VMC Vidyamandir Classes SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

CODE A

JEE Main Full Length Test - 1 | JEE 2024 | Gen-1 & 2

Date: 13/04/2023 **Maximum Marks: 300**

Timing: 3:30 PM to 6:30 PM

General Instructions

1. The test is **3 hours** duration and the maximum marks is **300.**
2. The question paper consists of **3 Parts** (Part I: **Physics**, Part II: **Chemistry**, Part III: **Mathematics**). Each Part has **two** sections (Section 1 & Section 2).
3. **Section 1** contains **20 Multiple Choice Questions**. Each question has 4 choices **(A)**, **(B)**, **(C)** and **(D)**, out of which **ONLY ONE CHOICE** is correct.
4. **Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted.** The answer to each question should be **rounded off to the nearest integer**.
5. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. inside the examination room/hall.
6. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
7. On completion of the test, the candidate must hand over the Answer Sheet to the **Invigilator** on duty in the Room/Hall. **However, the candidates are allowed to take away this Test Booklet with them**.
8. **Do not fold or make any stray mark on the Answer Sheet (OMR).**

Marking Scheme

1. **Section – 1:** +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.
2. **Section – 2:** +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.

Name of the Candidate (In CAPITALS) : _____

Roll Number : _____

OMR Bar Code Number : _____

Candidate's Signature : _____ **Invigilator's Signature** _____

Syllabus

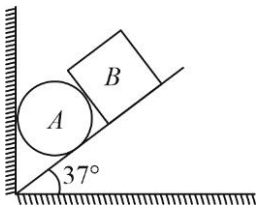
Physics: Vectors & Forces, Kinematics of a Particle, Motion in Two Dimensions, Dynamics of a Particle, Energy & Momentum, Rotational Motion, Gravitation, Liquids, Properties of Matter, Gaseous State and Thermodynamics, SHM
Chemistry: Stoichiometry-I, Atomic Structure, Periodic Classification, Chemical Bonding-I, II States of Matter, Thermochemistry, Thermodynamics, Chemical Equilibrium, Ionic Equilibrium, Stoichiometry-II, IOC, Hydrocarbons
Mathematics: Quadratic Equations, Trigonometry, Sequence and Series, Complex Numbers, Straight Line, Circles, Conic sections, Binomial Theorem

PART - I : PHYSICS 100 MARKS

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

1. A perfect smooth sphere A of mass 2 kg is in contact with a rectangular block B of mass 4 kg and vertical wall as shown in the figure. All surfaces are smooth. Find normal reaction by vertical wall on sphere A. (Take $g = 10\ \text{m/s}^2$)

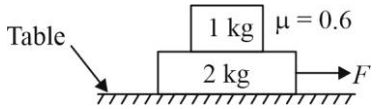


(A) 20 N **(B)** 25 N **(C)** 80 N **(D)** 45 N

2. 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 $r = \frac{L}{2}$. The speed of particle will be:

(A) $\left(\frac{gr}{\sqrt{3}}\right)^{1/2}$ **(B)** $\left(\sqrt{3gr}\right)^{1/2}$ **(C)** $(gr)^{1/2}$ **(D)** $\left(\frac{gr}{2}\right)^{1/2}$

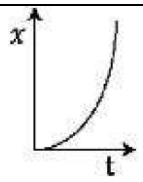
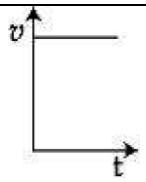
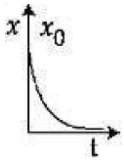
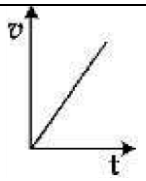
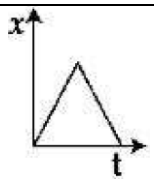
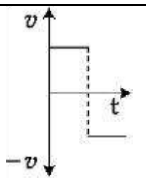
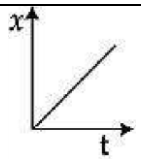
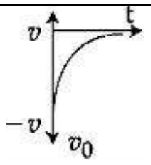
3. The coefficient of static friction between two blocks is 0.6 and the table is smooth. The maximum horizontal force that can be applied to move the blocks together is : (Take $g = 10\ \text{ms}^{-2}$)



(A) 15 N **(B)** 18 N **(C)** 21 N **(D)** 20 N

SPACE FOR ROUGH WORK

4. Column -I shows *x*-*t* graph for a particle moving on straight line and column -II shows *v*-*t* graph. Match Column-I with Column-II.

