}

14. The water is filled upto height of 12 m in a tank having vertical sidewalls. A hole is made in one of the walls at a depth 'h' below the water level. The value of 'h' for which the emerging stream of water strikes the ground at the maximum range is _____ m.

JEE Advanced 2021

1. A cylindrical tube, with its base as shown in the figure, is filled with water. It is moving down with a constant acceleration a along a fixed inclined plane with angle $\theta = 45°$. P_1 and P_2 are pressures at points 1 and 2, respectively located at the base of the tube. Let $\beta = (P_1 - P_2)/(\rho g d)$, where ρ is density of water, d is the inner diameter of the tube and g is the acceleration due to gravity. Which of the following statement(s) is(are) correct?



(A) $\beta = 0$ when $a = g/\sqrt{2}$

(B) $\beta > 0$ when $a = g/\sqrt{2}$

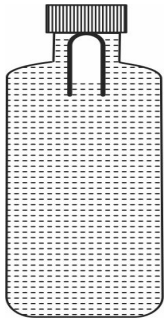
(C) $\beta = \dfrac{\sqrt{2}-1}{\sqrt{2}}$ when $a = g/2$

(D) $\beta = \dfrac{1}{\sqrt{2}}$ when $a = g/2$

Question Stem for Question Nos. 2 and 3

Question Stem

A soft plastic bottle, filled with water of density 1 gm/cc, carries an inverted glass test-tube with some air (ideal gas) trapped as shown in the figure. The test-tube has a mass of 5 gm, and it is made of a thick glass of density 2.5 gm/cc. Initially the bottle is sealed at atmospheric pressure $p_0 = 10^5 Pa$ so that the volume of the trapped air is $v_0 = 3.3 cc$. When the bottle is squeezed from outside at constant temperature, the pressure inside rises and the volume of the trapped air reduces. It is found that the test tube begins to sink at pressure $p_0 + \Delta p$ without changing its orientation. At this pressure, the volume of the trapped air is $v_0 - \Delta v$.



Let $\Delta v = X\, cc$ and $\Delta p = Y \times 10^3 Pa$.

2. The value of X is _____.

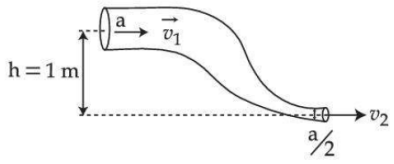
3. The value of Y is _____.

Archive - JEE Main & Advanced

Liquids	Class - XI | Physics

JEE Main 2022

1. An ideal fluid of density $800 kgm^{-3}$, flows smoothly through a bent pipe (as shown in figure) that tapers in cross-sectional area from a to $\frac{a}{2}$. The pressure difference between the wide and narrow sections of pipe is 4100 Pa. At wider section, the velocity of fluid is $\frac{\sqrt{x}}{6} ms^{-1}$ for $x =$ _____. (Given $g = 10 ms^{-2}$)



2. The terminal velocity (v_t) of the spherical rain drop depends on the radius (r) of the spherical rain drop as:

(A) $r^{1/2}$ **(B)** r **(C)** r^2 **(D)** r^3

3. The velocity of upper layer of water in a river is $36 kmh^{-1}$. Shearing stress between horizontal layers of water is $10^{-3} Nm^{-2}$. Depth of the river is _____m. (Co-efficient of viscosity of water is $10^{-2} Pa.s$)

4. If p is the density and η is coefficient of viscosity of fluid which flows with a speed v in the pipe of diameter d, the correct formula for Reynolds number R_e is:

(A) $R_e = \frac{\eta d}{\rho v}$ **(B)** $R_e = \frac{\rho v}{\eta d}$ **(C)** $R_e = \frac{\rho v d}{\eta}$ **(D)** $R_e = \frac{\eta}{\rho v d}$

5. The velocity of a small ball of mass 'm' and density d_1, when dropped in container filled with glycerine, becomes constant after some time. If the density of glycerine is d_2, then the viscous force acting on the ball, will be:

(A) $mg\left(1-\frac{d_1}{d_2}\right)$ **(B)** $mg\left(1-\frac{d_2}{d_1}\right)$ **(C)** $mg\left(\frac{d_1}{d_2}-1\right)$ **(D)** $mg\left(\frac{d_2}{d_1}-1\right)$

6. The area of cross-section of a large tank is $0.5 m^2$. It has a narrow opening near the bottom having area of cross-section $1 cm^2$. A load of 25 kg is applied on the water at the top in the tank. Neglecting the speed of water in the tank, the velocity of the water, coming out of the opening at the time when the height of water level in the tank is 40 cm above the bottom, will be _____cms^{-1}. [Take $g = 10 ms^{-2}$]

7. When a ball is dropped into a lake from a height 4.9m above the water level, it hits the water with a velocity v and then sinks to the bottom with the constant velocity v. It reaches the bottom of the lake 4.0 s after it is dropped. The approximate depth of the lake is:

(A) 19.6m **(B)** 29.4m **(C)** 39.2m **(D)** 73.5m

8. A water drop of diameter 2 cm is broken into 64 equal droplets. The surface tension of water is 0.075 N/m. In this process the gain in surface energy will be:

(A) $2.8\times10^{-4}J$ **(B)** $1.5\times10^{-3}J$ **(C)** $1.9\times10^{-4}J$ **(D)** $9.4\times10^{-5}J$

9. A water drop of radius $1\,\mu m$ falls in a situation where the effect of buoyant force is negligible. Co-efficient of viscosity of air is $1.8\times10^{-5}Nsm^{-2}$ and its density is negligible as compared to that of water $10^6\ gm^{-3}$. Terminal velocity of the water drop is: (Take acceleration due to gravity $=10ms^{-2}$)

(A) $145.4\times10^{-6}\ ms^{-1}$ **(B)** $118.0\times10^{-6}ms^{-1}$

(C) $132.6\times10^{-6}\ ms^{-1}$ **(D)** $123.4\times10^{-6}\ ms^{-1}$

10. A liquid of density $750\ kgm^{-3}$ flows smoothly through a horizontal pipe that tapers in cross-sectional area from $A_1=1.2\times10^{-2}m^2$ to $A_2=\frac{A_1}{2}$. The pressure difference between the wide and narrow sections of the pipe is 4500 Pa. The rate of flow of liquid is _____$\times10^{-3}m^3s^{-1}$.

11. A small spherical ball of radius 0.1 mm and density $10^4kg\,m^{-3}$ falls freely under gravity through a distance h before entering a tank of water. If, after entering the water the velocity of ball does not change and it continue to fall with same constant velocity inside water, then the value of h will be _____ m.

(Given $g=10\ ms^{-2}$, viscosity of water $=1.0\times10^{-5}N-sm^{-2}$).

12. A tube of length 50 cm is filled completely with an incompressible liquid of mass 250 g and closed at both ends. The tube is then rotated in horizontal plane about one of its ends with a uniform angular velocity $x\sqrt{F}$ rad s^{-1}. If F be the force exerted by the liquid at the other end then the value of x will be _____.

13. A drop of liquid of density ρ is floating half immersed in a liquid of density σ and surface tension $7.5\times10^{-4}\text{Ncm}^{-1}$. The radius of drop in cm will be: ($g=10\ \text{ms}^{-2}$)

(A) $\frac{15}{\sqrt{(2\rho-\sigma)}}$ **(B)** $\frac{15}{\sqrt{(\rho-\sigma)}}$ **(C)** $\frac{3}{2\sqrt{(\rho-\sigma)}}$ **(D)** $\frac{3}{20\sqrt{(2\rho-\sigma)}}$

14. A water drop of radius 1 cm is broken into 729 equal droplets. If surface tension of water is 75 dyne/cm, then the gain in surface energy upto first decimal place will be: (Given : $\pi=3.14$)

(A) $8.5\times10^{-4}J$ **(B)** $8.2\times10^{-4}J$ **(C)** $7.5\times10^{-4}J$ **(D)** $5.3\times10^{-4}J$

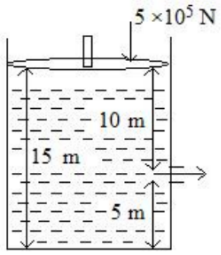
15. Two cylindrical vessels of equal cross-sectional area 16 cm^2 contain water upto heights 100 cm and 150 cm respectively. The vessels are interconnected so that the water levels in them become equal. The work done by the force of gravity during the process, is : [Take, density of water $=10^3\text{kg/m}^3$ and $g=10\ \text{ms}^{-2}$]:

(A) 0.25 J **(B)** 1 J **(C)** 8 J **(D)** 12 J

16. A spherical soap bubble of radius 3 cm is formed inside another spherical soap bubble of radius of 6 cm. If the internal pressure of the smaller bubble of radius 3 cm in the above system is equal to the internal pressure of the another single soap bubble of radius *r* cm. The value of *r* is ____ .

17. The diameter of an air bubble which was initially 2 mm, rises steadily through a solution of density $1750\,\text{kg m}^{-3}$ at the rate of $0.35\,\text{cms}^{-1}$. The coefficient of viscosity of the solution is _____ poise (in nearest integer). (The density of air is negligible).

18. Consider a cylindrical tank of radius 1*m* is filled with water. The top surface of water is at 15m from the bottom of the cylinder. There is a hole on the wall of cylinder at a height of 5m from the bottom. A force of $5\times10^5 N$ is applied on the top surface of water using a piston. The speed of ifflux from the hole will be: (Given atmospheric pressure $P_A = 1.01\times10^5 Pa$, density of water $\rho_w = 1000 kg/m^3$ and gravitational acceleration $g = 10 m/s^2$)



(A) 11.6 m/s **(B)** 10.8 m/s **(C)** 17.8 m/s **(D)** 14.4 m/s

19. Given below are two statements: One is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A) : Clothes containing oil or grease stains cannot be cleaned by water wash.

Reason (R) : Because the angle of contact between the oil/grease and water is obtuse.

In the light of the above statements, choose the correct answer from the option given below:

(A) Both (A) and (R) are true and (R) is the correct explanation of (A)

(B) Both (A) and (R) are true but (R) is not the correct explanation of (A)

(C) (A) is true but (R) is false

(D) (A) is false but (R) is true

20. The velocity of small ball of mass 0.3 *g* and density 8 *g*/*cc* when dropped in a container filled with glycerine becomes constant after some time. If the density of glycerine is 1.3 *g*/*cc*, then the value of viscous force acting on the ball will be $x\times10^{-4} N$. The value of *x* is _____. [Use : $g = 10\,\text{m/s}^2$]

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Properties of Matter	Class - XI | Physics

JEE Main 2021

1. Each side of a box made of metal sheet in cubic shape is 'a' at room temperature 'T', the coefficient of linear expansion of the metal sheet is 'a'. The metal sheet is heated uniformly, by a small temperature ΔT, so that its new temperature is $T+\Delta T$. Calculate the increase in the volume of the metal box.

(A) $3a^3\alpha\Delta T$ **(B)** $4a^3\alpha\Delta T$ **(C)** $\frac{4}{3}\pi a^3\alpha\Delta T$ **(D)** $4\pi a^3\alpha\Delta T$

2. If Y, K and η are the values of Young's modulus, bulk modulus and modulus of rigidity of any material respectively. Choose the correct relation for these parameters.

(A) $Y=\frac{9K\eta}{2\eta+3K}N/m^2$ **(B)** $Y=\frac{9K\eta}{3K-\eta}N/m^2$

(C) $\eta=\frac{3YK}{9K+Y}N/m^2$ **(D)** $K=\frac{Y\eta}{9\eta-3Y}N/m^2$

3. A uniform metallic wire is elongated by 0.04m when subjected to a linear force F. The elongation, if its length and diameter is doubled and subjected to the same force will be _____ cm.

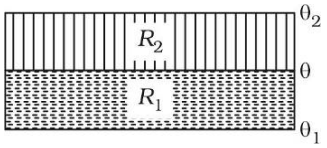
4. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.
Assertion A : When a rod lying freely is heated, no thermal stress is developed in it.
Reason R : On heating, the length of the rod increases.
In the light of the above statements, choose the correct answer from the options given below :

(A) A is true but R is false
(B) Both A and R are true and R is the correct explanation of A
(C) A is false but R is true
(D) Both A and R are true but R is NOT the correct explanation of A

5. The normal density of a material is ρ and its bulk modulus of elasticity is K. The magnitude of increase in density of material, when a pressure P is applied uniformly on all sides, will be:

(A) $\frac{PK}{\rho}$ **(B)** $\frac{\rho K}{P}$ **(C)** $\frac{\rho P}{K}$ **(D)** $\frac{K}{\rho P}$

6. The temperature θ at the junction of two insulating sheets, having thermal resistances R_1 and R_2 as well as top and bottom temperatures θ_1 and θ_2 (as shown in figure) is given by:



(A) $\frac{\theta_2R_2-\theta_1R_1}{R_2-R_1}$ **(B)** $\frac{\theta_1R_1+\theta_2R_2}{R_1+R_2}$ **(C)** $\frac{\theta_1R_2+\theta_2R_1}{R_1+R_2}$ **(D)** $\frac{\theta_1R_2-\theta_2R_1}{R_2+R_1}$

7. The length of metallic wire is l_1 when tension in it is T_1. It is l_2 when the tension is T_2. The original length of the wire will be :

(A) $\frac{T_1 l_1 - T_2 l_2}{T_2 - T_1}$ **(B)** $\frac{T_2 l_1 - T_1 l_2}{T_2 - T_1}$ **(C)** $\frac{l_1 + l_2}{2}$ **(D)** $\frac{T_2 l_1 + T_1 l_2}{T_1 + T_2}$

8. An object is located at $2km$ beneath the surface of the water. If the fractional compression $\frac{\Delta V}{V}$ is 1.36%, the ratio of hydraulic stress to the corresponding hydraulic strain will be _____.

[Given : density of water is $1000 kgm^{-3}$ and $g = 9.8 ms^{-2}$]

(A) $2.26 \times 10^9 Nm^{-2}$ **(B)** $1.44 \times 10^7 Nm^{-2}$

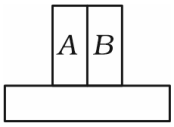
(C) $1.44 \times 10^9 Nm^{-2}$ **(D)** $1.96 \times 10^7 Nm^{-2}$

9. Two identical metal wires of thermal conductivities K_1 and K_2 respectively are connected in series. The effective thermal conductivity of the combination is;

(A) $\frac{K_1 K_2}{K_1 + K_2}$ **(B)** $\frac{K_1 + K_2}{2K_1 K_2}$ **(C)** $\frac{K_1 + K_2}{K_1 K_2}$ **(D)** $\frac{2K_1 K_2}{K_1 + K_2}$

10. Two separate wires A and B are stretched by 2 *mm* and 4 *mm* respectively, when they are subjected to a force of 2N. Assume that both the wires are made up of same material and the radius of wire B is 4 times that of the radius of wire A. The length of the wires A and B are in the ratio of a : b. Then $\frac{a}{b}$ can be expressed as $\frac{1}{x}$ where x is _____ .

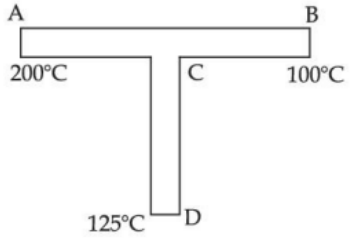
11. A bimetallic strip consists of metals *A* and *B*. It is mounted rigidly as shown. The metal *A* has higher coefficient of expansion compared to that of metal *B*. When the bimetallic strip is placed in a cold bath, it will:



(A) Bend towards the left **(B)** Not bend but shrink

(C) Neigher bend nor shrink **(D)** Bend towards the right

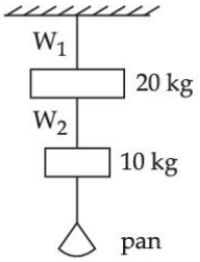
12. A rod CD of thermal resistance $10.0 KW^{-1}$ is joined at the middle of an identical rod AB as shown in figure. The ends A, B and D are maintained at $200°C, 100°C$ and $125°C$ respectively. The heat current in CD is P watt. The value of P is _____.



13. The height of Victoria falls is $63m$. What is the difference in temperature of water at the top and at the bottom of fall ? [Given : $1 cal = 4.2 J$ and specific heat of water $= 1 cal\, g^{-1} °C^{-1}$]

(A) 0.014°C **(B)** 14.76°C **(C)** 0.147°C **(D)** 1.476°C

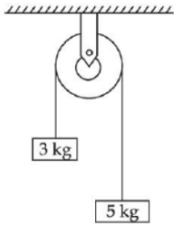
14. Wires W_1 and W_2 are made of same material having the breaking stress of $1.25\times10^9 N/m^2$. W_1 and W_2 have cross-sectional area of $8\times10^{-7}m^2$ and $4\times10^{-7}m^2$, respectively. Masses of $20kg$ and $10kg$ hang from them as shown in the figure. The maximum mass that can be placed in the pan without breaking the wires is _____ *kg*. (Use : $g=10m/s^2$)



15. The temperature of equal masses of three different liquids *x*, *y* and *z* are 10°C, 20°C and 30°C respectively. The temperature of mixture when *x* is mixed with *y* is 16°C and that when *y* is mixed with z is 26°*C*. The temperature of mixture when *x* and *z* are mixed will be:

(A) 20.28°C **(B)** 23.84°C **(C)** 25.62°C **(D)** 28.32°C

16. Two blocks of masses 3 kg and 5 kg are connected by a metal wire going over a smooth pulley. The breaking stress of the metal is $\frac{24}{\pi}\times10^2$ Nm^{-2}. What is the minimum radius of the wire? (Take $g=10$ ms^{-2})



(A) 1250 cm **(B)** 125 cm

(C) 12.5 cm **(D)** 1.25 cm

17. A uniform heavy rod of weight$10kg\ ms^{-2}$, cross-sectional area $10cm^2$ and length $20cm$ is hanging from a fixed support. Young modulus of the material of the rod is $2\times10^{11}\ Nm^{-2}$. Neglecting the lateral contraction, find the elongation of rod due to its own weight:

(A) $5\times10^{-8}m$ **(B)** $5\times10^{-10}m$ **(C)** $2\times10^{-9}m$ **(D)** $4\times10^{-8}m$

18. When a rubber ball is taken to a depth of _____ *m* in deep sea, its volume decreases by 0.5%. (The bulk modulus of rubber $=9.8\times10^8 Nm^{-2}$ Density of sea water $=10^3 kgm^{-3}$, $g=9.8m/s^2$)

19. A steel rod with $y=2.0\times10^{11}\ Nm^{-2}$ and $\alpha=10^{-5}{}^{\circ}C^{-1}$ of length 4 m and area of cross-sectional 10 cm^2 is heated from °C and 400°C without being allowed to extend. The tension produced in the rod is $x\times10^5 N$ where the value of *x* is:

20. Two thin metallic spherical shells of radii r_1 *and* r_2 $(r_1<r_2)$ are placed with their centres coinciding. A material of thermal conductivity K is tilled in the space between the shells. The inner shell is maintained at temperature θ_1 and the outer shell at temperature $\theta_2(\theta_1<\theta_2)$. The rate at which heat flows radially through the material is :

(A) $\frac{K(\theta_2-\theta_1)(r_2-r_1)}{4\pi r_1 r_2}$ **(B)** $\frac{\pi r_1 r_2(\theta_2-\theta_1)}{r_2-r_1}$

(C) $\frac{K(\theta_2-\theta_1)}{r_2-r_1}$ **(D)** $\frac{4\pi K r_1 r_2(\theta_2-\theta_1)}{r_2-r_1}$

21. Four identical hollow cylindrical columns of mild steel support a big structure of mass $50\times10^3 kg$. The inner and outer radii of each column are 50 cm and 100 cm respectively.
Assuming uniform local distribution, calculate the compression strain of each column,
[use $Y = 2.0\times10^{11}\ Pa$, $g = 9.8\ m/s^2$]

(A) 2.60×10^{-7} **(B)** 3.60×10^{-8} **(C)** 1.87×10^{-3} **(D)** 7.07×10^{-4}

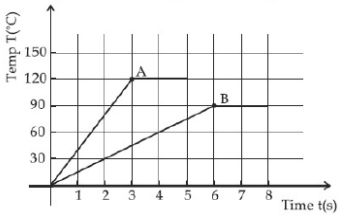
22. Due to cold weather a 1 m water pipe of cross-sectional area 1 cm^2 is filled with ice at –10°C. Resistive heating is used to melt the ice. Current of 0.5A is passed through $4k\Omega$ resistance. Assuming that all the heat produced is used for melting, what is the minimum time required?
(Given latent heat of fusion for water/ice $3.33\times10^5 J\ kg^{-1}$, specific heat of ice $= 2\times10^3 J\ kg^{-1}$ and density of ice $=10^3\ kg/m^3$)

(A) 0.353 s **(B)** 35.3 s **(C)** 3.53 s **(D)** 70.6 s

23. The length of a metal wire is l_1, when the tension in it is T_1 and is l_2 when the tension is T_2. The natural length of the wire is:

(A) $\dfrac{l_1T_2 - l_2T_1}{T_2 - T_1}$ **(B)** $\dfrac{l_1 + l_2}{2}$ **(C)** $\sqrt{l_1\, l_2}$ **(D)** $\dfrac{l_1T_2 + l_2T_1}{T_2 + T_1}$

24. Two different metal bodies A and B of equal mass are heated at a uniform rate under similar conditions. The variation of temperature of the bodies is graphically represented as shown in the figure. The ratio of specific heat capacities is:



(A) $\dfrac{3}{4}$ **(B)** $\dfrac{4}{3}$ **(C)** $\dfrac{8}{3}$ **(D)** $\dfrac{3}{8}$

25. Two wires of same length and radius are joined end to end and loaded. The young's modulii of the materials of the two wires are Y_1 and Y_2. The combination behaves as a single wire then its Young's modulus is:

(A) $Y = \dfrac{2Y_1Y_2}{Y_1 + Y_2}$ **(B)** $Y = \dfrac{2Y_1Y_2}{3(Y_1 + Y_2)}$ **(C)** $Y = \dfrac{Y_1Y_2}{2(Y_1 + Y_2)}$ **(D)** $Y = \dfrac{Y_1Y_2}{Y_1 + Y_2}$

26. A body takes 4 min. to cool from 61°C and 59°C. If the temperature of the surroundings is 30°C, the time taken by the body to cool from 51°C to 49°C is :

(A) 6 min **(B)** 4 min **(C)** 8 min **(D)** 3 min

27. A stone of mass $20g$ is projected from a rubber catapult of length $0.1m$ and area of cross section $10^{-6}m^2$ stretched by an amount $0.04m$. Take velocity of the projected stone is _____ m/s.
(Young's modulus of rubber $= 0.5\times10^9 N/m^2$)

28. The area of cross-section of a railway track is $0.01m^2$. The temperature variation is $10°C$. Coefficient of linear expansion of material of track is $10^{-5}/°C$. The energy stored per meter in the track is _____ J/m. (Young's modulus of material of track is $10^{11}Nm^{-2}$)

29. In 5 minutes, a body cools from 75°*C* to 65°*C* at room temperature of 25°*C*. The temperature of body at the end of next 5 minutes is _____°*C*.

30. The value of tension in a long thin metal wire has been changed from T_1 to T_2. The lengths of the metal wire at two different values of tension T_1 and T_2 are l_1 and l_2 respectively. The actual length of the metal wire is:

(A) $\sqrt{T_1 T_2 l_1 l_2}$ **(B)** $\frac{l_1 + l_2}{2}$ **(C)** $\frac{T_1 l_1 - T_2 l_2}{T_1 - T_2}$ **(D)** $\frac{T_1 l_2 - T_2 l_1}{T_1 - T_2}$

JEE Advanced 2021

1. A small object is placed at the center of a large evacuated hollow spherical container. Assume that the container is maintained at 0 K. At time $t = 0$, the temperature of the object is 200 K. The temperature of the object becomes 100 K at $t = t_1$ and 50 K at $t = t_2$. Assume the object and the container to be ideal black bodies. The heat capacity of the object does not depend on temperature. The ratio (t_2 / t_1) is _____.

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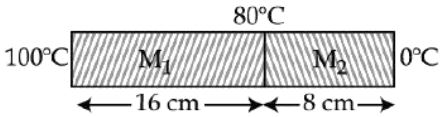
Properties of Matter	Class - XI | Physics

JEE Main 2022

1. The bulk modulus of a liquid is $3\times10^{10}Nm^{-2}$. The pressure required to reduce the volume of liquid by 2% is:

(A) $3\times10^{8}Nm^{-2}$ **(B)** $9\times10^{8}Nm^{-2}$ **(C)** $6\times10^{8}Nm^{-2}$ **(D)** $12\times10^{8}Nm^{-2}$

2. Two metallic blocks M_1 and M_2 of same area of cross-section are connected to each other (as shown in figure). If the thermal conductivity of M2 is K then the thermal conductivity of M_1 will be :
[Assume steady state heat conduction]

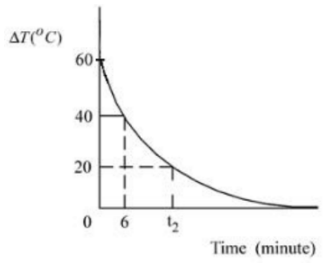


(A) 10 K **(B)** 8 K **(C)** 12.5 K **(D)** 2 K

3. A 100 g of iron nail is hit by a 1.5 kg hammer striking at a velocity of 60 ms^{-1}. What will be the rise in the temperature of the nail if one fourth of energy of the hammer goes into heating the nail ?
[Specific heat capacity of iron $= 0.42\ Jg^{-1}\ ^{\circ}C^{-1}$]

(A) 675°C **(B)** 1600°C **(C)** 16.07°C **(D)** 6.75°C

4. In an experiment to verify Newton's law of cooling, a graph is plotted between, the temperature difference (ΔT) of the water and surrounding and time as shown in figure. The initial temperature of water is taken as 80°C. The value of t_2 as mentioned in the graph will be _____ .



5. A steam engine intakes 50 g of steam at 100°C per minute and cools it down to 20°C. If latent heat of vaporization of steam is $540cal\,g^{-1}$, then the heat rejected by the steam engine per minute is _____$\times10^{3}cal$.

(Given : specific heat capacity of water : $1cal\,g^{-1}{}^{\circ}C^{-1}$)

6. A solid metallic cube having total surface are $24m^{2}$ is uniformly heated. If its temperature is increased by $10^{\circ}C$, calculate the increase in volume of the cube. (Given $\alpha = 5.0\times10^{-4}\,^{\circ}C^{-1}$).

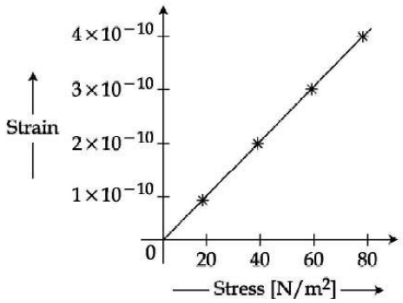
(A) $2.4\times10^{6}cm^{3}$ **(B)** $1.2\times10^{5}cm^{3}$ **(C)** $6.0\times10^{4}cm^{3}$ **(D)** $4.8\times10^{5}cm^{3}$

7. A copper block of mass 5.0*kg* is heated to a temperature of 500°*C* and is placed on large ice block. What is the maximum amount of ice that can melt?

[Specific heat of copper : $0.39 Jg^{-1}{}^{\circ}C^{-1}$ and latent heat of fusion of water : $335 Jg^{-1}$]

(A) 1.5 kg **(B)** 5.8 kg **(C)** 2.9 kg **(D)** 3.8 kg

8. The elastic behaviour of material for linear stress and linear strain, is shown in the figure. The energy density for a linear strain of 5×10^{-4} is _____ kJ/m^3. Assume that material is elastic upto the linear strain of 5×10^{-4}.



9. The elongation of a wire on the surface of the earth is $10^{-4}m$. The same wire of same dimensions is elongated by $6\times10^{-5}m$ on another planet. The acceleration due to gravity on the planet will be _____ ms^{-2}. (Take acceleration due to gravity on the surface of earth $=10ms^{-2}$)

10. A geyser heats water flowing at a rate of 2.0 *kg* per minute from 30°C to 70°C. If geyser operates on a gas burner, the rate of combustion of fuel will be _____ $g\,\text{min}^{-1}$.