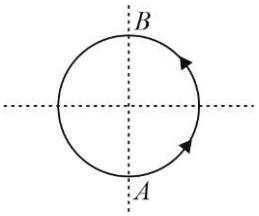
Column-I		Column-II	
A.		**I.**	
B.		**II.**	
C.		**III.**	
D.		**IV.**	

Choose the correct answer from the options given below:

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

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

5. A particle starts from rest from point *A* with a constant angular acceleration $2\text{rad}/\sec^2$ in a circle of radius 1 m. Find the acceleration of particle when it reaches the point *B*.

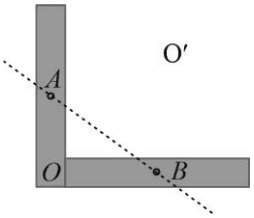


(A) $2\sqrt{\pi^2+4}\ \text{m/s}^2$ **(B)** $2\sqrt{4\pi^2+1}\ \text{m/s}^2$

(C) $4\pi\ \text{m/s}^2$ **(D)** $2\ \text{m/s}^2$

SPACE FOR ROUGH WORK

6. Figure shows two cylindrical rods whose center of mass is marked as *A* and *B*. Line *AB* divides the region in two parts one containing point *O* (region 1) and other containing point *O*' (region 2). Choose the correct option regarding the centre of mass of the combined system.



(A) The center of mass of the system lies in region 1

(B) The center of mass of the system lies in region 2

(C) The center of mass of the system lies on line AB

(D) The center of mass of the system may lie in region 1 or region 2 depending on the mass of the rods

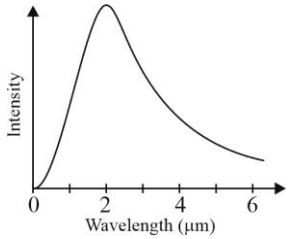
7. A solid cylinder is rolling along the ground at 7.0 m/s. It comes to a hill and starts rolling up without slipping. Assuming no losses to friction, how high does it get before it stops? (Take $g = 9.8\ \text{m/s}^2$)

(A) 1.2 m **(B)** 3.7 m **(C)** 4.2 m **(D)** 5.9 m

8. An air bubble of radius *r* rises steadily through a liquid of density ρ with velocity *v*. The coefficient of viscosity of liquid is:

(A) $\frac{2}{9}\frac{r^2\rho g}{v}$ **(B)** $\frac{2}{9}\frac{r^2 g}{v\rho}$ **(C)** $\frac{2}{9}\frac{v\rho g}{r^2}$ **(D)** $\frac{2}{9}\frac{\rho g}{vr^2}$

9. The distribution of relative intensity of blackbody radiation from a solid object versus the wavelength λ is shown in the figure. If the Wien displacement law constant is $2.9\times10^{-3} mK,$ what is the approximate temperature of the object?



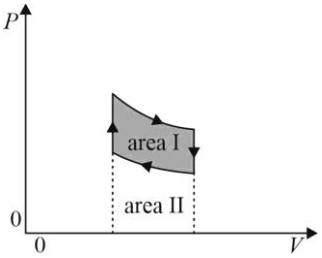
(A) 10 K **(B)** 50 K **(C)** 250 K **(D)** 1500 K

SPACE FOR ROUGH WORK

10. A pipe of length 10.0 m increases in length by 1.5 cm when its temperature is increased by 90°F. What is its coefficient of linear expansion?

(A) $30\times10^{-6}/°C$ **(B)** $17\times10^{-6}/°C$ **(C)** $13\times10^{-6}/°C$ **(D)** $23\times10^{-6}/°C$

11. The diagram shows the pressure-volume (PV) relationship for a gas.



Which of the following area(s) is/are equal to the work done by the gas as it expands?

(A) area I **(B)** area II **(C)** area I + area II **(D)** area I – area II

12. During an adiabatic expansion, a gas does 50 J of work against the surroundings. It is then cooled at constant volume by removing 20 J of energy from the gas. The magnitude of the total change in internal energy of the gas is:

(A) 70 J **(B)** 50 J **(C)** 30 J **(D)** 20 J

13. The Carnot cycle consists of a combination of _____ and _____ processes.

(A) Isobaric, Isochoric **(B)** Isochoric, Adiabatic

(C) Isobaric, Isothermal **(D)** Adiabatic, Isothermal

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

Assertion A: A pendulum clock when taken to Mount Everest becomes fast.

Reason R: The value of g (acceleration due to gravity) is less at Mount Everest than its value on the surface of earth.

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.

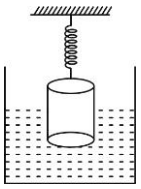
(B) A is correct but R is not correct.

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

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

SPACE FOR ROUGH WORK

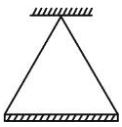
15. A solid cylinder of mass *m* and volume *v* is suspended from ceiling by a spring of spring constant *K*. It has cross-section area *A*. It is submerged in a liquid of density ρ upto half its length. If a small block of mass M_0 is kept at the centre of the top, the amplitude of small oscillation will be:



(A) $\dfrac{M_0 g}{K + v\rho g}$ **(B)** $\dfrac{M_0 g}{K + A\rho g}$

(C) $\dfrac{(M_0 + m)g}{K + A\rho g}$ **(D)** $\dfrac{M_0 g}{K}$

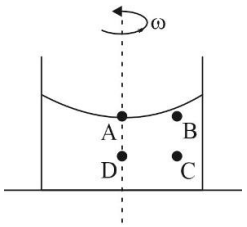
16. A rod of mass *m* and length ℓ is suspended from ceiling with two strings of length ℓ as shown. When the system is rotated slightly in the plane of page and released, time period of oscillation is T_1 and when the rod is given a push perpendicular to plane, time period of oscillation is T_2. The ratio $\dfrac{T_1^2}{T_2^2}$ is:



(A) 1 **(B)** $\dfrac{10}{9}$

(C) $\dfrac{9}{10}$ **(D)** $\dfrac{\sqrt{3}}{2}$

17. A cylindrical container filled with a liquid is being rotated about its central axis at a constant angular velocity ω. Four points *A, B, C* and *D* are chosen in the same plane such that *ABCD* is a square of side length a and *AB* is horizontal while *BC* is vertical. *A* and *D* lie on the axis of rotation. Let the pressure at *A, B, C* and *D* be denoted by P_A, P_B, P_C and P_D. Now, consider the following two statements:



(I) $P_C < P_A$ for all values of ω **(II)** $P_B > P_D$ only if $\omega > \sqrt{\dfrac{2g}{a}}$

Which of these options is correct?

(A) Both (I) and (II) are correct **(B)** (I) is correct and (II) is incorrect

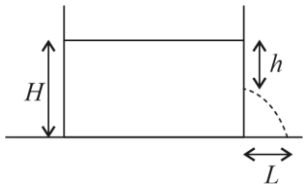
(C) (II) is correct and (I) is incorrect **(D)** Both (I) and (II) are incorrect

SPACE FOR ROUGH WORK

18. A solid cylinder of mass *M*, radius 2*R* and height 9*R* is melted and formed into a solid sphere. Find the ratio of moment of inertia of solid cylinder about its axis to solid sphere about its diameter.

(A) $\frac{5}{9}$ **(B)** $\frac{9}{5}$ **(C)** $1:1$ **(D)** $2:1$

19. A liquid is filled in a container to a height H. A small hole is opened in the side of the container a height h below the surface of the liquid. Let the distance of the point where the stream of liquid leaving the container meets the ground from the bottom of the container be L. Then, if $h = 2H/5$, the ratio $\frac{L}{H}$ is equal to:



(A) $\frac{2}{\sqrt{15}}$ **(B)** $\frac{4}{\sqrt{15}}$ **(C)** $\frac{2\sqrt{6}}{5}$ **(D)** $\frac{4\sqrt{6}}{5}$

20. The orbital velocity of satellite around a planet is independent of :

(A) Mass of satellite **(B)** Mass of planet

(C) Radius of orbit of satellite **(D)** Universal gravitational constant

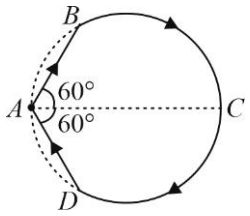
SPACE FOR ROUGH WORK

SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted. The answer to each question should be **rounded off to the nearest integer**.