[Heat of combustion $= 8\times10^3\,Jg^{-1}$, Specific heat of water $= 4.2\,Jg^{-1}{}^{\circ}C^{-1}$]

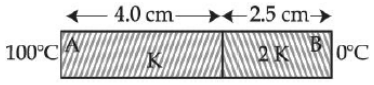
11. A lead bullet penetrates into a solid object and melts. Assuming that 40% of its kinetic energy is used to heat it, the initial speed of bullet is: (Given, initial temperature of the bullet = 127° C, Melting point of the bullet= 327°C, Latent heat of fusion of lead $= 2.5\times10^4\,J\,kg^{-1}$, Specific heat capacity of lead = 125 J/kg K)

(A) $125ms^{-1}$ **(B)** $500ms^{-1}$ **(C)** $250ms^{-1}$ **(D)** $600ms^{-1}$

12. A wire of length L is hanging from a fixed support. The length changes to L_1 and L_2 when masses 1 kg and 2 kg are suspended respectively from its free end. Then the value of L is equal to:

(A) $\sqrt{L_1L_2}$ **(B)** $\frac{L_1+L_2}{2}$ **(C)** $2L_1-L_2$ **(D)** $3L_1-2L_2$

13. As per the given figure, two plates A and B of thermal conductivity K and 2 K are joined together to form a compound plate. The thickness of plates arc 4.0 cm and 2.5 cm respectively and the area of cross-section is 120 cm^2 for each plate. The equivalent thermal conductivity of the compound plate is $\left(1+\frac{5}{\alpha}\right)$ K, then the value of α will be_____.



14. At what temperature a gold ring of diameter 6.230 *cm* be heated so that it can be fitted on a wooden bangle of diameter 6.241 *cm*? Both the diameters have been measured at room temperature (27°*C*).

(Given: coefficient of linear thermal expansion of gold $\alpha_L = 1.4\times10^{-5}K^{-1}$).

(A) 125.7°*C* **(B)** 91.7°*C* **(C)** 425.7°*C* **(D)** 152.7°*C*

15. A wire of length L and radius r is clamped rigidly at one end. When the other end of the wire is pulled by a force F, its length increases by 5 cm. Another wire of the same material of length $4L$ and radius $4r$ is pulled by a force $4F$ under same conditions. The increase in length of this wire is _____ cm.

16. A unit scale is to be prepared whose length does not change with temperature and remains 20 cm, using a bimetallic strip made of brass and iron each of different length. The length of both components would change in such a way that difference between their lengths remains constant. If length of brass is 40 cm and length of iron will be _____ cm. ($\alpha_{iron} = 1.2\times10^{-5}K^{-1}$ & $\alpha_{brass} = 1.8\times10^{-5}K^{-1}$).

17. A block of ice of mass 120 g at temperature 0°C is put in 300 g of water at 25°C. The xg of ice melts as the temperature of the water reaches 0°C. The value of x is _____ . (Use specific heat capacity of water = 4200 $Jkg^{-1}K^{-1}$, Latent heat of ice $= 3.5\times10^{5}$ Jkg^{-1}]

18. An ice cube of dimension 60cm × 50 cm × 20 cm in placed in an insulation box of wall thickness 1 cm. The box keeping the ice cube at 0°C of temperature is brought to a room of temperature 40°C. The rate of melting of ice is approximately: (Latent heat of fusion of ice is $3.4\times10^{5}\,Jkg^{-1}$ and thermal conducting of insulation wall is $0.05\,Wm^{-1}{}^{\circ}C^{-1}$)

(A) 61×10^{-3} kgs^{-1} **(B)** 61×10^{-5} kgs^{-1}

(C) 208 kgs^{-1} **(D)** 30×10^{-5} kgs^{-1}

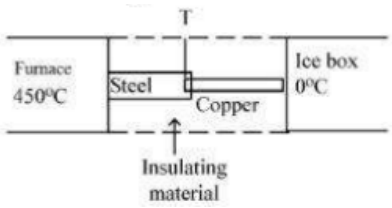
19. The area of cross section of the rope used to lift a load by a crane is $2.5\times10^{-4}m^{2}$. The maximum lifting capacity of the crane is 10 metric tons. To increase the lifting capacity of the crane to 25 metric tons, the required area of cross section of the rope should be: (Take $g = 10\,ms^{-2}$)

(A) $6.25\times10^{-4}m^{2}$ **(B)** $10\times10^{-4}m^{2}$

(C) $1\times10^{-4}m^{2}$ **(D)** $1.67\times10^{-4}m^{2}$

20. A uniform heavy rod of mass 20 kg, cross sectional area 0.4 m^{2} and length 20 m is hanging from a fixed support. Neglecting the lateral contraction, the elongation in the rod due to its own weight is $x\times10^{-9}m$. The value of x is _____. (Given, young modulus $Y = 2\times10^{11}$ Nm^{-2} and $g = 10\,ms^{-2}$)

21. If K_1 and K_2 are the thermal conductivities, L_1 and L_2 are the lengths and A_1 and A_2 are the cross sectional areas of steel and copper rods respectively such that $\frac{K_2}{K_1} = 9, \frac{A_1}{A_2} = 2, \frac{L_1}{L_2} = 2$. Then, for the arrangement as shown in the figure, the values of temperature T of the steel – copper junction in the steady state will be:



(A) 18°C **(B)** 14°C **(C)** 45°C **(D)** 150°C

22. A square aluminum (shear modulus is $25\times10^{9}Nm^{-2}$) slab of side 60 cm and thickness 15 cm is subjected to a shearing force (on its narrow face) of $18.0\times10^{4}N$. The lower edge is riveted to the floor. The displacement of the upper edge is _____ μm.

23. A steel wire of length 3.2 m ($Y_S = 2.0 \times 10^{11} Nm^{-2}$) and a copper wire of length 4.4 m ($Y_C = 1.1 \times 10^{11} Nm^{-2}$), both of radius 1.4 mm are connected end to end. When stretched by a load, the net elongation is found to be 1.4 mm. The load applied, in Newton, will be: (Given : $\pi = \frac{22}{7}$)

(A) 360 **(B)** 180 **(C)** 1080 **(D)** 154

24. The force required to stretch a wire of cross-section $1cm^2$ to double its length will be: (Given Young's modulus of the wire $= 2 \times 10^{11} N/m^2$)

(A) $1 \times 10^7 N$ **(B)** $1.5 \times 10^7 N$ **(C)** $2 \times 10^7 N$ **(D)** $2.5 \times 10^7 N$

25. A string of area of cross-section $4\ mm^2$ and length $0.5m$ is connected with a rigid body of mass 2 kg. The body is rotated in a vertical circular path of radius 0.5 m. The body acquires a speed of 5m/s at the bottom of the circular path. Strain produced in the string when the body is at the bottom of the circle is _____ $\times 10^{-5}$. (Use young's modulus $10^{11} N/m^2$ and $g = 10 m/s^2$)

26. If the length of a wire is made double and radius is halved of its respective values. Then, the Young's modulus of the material of the wire will:

(A) Remain same **(B)** Become 8 times its initial value

(C) Become $1/4^{th}$ of its initial value **(D)** Become 4 times its initial value

27. A metal wire of length $0.5m$ and cross-sectional area $10^{-4} m^2$ has breaking stress $5 \times 10^8 Nm^{-2}$. A block of 10 kg is attached at one end of the string and is rotating in a horizontal circle. The maximum linear velocity of block will be _____ ms^{-1}.

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Gaseous State and Thermodynamics	Class - XI | Physics

JEE Main 2021

1. Match List I with List II.

	List I		List II
(a)	Isothermal	(i)	Pressure constant
(b)	Isochoric	(ii)	Temperature constant
(c)	Adiabatic	(iii)	Volume constant
(d)	Isobaric	(iv)	Heat content is constant

Choose the correct answer from the options given below:

(A) (a) – (iii), (b) – (ii), (c) – (i), (d) – (iv) **(B)** (a) – (ii), (b) – (iv), (c) – (iii), (d) – (i)

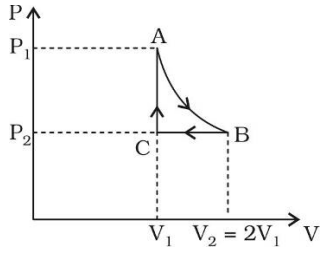
(C) (a) – (ii), (b) – (iii), (c) – (iv), (d) – (i) **(D)** (a) – (i), (b) – (iii), (c) – (ii), (d) – (iv)

2. n mole of a perfect gas undergoes a cyclic process $ABCA$ (see figure) consisting of the following processes.

$A \to B$: Isothermal expansion at temperature T so that the volume is doubled from V_1 to $V_2 = 2V_1$ and pressure changes from P_1 to P_2

$B \to C$: Isobaric compression at pressure P_2 to initial volume V_1

$C \to A$: Isochoric change leading to change of pressure from P_2 to P_1



Total workdone in the complete cycle ABCA is:

(A) $nRT\left(\ln 2 - \frac{1}{2}\right)$ **(B)** $nRT \ln 2$

(C) 0 **(D)** $nRT\left(\ln 2 + \frac{1}{2}\right)$

3. On the basis of kinetic theory of gases, the gas exerts pressure because its molecules:

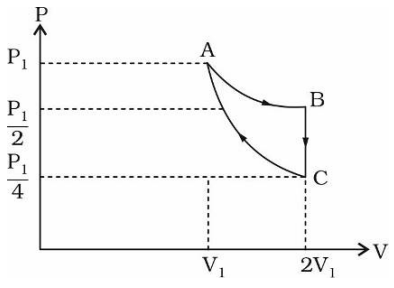
(A) Are attracted by the walls of container

(B) Continuously stick to the walls of container

(C) Continuously lose their energy till it reaches wall

(D) Suffer change in momentum when impinge on the walls of container

4. If one mole of an ideal gas at (P_1, V_1) is allowed to expand reversibly and isothermally (A to B) its pressure is reduced to one-half of the original pressure (see figure). This is followed by a constant volume cooling till its pressure is reduced to one-fourth of the initial value ($B \to C$). Then it is restored to its initial state by a reversible adiabatic compression (C to A). The net workdone by the gas is equal to:



(A) 0 **(B)** RT ln 2

(C) $RT\left(\ln 2 - \frac{1}{2(\gamma - 1)}\right)$ **(D)** $-\frac{RT}{2(\gamma - 1)}$

5. The root mean square speed of molecules of a given mass of a gas at 27°C and 1 atmosphere pressure is $200 ms^{-1}$. The root mean square speed of molecules of the gas at 127°C and 2 atmosphere pressure is $\frac{x}{\sqrt{3}} ms^{-1}$. The value of x will be _____.

6. A diatomic gas, having $C_P = \frac{7}{2}R$ and $C_V = \frac{5}{2}R$, is heated at constant pressure. The ratio $dU : dQ : dW$:

(A) 3 : 5 : 2 **(B)** 5 : 7 : 3 **(C)** 3 : 7 : 2 **(D)** 5 : 7 : 2

7. A monoatomic gas of mass 4.0 u is kept in an insulated container. Container is moving with velocity 30 m/s. If container is suddenly stopped then change in temperature of the gas (R = gas constant) is $\frac{x}{3R}$. Value of x is____.

8. Given below are two statements:

Statement I: In a diatomic molecule, the rotational energy at a given temperature obeys Maxwell's distribution.

Statement II: In a diatomic molecule, the rotational energy at a given temperature equals the translational kinetic energy for each molecule.

In the light of the above statements, choose the correct answer from the options given below:

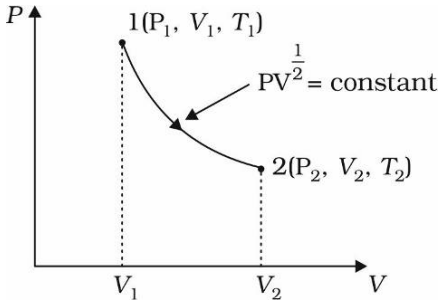
(A) Statement I is false but Statement II is true.

(B) Statement I is true but Statement II is false.

(C) Both Statement I and Statement II are true.

(D) Both Statement I and Statement II are false.

9. Thermodynamic process is shown below on a P-V diagram for one mole of an ideal gas. If $V_2 = 2V_1$ then the ratio of temperature T_2 / T_1 is:



(A) 2 **(B)** $\sqrt{2}$ **(C)** $\frac{1}{2}$ **(D)** $\frac{1}{\sqrt{2}}$

10. A reversible heat engine converts one-fourth of the heat input into work. When the temperature of the sink is reduced by 52 K, its efficiency is doubled. The temperature in Kelvin of the source will be _____.

11. A container is divided into two chambers by a partition. The volume of first chamber is 4.5 litre and second chamber is 5.5 litre. The first chamber contain 3.0 moles of gas at pressure 2.0 atm and second chamber contain 4.0 moles of gas at pressure 3.0 atm. After the partition is removed and the mixture attains equilibrium, then the common equilibrium pressure existing in the mixture is $x \times 10^{-1}$ atm. Value of x is _____ .

12. The internal energy (U), pressure (P) and volume (V) of an ideal gas are related as $U = 3PV + 4$. The gas is :

(A) diatomic only **(B)** either monoatomic or diatomic

(C) monoatomic only **(D)** polyatomic only

13. The volume V of a given mass of monoatomic gas changes with temperature T according to the relation $V = KT^{2/3}$. The work done when temperature changes by 90 K will be xR. The value of x is _____ .
[R = universal gas constant]

14. 1 mole of rigid diatomic gas performs a work of $\frac{Q}{5}$ when heat Q is supplied to it. The molar heat capacity of the gas during this transformation is $\frac{xR}{8}$. The value of x is _____ .

R = universal gas constant]

15. A polyatomic ideal gas has 24 vibrational modes. What is the value of γ ?

(A) 1.37 **(B)** 1.03 **(C)** 10.3 **(D)** 1.30

16. A Carnot's engine working between 400K and 800 K has a work output 1200 J per cycle. The amount of heat energy supplied to the engine from the source in each cycle is:

(A) 3200 J **(B)** 2400 J **(C)** 1800 J **(D)** 1600 J

17. Two ideal polyatomic gases at temperatures $T_1 \text{ and } T_2$ are mixed so that there is no loss of energy. If $F_1 \text{ and } F_2, m_1 \text{ and } m_2, n_1 \text{ and } n_2$ be the degrees of freedom, masses, number of molecules of the first and second gas respectively, the temperature of mixture of these two gases is;

(A) $\frac{n_1F_1T_1 + n_2F_2T_2}{n_1F_1 + n_2F_2}$ **(B)** $\frac{n_1T_1 + n_2T_2}{n_1 + n_2}$

(C) $\frac{n_1F_1T_1 + n_2F_2T_2}{n_1 + n_2}$ **(D)** $\frac{n_1F_1T_1 + n_2F_2T_2}{F_1 + F_2}$

18. The volume V of an enclosure contains a mixture of three gases, 16 g of oxygen, 28 g of nitrogen and 44 g of carbon dioxide at absolute temperature T. Consider R as universal gas constant. The pressure of the mixture of gases is :

(A) $\frac{4RT}{V}$ **(B)** $\frac{3RT}{V}$ **(C)** $\frac{5}{2}\frac{RT}{V}$ **(D)** $\frac{88\,RT}{V}$

19. In thermodynamics, heat and work are :

(A) Intensive thermodynamic state variables

(B) Point functions

(C) Path functions

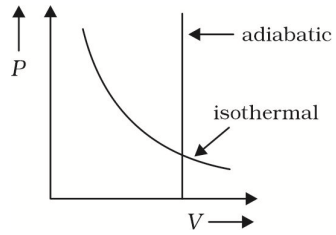
(D) Extensive thermodynamic state variables

20. If one mole of the polyatomic gas is having two vibrational modes and β is the ratio of molar specific heats for polyatomic gas $\left(\beta = \frac{C_P}{C_V}\right)$ then the value of β is :

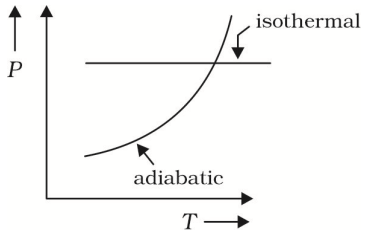
(A) 1.35 **(B)** 1.25 **(C)** 1.2 **(D)** 1.02

21. Which one is the correct option for the two different thermodynamic processes ?

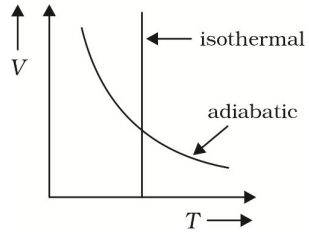
(a)



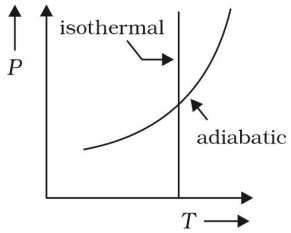
(b)



(c)

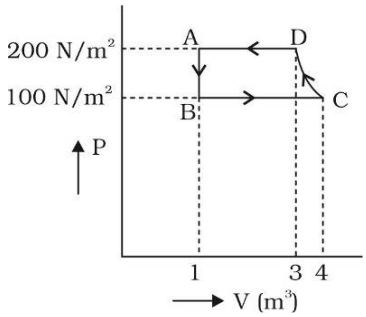


(d)



(A) (b) and (c) **(B)** (a) only **(C)** (c) and (d) **(D)** (c) and (a)

22. The P-V diagram of a diatomic ideal gas system going under cyclic process as shown in figure. The work done during an adiabatic process CD is (use $\gamma = 1.4$)



(A) 200 J **(B)** 400 J **(C)** –500 J **(D)** –400 J

23. What will be the average value of energy along one degree of freedom for an ideal gas in thermal equilibrium at a temperature T? (k_B is Boltzmann constant)

(A) $\frac{3}{2}k_BT$ **(B)** $\frac{2}{3}k_BT$ **(C)** k_BT **(D)** $\frac{1}{2}k_BT$

24. For an adiabatic expansion of an ideal gas, the fractional change in its pressure is equal to: (Where γ is the ratio of specific heats).

(A) $-\frac{1}{\gamma}\frac{dV}{V}$ **(B)** $-\gamma\frac{V}{dV}$ **(C)** $\frac{dV}{V}$ **(D)** $-\gamma\frac{dV}{V}$

25. An ideal gas in a cylinder is separated by a piston in such a way that the entropy of one part is S_1 and that of the other part is S_2. Given that $S_1 > S_2$. If the piston is removed then the total entropy of the system will be:

(A) $\frac{S_1}{S_2}$ **(B)** $S_1 - S_2$ **(C)** $S_1 \times S_2$ **(D)** $S_1 + S_2$

26. Consider a sample of oxygen behaving like an ideal gas. At 300 K, the ratio of root mean square (rms) velocity to the average velocity of gas molecule would be:
(Molecular weight of oxygen is 32 g/mol; R = 8.3 J K^{-1} mol^{-1})

(A) $\sqrt{\frac{8}{3}}$ **(B)** $\sqrt{\frac{3\pi}{8}}$ **(C)** $\sqrt{\frac{3}{3}}$ **(D)** $\sqrt{\frac{8\pi}{3}}$

27. Calculate the value of mean free path (λ) for oxygen molecules at temperature 27°C and pressure 1.01×10^5 Pa. Assume the molecular diameter 0.3 nm and the gas is ideal. ($k = 1.38\times10^{-23}$ JK^{-1})

(A) 86 nm **(B)** 102 nm **(C)** 58 nm **(D)** 32 nm

28. For an ideal heat engine, the temperature of the source is 127°C. In order to have 60% efficiency the temperature of the sink should be _____ °C. (Round off to the Nearest Integer)

29. An ideal gas is expanding such that PT^3 = constant. The coefficient of volume expansion of the gas is:

(A) $\frac{4}{T}$ **(B)** $\frac{2}{T}$ **(C)** $\frac{3}{T}$ **(D)** $\frac{1}{T}$

30. The balloon carries a total load of 185 kg at normal pressure and temperature of 27°C. What load will the balloon carry on rising to a height at which the barometric pressure is 45 cm of Hg and the temperature – 7°C. Assuming the volume constant?

(A) 181.46 kg **(B)** 123.54 kg **(C)** 219.07 kg **(D)** 214.15 kg

31. If the rms speed of oxygen molecules at 0°C is 160 m/s, find the rms speed of hydrogen molecules at 0°C.

(A) 40 m/s **(B)** 80 m/s **(C)** 332 m/s **(D)** 640 m/s

32. The rms speeds of the molecules of Hydrogen, Oxygen and Carbondioxide at the same temperature are V_H, V_O and V_C respectively then:

(A) $V_H = V_O > V_C$ **(B)** $V_C > V_O > V_H$

(C) $V_H = V_O = V_C$ **(D)** $V_H > V_O > V_C$

33. An electric appliance supplies 6000 J/min heat to the system. If the system delivers a power of 90 W. How long it would take to increase the internal energy by 2.5×10^3 J?

(A) 4.1×10^1 s **(B)** 2.5×10^2 s **(C)** 2.4×10^3 s **(D)** 2.5×10^1 s

34. A cylinder container of volume 4.0×10^{-3} m^3 contains one mole of hydrogen and two moles of carbon dioxide. Assume the temperature of the mixture is 400 K. The pressure of the mixture of gases is:
[Take gas constant as 8.3 J $mol^{-1}K^{-1}$]

(A) 24.9 Pa **(B)** 249×10^1 Pa **(C)** 24.9×10^5 Pa **(D)** 24.9×10^3 Pa

35. A refrigerator consumes an average 35 W power to operate between temperature –10°C to 25°C. If there is no loss of energy then how much average heat per second does it transfer?

(A) 35 J/s **(B)** 350 J/s **(C)** 263 J/s **(D)** 298 J/s

36. A heat engine operates between a cold reservoir at temperature $T_2 = 400K$ and a hot reservoir at temperature T_1. It takes 300J of heat from the hot reservoir and delivers 240J of heat to the cold reservoir in a cycle. The minimum temperature of the hot reservoir has to be _____ K.

37. For an ideal gas the instantaneous change in pressure 'p' with violume 'v' is given by the equation $\frac{dp}{dv} = -ap$. If $p = p_0$ at $v = 0$ is the given boundary condition, then the maximum temperature one mole of gas can attain is:
(Here R is the gas constant)

(A) $\frac{ap_0}{eR}$ **(B)** 0°C **(C)** infinity **(D)** $\frac{p_0}{aeR}$

38. A reversible engine has an efficiency of $\frac{1}{4}$. If the temperature of the sink is reduced by 58°C, its efficiency becomes double. Calculate the temperature of the sink:

(A) 280°C **(B)** 174°C **(C)** 180.4°C **(D)** 382°C

39. The temperature of 3.00 mol of an ideal diatomic gas is increased by 40.0°C without changing the pressure of the gas. The molecular in the gas rotate but do not oscillate. If the ratio of change in internal energy of the gas to the amount of work done by the gas is $\frac{x}{10}$. Then the value of x is:

40. The average translational kinetic energy of N_2 gas molecules at _____ °C becomes equal to the K.E. of an electron accelerated from rest through a potential difference of 0.1 volt. (Given $k_B = 1.38 \times 10^{-23} J / K$).

41. A mixture of hydrogen and oxygen has volume 500 cm^3, temperature 300 K, pressure 400 kPa and mass 0.76 g. The ratio of masses of oxygen to hydrogen will be :

(A) 16 : 3 **(B)** 3 : 16 **(C)** 8 : 3 **(D)** 3 : 8

42. A sample of gas with $\gamma = 1.5$ is taken through an adiabatic process in which the volume is compressed from 1200 cm^3 to 300 cm^3. If the initial pressure is 200 kPa. The absolute value of the workdone by the gas in the process $=$ _____ J.

43. The correct relation between the degrees of freedom f and the ratio of specific heat γ is:

(A) $f = \frac{2}{\gamma + 1}$ **(B)** $f = \frac{\gamma + 1}{2}$ **(C)** $f = \frac{2}{\gamma - 1}$ **(D)** $f = \frac{1}{\gamma + 1}$

44. A monoatomic ideal gas, initially at temperature T_1 is enclosed in a cylinder fitted with a frictionless piston. The gas is allowed to expand adiabatically to a temperature T_2 by releasing the piston suddenly. If l_1 and l_2 are the lengths of the gas column, before and after the expansion respectively, then the value of $\frac{T_1}{T_2}$ will be:

(A) $\frac{l_2}{l_1}$ **(B)** $\frac{l_1}{l_2}$ **(C)** $\left(\frac{l_2}{l_1}\right)^{\frac{2}{3}}$ **(D)** $\left(\frac{l_1}{l_2}\right)^{\frac{2}{3}}$

45. For a gas $C_P - C_V = R$ in a state P and $C_P - C_V = 1.10\ R$ in a state Q, T_P and T_Q are the temperatures in two different states P and Q respectively. Then

(A) $T_P < T_Q$ **(B)** $T_P > T_Q$ **(C)** $T_P = 0.9 T_Q$ **(D)** $T_P = T_Q$

46. A heat engine has an efficiency of $\frac{1}{6}$. When the temperature of sink is reduced by 62ºC, its efficiency get doubled. The temperature of the source is:

(A) 62ºC **(B)** 99ºC **(C)** 37ºC **(D)** 124ºC

47. A system consists of two types of gas molecules A and B having same number density $2 \times 10^{25} / m^3$. The diameter of A and B are $10 Å$ and $5 Å$ respectively. They suffer collision at room temperature. The ratio of average distance covered by the molecule A to that of B between two successive collision is _____ $\times 10^{-2}$.

48. One mole of an ideal gas is taken through an adiabatic process where the temperature rises from 27°C to 37°C. If the ideal gas is composed of polyatomic molecule that the 4 vibrational modes, which of the following is true ?

[R = 8.314 J mol^{-1} K^{-1}]

(A) Work done on the gas is close to 332 J **(B)** Work done by the gas is close to 582 J

(C) Work done on the gas is close to 582 J **(D)** Work done by the gas is close to 332 J

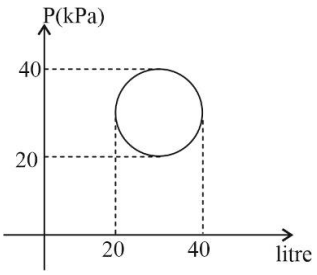
49. Two Carnot engines A and B operate in series such that engine A absorbs heat at T_1 and rejects heat to a sink at temperature T. Engine B absorbs half of the heat rejected by Engine A and rejects to the sink at T_3 . When workdone in both the cases is equal, the value of T is:

(A) $\frac{2}{3}T_1 + \frac{1}{3}T_3$ **(B)** $\frac{1}{3}T_1 + \frac{2}{3}T_3$ **(C)** $\frac{2}{3}T_1 + \frac{3}{2}T_3$ **(D)** $\frac{3}{2}T_1 + \frac{1}{3}T_3$

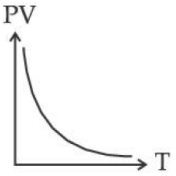
50. The amount of heat needed to raise the temperature of 4 moles of a rigid diatomic gas from 0°C when no work is done is _____. (R is the universal gas constant)

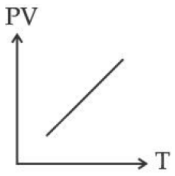
(A) 750 R **(B)** 500 R **(C)** 250 R **(D)** 175 R

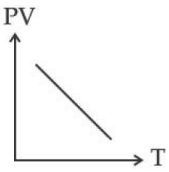
51. In the reported figure, heat energy absorbed by a system in going through a cyclic process is _____ πJ.

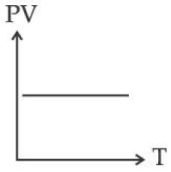


52. Which of the following graphs represent the behavior of an ideal gas? Symbols have their usual meaning.

(A) 

(B) 

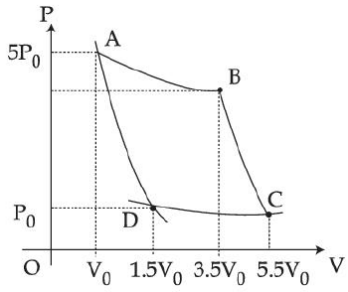
(C) 

(D) 

53. The number of molecules in one litre of an ideal gas at 300K and 2 atmosphere pressure with mean kinetic energy $2\times10^{-9}J$ per molecule is :

(A) 0.75×10^{11} **(B)** 3×10^{11} **(C)** 1.5×10^{11} **(D)** 6×10^{11}

54. In the reported figure, there is a cyclic process *ABCDA* on a sample of 1 mole of a diatomic gas. The temperature of the gas during the process $A \to B$ and $C \to D$ are T_1 and $T_2 (T_1 > T_2)$ respectively.

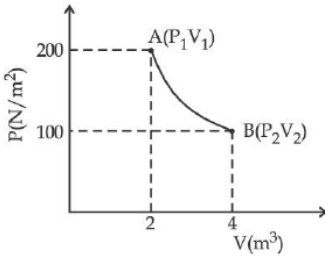


Choose the correct option out of the following for work done if processes *BC* and *DA* are adiabatic.

(A) $W_{AB} = W_{DC}$ **(B)** $W_{AD} = W_{BC}$ **(C)** $W_{AB} < W_{CD}$ **(D)** $W_{BC} + W_{DA} > 0$

55. One mole of an ideal gas at 27°C is taken from A to B as shown in the given PV indicator diagram. The work done by the system will be _____ $\times 10^{-1} J$.

[Given : R = 8.3 J/mol K, ln 2 = 0.6931]

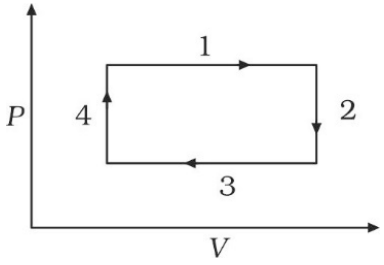


56. Consider a mixture of gas molecule of types A, B and C having masses $m_A < m_B < m_C$. The ratio of their root mean square speeds at normal temperature and pressure is:

(A) $v_A = v_B \neq v_C$ **(B)** $\frac{1}{v_A} < \frac{1}{v_B} < \frac{1}{v_C}$ **(C)** $v_A = v_B = v_C = 0$ **(D)** $\frac{1}{v_A} > \frac{1}{v_B} > \frac{1}{v_C}$

JEE Advanced 2021

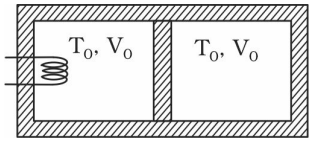
1. An ideal gas undergoes a four step cycle as shown in the $P-V$ diagram below. During this cycle, heat is absorbed by the gas in



(A) steps 1 and 2 **(B)** steps 1 and 3 **(C)** steps 1 and 4 **(D)** steps 2 and 4

Paragraph

A thermally insulating cylinder has a thermally insulating and frictionless movable partition in the middle, as shown in the figure below. On each side of the partition, there is one mole of an ideal gas, with specific heat at constant volume, $C_V = 2R$. Here, R is the gas constant. Initially, each side has a volume V_0 and temperature T_0. The left side has an electric heater, which is turned on at very low power to transfer heat Q to the gas on the left side. As a result the partition moves slowly towards the right reducing the right side volume to $V_0/2$. Consequently, the gas temperatures on the left and the right sides become T_L and T_R, respectively. Ignore the changes in the temperatures of the cylinder, heater and the partition.



2. The value of $\frac{T_R}{T_0}$ is:

(A) $\sqrt{2}$ **(B)** $\sqrt{3}$ **(C)** 2 **(D)** 3

3. The value of $\frac{Q}{RT_0}$ is:

(A) $4(2\sqrt{2}+1)$ **(B)** $4(2\sqrt{2}-1)$ **(C)** $(5\sqrt{2}+1)$ **(D)** $(5\sqrt{2}-1)$

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Archive - JEE Main & Advanced

Gaseous State and Thermodynamics	Class - XI | Physics

JEE Main 2022

1. Given below are two statements:

Statement-I: When μ amount of an ideal gas undergoes adiabatic change from state (P_1,V_1,T_1) to state (P_2,V_2,T_2), then work done is $W=\frac{\mu R(T_2-T_1)}{1-\gamma}$, where $\gamma=\frac{C_p}{C_v}$ and $R=$ universal gas constant.

Statement-II: In the above case, when work is done on the gas, the temperature of the gas would rise.

Choose the correct answer from the options given below:

(A) Both statement-I and statement-II are true.

(B) Both statement-I and statement-II are false

(C) Statement-I is true but statement-II is false

(D) Statement-I is false but statement-II is true.

2. The ratio of specific heats $\left(\frac{C_P}{C_V}\right)$ in terms of degree of freedom (f) is given by :

(A) $\left(1+\frac{f}{3}\right)$ **(B)** $\left(1+\frac{2}{f}\right)$ **(C)** $\left(1+\frac{f}{2}\right)$ **(D)** $\left(1+\frac{1}{f}\right)$

3. A vessel contains 16 *g* of hydrogen and 128 *g* of oxygen at standard temperature and pressure. The volume of the vessel in cm^3 is:

(A) 72×10^5 **(B)** 32×10^5 **(C)** 27×10^5 **(D)** 54×10^5

4. A Carnot engine whose heat sinks at 27°C, has an efficiency of 25%. By how many degrees should the temperature of the source be changed to increase the efficiency by 100% of the original efficiency ?

(A) Increases by 18°C **(B)** Increases by 200°C

(C) Increases by 120°C **(D)** Increases by 73°C

5. 0.056 kg of Nitrogen is enclosed in a vessel at a temperature of 127°C. The amount of heat required to double the speed of its molecules is _____ k cal.

(Take R = 2 cal $mole^{-1}$ K^{-1})

6. A Carnot engine takes 5000 kcal of heat from a reservoir at 727°C and gives heat to a sink at 127°C. The work done by engine is:

(A) $3\times10^6 J$ **(B)** Zero **(C)** $12.6\times10^6 J$ **(D)** $8.4\times10^6 J$

7. A monoatomic gas performs a work of $\frac{Q}{4}$ where *Q* is the heat supplied to it. The molar heat capacity of the gas will be _____ R during this transformation. Where *R* is the gas constant.

8. The relation between root mean square speed (v_{rms}) and most probable speed (v_p) for molar mass M of oxygen gas molecule at the temperature of 300 K will be:

(A) $v_{rms} = \sqrt{\frac{2}{3}} v_p$ **(B)** $v_{rms} = \sqrt{\frac{3}{2}} v_p$ **(C)** $v_{rms} = v_p$ **(D)** $v_{rms} = \sqrt{\frac{1}{3}} v_p$

9. When a gas filled in a closed vessel is heated by raising the temperature by 1°C, its pressure increases by 0.4%. The initial temperature of the gas is _____ *K*.

10. The efficiency of a Carnot's engine, working between steam point and ice point, will be:

(A) 26.81% **(B)** 37.81% **(C)** 47.81% **(D)** 57.81%

11. A thermally insulated vessel contains an ideal gas of molecular mass M and ratio of specific heats 1.4. Vessel is moving with speed υ and is suddenly brought to rest. Assuming no heat is lost to the surrounding and vessel temperature of the gas increases by: (R = universal gas constant)

(A) $\frac{M\upsilon^2}{7R}$ **(B)** $\frac{M\upsilon^2}{5R}$ **(C)** $2\frac{M\upsilon^2}{7R}$ **(D)** $7\frac{M\upsilon^2}{5R}$

12. A flask contains argon and oxygen in the ratio of 3 : 2 in mass and the mixture is kept at 27°C. The ratio of their average kinetic energy per molecule respectively will be:

(A) 3 : 2 **(B)** 9 : 4 **(C)** 2 : 3 **(D)** 1 : 1

13. A heat engine operates with the cold reservoir at temperature 324 *K*. The minimum temperature of the hot reservoir, if the heat engine takes 300 *J* heat from the hot reservoir and delivers 180 *J* heat to the cold reservoir per cycle, is _____ *K*.

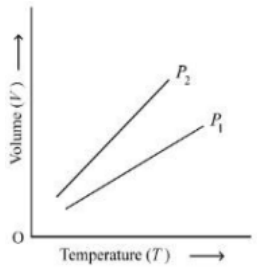
14. A mixture of hydrogen and oxygen has volume $2000\,cm^3$, temperature 300 K, pressure 100 kPa and mass 0.76 g. The ratio of number of moles of hydrogen to number of moles of oxygen in the mixture will be:

[Take gas constant $R = 8.3\,JK^{-1}mol^{-1}$]

(A) $\frac{1}{3}$ **(B)** $\frac{3}{1}$ **(C)** $\frac{1}{16}$ **(D)** $\frac{16}{1}$

15. In a carnot engine, the temperature of reservoir is 527°C and that of sink is 200 K. If the workdone by the engine when it transfers heat from reservoir to sink is 12000 kJ, the quantity of heat absorbed by the engine from reservoir is _____ $\times 10^6 J$.

16. For a perfect gas, two pressures P_1 and P_2 are shown in figure. The graph shows:



(A) $P_1 > P_2$

(B) $P_1 < P_2$

(C) $P_1 = P_2$

(D) Insufficient data to draw any conclusion

17. According to kinetic theory of gases,

A. The motion of the gas molecules freezes at 0°C.

B. The mean free path of gas molecules decreases if the density of molecules is increased.

C. The mean free path of gas molecules increases if temperature is increased keeping pressure constant.

D. Average kinetic energy per molecule per degree of freedom is $\frac{3}{2}k_BT$ (for monoatomic gases).

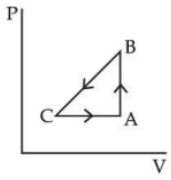
Choose the most appropriate answer from the potions given below:

(A) A and C only **(B)** B and C only **(C)** A and B only **(D)** C and D only

18. A diatomic gas $(\gamma = 1.4)$ does 400J of work when it is expanded isobarically. The heat given to the gas in the process is _____J.

19. The total internal energy of two mole monoatomic ideal gas at temperature T = 300 K will be _____ J. (Given R = 8.31 J/mol. K)

20. A sample of an ideal gas is taken through the cyclic process $ABCA$ as shown in figure. It absorbs, $40\,J$ of heat during the part AB, no heat during BC and rejects $60\,J$ of heat during CA. A work of $50\,J$ is done on the gas during the part BC. The internal energy of the gas at A is $1560\,J$. The workdone by the gas during the part CA is:



(A) $20\,J$ **(B)** $30\,J$ **(C)** $-30\,J$ **(D)** $-60\,J$

21. What will be the effect on the root mean square velocity of oxygen molecules if the temperature is doubled and oxygen molecule dissociates into atomic oxygen?

(A) The velocity of atomic oxygen remains same

(B) The velocity of atomic oxygen doubles

(C) The velocity of atomic oxygen becomes half

(D) The velocity of atomic oxygen becomes four times

22. A cylinder of fixed capacity of 44.8 litres contains helium gas at standard temperature and pressure. The amount of heat needed to raise the temperature of gas in the cylinder by 20.0°C will be: (Given gas constant R = 8.3 JK^{-1}-mol^{-1})

(A) 249 J **(B)** 415 J **(C)** 498 J **(D)** 830 J

23. 300 cal. of heat is given to a heat engine and it rejects 225 cal. of heat. If source temperature is 227°C, then the temperature of sink will be _____ °C.

24. Starting with the same initial conditions, an ideal gas expands from volume V_1 to V_2 in three different ways. The work done by the gas is W_1 if the process is purely isothermal, W_2, if the process is purely adiabatic and W_3 if the process is purely isobaric. Then, choose the correct option.

(A) $W_1 < W_2 < W_3$ **(B)** $W_2 < W_3 < W_1$ **(C)** $W_3 < W_1 < W_2$ **(D)** $W_2 < W_1 < W_3$

25. A certain amount of gas of volume V at 27°C temperature and pressure $2\times10^7\,Nm^{-2}$ expands isothermally until its volume gets doubled. Later it expands adiabatically until its volume gets redoubled. The final pressure of gas will be (Use $\gamma = 1.5$)

(A) $3.536\times10^5\,Pa$ **(B)** $3.536\times10^6\,Pa$ **(C)** $1.25\times10^6\,Pa$ **(D)** $1.25\times10^5\,Pa$

26. Following statements are given:

I. The average kinetic energy of a gas molecule decreases when the temperature is reduced.

II. The average kinetic energy of a gas molecule increases with increase in pressure at constant temperature.

III. The average kinetic energy of a gas molecule decreases with increase in volume

IV. Pressure of a gas increases with increase in temperature at constant pressure

V. The volume of gas decreases with increase in temperature

Choose the correct answer from the options given below:

(A) I and IV only **(B)** I, II and IV only

(C) II and IV only **(D)** I, II and V only

27. Let η_1 is the efficiency of an engine at $T_1 = 447°C$ and $T_2 = 147°C$ while η_2 is the efficiency at $T_1 = 947°C$ and $T_2 = 47°C$. The ratio $\frac{\eta_1}{\eta_2}$ will be:

(A) 0.41 **(B)** 0.56 **(C)** 0.73 **(D)** 0.70

28. 7 mol of a certain monoatomic ideal gas undergoes a temperature increase of 40K at constant pressure. The increase in the internal energy of the gas in this process is: (Given $R = 8.3JK^{-1}\,mol^{-1}$)

(A) 5810J **(B)** 3486J **(C)** 11620J **(D)** 6972J

29. A monoatomic gas at pressure P and volume V is suddenly compressed to one eighth of its original volume. The final pressure at constant entropy will be:

(A) P **(B)** 8P **(C)** 32P **(D)** 64P

30. A gas has *n* degrees of freedom. The ratio of specific heat of gas at constant volume to the specific heat of gas at constant pressure will be:

(A) $\frac{n}{n+2}$ **(B)** $\frac{n+2}{n}$ **(C)** $\frac{n}{2n+2}$ **(D)** $\frac{n}{n-2}$

31. Read the following statements:

(I) When small temperature difference between a liquid and its surrounding is doubled, the rate of loss of heat of the liquid becomes twice

(II) Two bodies *P* and *Q* having equal surface areas are maintained at temperature 10°*C* and 20°*C*. The thermal radiation emitted in a given time by *P* and *Q* are in the ratio 1 : 1.15

(III) A Carnot Engine working between 100 *K* and 400 *K* has an efficiency of 75%

(IV) When small temperature difference between a liquid and its surrounding is quadrupled, the rate of loss of heat of the liquid becomes twice.

(A) I, II, III only **(B)** I, II only **(C)** I, III only **(D)** II, III, IV only

32. Same gas is filled in two vessels of the same volume at the same temperature. If the ratio of the number of molecules is 1 : 4. Then:

(I) The r.m.s. velocity of gas molecules in two vessels will be the same

(II) The ratio of pressure in these vessels will be 1 : 4

(III) The ratio of pressure will be 1 : 1

(IV) The r.m.s. velocity of gas molecules in two vessels will be in the ratio of 1 : 4

(A) (I) and (III) only **(B)** (II) and (IV) only

(C) (I) and (II) only **(D)** (III) and (IV) only

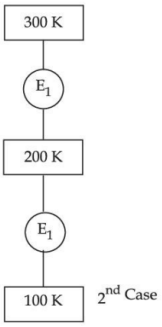
33. In 1st case. Carnot engine operates between temperature 300 K and 100 K. In 2nd case, as shown in the figure, a combination of two engines is used. The efficiency of this combination (in 2nd case) will be:

(A) Same as the 1st case

(B) Always greater than the 1st case

(C) Always less than the 1st case

(D) May increase or decreased with respect to the 1st case.



34. Which statements are correct about degrees of freedom?

(A) A molecule with n degrees of freedom has n^2 different ways of storing energy.

(B) Each degree of freedom is associated with $\frac{1}{2}RT$ average energy per mole.

(C) A monatomic gas molecule has 1 rotational degree of freedom where as diatomic molecule has 2 rotational degrees of freedom.

(D) CH_4 has a total of 6 degrees of freedom.

Choose the correct answer from the options given below:

(A) (B) and (C) only **(B)** (B) and (D) only

(C) (A) and (B) only **(D)** (C) and (D) only

35. A Carnot engine has efficiency of 50%. If the temperature of sink is reduced by 40°*C*, its efficiency increases by 30%. The temperature of the source will be:

(A) 166.7 *K* **(B)** 255.1*K* **(C)** 266.7 *K* **(D)** 367.7 *K*

36. Given below are two statements :

Statement I: The average momentum of a molecule in a sample of an ideal gas depends on temperature.

Statement II: The rms speed of oxygen molecules in a gas is *v*. If the temperature is doubled and the oxygen molecules dissociate into oxygen atoms, the rms speed will become 2*v*.

In the light of the above statements, choose the correct answer from the options given below:

(A) Both Statement I and Statement II are true

(B) Both Statement I and Statement II are false

(C) Statement I is true but Statement II is false

(D) Statement I is false but Statement II is true

37. A vessel contains 14g of nitrogen gas at a temperature of 27°C. The amount of heat to be transferred to the gas to double the r.m.s. speed of its molecules will be: (Take : $R = 8.32 J\, mol^{-1} k^{-1}$).

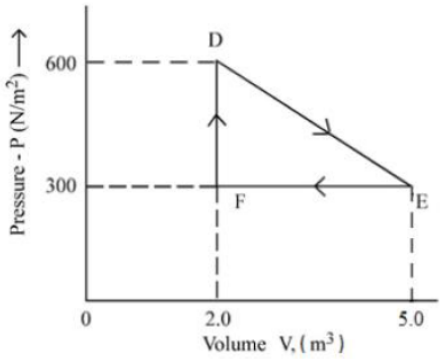
(A) 2229 J **(B)** 5616 J **(C)** 9360 J **(D)** 13.104 J

38. At a certain temperature, the degrees of freedom per molecule for gas is 8. The gas performs 150 J of work when it expands under constant pressure. The amount of heat absorbed by the gas will be _____ J.

39. The pressure P_1 and density d_1 of diatomic gas $\left(\gamma = \frac{7}{5}\right)$ changes suddenly to $P_2 (> P_1)$ and d_2 respectively during an adiabatic process. The temperature of the gas increases and becomes ____ times of its initial temperature. (Given : $\frac{d_2}{d_1} = 32$)

40. One mole of a monoatomic gas is mixed with three moles of a diatomic gas. The molecular specific heat of mixture at constant volume is $\frac{\alpha^2}{4} R\ J\ /\ mol\ K$; then the value of α will be _____. (Assume that the given diatomic gas has no vibrational mode).

41. A thermodynamic system is taken from an original state *D* to an intermediate state *E* by the linear process shown in the figure. Its volume is then reduced to the original volume from *E* to *F* by an isobaric process. The total work done by the gas from *D* to *E* to *F* will be:



(A) $-450J$ **(B)** $450J$ **(C)** $900J$ **(D)** $1350J$

42. The root mean square speed of smoke particles of mass $5\times10^{-17}kg$ in their Brownian motion in air at NTP is approximately. [Given $k=1.38\times10^{-23}JK^{-1}$]

(A) $60mm\,s^{-1}$ **(B)** $12mm\,s^{-1}$ **(C)** $15mm\,s^{-1}$ **(D)** $36mm\,s^{-1}$

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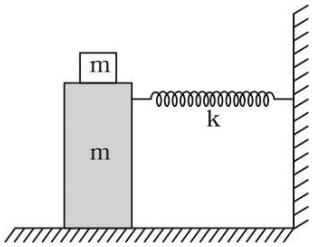
Archive - JEE Main & Advanced

Simple Harmonic Motion	Class - XI | Physics

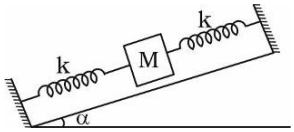
JEE Main 2021

1. In the given figure, *a* mass M is attached to a horizontal spring which is fixed on one side to a rigid support. The spring constant of the spring is *k*. The mass oscillates on a frictionless surface with time period T and amplitude A. When the mass is in equilibrium position, as shown in the figure, another mass *m* is gently fixed upon it. The new amplitude of oscillation will be:



(A) $A\sqrt{\frac{M+m}{M}}$ **(B)** $A\sqrt{\frac{M}{M+m}}$ **(C)** $A\sqrt{\frac{M-m}{M}}$ **(D)** $A\sqrt{\frac{M}{M-m}}$

2. In the given figure, a body of mass *M* is held between two massless springs, on a smooth inclined plane. The free ends of the springs are attached to firm supports. If each spring has spring constant *k*, the frequency of oscillation of given body is:



(A) $\frac{1}{2\pi}\sqrt{\frac{k}{Mg\sin\alpha}}$ **(B)** $\frac{1}{2\pi}\sqrt{\frac{k}{2M}}$ **(C)** $\frac{1}{2\pi}\sqrt{\frac{2k}{Mg\sin\alpha}}$ **(D)** $\frac{1}{2\pi}\sqrt{\frac{2k}{M}}$

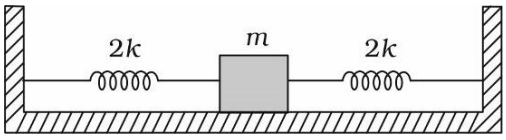
3. When a particle executes SHM, the nature of graphical representation of velocity as a function of displacement is:

(A) parabolic **(B)** straight line **(C)** elliptical **(D)** circular

4. If the time period of a two meter long simple pendulum is 2 s, the acceleration due to gravity at the place where pendulum is executing S.H.M. is :

(A) $2\pi^2 ms^{-2}$ **(B)** $\pi^2 ms^{-2}$ **(C)** $9.8\ ms^{-2}$ **(D)** $16\ ms^{-2}$

5. Two identical springs of spring constant '2*k*' are attached to a block of mass m and to fixed support (see figure). When the mass is displaced from equilibrium position on either side, it executes simple harmonic motion. The time period of oscillations of this system is:

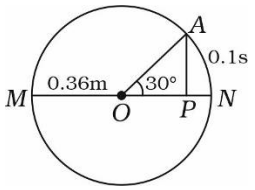


(A) $\pi\sqrt{\frac{m}{2k}}$ **(B)** $2\pi\sqrt{\frac{m}{2k}}$ **(C)** $2\pi\sqrt{\frac{m}{k}}$ **(D)** $\pi\sqrt{\frac{m}{k}}$

6. $Y = A\sin(\omega t + \phi_0)$ is the time-displacement equation of a SHM. At $t = 0$ the displacement of the particle is $Y = \frac{A}{2}$ and it is moving along negative *x*-direction. Then the initial phase angle ϕ_0 will be:

(A) $\frac{\pi}{3}$ **(B)** $\frac{5\pi}{6}$ **(C)** $\frac{\pi}{6}$ **(D)** $\frac{2\pi}{3}$

7. The point A moves with a uniform speed along the circumference of a circle of radius 0.36m and covers 30° in 0.1s. The perpendicular projection '*P*' from '*A*' on the diameter *MN* represents the simple harmonic motion of '*P*'. The restoration force per unit mass when *P* touches *M* will be:



(A) 50 N **(B)** 100 N **(C)** 9.87 N **(D)** 0.49 N

8. If two similar springs each of spring constant K_1 are joined in series, the new spring constant and time period would be changed by a factor :

(A) $\frac{1}{2}, \sqrt{2}$ **(B)** $\frac{1}{2}, 2\sqrt{2}$ **(C)** $\frac{1}{4}, 2\sqrt{2}$ **(D)** $\frac{1}{4}, \sqrt{2}$

9. Assume that a tunnel is dug along a chord of the earth, at a perpendicular distance $(R / 2)$ from the earths centre, where '*R*' is the radius of the Earth. The wall of the tunnel is frictionless. If a particle is released in this tunnel, it will execute a simple harmonic motion with a time period :

(A) $2\pi\sqrt{\frac{R}{g}}$ **(B)** $\frac{g}{2\pi R}$ **(C)** $\frac{1}{2\pi}\sqrt{\frac{g}{R}}$ **(D)** $\frac{4\pi R}{g}$

10. A particle executes S.H.M., the graph of velocity as a function of displacement is :

(A) a circle **(B)** a helix **(C)** an ellipse **(D)** a parabola

11. Given below are two statements:

Statement I : A second's pendulum has a time period of 1 second.

Statement II : It takes precisely one second to move between the two extreme positions.

In the light of the above statements, choose the correct answer from the options given below:

(A) Statement I is true but Statement II is false

(B) Statement I is false but Statement II is true

(C) Both Statement I and Statement II are true

(D) Both Statement I and Statement II are false

12. A particle executes S.H.M. with amplitude `*a*' and time period `*T*'. The displacement of the particle when its speed is half of maximum speed is $\frac{\sqrt{x}\,a}{2}$. The value of *x* is _____ .

13. Time period of a simple pendulum is *T*. The time taken to complete $\frac{5}{8}$ oscillations starting from mean position is $\frac{\alpha}{\beta}T$. The value of α is _____.

14. A block of mass 1*kg* attached to a spring is made to oscillate with an initial amplitude of 12*cm*. After 2 minutes the amplitude decreases to 6*cm*. Determine the value of the damping constant for this motion. (Take $\ln 2 = 0.693$)

(A) $5.7\times10^{-3}\,kg\,s^{-1}$ **(B)** $1.16\times10^{2}\,kg\,s^{-1}$

(C) $3.3\times10^{2}\,kg\,s^{-1}$ **(D)** $0.69\times10^{2}\,kg\,s^{-1}$

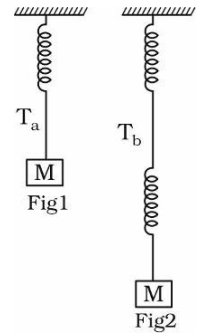
15. Two particles A and B of equal masses are suspended from two massless springs of spring constants K_1 and K_2 respectively. If the maximum velocities during oscillations are equal, the ratio of the amplitude of *A* and *B* is :

(A) $\frac{K_1}{K_2}$ **(B)** $\sqrt{\frac{K_2}{K_1}}$ **(C)** $\sqrt{\frac{K_1}{K_2}}$ **(D)** $\frac{K_2}{K_1}$

16. For what value of displacement the kinetic energy and potential energy of a simple harmonic oscillation become equal?

(A) $x = 0$ **(B)** $x = \pm \frac{A}{\sqrt{2}}$ **(C)** $x = \pm A$ **(D)** $x = \frac{A}{2}$

17. Consider two identical springs each of spring constant k and negligible mass compared to the mass M as shown. Figure 1 shows one of them and Figure 2 shows their series combination. The ratio of time period of oscillation of the two SHM is $\frac{T_b}{T_a} = \sqrt{x}$, where value of *x* is _____. (Round off to the Nearest Integer)



18. Time period of a simple pendulum is T inside a lift when the lift is stationary. If the lift moves upwards with an acceleration $g/2$, the time period of pendulum will be :

(A) $\sqrt{3}\,T$ **(B)** $\sqrt{\frac{2}{3}}\,T$ **(C)** $\sqrt{\frac{3}{2}}\,T$ **(D)** $\frac{T}{\sqrt{3}}$

19. A particle performs simple harmonic motion with a period of 2 second. The time taken by the particle to cover a displacement equal to half of its amplitude from the mean position is $\frac{1}{a}s$.

The value of '*a*' to the nearest integer is _____ .

20. The function of time representing a simple harmonic motion with a periodic of $\frac{\pi}{\omega}$ is:

(A) $\sin^2(\omega t)$ **(B)** $\cos(\omega t) + \cos(2\omega t) + \cos(3\omega t)$

(C) $\sin(\omega t) + \cos(\omega t)$ **(D)** $3\cos\left(\frac{\pi}{4} - 2\omega t\right)$

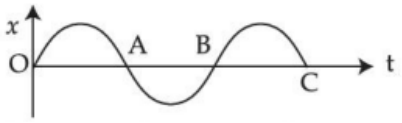
21. Amplitude of a mass-spring system, which is executing simple harmonic motion decreases with time. If mass = 500 g, Decay constant = 20 g/s then how much time is required for the amplitude of the system to drop to half of its initial value ?

(ln 2 = 0.693)

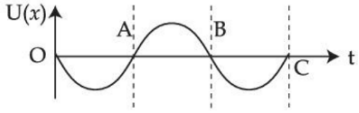
(A) 17.32 s **(B)** 0.034 s **(C)** 34.65 s **(D)** 15.01 s

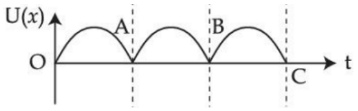
22. Two simple harmonic motions are represented by the equations $x_1 = 5\sin\left(2\pi t + \frac{\pi}{4}\right)$ and $x_2 = 5\sqrt{2}(\sin 2\pi t + \cos 2\pi t)$. The amplitude of second motion is _____ times the amplitude in first motion.

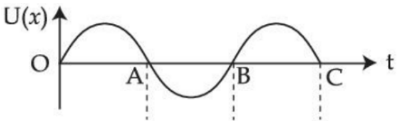
23. The variation of displacement with time of a particle executing free simple harmonic motion is shown in the figure.