1. A boat travels upstream and after one hour has gone 10 km. The boat next travels downstream and after one hour has gone 14 km. If the boat's speed relative to the water is constant, what is the speed (in km/h) of the current in the river?

2. Consider a circle of radius 42 cm. An insect crawls with uniform speed of 1.3 cm/s along the chord *AB* then along the circular arc *BCD* to reach point *D* and then following cord *DA* to reach finally *A*. Time (in sec) spend by the insect to crawl from *A* to *A* is _____ .



3. A particle is projected from the ground with a speed of 20 m/s at an angle of 60° with the ground. The time after which the speed of the particle is minimum during the flight is $\sqrt{n}$ sec. Find *n*.

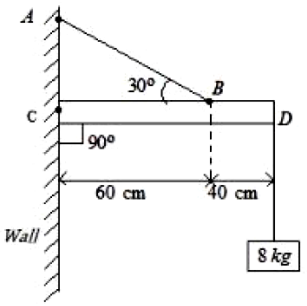
4. A body of mass 4 kg collides head-on elastically with another body of mass 2 kg kept at rest in free space. Time of collision is 0.02 sec and average impulsive force acted on each body is 100N. Find the velocity (in m/s) of the 2 kg body after the impact.

5. A metallic body of material with density of 8000 kg/m^3 has a cavity inside. A spring balance shows its mass to be 10.0 kg in air and 7.5 kg when immersed in water. The ratio of the volume of the cavity to the volume of the material of the body is x : 1. Find x.

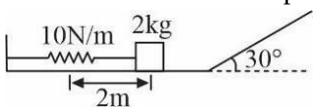
SPACE FOR ROUGH WORK

6. An otherwise thermally insulated room can only exchange heat with the surroundings through a window with a glass pane of area $1.2\ m^2$ and thickness 0.5 cm. A heater placed inside the room supplies heat to the room at a constant rate 1920 W. On a day when the temperature outside the room is 14 °C, the temperature inside the room (in °C) a long time after the heater is switched on becomes_____.
(Thermal conductivity of glass $= 1.0\ W/m\ °C$)

7. An object of mass $8\,kg$ is hanging from one end of a uniform rod CD of mass $2\,kg$ and length $1\,m$ pivoted at its end C on a vertical wall as shown in figure. It is supported by a cable AB such that the system is in equilibrium. The tension in the cable is _____ Newton. (Take $g = 10\,m/s^2$)



8. In the figure shown, all surfaces are smooth and force constant of spring is 10 N/m. Block of mass 2 kg is not attached with the spring. The spring is compressed by 2m and then released. The maximum distance (in meter) travelled by the block over the inclined plane will be _____ . (Take g = 10 m/s^2)



9. A planet *P* has mass 10 times the mass of earth and radius one-tenth the radius of earth. The escape velocity from the surface of planet is *n* times the escape velocity from surface of earth. Find *n*.

10. A uniform heavy rod of weight 10 kg ms^{-2}, cross-sectional area $10\ cm^2$ and length 40 cm is hanging from a fixed support. Young modulus of the material of the rod is $4\times10^{11}Nm^{-2}$. Neglecting the internal contraction, the elongation of rod due to its own weight is $x\times10^{-9}\,m$. Find *x*.

SPACE FOR ROUGH WORK

PART - II : CHEMISTRY 100 MARKS

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

1. If the pK_a of lactic acid is 5, then which of the following is correct? Lactic acid is 2-hydroxy propanoic acid.

(a) pH of 0.0025 M calcium lactate and 0.005 M lactic acid solution is 5.

(b) pH of 0.005 M calcium lactate is 8.5.

(c) pH of 0.001 M lactic acid is 3.

(A) a and b **(B)** b and c **(C)** a, b and c **(D)** Only b

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

Assertion A : Gases expand and occupy all the space available to them.

Reason R : There is no force of attraction between the particles of gas at ordinary temperature and pressure.