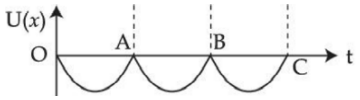


The potential energy $U(x)$ versus time (t) plot of the particle is correctly shown in figure :

(A) 

(B) 

(C) 

(D) 

24. Two simple harmonic motion, are represented by the equations

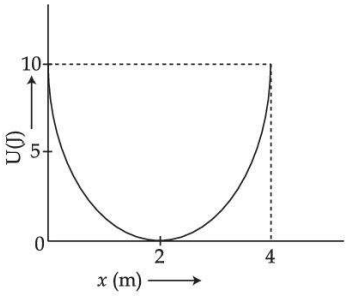
$y_1 = 10\sin\left(3\pi t + \frac{\pi}{3}\right)$

$y_2 = 5\left(\sin 3\pi t + \sqrt{3}\cos 3\pi t\right)$

Ratio of amplitude of y_1 to $y_2 = x:1$. The value of x is _____.

25. A particle of mass 1kg is hanging from a spring of force constant $100 Nm^{-1}$. The mass is pulled slightly downward and released so that it executes free simple harmonic motion with time period T. The time when the kinetic energy and potential energy of the system will become equal, is $\frac{T}{x}$. The value of x is _____ .

26. A mass of 5 kg is connected to a spring. The potential energy curve of the simple harmonic motion executed by the system is shown in the figure. A simple pendulum of length 4 m has the same period of oscillation as the spring system.



(A) $5\ m/s^2$ **(B)** $9.8\ m/s^2$

(C) $10\ m/s^2$ **(D)** $4\ m/s^2$

27. A bob of mass 'm' suspended by a thread of length l undergoes simple harmonic oscillations with time period T. If the bob is immersed in a liquid that has density $\frac{1}{4}$ times that of the bob and the length of the thread is increased by $l/3^{rd}$ of the original length, then the time period of the simple harmonic oscillations will be :

(A) T **(B)** $\frac{3}{4}T$ **(C)** $\frac{3}{2}T$ **(D)** $\frac{4}{3}T$

28. For a body executing S.H.M.:

(a) Potential energy is always equal to its K.E.

(b) Average potential and kinetic energy over any given time interval are always equal.

(c) Sum of the kinetic and potential energy at any point of time is constant.

(d) Average K.E. in one time period is equal to average potential energy in one time period.

Choose the most appropriate option from the options given below :

(A) (b) and (c) **(B)** only (b) **(C)** (c) and (d) **(D)** only (c)

29. In a simple harmonic oscillation, what fraction of total mechanical energy is in the form of kinetic energy, when the particle is midway between mean and extreme position.

(A) $\frac{3}{4}$ **(B)** $\frac{1}{2}$ **(C)** $\frac{1}{4}$ **(D)** $\frac{1}{3}$

30. A particle starts executing simple harmonic motion (SHM) of amplitude 'a' and total energy E. At any instant, its kinetic energy is $\frac{3E}{4}$ then its displacement 'y' is given by :

(A) $y = a$ **(B)** $y = \frac{a\sqrt{3}}{2}$ **(C)** $y = \frac{a}{2}$ **(D)** $y = \frac{a}{\sqrt{2}}$

31. An object of mass 0.5 kg is executing simple harmonic motion. Its amplitude is 5 cm and time period (T) is 0.2 s. What will be the potential energy of the object at an instant $t = \frac{T}{4}s$ starting from mean position. Assume that the initial phase of the oscillation is zero.

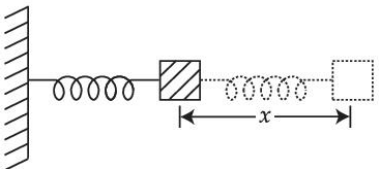
(A) $1.2 \times 10^3 J$ **(B)** $6.2 \times 10^3 J$ **(C)** $0.62J$ **(D)** $6.2 \times 10^{-3} J$

32. A particle executes simple harmonic motion represented by displacement function as $x(t) = A\sin(\omega t + \phi)$ If the position and velocity of the particle at t = 0 s are 2 cm and 2ω cm s^{-1} respectively, then its amplitude is $x\sqrt{2}cm$ where the value of x is_____.

33. T_0 is the time period of a simple pendulum at a place. If the length of the pendulum is reduced to $\frac{1}{16}$ times of its initial value, the modified time period is:

(A) $8\pi\, T_0$ **(B)** T_0 **(C)** $\frac{1}{4}T_0$ **(D)** $4\, T_0$

34. The motion of a mass on a spring, with spring constant K is as shown in figure.



The equation of motion is given by $x(t) = A\sin\omega t + B\cos\omega t$ with $\omega = \sqrt{\frac{K}{m}}$

Suppose that at time t = 0, the position of mass is $x(0)$ and velocity $v(0)$, then its displacement can also be represented as $x(t) = C\cos(\omega t - \phi)$, where C and ϕ are:

(A) $C = \sqrt{\frac{v(0)^2}{\omega^2} + x(0)^2}, \phi = \tan^{-1}\left(\frac{v(0)}{x(0)\omega}\right)$ **(B)** $C = \sqrt{\frac{2v(0)^2}{\omega^2} + x(0)^2}, \phi = \tan^{-1}\left(\frac{v(0)}{x(0)\omega}\right)$

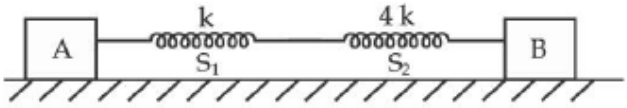
(C) $C = \sqrt{\frac{v(0)^2}{\omega^2} + x(0)^2}, \phi = \tan^{-1}\left(\frac{x(0)\omega}{v(0)}\right)$ **(D)** $C = \sqrt{\frac{2v(0)^2}{\omega^2} + x(0)^2}, \phi = \tan^{-1}\left(\frac{x(0)\omega}{2v(0)}\right)$

35. A particle is making simple harmonic motion along the X-axis. If at a distances x_1 and x_2 from the mean position the velocities of the particle are v_1 and v_2 respectively. The time period of its oscillation is given as:

(A) $T = 2\pi\sqrt{\frac{x_2^2 + x_1^2}{v_1^2 - v_2^2}}$ **(B)** $T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{v_1^2 + v_2^2}}$

(C) $T = 2\pi\sqrt{\frac{x_2^2 + x_1^2}{v_1^2 + v_2^2}}$ **(D)** $T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{v_1^2 - v_2^2}}$

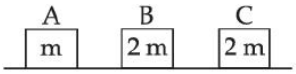
36. In the reported figure, two bodies A and B of masses 200 *g* and 800 *g* are attached with the system of springs. Springs are kept in a stretched position with some extension when the system is released. The horizontal surface is assumed to frictionless. The angular frequency will be _____ rad/s when k = 20 N/*m*.



37. A body at rest is moved along a horizontal straight line by a machine delivering a constant power. The distance moved by the body in time '*t*' is proportional to:

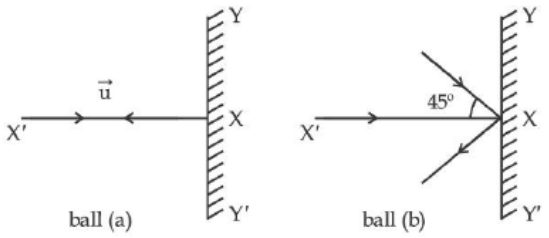
(A) $t^{\frac{1}{4}}$ **(B)** $t^{\frac{1}{2}}$ **(C)** $t^{\frac{3}{4}}$ **(D)** $t^{\frac{3}{2}}$

38. These objects *A*, *B* and *C* are kept in a straight line on a frictionless horizontal surface. The masses of *A*, *B* and *C* are *m*, 2*m* and 2*m* respectively. *A* moves towards *B* with a speed of $9m/s$ and makes an elastic collision with it. Thereafter *B* makes completely inelastic collision with *C*. All motions occurs along same straight line. The final speed of *C* is :



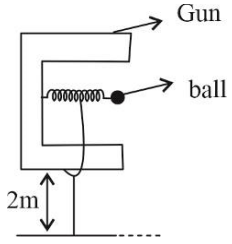
(A) $6m/s$ **(B)** $4m/s$ **(C)** $3m/s$ **(D)** $9m/s$

39. Two billiard balls of equal mass 30 *g* strike a rigid wall with same speed of 108 *kmph* (as shown) but at different angles. If the balls get reflected with the same speed then the ratio of the magnitude of impulses imparted to ball 'a' and ball 'b' by the wall along 'X' direction is :



(A) 1 : 1 **(B)** 2 : 1 **(C)** $\sqrt{2}:1$ **(D)** $1:\sqrt{2}$

40. In a spring gun having spring constant 100 N/m a small ball '*B*' of mass 100 g is put in its barrel (as shown in figure) by compressing the spring through 0.05 m. There should be a box placed at a distance 'd' on the ground so that the ball falls in it. If the ball leaves the gun horizontally at a height of 2 m above the ground. The value of d is _____ m. ($g = 10m/s^2$).



41. A bullet of $4g$ mass is fired from a gun of mass 4 *kg*. If the bullet moves with the muzzle speed of $50\,ms^{-1}$, the impulse imparted to the gun and velocity of recoil of gun are:

(A) 0.2 $kg\ ms^{-1}$, 0.1 ms^{-1} **(B)** 0.4 $kg\ ms^{-1}$, 0.05 ms^{-1}

(C) 0.2 $kg\ ms^{-1}$, 0.05 ms^{-1} **(D)** 0.4 $kg\ ms^{-1}$, 0.1 ms^{-1}

42. A porter lifts a heavy suitcase of mass 80 *kg* and at the destination lowers it down by a distance of 80 *cm* with a constant velocity. Calculate the workdone by the porter in lowering the suitcase.

(Take $g = 9.8\ ms^{-2}$)

(A) 784.0 *J* **(B)** –62720.0 *J* **(C)** –627.2 *J* **(D)** +627.2 *J*

43. The position of the centre of mass of a uniform semi-circular wire of radius '*R*' placed in *x*-*y* plane with its centre at the origin and the line joining its ends as *x*-axis is given by $\left(0, \frac{xR}{\pi}\right)$. Then, the value of $|x|$ is _____.

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Simple Harmonic Motion	Class - XI | Physics

JEE Main 2022

1. Two massless springs with spring constants 2 k and 9 k, carry 50 g and 100 g masses at their free ends. These two masses oscillate vertically such that their maximum velocities are equal. Then, the ratio of their respective amplitudes will be:

(A) 1 : 2 **(B)** 3 : 2 **(C)** 3 : 1 **(D)** 2 : 3

2. Time period of a simple pendulum in a stationary lift is 'T'. If the lift acceleration with $\frac{g}{6}$ vertically upwards then the time period will be: (where g = acceleration due to gravity)

(A) $\sqrt{\frac{6}{5}}T$ **(B)** $\sqrt{\frac{5}{6}}T$ **(C)** $\sqrt{\frac{6}{7}}T$ **(D)** $\sqrt{\frac{7}{6}}T$

3. The displacement of simple harmonic oscillator after 3 seconds starting from its mean position is equal to half of its amplitude. The time period of harmonic motion is:

(A) 6s **(B)** 8s **(C)** 12s **(D)** 36 s

4. The equation of a particle executing simple harmonic motion is given by $x = \sin\pi\left(t + \frac{1}{3}\right)m$. At t = 1s, the speed of particle will be: (Given : $\pi = 3.14$).

(A) 0 $cm\ s^{-1}$ **(B)** 157 $cm\ s^{-1}$ **(C)** 272 $cm\ s^{-1}$ **(D)** 314 $cm\ s^{-1}$

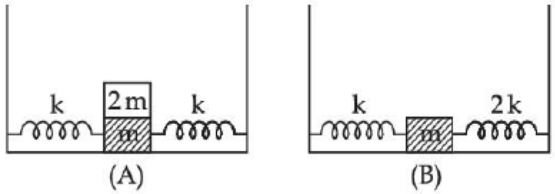
5. A particle executes simple harmonic motion. Its amplitude is 8 cm and time period is 6 s. The time it will take to travel from its position of maximum displacement to the point corresponding to half of its amplitude, is _____s.

6. A body is performing simple harmonic with an amplitude of 10 cm. The velocity of the body was tripled by air Jet when it is at 5 cm from its mean position. The new amplitude of vibration is $\sqrt{x}$ cm. The value of x is _____.

7. The motion of a simple pendulum executing S.H.M. is represented by the following equation. $y = A\sin(\pi t + \phi)$, where time is measured in second. The length of pendulum is:

(A) 97.23 cm **(B)** 25.3 cm **(C)** 99.4 cm **(D)** 406.1 cm

8. In figure (A), mass 2m is fixed on mass m which is attached to two springs of spring constant k. In figure (B), mass m is attached to two springs of spring constant k and 2k. If mass m in (A) and (B) are displaced by distance x horizontally and then released, then time period T_1 & T_2 corresponding to (A) and (B) respectively follow the relation.



(A) $\frac{T_1}{T_2} = \frac{3}{\sqrt{2}}$ **(B)** $\frac{T_1}{T_2} = \sqrt{\frac{3}{2}}$ **(C)** $\frac{T_1}{T_2} = \sqrt{\frac{2}{3}}$ **(D)** $\frac{T_1}{T_2} = \frac{\sqrt{2}}{3}$

9. The length of a seconds pendulum at a height $h = 2R$ from earth surface will be:

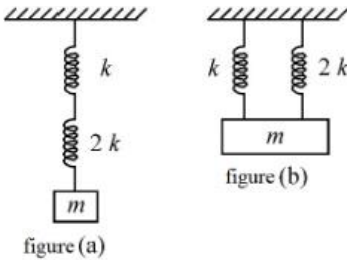
(Given R = Radius of earth and acceleration due to gravity at the surface of earth, $g = \pi^2\ ms^{-2}$)

(A) $\frac{2}{9}m$ **(B)** $\frac{4}{9}m$ **(C)** $\frac{8}{9}m$ **(D)** $\frac{1}{9}m$

10. When a particle executes Simple Hormonic Motion, the nature of graph of velocity as a function of displacement will be:

(A) Circular **(B)** Elliptical **(C)** Sinusoidal **(D)** Straight line

11. As per given figures, two springs of spring constants k and $2k$ are connected to mass m. If the period of oscillation in figure (a) is 3s, then the period of oscillation in figure (b) will be $\sqrt{x}s$. The value of x is _____.



12. A mass 0.9 kg, attached to a horizontal spring, executes SHM with an amplitude A_1. When this mass passes through its mean position, then a smaller mass of 124 g is placed over it and both masses move together with amplitude A_2. If the ratio A_1/A_2 is $\frac{\alpha}{\alpha-1}$, then the value of α will be_____.

13. Assume there are two identical simple pendulum clocks. Clock-1 is placed on the earth and Clock-2 is placed on a space station located at a height h above the earth surface. Clock-1 and Clock-2 operate at time periods 4s and 6s respectively. Then value of h is: (Consider radius of earth $R_E = 6400km$ and g on earth $10m/s^2$)

(A) 1200 km **(B)** 1600 km **(C)** 3200 km **(D)** 4800 km

14. The potential energy of a particle of mass 4 kg in motion along the x-axis is given by $U = 4(1-\cos 4x)J$. The time period of the particle for small oscillation $(\sin\theta \simeq \theta)$ is $\left(\frac{\pi}{K}\right)s$. The value of K is_____.

15. The time period of oscillation of a simple pendulum of length L suspended from the roof of a vehicle, which moves without friction down an inclined plane of inclination α, is given by:

(A) $2\pi\sqrt{L/(g\cos\alpha)}$ **(B)** $2\pi\sqrt{L/(g\sin\alpha)}$

(C) $2\pi\sqrt{L/g}$ **(D)** $2\pi\sqrt{L/(g\tan\alpha)}$

16. The metallic bob of simple pendulum has the relative density 5. The time period of this pendulum is $10s$. If the metallic bob is immersed in water, then the new time period becomes $5\sqrt{x}s$. The value of x will be _____.

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Archive - JEE Main & Advanced

Wave Motion	Class - XI | Physics

JEE Main 2021

1. Which of the following equations represents a travelling wave?

(A) $y = A\sin(15x - 2t)$ **(B)** $y = Ae^{x}\cos(\omega t - \theta)$

(C) $y = Ae^{-x^2}(vt + \theta)$ **(D)** $y = A\sin x\cos\omega t$

2. Two cars are approaching each other at an equal speed of 7.2 km/hr. When they see each other, both blow horns having frequency of 676 Hz. The beat frequency heard by each driver will be _____ Hz. [Velocity of sound in air is 340 m/s]

3. The mass per unit length of a uniform wire is $0.135 g/cm$. A transverse wave of the form $y = -0.21\sin(x + 30t)$ is produced in it, where x is in meter and t is in second. Then, the expected value of tension in the wire is $x \times 10^{-2} N$. Value of x is_____. (Round-off to the nearest integer)

4. A tuning fork A of unknown frequency produces 5 beat/s with a fork of known frequency 340 Hz. When fork A is filed, the beat frequency decreases to 2 beats/s. What is the frequency of fork A ?

(A) 345 Hz **(B)** 338 Hz **(C)** 335 Hz **(D)** 342 Hz

5. The percentage increase in the speed of transverse waves produced in a stretched string if the tension is increased by 4%, will be _____%.

6. A sound wave of frequency 245 Hz travels with the speed of $300 ms^{-1}$ along the positive x-axis. Each point of the wave moves to and fro through a total distance of $6cm$. What will be the mathematical expression of this traveling wave ?

(A) $Y(x,t) = 0.06[\sin 5.1x - (1.5\times10^3)t]$ **(B)** $Y(x,t) = 0.03[\sin 5.1x - (0.2\times10^3)t]$

(C) $Y(x,t) = 0.06[\sin 0.8x - (0.5\times10^3)t]$ **(D)** $Y(x,t) = 0.03[\sin 5.1x - (1.5\times10^3)t]$

7. A closed organ pipe of length L and an open organ pipe contain gases of densities ρ_1 and ρ_2 respectively. The compressibility of gases are equal in both the pipes. Both the pipes are vibrating in their first overtone with same frequency. The length of the open pipe is $\frac{x}{3}L\sqrt{\frac{\rho_1}{\rho_2}}$ where x is _____.

(Round off to the Nearest Integer)

8. A source and a detector move away from each other in absence of wind with a speed of 20 m/s with respect to the ground. If the detector detects a frequency of 1800 Hz of the sound coming from the source, then the original frequency of source considering speed of sound in air 340 m/s will be _____ Hz.

9. Two travelling waves produces a standing wave represented by equation. $y = 1.0 \text{ mm} \cos(1.57 \text{ cm}^{-1})x \sin(78.5 \text{ s}^{-1})t$. The node closest to the origin in the region $x > 0$ will be at $x =$ _____ cm.

10. The cars X and Y are approaching each other with velocities 36 km/h and 72 km/h respectively. The frequency of a whistle sound as emitted by a passenger in car X, heard by the passenger in car Y is 1320 Hz. If the velocity of sound in air is 340 m/s, the actual frequency of the whistle sound produced is _____ Hz.

11. A tuning fork is vibrating at $250 Hz$. The length of the shortest closed organ pipe that will resonate with the tuning fork will be _____ *cm*. (Take speed of sound in air as $340 ms^{-1}$)

12. Two waves are simultaneously passing through a string and their equations are: $y_1 = A_1 \sin k(x - vt)$, $y_2 = A_2 \sin k(x - vt + x_0)$. Given amplitudes $A_1 = 12 \text{ mm}$ and $A_2 = 5 \text{ mm}$, $x_0 = 3.5 \text{ cm}$ and wave number $k = 6.28 \text{ cm}^{-1}$. The amplitude of resulting wave will be _____ *mm*.

13. A wire having a linear mass density $9.0 \times 10^{-4} kg / m$ is stretched between two rigid supports with a tension of $900 N$. The wire resonates at a frequency of 500 Hz. The next higher frequency at which the same wire resonates is 550 Hz. The length of the wire is _____ m.

14. The frequency of a car horn encountered a change from 400 Hz to 500 Hz, when the car approaches a vertical wall. If the speed of sound is 330 m/s. Then the speed of car is _____ km/h.

15. The amplitude of wave disturbance propagating in the positive x-direction is given by $y = \dfrac{1}{(1+x)^2}$ at time $t = 0$ and $y = \dfrac{1}{1+(x-2)^2}$ at $t = 1s$, where x and y are in metres. The shape of wave does not change during the propagation. The velocity of the wave will be _____ m/s.

JEE Advanced 2021

1. A source, approaching with speed u towards the open end of a stationary pipe of length L, is emitting a sound of frequency f_s. The farther end of the pipe is closed. The speed of sound in air is v and f_0 is the fundamental frequency of the pipe. For which of the following combination(s) of u and f_s, will the sound reaching the pipe lead to a resonance?

(A) $u = 0.8v$ and $f_s = f_0$ **(B)** $u = 0.8v$ and $f_s = 2f_0$

(C) $u = 0.8v$ and $f_s = 0.5f_0$ **(D)** $u = 0.5v$ and $f_s = 1.5 f_0$

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Archive - JEE Main & Advanced

Wave Motion	Class - XI | Physics

JEE Main 2022

1. The equations of two waves are given by :

$y_1 = 5\sin\ 2\pi(x - vt)cm$; $y_2 = 3\sin\ 2\pi(x - vt + 1.5)cm$

These waves are simultaneously passing through a string. The amplitude of the resulting wave is :

(A) 2 cm **(B)** 4cm **(C)** 5.8 cm **(D)** 8cm

2. Two travelling waves of equal amplitudes and equal frequencies move in opposite directions along a string. They interfere to produce a stationary wave whose equation is given by $y = (10\cos\pi x \sin\frac{2\pi t}{T})$cm. The amplitude of the particle at $x = \frac{4}{3}$cm will be _____ cm.

3. The first overtone frequency of an open organ pipe is equal to the fundamental frequency of a closed organ pipe. If the length of the closed organ pipe is 20 cm. The length of the open organ pipe is ___ cm.

4. A set of 20 tuning forks is arranged in a series of increasing frequencies. If each fork gives 4 beats with respect to the preceding fork and the frequency of the last fork is twice the frequency of the first, then the frequency of last fork is _____ *Hz*.

5. An observer moves towards a stationary source of sound with a velocity equal to one-fifth of the velocity of sound. The percentage change in the frequency will be:

(A) 20% **(B)** 10% **(C)** 5% **(D)** 0%

6. The velocity of sound in a gas, in which two wavelengths 4.08 m and 4.16 m produce 40 beats in 12 s, will be:

(A) 282.8 ms^{-1} **(B)** 175.5 ms^{-1} **(C)** 353.6 ms^{-1} **(D)** 707.2 ms^{-1}

7. A tunning fork of frequency $340\,Hz$ resonates in the fundamental mode with an air column of length $125\,cm$ in a cylindrical tube closed at one end. When water is slowly poured in it, the minimum height of water required for observing resonance once again is _____cm.

(Velocity of sound in air is $340 ms^{-1}$)

8. A longitudinal wave is represented by $x = 10\sin 2\pi\left(nt - \frac{x}{\lambda}\right)$ cm. The maximum particle velocity will be four times the wave velocity if the determined value of wavelength is equal to:

(A) 2π **(B)** 5π **(C)** π **(D)** $\frac{5\pi}{2}$

9. In an experiment to determine the velocity of sound in air at room temperature using a resonance tube, the first resonance is observed when the air column has a length of 20.0 *cm* for a tuning fork of frequency 400 *Hz* is used. The velocity of the sound at room temperature is 336 ms^{-1}. The third resonance is observed when the air column has a length of _____ *cm*.

10. The speed of a transverse wave passing through a string of length 50 cm and mass 10 g is $60 ms^{-1}$.The area of cross-section of the wire is $2.0 mm^2$ and its Young's modulus is $1.2\times10^{11} Nm^{-2}$. The extension of the wire over its natural length due to its tension will be $x\times10^{-5} m$. The value of x is ___.

11. Sound travels in a mixture of two moles of helium and n moles of hydrogen. If rms speed of gas molecules in the mixture is $\sqrt{2}$ times the speed of sound, then the value of n will be:

(A) 1 **(B)** 2 **(C)** 3 **(D)** 4

12. Two waves executing simple harmonic motions travelling in the same direction with same amplitude and frequency are superimposed. The resultant amplitude is equal to the $\sqrt{3}$ times of amplitude of individual motions. The phase difference between the two motions is _____ (degree).

13. When a car is approaching the observer, the frequency of horn is 100Hz. After passing the observer, it is 50 Hz. If the observer moves with the car, the frequency will be $\frac{x}{3}$ Hz where x = _____.

14. An observer is riding on a bicycle and moving towards a hill at $18 kmh^{-1}$. He hears a sound from a source at some distance behind him directly as well as after its reflection from the hill. If the original frequency of the sound as emitted by source is 640 Hz and velocity of the sound in air is 320 m/s the beat frequency between the two sounds heard by observer will be _____Hz.

15. A transverse wave is represented by $y = 2\sin\left(\omega t - kx\right)$ cm. The value of wavelength (in cm) for which the wave velocity becomes equal to the maximum particle velocity, will be:

(A) 4π **(B)** 2π **(C)** π **(D)** 2

16. A wire of length 30 cm, stretched between rigid supports, has it's n^{th} and $\left(n+1\right)^{th}$ harmonics at 400 Hz and 450 Hz , respectively. If tension in the string is 2700 N, it's linear mass density is _____ kg/m.

17. In the wave equation

$$y = 0.5\sin\frac{2\pi}{\lambda}\left(400t - x\right)m$$

The velocity of the wave will be:

(A) 200 m/s **(B)** $200\sqrt{2}$ m/s **(C)** 400 m/s **(D)** $400\sqrt{2}\, m/s$

18. The frequency of echo will be _____Hz if the train blowing a whistle of frequency 320 Hz is moving with a velocity of 36 km/h towards a hill from which an echo is heard by the train driver. Velocity of sound in air is $330 m/s$.

19. The velocity of sound in a gas, in which two wavelengths 4.08 m and 4.16 m produce 40 beats in 12 s, will be:

(A) 282.8 ms^{-1} **(B)** 175.5 ms^{-1} **(C)** 353.6 ms^{-1} **(D)** 707.2 ms^{-1}

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Archive - JEE Main & Advanced

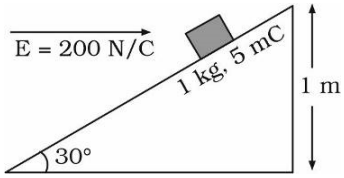
Electrostatics	Class - XII | Physics

JEE Main 2021

1. Two electrons each are fixed at a distance '$2d$'. A third charge proton placed at the midpoint is displaced slightly by a distance $x(x << d)$ perpendicular to the line joining the two fixed charges. Proton will execute simple harmonic motion having angular frequency: (m = mass of charged particle)

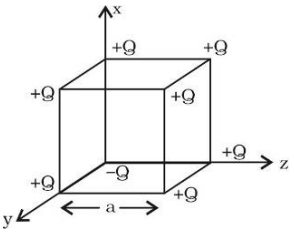
(A) $\left(\frac{2q^2}{\pi\varepsilon_0 md^3}\right)^{\frac{1}{2}}$ **(B)** $\left(\frac{\pi\varepsilon_0 md^3}{2q^2}\right)^{\frac{1}{2}}$ **(C)** $\left(\frac{q^2}{2\pi\varepsilon_0 md^3}\right)^{\frac{1}{2}}$ **(D)** $\left(\frac{2\pi\varepsilon_0 md^3}{q^2}\right)^{\frac{1}{2}}$

2. An inclined plane making an angle of 30° with the horizontal is placed in a uniform horizontal electric field $200\frac{N}{C}$ as shown in the figure. A body of mass 1 kg and charge 5 mC is allowed to slide down from rest at a height of 1 m. If the coefficient of friction is 0.2, find the time taken by the body to reach the bottom. [$g = 9.8$ m/s^2, $\sin 30° = \frac{1}{2}$; $\cos 30° = \frac{\sqrt{3}}{2}$]



(A) 1.3 s **(B)** 0.46 s **(C)** 0.92 s **(D)** 2.3 s

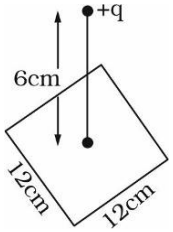
3. A cube of side 'a' has point charges $+Q$ located at each of its vertices except at the origin where the charge is $-Q$. The electric field at the centre of cube is:



(A) $\frac{-2Q}{3\sqrt{3}\pi\varepsilon_0 a^2}(\hat{x}+\hat{y}+\hat{z})$ **(B)** $\frac{-Q}{3\sqrt{3}\pi\varepsilon_0 a^2}(\hat{x}+\hat{y}+\hat{z})$

(C) $\frac{Q}{3\sqrt{3}\pi\varepsilon_0 a^2}(\hat{x}+\hat{y}+\hat{z})$ **(D)** $\frac{2Q}{3\sqrt{3}\pi\varepsilon_0 a^2}(\hat{x}+\hat{y}+\hat{z})$

4. A point charge of $+12\mu C$ is at a distance 6 cm vertically above the centre of a square of side 12 cm as shown in figure. The magnitude of the electric flux through the square will be _____ × 10^3 Nm^2 / C

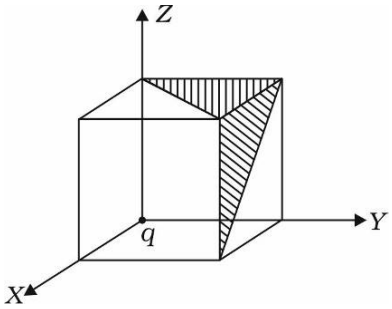


5. The electric field in a region is given by $\vec{E} = \left(\frac{3}{5}E_0\hat{i} + \frac{4}{5}E_0\hat{j}\right)\frac{N}{C}$. The ratio of flux of reported field through the rectangular surface of area $0.2\,m^2$ (parallel to $y-z$ plane) to that of the surface of area $0.3m^2$ (parallel to $x-z$ plane) is $a:b$, where $a =$ _____.

[Here $\hat{i}$, $\hat{j}$ and $\hat{k}$ are unit vectors along x, y and z-axis respectively]

6. 512 identical drops of mercury are charged to a potential of 2 V each. The drops are joined to form a single drop. The potential of this drop is_____ V.

7. A charge 'q' is placed at one corner of a cube as shown in figure. The flux of electrostatic field $\vec{E}$ through the shaded area is:

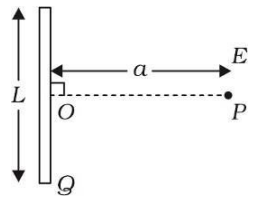


(A) $\frac{q}{48\varepsilon_0}$ **(B)** $\frac{q}{4\varepsilon_0}$ **(C)** $\frac{q}{8\varepsilon_0}$ **(D)** $\frac{q}{24\varepsilon_0}$

8. Two identical conducting spheres with negligible volume have $2.1nC$ and $-0.1\,nC$ charges, respectively. They are brought into contact and then separated by a distance of 0.5 m. The electrostatic force acting between the spheres is _____$\times 10^{-9}N$. [Given : $4\pi\varepsilon_0 = \frac{1}{9\times10^9}$ SI unit]

9. Two small spheres each of mass 10 mg are suspended from a point by threads 0.5 m long. They are equally charged and repel each other to a distance of 0.20 m. The charge on each of the sphere is $\frac{a}{21}\times10^{-8}C$. The value of '$a$' will be _____ . [Given $g = 10\ ms^{-2}$]

10. Find the electric field at point P (as shown in figure) on the perpendicular bisector of a uniformly charged thin wire of length L carrying a charge Q. The distance of the point P from the centre of the rod is $a = \frac{\sqrt{3}}{2}L$.



(A) $\frac{Q}{3\pi\varepsilon_0L^2}$ **(B)** $\frac{Q}{2\sqrt{3}\pi\varepsilon_0L^2}$ **(C)** $\frac{Q}{4\pi\varepsilon_0L^2}$ **(D)** $\frac{\sqrt{3}Q}{4\pi\varepsilon_0L^2}$

11. Given below are two statements :

Statement I : An electric dipole is placed at the centre of a hollow sphere. The flux of electric field through the sphere is zero but the electric field is not zero anywhere in the sphere.

Statement II : If R is the radius of a solid metallic sphere and Q be the total charge on it. The electric field at any point on the spherical surface of radius $r(< R)$ is zero but the electric flux passing through this closed spherical surface of radius r is not zero.

In the light of the above statements, choose the correct answer from the options given below :

(A) Statement I is true but Statement II is false

(B) Statement I is false but Statement II is true

(C) Both Statement I and Statement II are false

(D) Both Statement I and Statement II are true

12. 27 similar drops of mercury are maintained at 10 V each. All these spherical drops combine into a single big drop. The potential energy of the bigger drop is _____ times that of a smaller drop.

13. The electric field in a region is given by $\vec{E} = \frac{2}{5}E_0\,\hat{i} + \frac{3}{5}E_0\,\hat{j}$ with $E_0 = 4.0\times10^3\,\frac{N}{C}$. The flux of this field through a rectangular surface area $0.4\,m^2$ parallel to the $Y-Z$ plane is _____ Nm^2C^{-1}.

14. An infinite number of point charges, each carrying $1\mu C$ charge, are placed along the y-axis at $y = 1m, 2m, 4m, 8m.....$ The total force on a 1C point charge, placed at the origin is $x\times10^3 N$.

The value of x, to the nearest integer is:

[Take $\frac{1}{4\pi\in_0} = 9\times10^9 Nm^2/C^2$]

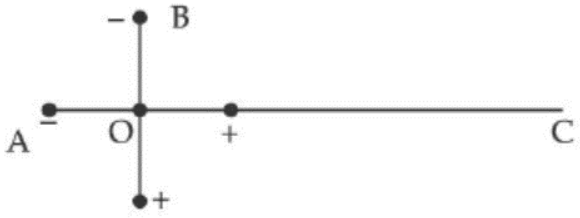
15. Find out the surface charge density at the intersection of point $x = 3m$ plane and x-axis, in the region of uniform line charge of 8 nC/m lying along the z-axis in free space.

(A) 47.88 C/m **(B)** 0.424 nC m^{-2} **(C)** 0.07 nC m^{-2} **(D)** 4.0 nC m^{-2}

16. A particle of mass 1 mg and charge q is lying at the mid-point of two stationary particles kept at a distance '2 m' when each is carrying same charge 'q'. If the free charged particle is displaced from its equilibrium position through distance 'x' ($x << 1$ m). The particle executes SHM. Its angular frequency of oscillation will be _____ $\times10^5\,rad/s$ if $q^2 = 10\ C^2$.

17. Two ideal electric dipoles A and B, having their dipole moment p_1 and p_2 respectively are placed on a plane with their centres at O as shown in the figure. At point C on the axis of dipole A, the resultant electric field is making an angle of 37º with the axis.

The ratio of the dipole moment of A and B, $\frac{p_1}{p_2}$ is : $\left(\text{Take } \sin 37^o C = \frac{3}{5}\right)$



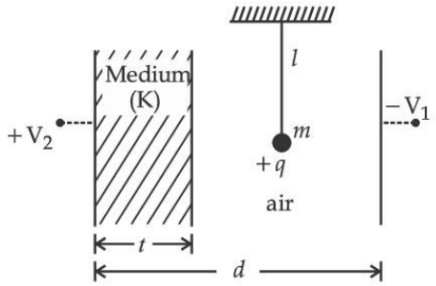
(A) $\frac{3}{8}$ **(B)** $\frac{2}{3}$ **(C)** $\frac{3}{2}$ **(D)** $\frac{4}{3}$

18. Two identical tennis balls each having mass 'm' and charge 'q' are suspended from a fixed point by threads σ length 'l'. What is the equilibrium separation when each thread makes a small angle 'θ' with the vertical ?

(A) $x=\left(\dfrac{q^2l^2}{2\pi\varepsilon_0 m^2 g}\right)^{1/3}$ **(B)** $x=\left(\dfrac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{1/2}$

(C) $x=\left(\dfrac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{1/3}$ **(D)** $x=\left(\dfrac{q^2l^2}{2\pi\varepsilon_0 m^2 g^2}\right)^{1/3}$

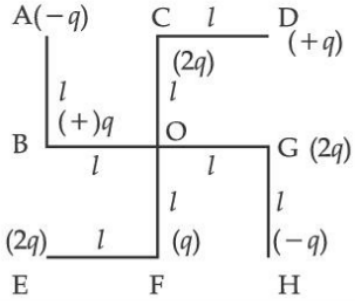
19. A simple pendulum of mass 'm', length 'l' and charge '$+q$' suspended in the electric field produced by two conducting parallel plates as shown. The value of deflection of pendulum in equilibrium position will be :



(A) $\tan^{-1}\left[\dfrac{q}{mg}\times\dfrac{C_1(V_2-V_1)}{(C_1+C_2)(d-t)}\right]$ **(B)** $\tan^{-1}\left[\dfrac{q}{mg}\times\dfrac{C_2(V_1+V_2)}{(C_1+C_2)(d-t)}\right]$

(C) $\tan^{-1}\left[\dfrac{q}{mg}\times\dfrac{C_2(V_2-V_1)}{(C_1+C_2)(d-t)}\right]$ **(D)** $\tan^{-1}\left[\dfrac{q}{mg}\times\dfrac{C_1(V_1+V2)}{(C_1+C_2)(d-t)}\right]$

20. What will be the magnitude of electric field at point O as shown in figure? Each side of the figure is l and perpendicular to each other?



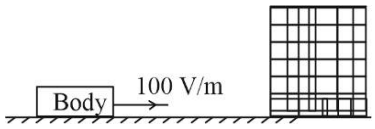
(A) $\dfrac{1}{4\pi\varepsilon_0}\dfrac{q}{(2l^2)}(2\sqrt{2}-1)$ **(B)** $\dfrac{q}{4\pi\varepsilon_0(2l)^2}$

(C) $\dfrac{1}{4\pi\varepsilon_0}\dfrac{q}{l^2}$ **(D)** $\dfrac{1}{4\pi\varepsilon_0}\dfrac{2q}{2l^2}(\sqrt{2})$

21. A certain charge Q is divided into two part q and $(Q-q)$. How should the charge Q and q be divided so that q and $(Q-q)$ placed at a certain distance apart experience maximum electrostatic repulsion?

(A) $Q=2q$ **(B)** $Q=3q$ **(C)** $Q=4q$ **(D)** $Q=q/2$

22. A body having specific charge $8\mu C/g$ is resting on a frictionless plane at a distance 10 cm from the wall (as sown in the figure). It starts moving towards the wall when a uniform electric field of 100 V/m is applied horizontally towards the wall. If the collision of the body with the wall is perfectly elastic, then the time period of the motion will be _____s.



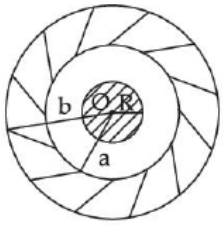
23. An electric dipole is placed on *x*-axis in proximity to a line charge of linear charge density $3.0\times10^{-6}C/m$. Line charge is placed on *z*-axis and positive and negative charge of dipole is at a distance of 10 *mm* and 12 *mm* from the origin respectively. If total force of 4 *N* is exerted on the dipole, find out the amount of positive or negative charge of the dipole.

(A) $8.8\,\mu C$ **(B)** $815.1\,nC$ **(C)** $0.485\,mC$ **(D)** $4.44\,\mu C$

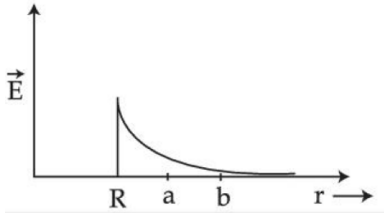
24. The total charge enclosed in an incremental volume of $2\times10^{-9}m^3$ located at the origin is _____ *nC*, if electric flux density of its field is found as:

$D=e^{-x}\sin y\,\hat{i}-e^{-x}\cos y\,\hat{j}+2z\,\hat{k}\,C/m^2.$

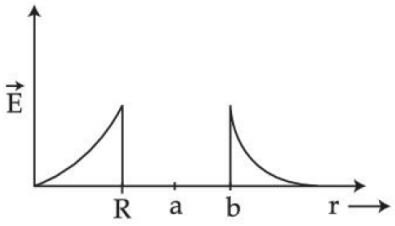
25. A solid metal sphere of radius R having charge q is enclosed inside the concentric spherical shell of inner radius a and outer radius b as shown in figure. The approximate variation electric field $\vec{E}$ as a function of distance r from centre O is given by:



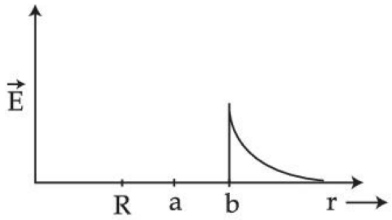
(A)



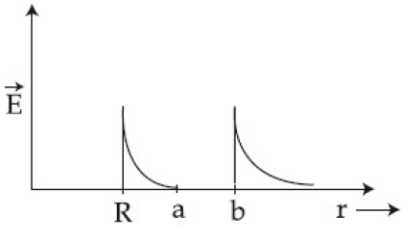
(B)



(C)



(D)



26. The two thin coaxial rings, each of radius '*a*' and having charges $+Q$ and $-Q$ respectively are separated by a distance of '*s*'. The potential difference between the centres of the two rings is:

(A) $\dfrac{Q}{4\pi\varepsilon_0}\left[\dfrac{1}{a}+\dfrac{1}{\sqrt{s^2+a^2}}\right]$ **(B)** $\dfrac{Q}{2\pi\varepsilon_0}\left[\dfrac{1}{a}+\dfrac{1}{\sqrt{s^2+a^2}}\right]$

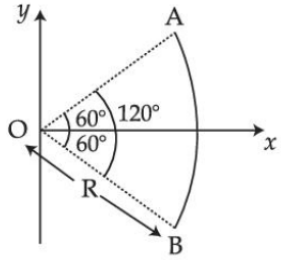
(C) $\dfrac{Q}{4\pi\varepsilon_0}\left[\dfrac{1}{a}-\dfrac{1}{\sqrt{s^2+a^2}}\right]$ **(D)** $\dfrac{Q}{2\pi\varepsilon_0}\left[\dfrac{1}{a}-\dfrac{1}{\sqrt{s^2+a^2}}\right]$

27. A uniformly charged disc of radius R having surface charge density σ is placed in the *xy* plane with its centre at the origin. Find the electric field intensity along the z-axis at a distance Z from origin:

(A) $E=\frac{2\varepsilon_0}{\sigma}\left(\frac{1}{(Z^2+R^2)^{1/2}}+Z\right)$ **(B)** $E=\frac{\sigma}{2\varepsilon_0}\left(1+\frac{Z}{(Z^2+R^2)^{1/2}}\right)$

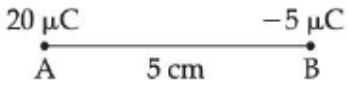
(C) $E=\frac{\sigma}{2\varepsilon_0}\left(1-\frac{Z}{(Z^2+R^2)^{1/2}}\right)$ **(D)** $E=\frac{\sigma}{2\varepsilon_0}\left(\frac{1}{(Z^2+R^2)}+\frac{1}{Z^2}\right)$

28. Figure shows a rod *AB*, which is bent in a 120° circular are of radius *R*. A charge $(-Q)$ is uniformly distributed over rod *AB*. What is the electric field $\vec{E}$ at the centre of curvature *O* ?



(A) $\frac{3\sqrt{3}Q}{8\pi\varepsilon_0 R^2}(\hat{i})$ **(B)** $\frac{3\sqrt{3}Q}{16\pi^2\varepsilon_0 R^2}(\hat{i})$ **(C)** $\frac{3\sqrt{3}Q}{8\pi^2\varepsilon_0 R^2}(-\hat{i})$ **(D)** $\frac{3\sqrt{3}Q}{8\pi^2\varepsilon_0 R^2}(\hat{i})$

29. Two particles A and B having charges $20\mu C$ and $-5\mu C$ respectively are held fixed with a separation of $5cm$. At what position a third charged particle should be placed so that it does not experience a net electric force?



(A) At midpoint between two charges

(B) At $5cm$ from $-5\mu C$ on the right side

(C) At $1.25cm$ from $-5\mu C$ between two charges

(D) At $5cm$ from $20\mu C$ on the left side of system

30. A cube is placed inside an electric field, $\vec{E}=150y^2\hat{j}$. The side of the cube is $0.5m$ and is placed in the field as shown in the given figure. The charge inside the cube is:

(A) $3.8\times10^{-12}C$ **(B)** $8.3\times10^{-12}C$ **(C)** $3.8\times10^{-11}C$ **(D)** $8.3\times10^{-11}C$

31. Choose the incorrect statement:

(a) The electric lines of force entering into a Gaussian surface provide negative flux.

(b) A charge 'q' is placed at the centre of a cube. The flux through all the faces will be the same.

(c) In a uniform electric field net flux through a closed Gaussian surface containing no net charge, is zero.

(d) When electric field is parallel to a Gaussian surface, it provides a finite non-zero flux.

Choose the **most appropriate** answer from the options given below:

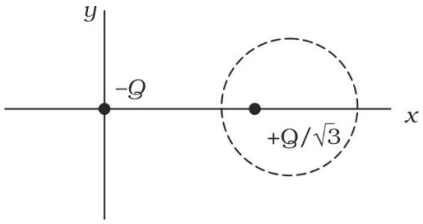
(A) (c) and (d) only **(B)** (b) and (d) only **(C)** (a) and (c) only **(D)** (d) Only

JEE Advanced 2021

Question Stem for Question Nos. 1 and 2

Question Stem

Two point charges $-Q$ and $+Q/\sqrt{3}$ are placed in the xy-plane at the origin $(0, 0)$ and a point $(2, 0)$, respectively, as shown in the figure. This results in an equipotential circle of radius R and potential $V = 0$ in the xy-plane with its center at $(b, 0)$. All lengths are measured in meters.



1. The value of R is _____ meter.

2. The value of b is _____ meter.

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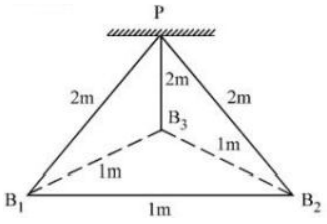
Archive - JEE Main & Advanced

Electrostatics	Class - XII | Physics

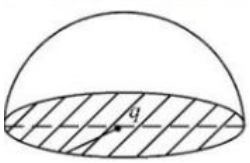
JEE Main 2022

1. Three identical charged balls each of charge 2C are suspended from a common point P by silk threads of 2m each (as shown in figure). They form an equilateral triangle of side 1m. The ratio of net force on a charge ball to the force between any two charged balls will be:



(A) 1 : 1 **(B)** 1 : 4 **(C)** $\sqrt{3}:2$ **(D)** $\sqrt{3}:1$

2. If a charge q is placed at the centre of a closed hemispherical non-conducting surface, the total flux passing through the flat surface would be:



(A) $\frac{q}{\epsilon_0}$ **(B)** $\frac{q}{2\epsilon_0}$ **(C)** $\frac{q}{4\epsilon_0}$ **(D)** $\frac{q}{2\pi\epsilon_0}$

3. A vertical electric field of magnitude $4.9\times10^5 N/C$ just prevents a water droplet of a mass 0.1 g from falling. The value of charge on the droplet will be: (Given $g = 9.8\ m/s^2$)

(A) $1.6\times10^{-9}C$ **(B)** $2.0\times10^{-9}C$ **(C)** $3.2\times10^{-9}C$ **(D)** $0.5\times10^{-9}C$

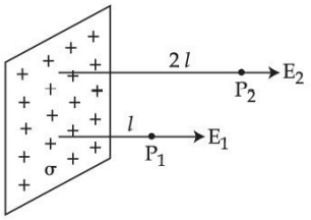
4. Two identical charged particles each having a mass 10 g and charge $2.0\times10^{-7}C$ are placed on a horizontal table with a separation of L between them such that they stay in limited equilibrium. If the coefficient of friction between each particle and the table is 0.25, find the value of L. [Use $g = 10\ ms^{-2}$]

(A) 12 cm **(B)** 10 cm **(C)** 8 cm **(D)** 5 cm

5. A long cylindrical volume contains a uniformly distributed charge of density ρ. The radius of cylindrical volume is R. A charge particle (q) revolves around the cylinder in a circular path. The kinetic energy of the particle is:

(A) $\frac{\rho q R^2}{4\varepsilon_0}$ **(B)** $\frac{\rho q R^2}{2\varepsilon_0}$ **(C)** $\frac{q\rho}{4\varepsilon_0 R^2}$ **(D)** $\frac{4\varepsilon_0 R^2}{\rho q}$

6. In the figure, a very large plane sheet of positive charge is shown. P_1 and P_2 are two points at distance ℓ and 2ℓ from the charge distribution. If σ is the surface charge density, then the magnitude of electric fields E_1 and E_2 at P_1 and P_2 respectively are:



(A) $E_1 = \sigma / \varepsilon_0, E_2 = \sigma / 2\varepsilon_0$ **(B)** $E_1 = 2\sigma / \varepsilon_0, E_2 = \sigma / \varepsilon_0$

(C) $E_1 = E_2 = \sigma / 2\varepsilon_0$ **(D)** $E_1 = E_2 = \sigma / \varepsilon_0$

7. 27 identical drop are charged at 22V each. The combine to form a bigger drop. The potential of the bigger drop will be _____ V

8. Sixty four conducting drops each of radius 0.02 m and each carrying a charge of $5\mu C$ are combined to form a bigger drop. The ratio of surface density of bigger drop to the smaller drop will be:

(A) 1 : 4 **(B)** 4 : 1 **(C)** 1 : 8 **(D)** 8 : 1

9. Given below are two statements:

Statement-I: A point charge is brought in an electric field. The value of electric field at a point near to the charge may increase if the charge is positive.

Statement-II: An electric dipole is placed in a non-uniform electric field. The net electric force on the dipole will not be zero.

Choose the correct answer from the options given below:

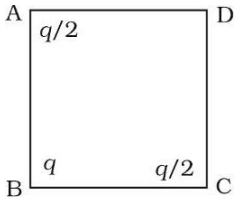
(A) Both statement-I and statement-II are true.

(B) Both statement-I and statement-II are false

(C) Statement-I is true but statement-II is false.

(D) Statement-I is false but statement-II is true.

10. The three charges $q/2$, q and $q/2$ are placed at the corners A. B and C of a square of side 'a' as shown in figure. The magnitude of electric field (E) at the corner D of the square, is:



(A) $\frac{q}{4\pi \in_0 a^2}\left(\frac{1}{\sqrt{2}}+\frac{1}{2}\right)$ **(B)** $\frac{q}{4\pi \in_0 a^2}\left(1+\frac{1}{\sqrt{2}}\right)$

(C) $\frac{q}{4\pi \in_0 a^2}\left(1-\frac{1}{\sqrt{2}}\right)$ **(D)** $\frac{q}{4\pi \in_0 a^2}\left(\frac{1}{\sqrt{2}}-\frac{1}{2}\right)$

11. Two point charges A and B of magnitude $+8\times10^{-6}C$ and $-8\times10^{-6}C$ respectively are placed at a distance d apart. The electric field at the middle point O between the charges is $6.4\times10^{4}\,NC^{-1}$. The distance 'd' between the point charges A and B is:

(A) 2.0m **(B)** 3.0m **(C)** 1.0m **(D)** 4.0m

12. A positive charge particle of 100 mg is thrown in opposite direction to a uniform electric field of strength $1\times10^{5}NC^{-1}$. If the charge on the particle is $40\mu C$ and the initial velocity is $200ms^{-1}$, how much distance it will travel before coming to the rest momentarily:

(A) 1m **(B)** 5m **(C)** 10m **(D)** 0.5m

13. Two-point charges Q each are placed at a distance d apart. A third point charge q is placed at a distance x from mid-point on the perpendicular bisector. The values x at which charge q will experience the maximum Coulomb's force is:

(A) $x = d$ **(B)** $x = \frac{d}{2}$ **(C)** $x = \frac{d}{\sqrt{2}}$ **(D)** $x = \frac{d}{2\sqrt{2}}$

14. If the electric potential at any point $(x, y, z)m$ in space is given by $V = 3x^2$ *volt.* The electric field at the point $(1,0,3)m$ will be:

(A) 3 Vm^{-1}, directed along positive x-axis **(B)** 3 Vm^{-1}, directed along negative x-axis

(C) 6 Vm^{-1}, directed along positive x-axis **(D)** 6 Vm^{-1}, directed along negative x-axis

15. Two uniformly charged spherical conductors A and B of radii 5 mm and 10 mm are separated by a distance of 2 cm. If the spheres are connected by a conducting wire, then in equilibrium condition. The ratio of the magnitudes of the electric fields at the surface of the sphere A and B will be:

(A) 1 : 2 **(B)** 2 : 1 **(C)** 1 : 1 **(D)** 1 : 4

16. The volume charge density of a sphere of radius 6 m is $2\mu C\,cm^{-3}$. The number of lines of force per unit surface area coming out from the surface of the sphere is _____ $\times10^{10}$ NC^{-1}.

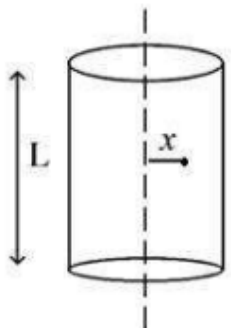
(Given : Permittivity of vacuum $\in_0 = 8.85\times10^{-12}C^2\,N^{-1}-m^{-2}$)

17. Three point charges of magnitude $5\mu C$, $0.16\mu C$ *and* $0.3\mu C$ are located at the vertices A, B, C of a right angled triangle whose sides are $AB = 3\ cm$, $BC = 3\sqrt{2}$ cm and $CA = 3\ cm$ and point A is the right angle corner. Charge at point A experiences _____ N of electrostatic force due to the other two charges.

18. Two identical positive charges Q each are fixed at a distance of '$2a$' apart from each other. Another point charge q_0 with mass 'm' is placed at midpoint between two fixed charges. For a small displacement along the line joining the fixed charges, the charge q_0 executes SHM. The time period of oscillation of charge q_0 will be:

(A) $\sqrt{\frac{4\pi^3\varepsilon_0 ma^3}{q_0Q}}$ **(B)** $\sqrt{\frac{q_0Q}{4\pi^3\varepsilon_0 ma^3}}$ **(C)** $\sqrt{\frac{2\pi^3\varepsilon_0 ma^3}{q_0Q}}$ **(D)** $\sqrt{\frac{8\pi^3\varepsilon_0 ma^3}{q_0Q}}$

19. A long cylindrical volume contains a uniformly distributed charge of density $\rho\ Cm^{-3}$. The electric field inside the cylindrical volume at a distance $x = \frac{2\varepsilon_0}{\rho}m$ from its axis is _____ Vm^{-1}.



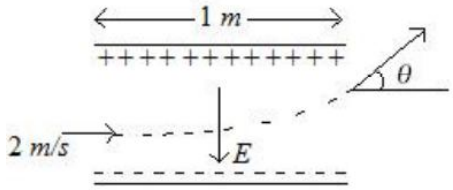
20. A charge of 4 μC is to be divided into two. The distance between the two divided charges is constant. The magnitude of the divided charges so that the force between them is maximum, will be:

(A) $1\mu C$ and $3\mu C$ **(B)** $2\mu C$ and $2\mu C$

(C) 0 and $4\mu C$ **(D)** $1.5\mu C$ and $2.5\mu C$

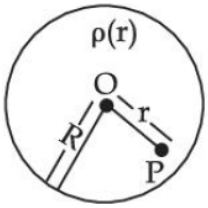
21. Two electric dipoles of dipole moments $1.2\times10^{-30}Cm$ and $2.4\times10^{-30}Cm$ are placed in two different uniform electric fields of strengths $5\times10^{4}NC^{-1}$ and $15\times10^{4}NC^{-1}$ respectively. The ratio of maximum torque experienced by the electric dipoles will be $\frac{1}{x}$. The value of x is _____.

22. A uniform electric field $E=(8m/e)V/m$ is created between two parallel plates of length 1 m as shown in figure, (where m = mass of electron and e = charge of electron). An electron enters the field symmetrically between the plates with a speed of 2 m/s. The angle of the deviation (θ) of the path of the electron as it comes out of the field will be_____.



(A) $\tan^{-1}(4)$ **(B)** $\tan^{-1}(2)$ **(C)** $\tan^{-1}\left(\frac{1}{3}\right)$ **(D)** $\tan^{-1}(3)$

23. A spherically symmetric charge distribution is considered with charge density varying as $\rho(r)=\begin{cases}\rho_0\left(\frac{3}{4}-\frac{r}{R}\right) & for\, r\le R\\ zero & for\, r>R\end{cases}$. Where, $r(r<R)$ is the distance from the centre O (as shown in figure). The electric field at point P will be:



(A) $\frac{\rho_0 r}{4\varepsilon_0}\left(\frac{3}{4}-\frac{r}{R}\right)$ **(B)** $\frac{\rho_0 r}{3\varepsilon_0}\left(\frac{3}{4}-\frac{r}{R}\right)$ **(C)** $\frac{\rho_0 r}{4\varepsilon_0}\left(1-\frac{r}{R}\right)$ **(D)** $\frac{\rho_0 r}{5\varepsilon_0}\left(1-\frac{r}{R}\right)$

24. Given below are two statements.

Statement I : Electric potential is constant within and at the surface of each conductor.

Statement II : Electric field just outside a charged conductor is perpendicular to the surface of the conductor at every point.

In the light of the above statements, choose the most appropriate answer from the options given below.

(A) Both Statement I and Statement II are correct

(B) Both Statement I and Statement II are incorrect

(C) Statement I is correct but Statement II is incorrect

(D) Statement I is incorrect but Statement II is correct

25. Two identical metallic spheres A and B when placed at certain distance in air repel each other with a force of F. Another identical uncharged sphere C is first placed in contact with A and then in contact with B and finally placed at midpoint between spheres A and B. The force experienced by sphere C will be:

(A) $3F/2$ **(B)** $3F/4$ **(C)** F **(D)** $2F$

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Archive - JEE Main & Advanced

DC Circuits	Class - XII | Physics

JEE Main 2021

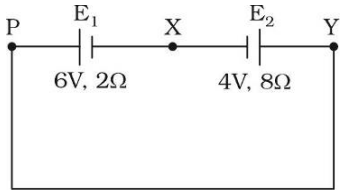
1. A current through a wire depends on time as

$$i = \alpha_0 t + \beta t^2$$

where $\alpha_0 = 20A/s$ and $\beta = 8As^{-2}$. Find the charge crossed through a section of the wire in $15s$.

(A) 11250 C **(B)** 2250 C **(C)** 2100 C **(D)** 260 C

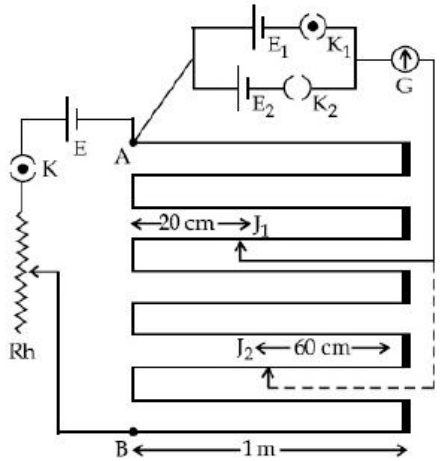
2. A cell E_1 of emf $6V$ and internal resistance 2Ω is connected with another cell E_2 of emf $4V$ and internal resistance 8Ω (as shown in the figure). The potential difference across points X and Y is:



(A) $2.0V$ **(B)** $10.0V$ **(C)** $3.6V$ **(D)** $5.6V$

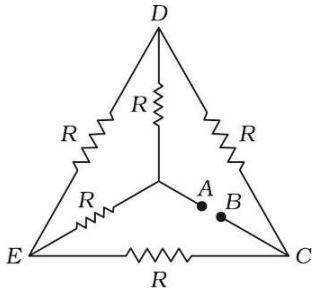
3. A cylindrical wire of radius 0.5 mm and conductivity $5 \times 10^7\ S/m$ is subjected to an electric field of $10mV/m$. The expected value of current in the wire will be $x^3\pi$ mA. The value of x is _____.

4. In the given circuit of potentiometer, the potential difference E across AB (10 m length) is larger than E_1 *and* E_2 as well. For key K_1 (closed), the jockey is adjusted to touch the wire at point J_1 so that there is no deflection in the galvanometer. Now the first battery (E_1) is replaced by second battery (E_2) for working by making K_1 open and K_2 closed. The galvanometer gives then null deflection at J_2. The value of $\frac{E_1}{E_2}$ is $\frac{a}{b}$, where a = _____.



5. A current of 6 A enters one corner P of an equilateral triangle PQR having 3 wires of resistance 2Ω each and leaves by the corner R. The currents i_1 in ampere is _____ .

6. Five equal resistances are connected in a network as shown in figure. The net resistance between the points A and B is :



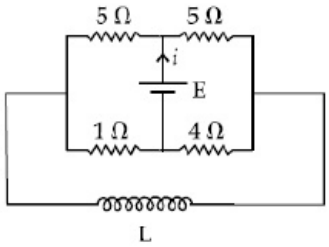
(A) $2R$ **(B)** $\frac{R}{2}$ **(C)** R **(D)** $\frac{3R}{2}$

7. In an electrical circuit, a battery is connected to pass $20C$ of charge through it in a certain given time. The potential difference between two plates of the battery is maintained at $15V$. The work done by the battery is_____J.

8. A wire of 1Ω has a length of 1 m. It is stretched till its length increases by 25%. The percentage change in resistance to the nearest integer is :

(A) 56 % **(B)** 76 % **(C)** 25 % **(D)** 12.5 %

9. The current (i) at time $t = 0$ and $t = \infty$ respectively for the given circuit is:



(A) $\frac{5E}{18}, \frac{18E}{55}$ **(B)** $\frac{5E}{18}, \frac{10E}{33}$ **(C)** $\frac{18E}{55}, \frac{5E}{18}$ **(D)** $\frac{10E}{33}, \frac{5E}{18}$

10. A current of 10A exists in a wire of crossectional area of $5mm^2$ with a drift velocity of $2 \times 10^{-3} ms^{-1}$. The number of free electrons in each cubic meter of the wire is _____.

(A) 625×10^{25} **(B)** 2×10^{25} **(C)** 1×10^{23} **(D)** 2×10^{6}

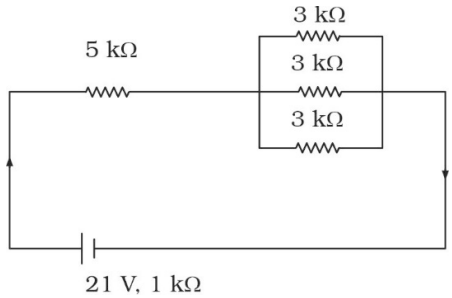
11. The equivalent resistance of series combination of two resistor is 's'. When they are connected in parallel, the equivalent resistance is 'p'. If s = np, then the minimum value for n is _____. (Round off to the Nearest Integer)

12. A conducting wire of length `l' , area of cross-section A and electric resistivity ρ is connected between the terminals of a battery. A potential difference V is developed between its ends, causing an electric current.

If the length of the wire of the same material is doubled and the area of cross-section is halved, the resultant current would be :

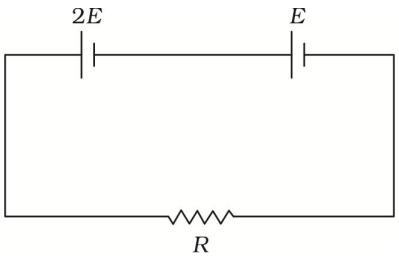
(A) $\frac{1}{4}\frac{\rho l}{VA}$ **(B)** $\frac{3}{4}\frac{VA}{\rho l}$ **(C)** $4\frac{VA}{\rho l}$ **(D)** $\frac{1}{4}\frac{VA}{\rho l}$

13. In the figure given, the electric current flowing through the $5\,k\Omega$ resistor is `x' mA.



The value of x to the nearest integer is _____ .

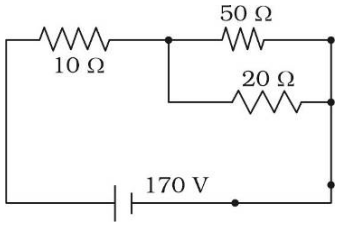
14. Two cells of emf $2E$ and E with internal resistance r_1 and r_2 respectively are connected in series to an external resistor R (see figure). The value of R, at which the potential difference across the terminals of the first cell becomes zero is :



(A) $\frac{r_1}{2}+r_2$ **(B)** $\frac{r_1}{2}-r_2$

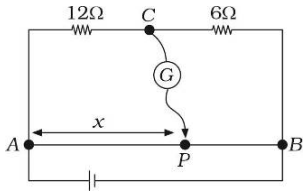
(C) r_1-r_2 **(D)** r_1+r_2

15. The voltage across the 10Ω resistor in the given circuit is x volt.



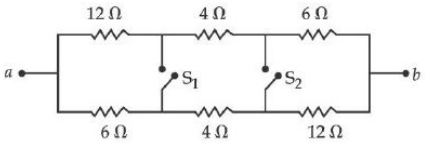
The value of 'x' to the nearest integer is _____ .

16. Consider a 72 cm long wire AB as shown in the figure. The galvanometer jockey is placed at P on AB at a distance x cm from A. The galvanometer shows zero deflection.
The value of x, to the nearest integer, is:

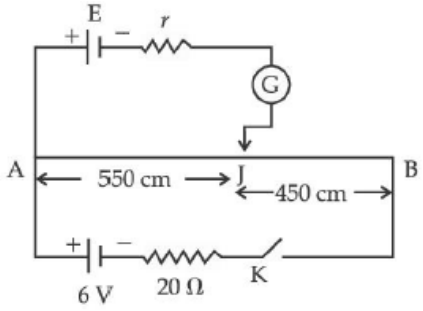


17. Two wires of same length and thickness having specific resistances $6\,\Omega$ cm and 3Ω cm respectively are connected in parallel. The effective resistivity is $\rho\Omega\,cm$. The value of ρ , to the nearest integer is:

18. In the given figure switches S_1 and S_2 are in open condition. The resistance across ab when the switches S_1 and S_2 are closed is _____ Ω.



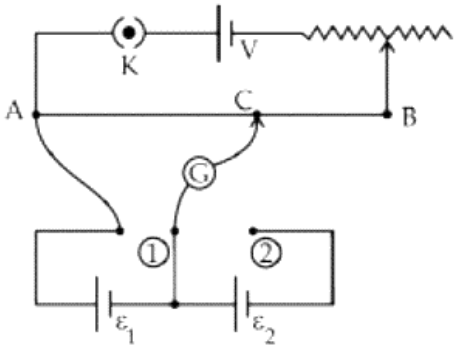
19. In the given figure, there is a circuit of potentiometer of length AB = 10*m*. The resistance per unit length is 0.1Ω per *cm*. Across AB, a battery of emf E and internal resistance 'r' is connected. The maximum value of emf measured by this potentiometer is:



(A) 5V **(B)** 6V **(C)** 2.75V **(D)** 2.25V

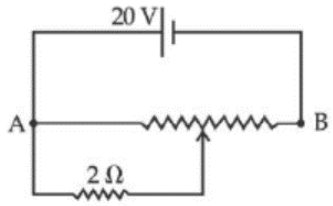
20. An electric bulb rated as 200 W at 100 V is used in a circuit having 200 V supply. The resistance 'R' that must be put in series with the bulb so that the bulb delivers the same power is _____ Ω.

21. In the given potentiometer circuit arrangement, the balancing length AC is measured to be 250 cm. When the galvanometer connection is shifted from point (1) to point (2) in the given diagram, the balancing length becomes 400 cm. The ratio of the emf of two cells, $\frac{\varepsilon_1}{\varepsilon_2}$ is :



(A) $\frac{8}{5}$ **(B)** $\frac{3}{2}$ **(C)** $\frac{4}{3}$ **(D)** $\frac{5}{3}$

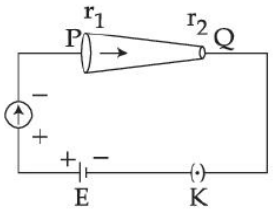
22. The given potentiometer has its wire of resistance 10Ω. When the sliding contact is in the middle of the potentiometer wire, the potential drop across 2Ω resistor is :



(A) $10V$ **(B)** $\frac{40}{11}V$ **(C)** $5V$ **(D)** $\frac{40}{9}V$

23. A 16Ω wire is bend to form a square loop. A 9 V supply having internal resistance of 1Ω is connected across one of its sides. The potential drop across the diagonals of the square loop is _____ $\times 10^{-1}V$.

24. In the given figure, a battery of emf E is connected across a conductor PQ of length $'l'$ and different area of cross-sections having radii r_1 and $r_2 (r_2 < r_1)$.



(A) Electric field decreases **(B)** Electron current decreases

(C) Drift velocity of electron increases **(D)** All of these

25. The resistance of a conductor 15°C is 16Ω and at 100°C is 20Ω. What will be the temperature coefficient of resistance of the conductor?

(A) $0.033°C^{-1}$ **(B)** $0.010°C^{-1}$ **(C)** $0.042°C^{-1}$ **(D)** $0.003°C^{-1}$

26. For the circuit shown, the value of current at time t = 3.2s will be _____A.

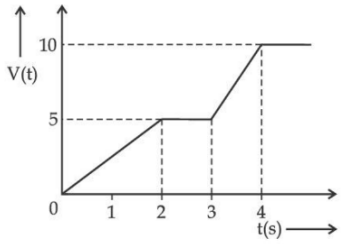


Figure 1

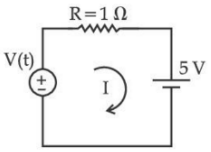


Figure 2

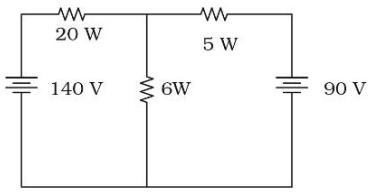
[Voltage distribution V(t) is shown by Fig. (1) and the circuit is shown in Fig. (2)]

27. A current of 5A is passing through a non-linear magnesium wire of cross-section 0.04 m^2. At every point the direction of current density is at an angle of 60° with the unit vector of area of cross-section. The magnitude of electric field at every point of the conductor is: [Resistivity of magnesium $\rho = 44 \times 10^{-8}\,\Omega m$]

(A) $11 \times 10^{-7} V/m$ **(B)** $11 \times 10^{-3} V/m$

(C) $11 \times 10^{-5} V/m$ **(D)** $11 \times 10^{-2} V/m$

28.

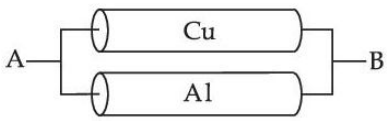


The value of current in the 6Ω resistance is:

(A) 4A **(B)** 10A **(C)** 6A **(D)** 8A

29. A copper (Cu) rod of length 25 cm and cross-sectional area $3\,mm^2$ is joined with a similar Aluminium (Al) rod as shown in figure. Find the resistance of the combination between the ends A and B.

(Take Resistivity of Copper $= 1.7 \times 10^{-8}\ \Omega m$, Resistivity of Aluminium $= 2.6 \times 10^{-8}\ \Omega m$)



(A) 1.420 $m\Omega$ **(B)** 0.858 $m\Omega$ **(C)** 2.170 $m\Omega$ **(D)** 0.0858 $m\Omega$

30. In an electric circuit, a cell of certain emf provides a potential difference of 1.25 V across a load resistance of 5 Ω. However, it provides a potential difference of 1 V across a load resistance of 2 Ω. The emf of the cell is given by $\frac{x}{10}V$. Then the value of x is _____.

31. What equal length of an iron wire and a copper-nickel alloy wire, each of 2 mm diameter connected parallel to give an equivalent resistance of 3 Ω?

(Given resistivities of iron and copper-nickel alloy wire are 12 μΩ cm and 51 μΩ cm respectively).

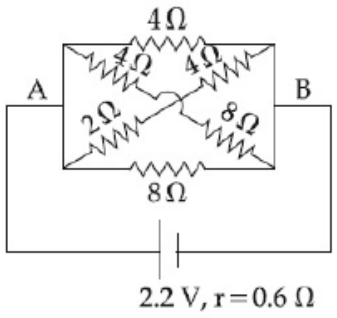
(A) 90 m

(B) 97 m

(C) 82 m

(D) 110 m

32. In the given figure, the emf of the cell is 2.2 V and if internal resistance is 0.6 Ω. Calculate the power dissipated in the whole circuit:



(A) 1.32 W **(B)** 2.2 W

(C) 4.4 W **(D)** 0.65 W

33. If you are provided a set of resistances 2Ω, 4Ω, 6Ω and 8Ω. Connect these resistances so as to obtain an equivalent resistance of $\frac{46}{3}\Omega$.

(A) 4Ω and 6Ω are in parallel with 2Ω and 8Ω in series

(B) 6Ω and 8Ω are in parallel with 2Ω and 4Ω in series

(C) 2Ω and 6Ω are in parallel with 4Ω and 8Ω in series

(D) 2Ω and 4Ω are in parallel with 6Ω and 8Ω in series

34. An electric bulb of 500 watt at 100 volt is used in a circuit having a 200 V supply. Calculate the resistance R to be connected in series with the bulb so that the power delivered by the bulb is 500 W.

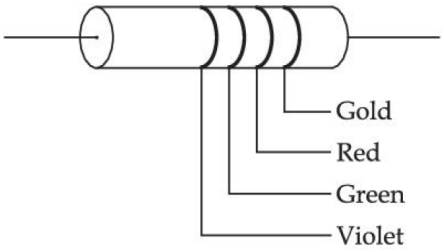
(A) 5Ω **(B)** 20Ω **(C)** 30Ω **(D)** 10Ω

35. Five identical cells each of internal resistance 1Ω and emf 5V are connected in series and in parallel with an external resistance 'R'. For what value of 'R', current in series and parallel combination will remain the same?

(A) 5Ω **(B)** 25Ω **(C)** 1Ω **(D)** 10Ω

36. First, a set of n equal resistors of 10Ω each are connected in series to a battery of emf 20V and internal resistance 10Ω. A current I is observed to flow. Then, the n resistors are connected in parallel to the same battery. It is observed that the current is increased 20 times, then the value of n is_____.

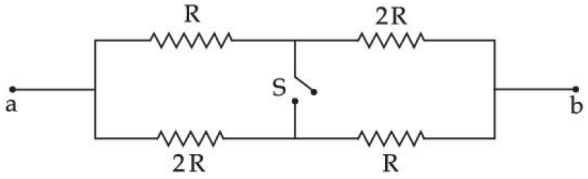
37. The colour coding on a carbon resistor is shown in the given figure. The resistance value of the given resistor is :



(A) $(5700 \pm 375)\Omega$ **(B)** $(7500 \pm 375)\Omega$

(C) $(7500 \pm 750)\Omega$ **(D)** $(5700 \pm 285)\Omega$

38. The ratio of the equivalent resistance of the network (shown in figure) between the points a and b when switch is closed is $x : 8$. The value of x is _____.

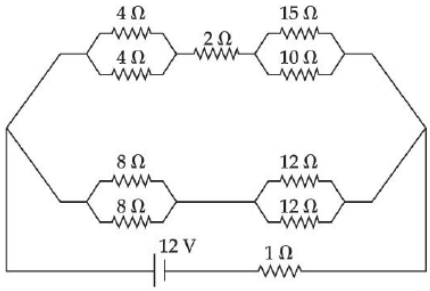


39. Consider a galvanometer shunted with 5Ω resistance and 2% of current passes through it. What is the resistance of the given galvanometer?

(A) 300Ω **(B)** 226Ω **(C)** 344Ω **(D)** 245Ω

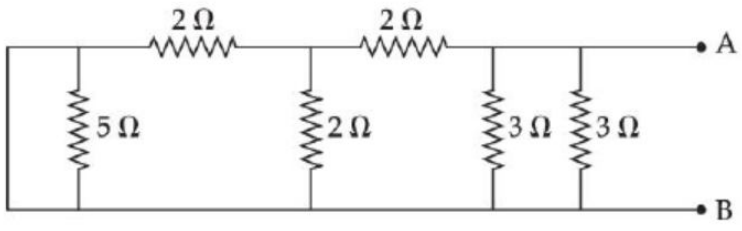
40. A square shaped wire with resistance of each side 3Ω is bent to form a complete circle. The resistance between two diametrically opposite points of the circle in unit of Ω will be _____ .

41. The voltage drop across 15Ω resistance in the given figure will be _____ V.



42. A uniform heating wire of resistance 36Ω is connected across a potential difference of 240 V. The wire is then cut into half and a potential difference of 240 V is applied across each half separately. The ratio of power dissipation in first case to the total power dissipation in the second case would be $1 : x$, where x is:

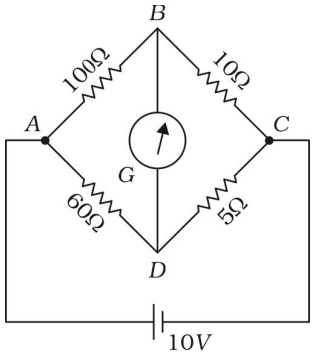
43. The equivalent resistance of the given circuit between the terminals A and B is :



(A) 1Ω **(B)** 0Ω **(C)** $\frac{9}{2}\Omega$ **(D)** 3Ω

44. A resistor dissipates 192 J energy in 1s when a current of 4 A is passed through it. Now, when the current is doubled, the amount of thermal energy dissipated in 5 s is _____J.

45. The four arms of a Wheatstone bridge have resistances as shown in the figure. A galvanometer of 15Ω resistance is connected across *BD*. Calculate the current through the galvanometer when a potential difference of $10V$ is maintained across *AC*.



(A) $2.44\,\mu A$ **(B)** $2.44\,mA$ **(C)** $4.87\,\mu A$ **(D)** $4.87\,mA$

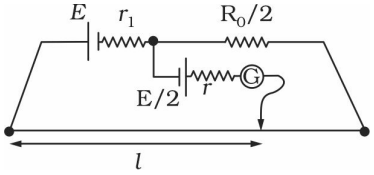
46. A resistor develops 500 J of thermal energy in 20 s when a current of 1.5 A is passed through it. If the current is increased from 1.5 A to 3 A, what will be the energy developed in 20 s.

(A) 1500 J **(B)** 2000 J **(C)** 1000 J **(D)** 500 J

47. The energy dissipated by a resistor is 10 mJ in 1 s when an electric current of 2 mA flows through it. The resistance is _____ Ω. (Round off to the Nearest Integer)

JEE Advanced 2021

1. In order to measure the internal resistance r_1 of a cell of emf E, a meter bridge of wire resistance $R_0 = 50\Omega$, a resistance $R_0/2$, another cell of emf E/2 (internal resistance *r*) and a galvanometer G are used in a circuit, as shown in the figure. If the null point in found at l = 72 cm, then the value of $r_1 =$ _____ Ω



Archive - JEE Main & Advanced

DC Circuits	Class - XII | Physics

JEE Main 2022

1. Two identical cells each of emf 1.5 V are connected in parallel across a parallel combination of two resistors each of resistance 20Ω. A voltmeter connected in the circuit measures 1.2 V. The internal resistance of each cell is :

(A) 2.5Ω **(B)** 4Ω **(C)** 5Ω **(D)** $10\ \Omega$

2. In a potentiometer arrangement, a cell gives a balancing point at 75 cm length of wire. This cell is now replaced by another cell of unknown emf. If the ratio of the emf's of two cells respectively is 3 : 2, the difference in the balancing length of the potentiometer wire in above two cases will be _____ cm.

3. What will be the most suitable combination of three resistors $A = 2\Omega, B = 4\Omega, C = 6\Omega$ so that $\left(\frac{22}{3}\right)\Omega$ is equivalent resistance of combination?

(A) Parallel combination of A and C connected in series with B.

(B) Parallel combination of A and B connected in series with C.

(C) Series combination of A and C connected in parallel with B.

(D) Series combination of B and C connected in parallel with A.

4. A potentiometer wire of length 10 m and resistance 20Ω is connected in series with a 25 V battery and an external resistance 30Ω. A cell of emf E in secondary circuit is balanced by 250 cm long potentiometer wire. The value of E (in volt) is $\frac{x}{10}$. The value of x is _____ .

5. A teacher in his physics laboratory allotted an experiment to determine the resistance (G) of a galvanometer. Students took the observations for $\frac{1}{3}$ deflection in the galvanometer. Which of the below is **true** for measuring value of G?

(A) $\frac{1}{3}$ deflection method cannot be used for determining the resistance of the galvanometer

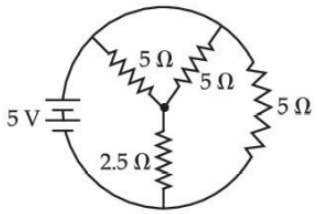
(B) $\frac{1}{3}$ deflection method can be used and in this case the G equals to twice the value of shunt resistance(s)

(C) $\frac{1}{3}$ deflection method can be used and in this case, the G equals to three times the value of shunt resistance(s)

(D) $\frac{1}{3}$ deflection method can be used and in this case of G value equals to the shunt resistance(s)

6. A resistor develops 300 J of thermal energy in 15 s, when a current of 2A is passed through it. If the current increases to 3A, the energy developed in 10s is _____ J.

7. The total current supplied to the circuit as shown in figure by the 5V battery is _____A.



8. Two cells of same emf but different internal resistance r_1 and r_2 are connected in series with a resistance R. The value of resistance R, for which the potential difference across second cell is zero, is:

(A) $r_2 - r_1$ **(B)** $r_1 - r_2$ **(C)** r_1 **(D)** r_2

9. If n represents the actual number of deflections in a converted galvanometer of resistance G and shunt resistance S. Then the total current I when its figure of merit is K will be :

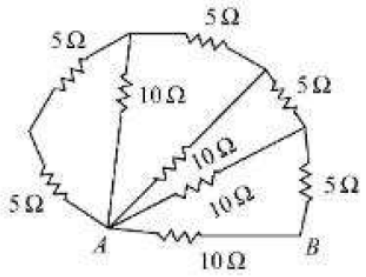
(A) $\frac{KS}{(S+G)}$ **(B)** $\frac{(G+S)}{nKS}$ **(C)** $\frac{nKS}{(G+S)}$ **(D)** $\frac{nK(G+S)}{S}$

10. The length of a given cylindrical wire is increased to double of its original length. The percentage increase in the resistance of the wire will be _____%.

11. An aluminium wire is stretched to make its length, 0.4% larger. The percentage change in resistance is:

(A) 0.4% **(B)** 0.2% **(C)** 0.8% **(D)** 0.6%

12. The equivalent resistance between points A and B in the given network is:



(A) 65Ω **(B)** 20Ω **(C)** 5Ω **(D)** 2Ω

13. A 72Ω galvanometer is shunted by a resistance of 8Ω. The percentage of the total current which passes through the galvanometer is :

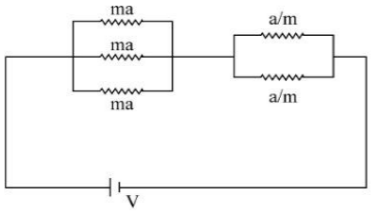
(A) 0.1% **(B)** 10% **(C)** 25% **(D)** 0.25%

14. A cell, shunted by a 8Ω resistance, is balanced across a potentiometer wire of length 3 m. The balancing length is 2 m when the cell is shunted by 4Ω resistance. The value of internal resistance of the cell will be ____Ω.

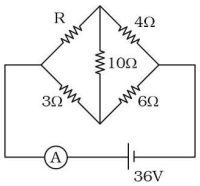
15. The current density in a cylindrical wire of radius 4 mm is $4\times10^6\ Am^{-2}$. The current through the outer portion of the wire between radial distances $\frac{R}{2}$ and R is _____75×10^9

16. The current density in a cylindrical wire of radius $r = 4.0\ mm$ is $1.0\times10^6\ A/m^2$. The current through the outer portion of the wire between radial distances $\frac{r}{2}$ and r is $x\pi\ A$; where x is _____.

17. In the given circuit 'a' is an arbitrary constant. The value of m for which the equivalent circuit resistance is minimum, will be $\sqrt{\frac{x}{2}}$. The value of x is _____.



18. Current measured by the ammeter Ⓐ in the reported circuit when no current flows through 10Ω resistance, will be _____A.



19. Water falls from a $40m$ high dam at the rate of $9\times10^4\,kg$ per hour. Fifty percentage of gravitational potential energy can be converted into electrical energy. Using this hydro electric energy number of $100\,W$ lamps, that can be lit, is:

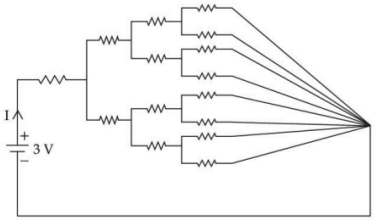
(Take $g = 10\ ms^{-2}$)

(A) 25 **(B)** 50 **(C)** 100 **(D)** 18

20. Resistance of the wire is measured as 2Ω and 3Ω at $10°C$ and $30°C$ respectively. Temperature co-efficient of resistance of the material of the wire is:

(A) $0.033\,°C^{-1}$ **(B)** $-0.033\,°C^{-1}$ **(C)** $0.011\,°C^{-1}$ **(D)** $0.055\,°C^{-1}$

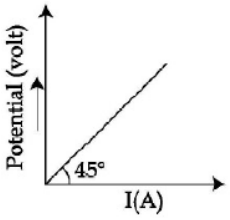
21. All resistances in figure are 1Ω each. The value of current 'I' is $\frac{a}{5}A$. The value of a is _____.



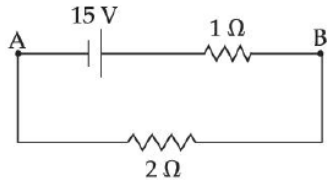
22. Two coils require 20 minutes and 60 minutes respectively to produce same amount of heat energy when connected separately to the same source. If they are connected in parallel arrangement to the same source; the time required to produce same amount of heat by the combination of coils, will be _____ min.

23. The variation of applied potential and current flowing through a given wire is shown in figure. The length of wire is 31.4 cm. The diameter of wire is measured as 2.4 cm. The resistivity of the given wire is measured as $x\times10^{-3}\Omega$ cm. The value of x is _____.

[Take π = 3.14]



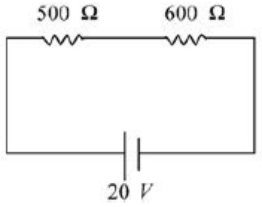
24. For the network shown below, the value of $V_B - V_A$ is _____ V.



25. The combination of two identical cells, whether connected in series or parallel combination provides the same current through an external resistance of 2 Ω. The value of internal resistance of each cell is:

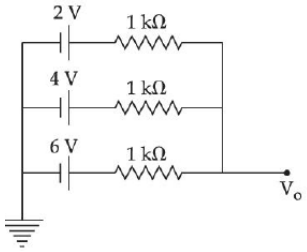
(A) 2 Ω **(B)** 4 Ω **(C)** 6 Ω **(D)** 8 Ω

26. Two resistors are connected in series across a battery as shown in figure. If a voltmeter of resistance 2000 Ω is used to measure the potential difference across 500 Ω resistor, the reading of the voltmeter will be _____ *V*.



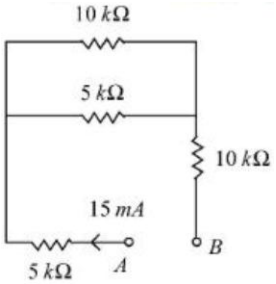
27. A $1m$ long copper wire carries a current of $1A$. If the cross section of the wire is $2.0\,mm^2$ and the resistivity of copper is $1.7\times10^{-8}\Omega m$, the force experienced by moving electron in the wire is $\_\_\_\times10^{-23}N$. [Charge on electron $=1.6\times10^{-19}C$]

28. In the given figure, the value of V_0 will be _____V.



29. Eight copper wire of length l and diameter d are joined in parallel to form a single composite conductor of resistance R. If a single copper wire of length $2l$ have the same resistance (R) then its diameter will be _____d.

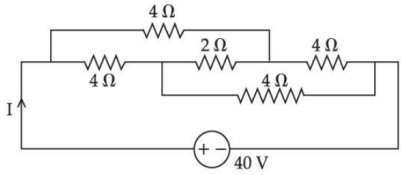
30. A current of 15 mA flows in the circuit as shown in figure. The value of potential difference between the points A and B will be:



(A) 50 V **(B)** 75 V **(C)** 150 V **(D)** 275 V

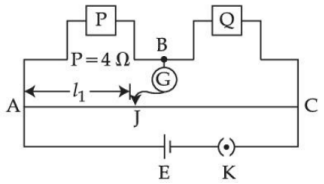
31. In a potentiometer arrangement, a cell of emf 1.20 V gives a balance point at 36 cm length of wire. This cell is now replaced by another cell of emf 1.80 V. The difference in balancing length of potentiometer wire in above conditions will be _____ cm.

32. The current I in the given circuit will be:

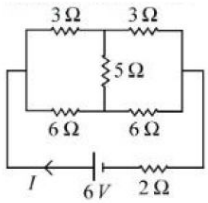


(A) 10 A **(B)** 20 A **(C)** 4 A **(D)** 40 A

33. Resistances are connected in a meter bridge circuit as shown in the figure. The balancing length l_1 is 40 cm. Now an unknown resistance *x* is connected in series with P and new balancing length is found to be 80 cm measured from the same end. Then the value of *x* will be _____ Ω.



34. A battery of 6V is connected to the circuit as shown below. The current I drawn from the battery is:



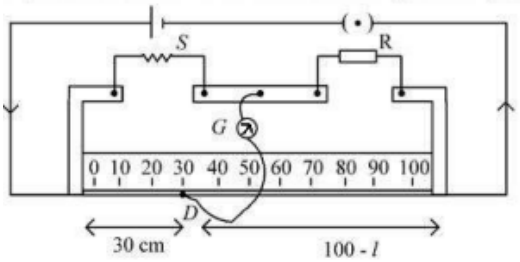
(A) 1A **(B)** 2 **(C)** $\frac{6}{11}A$ **(D)** $\frac{4}{3}A$

35. A potentiometer wire of length 300 cm is connected in series with a resistance 780Ω and a standard cell of emf 4V. A constant current flows through potentiometer wire. The length of the null point for cell of emf 20 mV is found to be 60 cm. The resistance of the potentiometer wire is _____ Ω.

36. Two sources of equal emfs are connected in series. This combination is connected to an external resistance *R*. The internal resistances of the two sources are r_1 *and* r_2 $(r_1 > r_2)$. If the potential difference across the source of internal resistance r_1 is zero, then the value of *R* will be:

(A) $r_1 - r_2$ **(B)** $\frac{r_1 r_2}{r_1 + r_2}$ **(C)** $\frac{r_1 + r_2}{2}$ **(D)** $r_2 - r_1$

37. In a meter bridge experiment, for measuring unknown resistance '*S*', the null point is obtained at a distance 30 *cm* from the left side as shown at point *D*. If *R* is $5.6\,k\Omega$, then the value of unknown resistance '*S*' will be _____ Ω.



38.

(A) The drift velocity of electrons decreases with the increase in the temperature of conductor.

(B) The drift velocity is inversely proportional to the area of cross-section of given conductor.

(C) The drift velocity does not depend on the applied potential difference to the conductor.

(D) The drift velocity of electron is inversely proportional to the length of the conductor.

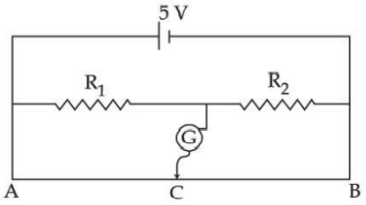
(E) The drift velocity increases with the increase in the temperature of conductor.

Choose the correct answer from the options given below:

(A) (A) and (B) only **(B)** (A) and (D) only

(C) (B) and (E) only **(D)** (B) and (C) only

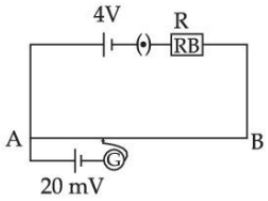
39. In the given figure of meter bridge experiment, the balancing length AC corresponding to null deflection of the galvanometer is 40 cm. the balancing length, if the radius of the wire AB is doubled, will be _____ cm.



40. A wire of resistance R_1 is drawn out so that its length is increased by twice of its original length. The ratio of new resistance to original resistance is:

(A) 9 : 1 **(B)** 1 : 9 **(C)** 4 : 1 **(D)** 3 :1

41. As shown in the figure, a potentiometer wire of resistance $20\,\Omega$ and length $300\,cm$ is connected with resistance box $(R.B.)$ and a standard cell of emf $4\,V$. For a resistance 'R' of resistance box introduced into the circuit, the null point for a cell of $20\,mV$ is found to be $60\,cm$. The value of 'R' is _____Ω.



42. Given below are two statements :

Statement I :	A uniform wire of resistance 80Ω is cut into four equal parts. These parts are now connected in parallel. The equivalent resistance of the combination will be 5Ω
Statement II :	Two resistances 2R and 3R are connected in parallel in a electric circuit. The value of thermal energy developed in 3R and 2R will be in the ratio 3 : 2.

In the light of the above statements, choose the ***most appropriate*** answer from the option given below:

(A) Both statements I and statement II are correct

(B) Both statement I and statement II are incorrect

(C) Statement I is correct but statement II is incorrect

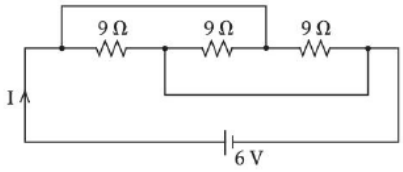
(D) Statement I is incorrect but statement II is correct

43. An electrical bulb rated 220 V, 100W, is connected in series with another bulb rated 220 V, 60 W. If the voltage across combination is 220 V, the power consumed by the 100 W bulb will be about _____ W.

44. Two metallic wires of identical dimensions are connected in series. If σ_1 and σ_2 are the conductivities of the these wires respectively, the effective conductivity of the combination is:

(A) $\frac{\sigma_1\sigma_2}{\sigma_1+\sigma_2}$ **(B)** $\frac{2\sigma_1\sigma_2}{\sigma_1+\sigma_2}$ **(C)** $\frac{\sigma_1+\sigma_2}{2\sigma_1\sigma_2}$ **(D)** $\frac{\sigma_1+\sigma_2}{\sigma_1\sigma_2}$

45. The current I flowing through the given circuit will be _____ A.



46. Given below are two statements: one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A: Alloys such as constantan and manganin are used in making standard resistance coils.

Reason R: Constantan and manganin have very small value of temperature coefficient of resistance.

In the light of the above statements, choose the ***correct*** answer from the options given below.

(A) Both **A** and **R** are true and **R** is the correct explanation of **A**.

(B) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**.

(C) **A** is true but **R** is false.

(D) **A** is false but **R** is true.

47. A 1m long wire is broken into two unequal parts X and Y. The X part of the wire is stretched into another wire W. Length of W is twice the length of X and the resistance of W is twice that of Y. Find the ratio of length of X and Y.

(A) 1:4 **(B)** 1:2 **(C)** 4:1 **(D)** 2:1

Archive - JEE Main & Advanced

Capacitors	Class - XII | Physics

JEE Main 2021

1. Two equal capacitors are first connected in series and then in parallel. The ratio of the equivalent capacities in the two cases will be:

(A) 2 : 1 **(B)** 1 : 2 **(C)** 4 : 1 **(D)** 1 : 4

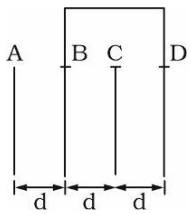
2. An electron with kinetic energy K_1 enters between parallel plates of a capacitor at an angle 'α' with the plates. It leaves the plates at angle 'β' with kinetic energy K_2. Then the ratio of kinetic energies $K_1 : K_2$ will be:

(A) $\frac{\cos^2\beta}{\cos^2\alpha}$ **(B)** $\frac{\cos\beta}{\cos\alpha}$ **(C)** $\frac{\cos\beta}{\sin\alpha}$ **(D)** $\frac{\sin^2\beta}{\cos^2\alpha}$

3. Consider the combination of 2 capacitors C_1 and C_2, with $C_2 > C_1$, when connected in parallel, the equivalent capacitance is $\frac{15}{4}$ times the equivalent capacitance of the same connected in series. Calculate the ratio of capacitors, $\frac{C_2}{C_1}$.

(A) $\frac{15}{4}$ **(B)** $\frac{111}{80}$ **(C)** $\frac{15}{11}$ **(D)** $\frac{29}{15}$

4. Four identical rectangular plates with length, $\ell = 2cm$ and breadth, $b = \frac{3}{2}cm$ are arranged as shown in figure. The equivalent capacitance between A and C is $\frac{x\varepsilon_0}{d}$. The value of x is _____. (Round off to the Nearest Integer)

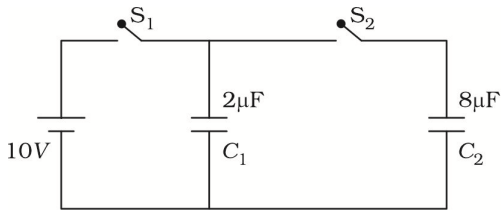


5. A parallel plate capacitor whose capacitance C is 14pF is charged by a battery to a potential difference V = 12 V between its plates. The charging battery is now disconnected and a porcelain plate with k = 7 is inserted between the plates, then the plate would oscillate back and forth between the plates with a constant mechanical energy of _____pJ. (Assume no friction)

6. For changing the capacitance of a given parallel plate capacitor, a dielectric material of dielectric constant K is used, which has the same area as the plates of the capacitor. The thickness of the dielectric slab is $\frac{3}{4}d$, where `d' is the separation between the plates of parallel plate capacitor. The new capacitance (C') in the terms of original capacitance (C_0) is given by the following relation :

(A) $C' = \frac{4K}{K+3}C_0$ **(B)** $C' = \frac{4+K}{3}C_0$ **(C)** $C' = \frac{3+K}{4K}C_0$ **(D)** $C' = \frac{4}{3+K}C_0$

7. A $2\mu F$ capacitor C_1 is first charged to a potential difference of $10V$ using a battery. Then the battery is removed and the capacitor is connected to an uncharged capacitor C_2 of $8\mu F$. The charge in C_2 on equilibrium condition is _____ μC. (Round off to the Nearest Integer)



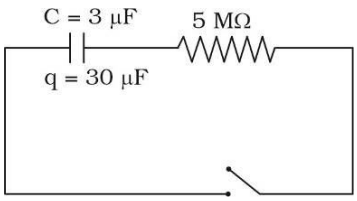
8. A parallel plate capacitor has plate area 100 m^2 and plate separation of 10m. The space between the plates is filled up to a thickness 5m with a material of dielectric constant of 10.

The resultant capacitance of the system is 'x' pF.

The value of $\varepsilon_0 = 8.85 \times 10^{-12}$ F.m^{-1}

The value of 'x'to the nearest integer is _____ .

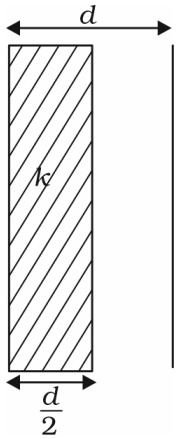
9.



The circuit shown in the figure consists of a charged capacitor of capacity $3\mu F$ and a charge of $30\mu C$. At time t = 0, when the key is closed, the value of current flowing through the $5M\Omega$ resistor is 'x' μA.

The value of 'x' to the nearest integer is _____ .

10. In a parallel plate capacitor set up, the plate area of capacitor is 2 m^2 and the plates are separated by 1 m. If the space between the plates are filled with a dielectric material of thickness 0.5 m and area 2 m^2 (see figure) the capacitance of the set-up will be _____ ε_0. (Dielectric constant of the material = 3.2) (Round off to the Nearest Integer)



11. A parallel plate capacitor with plate area 'A' and distance of separation 'd' is filled with a dielectric. What is the capacity of the capacitor when permittivity of the dielectric varies as:

$$\varepsilon(x) = \varepsilon_0 + kx, \text{for}\left(0 < x \le \frac{d}{2}\right) \quad ; \quad \varepsilon(x) = \varepsilon_0 + k(d-x), \text{for}\left(\frac{d}{2} \le x \le d\right)$$

(A) 0 **(B)** $\dfrac{kA}{2\ln\left(\dfrac{2\varepsilon_0 + kd}{2\varepsilon_0}\right)}$ **(C)** $\left(\varepsilon_0 + \dfrac{kd}{2}\right)^{2/kA}$ **(D)** $\dfrac{kA}{2}\ln\left(\dfrac{2\varepsilon_0}{2\varepsilon_0 - kd}\right)$

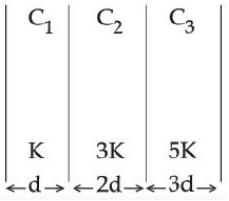
12. If q_f is the free charge on the capacitor plates and q_b is the bound charge on the dielectric slab of dielectric constant k placed between the capacitor plates, then bound charge q_b can be expressed as :

(A) $q_b = q_f\left(1-\frac{1}{k}\right)$ **(B)** $q_b = q_f\left(1+\frac{1}{k}\right)$ **(C)** $q_b = q_f\left(1+\frac{1}{\sqrt{k}}\right)$ **(D)** $q_b = q_f\left(1-\frac{1}{\sqrt{k}}\right)$

13. Two capacitors of capacities $2C$ and C are joined in parallel and charged up to potential V. The battery is removed and the capacitor capacity C is filled completely with a medium of dielectric constant K. Potential difference across the capacitors will now be :

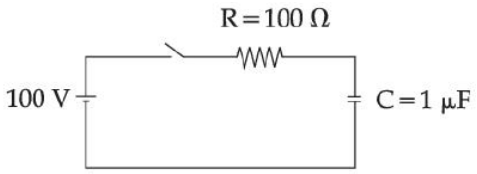
(A) $\frac{V}{K+2}$ **(B)** $\frac{V}{K}$ **(C)** $\frac{3V}{K}$ **(D)** $\frac{3V}{K+2}$

14. In the reported figure, a capacitor is formed by placing a compound dielectric between the plates of parallel plate capacitor. The expression for the capacity of the solid capacitor will be : (Given area of plate = A)



(A) $\frac{9}{6}\frac{K\varepsilon_0 A}{d}$ **(B)** $\frac{15}{6}\frac{K\varepsilon_0 A}{d}$ **(C)** $\frac{15}{34}\frac{K\varepsilon_0 A}{d}$ **(D)** $\frac{25}{6}\frac{K\varepsilon_0 A}{d}$

15.



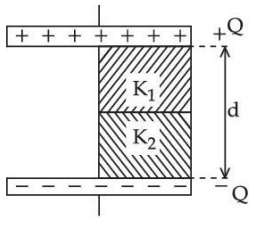
A capacitor of capacitance $C = 1\mu F$ is suddenly connected to a battery of 100 volt through a resistance $R = 100\,\Omega$. The time taken for the capacitor to be charged to get $50V$ is : [Take $\ln 2 = 0.69$]

(A) $1.44\times10^{-4}s$ **(B)** $0.69\times10^{-4}s$ **(C)** $0.30\times10^{-4}s$ **(D)** $3.33\times10^{-4}s$

16. The material filled between the plates of a parallel plate capacitor has resistivity 200 Ωm. The value of capacitance of the capacitor is 2 pF. If a potential difference of 40 V is applied across the plates of the capacitor, then the value of leakage current flowing out of the capacitor is : (given the value of relative permittivity of material is 50).

(A) 0.9 mA **(B)** 9.0 mA **(C)** 9.0 μA **(D)** 0.9 μA

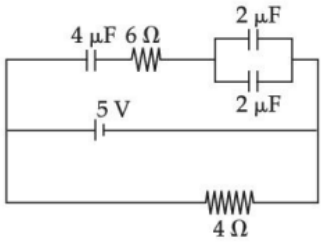
17. A parallel-plate capacitor with plate area A has separation d between the plates. Two dielectric slabs of dielectric constant K_1 and K_2 of same area $A/2$ and thickness $d/2$ are inserted in the space between the plates. The capacitance of the capacitor will be given by:



(A) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{K_1K_2}{K_1+K_2}\right)$ **(B)** $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{2(K_1+K_2)}{K_1K_2}\right)$

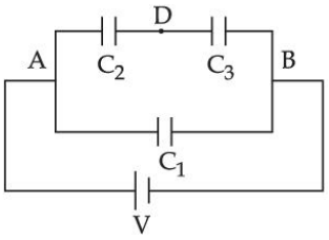
(C) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{K_1K_2}{2(K_1+K_2)}\right)$ **(D)** $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{K_1+K_2}{K_1K_2}\right)$

18. Calculate the amount of charge on capacitor of $4\mu F$. The internal resistance of battery is 1Ω :



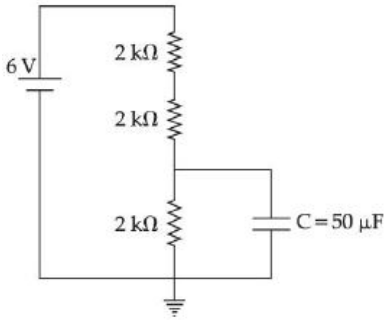
(A) $8\mu C$ **(B)** $4\mu C$ **(C)** Zero **(D)** $16\mu C$

19. Three capacitors $C_1 = 2\mu F, C_2 = 6\mu F$ and $C_3 = 12\mu F$ are connected as shown in figure. Find the ratio of the charge on capacitors C_1, C_2 and C_3 respectively :



(A) 1 : 2 : 2 **(B)** 3 : 4 : 4 **(C)** 2 : 1 : 1 **(D)** 2 : 3 : 3

20. A capacitor of $50\mu F$ is connected in a circuit as shown in figure. The charge on the upper plate of the capacitor is _____ μC .



21. A capacitor is connected to a 20 V battery through a resistance of 10Ω . It is found that the potential difference across the capacitor rises to 2V in $1\mu s$. The capacitance of the capacitor is_____ μF.

Given $\ell n\left(\frac{10}{9}\right) = 0.105$

(A) 1.85 **(B)** 0.95 **(C)** 9.52 **(D)** 0.105

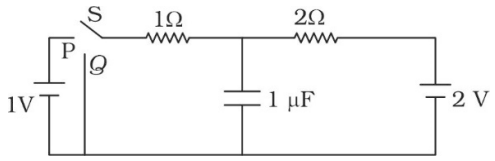
22. A parallel plate capacitor of capacitance 200 μF is connected to a battery of 200 V. A dielectric slab of dielectric constant 2 is now inserted into the space between plates of capacitor while the batter)' remain connected. The change in the electrostatic energy in the capacitor will be _____ J.

JEE Advanced 2021

Question Stem for Question Nos. 1 and 2

Question Stem

In the circuit shown below, the switch S is connected to position P for a long time so that the charge on the capacitor becomes q_1 μC. Then S is switched to position Q. After a long time, the charge on the capacitor is q_2 μC.



1. The magnitude of q_1 is _____.

2. The magnitude of q_2 is _____.

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Archive - JEE Main & Advanced

Capacitors	Class - XII | Physics

JEE Main 2022

1. A parallel plate capacitor filled with a medium of dielectric constant 10, is connected across a battery and is charged. The dielectric slab is replaced by another slab of dielectric constant 15. Then the energy of capacitor will:

(A) increase by 50% **(B)** decrease by 15%

(C) increase by 25% **(D)** increase by 33%

2. A force of 10N acts on a charged particle placed between two plates of a charged capacitor. If one plate of capacitor is removed, then the force acting on that particle will be.

(A) 5 N **(B)** 10N **(C)** 20 N **(D)** Zero

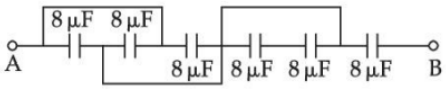
3. A parallel plate capacitor is formed by two plates each of area $30\pi\ cm^2$ separated by 1 mm. A material of dielectric strength $3.6\times10^7 Vm^{-1}$ is filled between the plates. If the maximum charge that can be stored on the capacitor without causing any dielectric breakdown is $7\times10^{-6}C$, the value of dielectric constant of the material is : [Use $\frac{1}{4\pi\epsilon_0}=9\times10^9 Nm^2C^{-2}$]

(A) 1.66 **(B)** 1.75 **(C)** 2.25 **(D)** 2.33

4. If the charge on a capacitor is increased by 2 C, the energy stored in it increases by 44%. The original charge on the capacitor is (in C) :

(A) 10 **(B)** 20 **(C)** 30 **(D)** 40

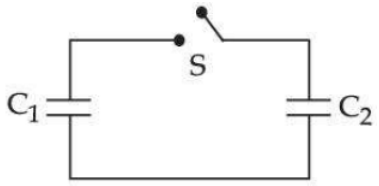
5. The equivalent capacitance between points A and B is below shown figure will be_____ μF .



6. Two metallic plates form a parallel plate capacitor. The distance between the plates is 'd'. A metal sheet of thickness $\frac{d}{2}$ and of area equal to area of each plate is introduced between the plates. What will be the ratio of the new capacitance to the original capacitance of the capacitor?

(A) 2:1 **(B)** 1:2 **(C)** 1:4 **(D)** 4:1

7. Two capacitors having capacitance C_1 and C_2 respectively are connected as shown in figure. Initially, capacitor C_1 is charged to a potential difference V volt by a battery. The battery is then removed and the charged capacitor C_1 is now connected to uncharged capacitor C_2 by closing the switch S. The amount of charge on the capacitor C_2, after equilibrium, is:



(A) $\frac{C_1C_2}{(C_1+C_2)}V$ **(B)** $\frac{(C_1+C_2)}{C_1C_2}V$ **(C)** $(C_1+C_2)V$ **(D)** $(C_1-C_2)V$

8. Given below two statements: One is labelled as Assertion (A) and other is labelled as Reason (R).

Assertion (A): Non-polar materials do not have any permanent dipole moment.

Reason (R): When a non-polar material is placed in an electric field, the centre of the positive charge distribution of it's individual atom or molecule coincides with the centre of the negative charge distribution.

In the light of above statements, choose the most appropriate answer from the options given below.

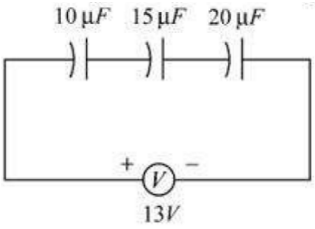
(A) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**

(B) Both **(A)** and **(R)** are correct and **(R)** is not the correct explanation of **(A)**

(C) **(A)** is correct but **(R)** is not correct

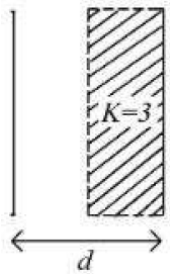
(D) **(A)** is not correct but **(R)** is correct

9. The charge on capacitor of capacitance $15\mu F$ in the figure given below is:



(A) $60\mu c$ **(B)** $130\mu c$ **(C)** $260\mu c$ **(D)** $585\,\mu c$

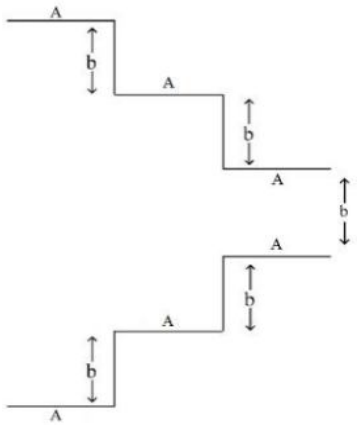
10. A parallel plate capacitor with plate area A and plate separation $d = 2m$ has a capacitance of $4\mu F$. The new capacitance of the system if half of the space between them is filled with a dielectric material of dielectric constant $K = 3$ (as show in figure) will be:



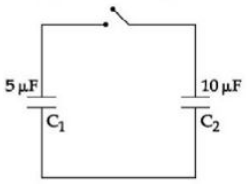
(A) $2\mu F$ **(B)** $32\mu F$ **(C)** $6\mu F$ **(D)** $8\mu F$

11. The capacitor of capacitance 50 pF is charged by 100 V source. It is then connected to another uncharged identical capacitor. Electrostatic energy loss in the process is _____nJ.

12. A parallel plate capacitor is made up of stair like structure with a plate area A of each star and that is connected with a wire of length b, as shown in the figure. The capacitance of the arrangement is $\frac{x}{15}\frac{\epsilon_0 A}{b}$, The value of x is _____.



13. A capacitor C_1 of capacitance $5\,\mu F$ is charged to a potential of $30\,V$ using a battery. The battery is then removed and the charged capacitor is connected to an uncharged capacitor C_2 of capacitance $10\,\mu F$ as shown in figure. When the switch is closed charge flows between the capacitors. At equilibrium, the charge on the capacitor C_2 is _____ μC.

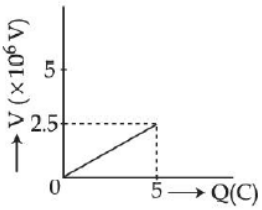


14. A capacitor is discharging through a resistor R. Consider in time t_1, the energy stored in the capacitor reduces to half its initial value and in time t_2, the charge stored reduces to one eight of its initial values. The ratio t_1/t_2 will be:

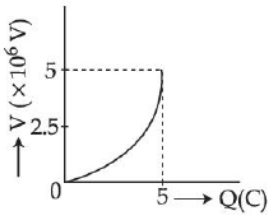
(A) ½ **(B)** 1/3 **(C)** ¼ **(D)** 1/6

15. A condenser of $2\mu F$ capacitance is charged steadily from 0 to 5C. Which of the following graph represents correctly the variation of potential difference (V) across it's plates with respect to the charge (Q) on the condenser?

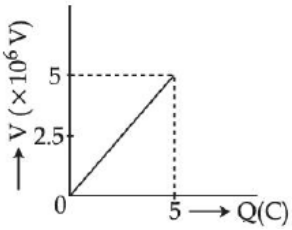
(A)



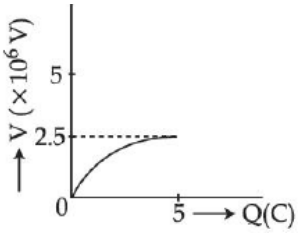
(B)



(C)



(D)



16. Capacitance of an isolated conducting sphere of radius R_1 becomes n times when it is enclosed by a concentric conducting sphere of radius R_2 connected to earth. The ratio of their radii $\left(\frac{R_2}{R_1}\right)$ is:

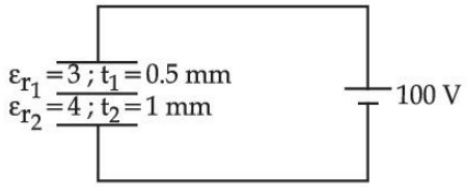
(A) $\frac{n}{n-1}$ **(B)** $\frac{2n}{2n+1}$ **(C)** $\frac{n+1}{n}$ **(D)** $\frac{2n+1}{n}$

17. Two parallel plate capacitors of capacity C and $3C$ are connected in parallel combination and charged to a potential difference 18 V. The battery is then disconnected and the space between the plates of the capacitor of capacity C is completely filled with a material of dielectric constant 9. The final potential difference across the combination of capacitors will be _____ V.

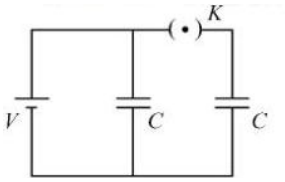
18. The total charge on the system of capacitors $C_1 = 1\ \mu F, C_2 = 2\ \mu F, C_3 = 4\ \mu F$ *and* $C_4 = 3\ \mu F$ connected in parallel is:
(Assume a battery of 20V is connected to the combination)

(A) 200 μC **(B)** 200 C **(C)** 10 μC **(D)** 10 C

19. A composite parallel plate capacitor is made up of two different dielectric materials with different thickness $(t_1 \text{ and } t_2)$ as shown in figure. The two different dielectric materials are separated by a conducting foil F. The voltage of the conducting foil is _____ V.

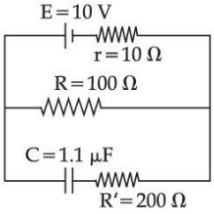


20. A source of potential difference V is connected to the combination of two identical capacitors as shown in the figure. When key 'K' is closed, the total energy stored across the combination is E_1. Now key 'K' is opened and dielectric of dielectric constant 5 is introduced between the plates of the capacitors. The total energy stored across the combination is now E_2. The ratio E_1 / E_2 will be:



(A) $\frac{1}{10}$ **(B)** $\frac{2}{5}$ **(C)** $\frac{5}{13}$ **(D)** $\frac{5}{26}$

21. As shown in the figure, in steady state, the charge stored in the capacitor is _____$\times 10^{-6} C$.



22. A parallel plate capacitor with width 4 cm, length 8 cm and separation between the plates of 4 mm is connected to a battery of 20 V. A dielectric slab of dielectric constant 5 having length 1 cm, width 4 cm and thickness 4 mm is inserted between the plates of parallel plate capacitor. The electrostatic energy of this system will be _____ $\epsilon_0\ J$.

(Where ϵ_0 is the permittivity of free space).

23. Two capacitors, each having capacitance $40\,\mu F$ are connected in series. The space between one of the capacitors is filled with dielectric material of dielectric constant K such that the equivalence capacitance of the system became $24\,\mu F$. The value of K will be:

(A) 1.5 **(B)** 2.5 **(C)** 1.2 **(D)** 3

24. A slab of dielectric constant K has the same cross-sectional area as the plates of a parallel plate capacitor and thickness $\frac{3}{4}d$, where d is the separation of the plates. The capacitance of the capacitor when the slab is inserted between the plates will be:
(Given C_0 = capacitance of capacitor with air as medium between plates.)

(A) $\frac{4KC_0}{3+K}$ **(B)** $\frac{3KC_0}{3+K}$ **(C)** $\frac{3+K}{4KC_0}$ **(D)** $\frac{K}{4+K}$

25. Two identical thin metal plates has charge q_1 and q_2 respectively such that $q_1 > q_2$. The plates were brought close to each other to form a parallel plate capacitor of capacitance C. The potential difference between them is :

(A) $\frac{(q_1+q_2)}{C}$ **(B)** $\frac{(q_1-q_2)}{C}$ **(C)** $\frac{(q_1-q_2)}{2C}$ **(D)** $\frac{2(q_1-q_2)}{C}$

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Archive - JEE Main & Advanced

Magnetic Effect of Current	Class - XII | Physics

JEE Main 2021

1. A proton, a deuteron and an α particle are moving with same momentum in a uniform magnetic field. The ratio of magnetic forces acting on them is____ and their speed is ____, in the ratio.

(A) 1 : 2 : 4 and 2 : 1 : 1 **(B)** 2 : 1 : 1 and 4 : 2 : 1

(C) 4 : 2 : 1 and 2 : 1 : 1 **(D)** 1 : 2 : 4 and 1: 1 : 2

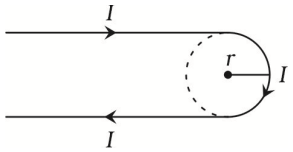
2. Magnetic fields at two points on the axis of a circular coil at a distance of 0.05 m and 0.2 m from the centre arc in the ratio 8 : 1. The radius of coil is_____.

(A) 1.0 m **(B)** 0.1 m **(C)** 0.2 m **(D)** 0.15 m

3. A solenoid of 1000 turns per meter has a core with relative permeability 500. Insulated windings of the solenoid carry an electric current of 5A. The magnetic flux density produced by the second is: (permeability of free space $= 4\pi\ 10^{-7} H/m$)

(A) $\frac{\pi}{5}T$ **(B)** $2\times 10^{-3}\pi T$ **(C)** πT **(D)** $10^{-4}\pi T$

4. A hairpin like shape as shown in figure is made by bending a long current carrying wire. What is the magnitude of a magnetic field at point P which lies on the centre of the semicircle ?



(A) $\frac{\mu_0 I}{4\pi r}(2-\pi)$ **(B)** $\frac{\mu_0 I}{2\pi r}(2-\pi)$ **(C)** $\frac{\mu_0 I}{2\pi r}(2+\pi)$ **(D)** $\frac{\mu_0 I}{4\pi r}(2+\pi)$

5. A loop of flexible wire of irregular shape carrying current is placed in an external magnetic field. Identify the effect of the field on the wire.

(A) loop assumes circular shape with its plane parallel to the field

(B) wire gets stretched to become straight

(C) loop assumes circular shape with its plane normal to the field

(D) shape of the loop remains unchanged

6. Which of the following statements are correct?

(A) Electric monopoles do not exist whereas magnetic monopoles exist.

(B) Magnetic field lines due to solenoid at its ends and outside cannot be completely straight and confined.

(C) Magnetic field lines are completely confined within a toroid.

(D) Magnetic field lines inside a bar magnet are not parallel.

(E) $x=-1$ is the condition for a perfect diamagnetic material, where χ is its magnetic susceptibility.

Choose the correct answer from the options given below.

(A) (C) and (E) only **(B)** (B) and (C) only **(C)** (B) and (D) only **(D)** (A) and (B) only

7. A proton and an α -particle, having kinetic energies K_p and K_α respectively, enter into a magnetic field at right angles. The ratio of the radii of trajectory of proton to that of α – particle is 2:1. The ratio of $K_p : K_\alpha$ is:

(A) 8 : 1 **(B)** 1 : 4 **(C)** 4 : 1 **(D)** 1 : 8

8. A charge Q is moving $\vec{dl}$ distance in the magnetic field $\vec{B}$. Find the value of work done by $\vec{B}$.

(A) 1 **(B)** Infinite **(C)** –1 **(D)** Zero

9. Figure A and B show two long straight wires of circular cross-section (a and b with a < b), carrying current I which is uniformly distributed across the cross-section. The magnitude of magnetic field B varies with radius r and can be represented as :

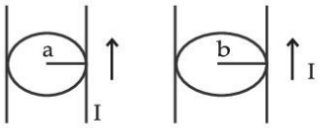
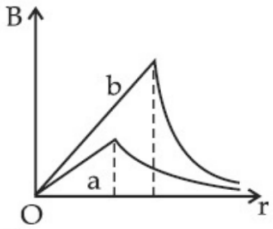
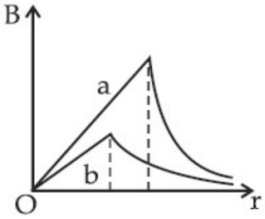


Fig. A Fig. B

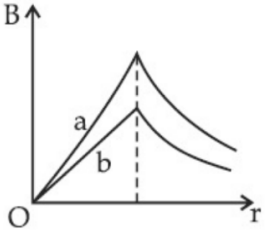
(A)



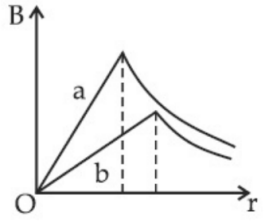
(B)



(C)



(D)



10. A deuteron and an alpha particle having equal kinetic energy enter perpendicularly into a magnetic field. Let r_d and r_α be their respective radii of circular path. The value of $\frac{r_d}{r_\alpha}$ is

(A) $\frac{1}{\sqrt{2}}$ **(D)** 2 **(C)** 1 **(D)** $\sqrt{2}$

11. Two ions having same mass have charges in the ratio 1 : 2. They are projected normally in a uniform magnetic field with their speeds in the ratio 2 : 3. The ratio of the radii of their circular trajectories is :

(A) 3 : 1 **(B)** 2 : 3 **(C)** 1 : 4 **(D)** 4 : 3

12. In a uniform magnetic field, the magnetic needle has a magnetic moment $9.85\times10^{-2} A/m^2$ and moment of inertia $5\times10^{-6} kg\,m^2$. If it performs 10 complete oscillations in 5 seconds then the magnitude of the magnetic field is _____ mT. [Take π^2 as 9.85]

13. The fractional change in the magnetic field intensity at a distance `$r$' from centre on the axis of current carrying coil of radius `a' to the magnetic field intensity at the centre of the same coil is : (Take $r << a$).

(A) $\frac{2}{3}\frac{r^2}{a^2}$ **(B)** $\frac{3}{2}\frac{r^2}{a^2}$ **(C)** $\frac{3}{2}\frac{a^2}{r^2}$ **(D)** $\frac{2}{3}\frac{a^2}{r^2}$

14. If the maximum value of accelerating potential provided by a radio frequency oscillator is 12 kV. The number of revolution made by a proton in a cyclotron to achieve one sixth of the speed of light is _____.
[$m_p = 1.67\times10^{-27}$kg, $e = 1.6\times10^{-19}C$, Speed of light $= 3\times10^8$m/s].

15. A coil in the shape of an equilateral triangle of side 10 cm lies in a vertical plane between the pole pieces of permanent magnet producing a horizontal magnetic field 20 mT. The torque acting on the coil when a current of 0.2 A is passed through it and its plane becomes parallel to the magnetic field will be $\sqrt{x}\times10^{-5}$ Nm. The value of x is _____.

16. Two ions of masses 4 amu and 16 amu have charges + 2e and + 3e respectively. These ions pass through the region of constant perpendicular magnetic field. The kinetic energy of both ions is same. Then :

(A) Lighter ion will be deflected less than heavier ion

(B) Lighter ion will be deflected more than heavier ion

(C) Both ions will be deflected equally

(D) no ion will deflected

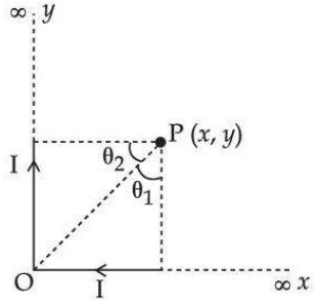
17. A uniform conducting wire of length is 24a, and resistance R is wound up as a current carrying coil in the shape of an equilateral triangle of side 'a' and then in the form of a square of side 'a'. The coil is connected to a voltage source V_0. The ratio of magnetic moment of the coils of equilateral triangle to that for square is $1:\sqrt{y}$ where y is_____.

18. A coil having N turns is would tightly in the form of a spiral with inner and outer radii $'a'$ and $'b'$ respectively. Find the magnetic field at centre, when a current I passes through coil:

(B) $\frac{\mu_0 I}{8}\left[\frac{a+b}{a-b}\right]$ **(B)** $\frac{\mu_0 I}{4(a-b)}\left[\frac{1}{a}-\frac{1}{b}\right]$

(C) $\frac{\mu_0 I}{8}\left(\frac{a-b}{a+b}\right)$ **(D)** $\frac{\mu_0 IN}{2(b-a)}\log_e\left(\frac{b}{a}\right)$

19. There are two infinitely long straight current carrying conductors and they are held at right angles to each other so that their common ends meet at the origin as shown in the figure given below. The ratio of current in both conductors is 1:1. The magnetic field at point P is:



(A) $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2+y^2}+(x+y)\right]$ **(B)** $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2+y^2}-(x+y)\right]$

(C) $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}+(x+y)\right]$ **(D)** $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}-(x+y)\right]$

20. A current of 1.5 A is flowing through a triangle, of side 9 cm each. The magnetic field at the centroid of the triangle is : (Assume that the current is flowing in the clockwise direction.)

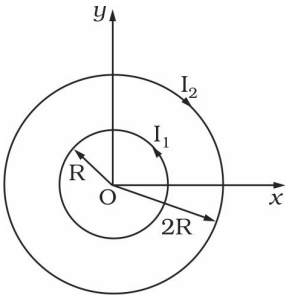
(A) $2\sqrt{3}\times10^{-7}T$, out of the plane of triangle **(B)** $3\times10^{-5}T$, into the plane of triangle

(C) $3\times10^{-7}T$, out of the plane of triangle **(D)** $2\sqrt{3}\times10^{-5}T$, into the plane of triangle

JEE Advanced 2021

1. An α -particle (mass 4 amu) and a singly charged sulfur ion (mass 32 amu) are initially at rest. They are accelerated through a potential V and then allowed to pass into a region of uniform magnetic field which is normal to the velocities of the particles. Within this region, the α -particle and the sulfur ion move in circular orbits of radii r_α and r_s, respectively. The ratio (r_s / r_α) is _____.

***2.** Two concentric circular loops, one of radius R and the other of radius 2R, lie in the xy-plane with the origin as their common centre, as shown in the figure. The smaller loop carries current I_1 in the anti-clockwise direction and the larger loop carries current I_2 in the clockwise direction, with $I_2 > 2I_1$. $\vec{B}(x,y)$ denotes the magnetic field at a point (x, y) in the *xy*-plane. Which of the following statement(s) is (are) correct?



(A) $\vec{B}(x,y)$ is perpendicular to the *xy*-plane at any point in the plane

(B) $|\vec{B}(x,y)|$ depends on x and y only through the radial distance $r=\sqrt{x^2+y^2}$

(C) $|\vec{B}(x,y)|$ is non-zero at all points for r < R

(D) $\vec{B}(x,y)$ points normally outward from the *xy*-plane for all the points between the two loops

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Magnetic Effect of Current	Class - XII | Physics

JEE Main 2022

1. Given below are two statements: One is labelled as Assertion (A) and the other is labelled as **Reason (R).**

Assertion (A) : In an uniform magnetic field, speed and energy remains the same for a moving charged particle.

Reason (R) : Moving charged particle experiences magnetic force perpendicular to its direction of motion.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).

(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

2. The magnetic field at the centre of a circular coil of radius r, due to current I flowing through it, is B. The magnetic field at a point along the axis at a distance $\frac{r}{2}$ from the centre

(A) $B/2$ **(B)** $2B$ **(C)** $\left(\frac{2}{5}\right)^3 B$ **(D)** $\left(\frac{2}{\sqrt{3}}\right)^3 B$

3. A proton, a deuteron and an α- particle with same kinetic energy enter into a uniform magnetic field at right angle to magnetic field. The ratio of the radii of their respective circular paths is:

(A) $1:\sqrt{2}:\sqrt{2}$ **(B)** $1:1:\sqrt{2}$ **(C)** $\sqrt{2}:1:1$ **(D)** $1:\sqrt{2}:1$

4. A long straight wire with a circular cross-section having radius R, is carrying a steady current I. The current I is uniformly distributed across this cross-section. Then the variation of magnetic field due to current I with distance $r(r<R)$ from its centre will be:

(A) $B \propto r^2$ **(B)** $B \propto r$ **(C)** $B \propto \frac{1}{r^2}$ **(D)** $B \propto \frac{1}{r}$

5. A long solenoid carrying a current produces a magnetic field B along its axis. If the current is doubled and the number of turns per cm is halved, the new value of magnetic field will be equal to:

(A) B **(B)** $2B$ **(C)** $4B$ **(D)** $\frac{B}{2}$

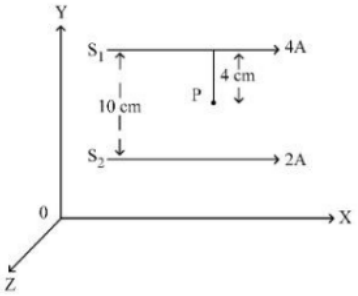
6. A proton and an alpha particle of the same velocity enter in a uniform magnetic field which is acting perpendicular to their direction of motion. The ratio of the radii of the circular paths described by the alpha particle and proton is:

(A) 1 : 4 **(B)** 4 : 1 **(C)** 2 : 1 **(D)** 1 : 2

7. Two 10 cm long, straight wires, each carrying a current of $5A$ are kept parallel to each other. If each wire experienced a force of $10^{-5}N$, then separation between the wires is _____ cm.

8. A deuteron and a proton moving with equal kinetic energy enter into to a uniform magnetic field at right angle to the field. If r_d and r_p are the radii of their circular paths respectively, then the ratio $\frac{r_d}{r_p}$ will be $\sqrt{x}$ where x is _____.

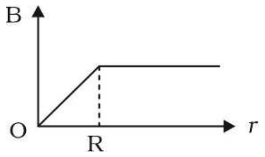
9. Two long parallel conductors S_1 and S_2 are separated by a distance 10 cm and carrying currents of 4A and 2A respectively. The conductors are placed along x-axis in X-Y plane. There is a point P located between the conductors (as shown in figure). A charge particle of 3π coulomb is passing through the point P with velocity $\vec{v}=\left(2\hat{i}+3\hat{j}\right)m/s$; where $\hat{i}\,\&\,\hat{j}$ represents unit vector along $x\,\&\,y$ axis respectively. The force acting on the charge particle is $4\pi\times10^{-5}\left(-x\hat{i}+2\hat{j}\right)N$. The value of x is:

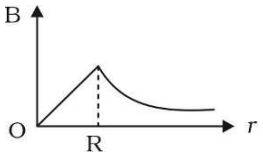


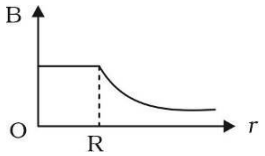
(A) 2 **(B)** 1 **(C)** 3 **(D)** – 3

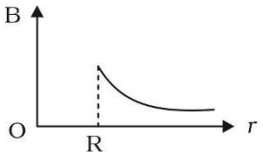
10. A single ionized magnesium atom (A = 24) ion is accelerated to kinetic energy 5 keV, and is projected perpendicularly into a magnetic field B of the magnitude 0.5 T. The radius of path formed will be _____ cm.

11. An infinitely long hollow conducting cylinder with radius R carries a uniform current along its surface. Choose the correct representation of magnetic field (B) as a function of radial distance (r) from the axis of cylinder.

(A)


(B)


(C)


(D)


12. Two parallel, long wires are kept $0.20\,m$ apart in vacuum, each carrying current of x A in the same direction. If the force of attraction per meter of each wire is $2\times10^{-6}N$, then the value of x is approximately:

(A) 1 **(B)** 2.4 **(C)** 1.4 **(D)** 2

13. A charge particle moves along circular path in a uniform magnetic field in a cyclotron. The kinetic energy of the charge particle increases to 4 times its initial value. What will be the ratio of new radius to the original radius of circular path of the charge particle:

(A) 1 : 1 **(B)** 1 : 2 **(C)** 2 : 1 **(D)** 1 : 4

14. Two long current carrying conductors are placed parallel to each other at a distance of 8 cm between them. The magnitude of magnetic field produced at mid-point between the two conductors due to current flowing in them is 300 μT. The equal current flowing in the two conductors is:

(A) 30 A in the same direction **(B)** 30 A in the opposite direction

(C) 60 A in the opposite direction **(D)** 300 A in the opposite direction

15. Given below are two statements:

Statement I: The electric force changes the speed of the charged particle and hence changes its kinetic energy; whereas the magnetic force does not change the kinetic energy of the charged particle.

Statement II: The electric force accelerates the positively charged particle perpendicular to the direction of electric field. The magnetic force accelerates the moving charged particle along the direction of magnetic field.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Both statement I and Statement II are correct

(B) Both Statement I and Statement II are incorrect

(C) Statement I is correct but Statement II is incorrect

(D) Statement I is incorrect but Statement II is correct

16. An electron with energy 0.1 keV moves at right angle to the earth's magnetic field of $1\times10^{-4}\ Wbm^{-2}$. The frequency of revolution of the electron will be (Take mass of electron $= 9.0\times10^{-31}kg$)

(A) $1.6\times10^{5}Hz$ **(B)** $5.6\times10^{5}Hz$ **(C)** $2.8\times10^{6}Hz$ **(D)** $1.8\times10^{6}Hz$

17. Two charged particles, having same kinetic energy are allowed to pass through a uniform magnetic field perpendicular to the direction of motion. If the ratio of radii of their circular paths is 6 : 5 and their respective masses ratio is 9 : 4. Then, the ratio of their charges will be :

(A) 8 : 5 **(B)** 5 : 4 **(C)** 5 : 3 **(D)** 8 : 7

18. The electric current in a circular coil of 2 turns produces a magnetic induction B_1 at its centre. The coil is unwound and is rewound into a circular coil of 5 turns and the same current produces a magnetic induction B_2 at its centre. The ratio of $\frac{B_2}{B_1}$ is:

(A) $\frac{5}{2}$ **(B)** $\frac{25}{4}$ **(C)** $\frac{5}{4}$ **(D)** $\frac{25}{2}$

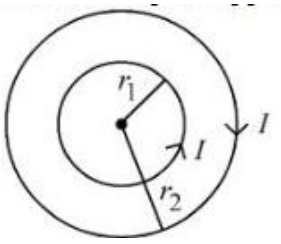
19. A charge particle is moving in a uniform magnetic field $\left(2\hat{i}+3\hat{j}\right)T$. If it has an acceleration of $\left(\alpha\hat{i}-4\hat{j}\right)m/s^2$, then the value of α will be:

(A) 3 **(B)** 6 **(C)** 12 **(D)** 2

20. B_X and B_Y are the magnetic field at the centre of two coils X and Y respectively each carrying equal current. If coil X has 200 turns and 20 cm radius and coil Y has 400 turns and 20 cm radius, the ratio of B_X and B_Y is:

(A) 1 : 1 **(B)** 1 : 2 **(C)** 2 : 1 **(D)** 4 : 1

21. Two concentric circular loops of radii $r_1 = 30\ cm$ and $r_2 = 50\ cm$ are placed in X-Y plane as shown in the figure. A current $I = 7A$ is flowing through them in the direction as shown in figure. The net magnetic moment of this system of two circular loops is approximately:



(A) $\frac{7}{2}\hat{k}\,Am^2$ **(B)** $-\frac{7}{2}\hat{k}\,Am^2$ **(C)** $7\hat{k}\,Am^2$ **(D)** $-7\hat{k}\,Am^2$

22. A velocity selector consists of electric field $\vec{E} = E\hat{k}$ and magnetic field $\vec{B} = B\hat{j}$ with $B = 12mT$. The value of E required for an electron of energy 728 eV moving along the positive x-axis to pass undeflected is:

(A) $192\,kVm^{-1}$ **(B)** $192\,mVm^{-1}$ **(C)** $9600\,kVm^{-1}$ **(D)** $16\,kVm^{-1}$

23. A cyclotron is used to accelerate protons. If the operating magnetic field is 1.0 T and the radius of the cyclotron 'dees' is 60 cm, the kinetic energy of the accelerated protons in MeV will be:

[use $m_p = 1.6\times10^{-27}kg, e = 1.6\times10^{-19}C$]

(A) 12 **(B)** 18 **(C)** 16 **(D)** 32

24. The current sensitivity of a galvanometer can be increased by :

(a) decreasing the number of turns

(b) increasing the magnetic field

(c) decreasing the area of the coil

(d) decreasing the torsional constant of the spring

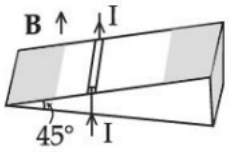
Choose the most appropriate answer form the options given below:

(A) (b) and (c) only **(B)** (c) and (d) only

(C) (a) and (c) only **(D)** (b) and (d) only

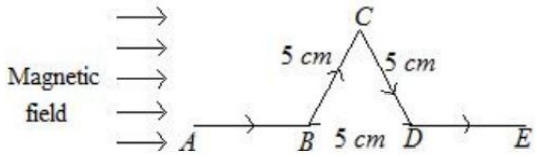
25. As shown in the figure, a metallic rod of linear density $0.45\,kg\,m^{-1}$ is lying horizontally on a smooth inclined plane which makes an angle of $45°$ with the horizontal. The minimum current flowing in the rod required to keep it stationary, when $0.15T$ magnetic field is acting on it in the vertical upward direction, will be:

{**Use** $g = 10\ m/s^2$}



(A) $30\,A$ **(B)** $15\,A$ **(C)** $10\,A$ **(D)** $3\,A$

26. A triangular shaped wire carrying 10 A current is placed in a uniform magnetic field of 0.5 T, as shown in figure. The magnetic force on segment CD is:
(Given BC = CD = BD = 5 cm)



(A) 0.126 N **(B)** 0.312 N **(C)** 0.216 N **(D)** 0.245 N

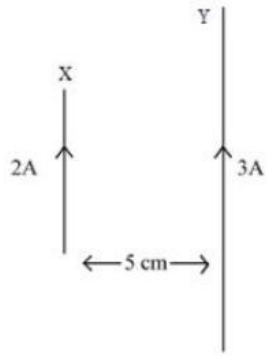
27. The magnetic field at the centre of current carrying circular loop is B_1. The magnetic field at a distance of $\sqrt{3}$ times radius of the given circular loop from the centre on its axis is B_2. The value of B_1 / B_2 will be:

(A) 9 : 4 **(B)** $12:\sqrt{5}$ **(C)** 8 : 1 **(D)** $5:\sqrt{3}$

28. A closely wounded circular coil of radius 5 cm produces a magnetic field of $37.68\times10^{-4}T$ at its center. The current through the coil is _____ A.
[Given, number of turns in the coil is 100 and $\pi = 3.14$]

29. A wire of length 314 cm carrying current of 14A is bent to form a circle. The magnetic moment of the coil is _____ A-m². [Given $\pi = 3.14$]

30. A wire X of length 50*cm* carrying a current of 2A is placed parallel to a long wire Y of length 5*m*. The wire Y carries a current of 3A. The distance between two wires is 5*cm* and currents flow in the same direction. The force acting on the wire Y is:



(A) $1.2\times10^{-5}N$ directed towards wire X **(B)** $1.2\times10^{-4}N$ directed away from wire X

(C) $1.2\times10^{-4}N$ directed towards wire X **(D)** $2.4\times10^{-5}N$ directed towards wire X