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 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

3. Match the List-I and List-II.

List-I (Titration)		List-II (Indicator)	
(P)	$H_2C_2O_4$ vs Acidified $KMnO_4$	**(I)**	Starch
(Q)	$FeSO_4$ vs Acidified $K_2Cr_2O_7$	**(II)**	Phenolphthalein
(R)	$CuSO_4$ vs KI	**(III)**	Self-indicator
(S)	$H_2C_2O_4$ vs NaOH	**(IV)**	Diphenylamine

(A) (P)-(II); (Q)-(IV); (R)-(I); (S)-(III) **(B)** (P)-(III); (Q)-(IV); (R)-(I); (S)-(II)

(C) (P)-(IV); (Q)-(III); (R)-(I); (S)-(II) **(D)** (P)-(I); (Q)-(II); (R)-(III); (S)-(IV)

SPACE FOR ROUGH WORK

4. Which of the following is not disproportionation reaction?

(a) $2F_2 + 2HO^-(aq) \longrightarrow 2F^-(aq) + OF_2(g) + H_2O$

(b) $Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \longrightarrow 2PbSO_4(s) + 2H_2O(\ell)$

(c) $F_2(g) + H_2O(s) \longrightarrow HF(g) + HOF(g)$

(d) $(CN)_2(g) + 2HO^-(aq) \longrightarrow CN^-(aq) + CNO^-(aq) + H_2O(\ell)$

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

5. How many of the following is/are protic acid?

(a) Orthoboric acid (H_3BO_3) **(b)** Orthophosphoric acid (H_3PO_4)

(c) Oxalic acid $(H_2C_2O_4)$ **(d)** Carbonic acid (H_2CO_3)

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

6. Which of the following is correct effect of increase of temperature on synthesis of ammonia using dinitrogen and dihydrogen according to Haber's process?

(A) Rate of reaction and yield of ammonia both increases

(B) Rate of reaction and yield of ammonia both decreases

(C) Rate of reaction increases but yield of ammonia decreases

(D) Rate of reaction decreases but yield of ammonia increases

SPACE FOR ROUGH WORK

7. Given below are two statements.

Statement-I : A dynamic equilibrium exists between the production and decomposition of ozone in the stratosphere.

Statement-II : Conversion of oxygen to ozone is thermodynamically non-spontaneous.

In the light of 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. ΔU° of combustion of methane is $-x$ kJ mol^{-1}. The value of ΔH° is:

(A) $= \Delta U^\circ$ **(B)** $> \Delta U^\circ$ **(C)** $< \Delta U^\circ$ **(D)** $= 0$

9. Match the List-I and List-II.

List-I (Intermolecular forces)		**List-II**	
(P)	Ion-Dipole forces	**(I)**	Vander Waals forces
(Q)	Dispersion forces	**(II)**	Always attractive
(R)	Dipole-Dipole forces	**(III)**	Interaction energy is proportional to $1/r^6$
(S)	Hydrogen bond	**(IV)**	Powerful force in determining the structure and properties of proteins
		(V)	Not Vander Waals forces

(A) (P)-(I, II, III); (Q)-(I, II, III, IV); (R)-(I, II, III, IV); (S)-(I, II, IV, V)

(B) (P)-(V); (Q)-(I, II, III); (R)-(III); (S)-(IV)

(C) (P)-(II, V); (Q)-(I, III); (R)-(II, III); (S)-(II, IV, V)

(D) (P)-(I, II); (Q)-(II, III, IV); (R)-(III); (S)-(IV, V)

10. Molecular shape of XeF_4 is square planar. What is hybridization state of the central atom?

(A) dsp^2 **(B)** sp^3d^2 **(C)** sp^3 **(D)** sp^2d

SPACE FOR ROUGH WORK

11. Which of the following is correct order of first ionization enthalpy of Na, Mg, Al and Si?

(A) Na < Mg < Al < Si **(B)** Si < Al < Mg < Na

(C) Na < Al < Mg < Si **(D)** Na < Al < Si < Mg

12. Identify quantum numbers of an atomic orbital having only conical node?

(A) $n = 4; \ell = 2; m = 0$ **(B)** $n = 3; \ell = 2; m = +2$

(C) $n = 3; \ell = 2; m = 0$ **(D)** $n = 2; \ell = 1; m = 0$

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

Assertion A : Ethene is more stable molecule in comparison to ethane.

Reason R : Strength of the double bond of ethene is greater than that of a carbon-carbon single bond in ethane.

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 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

14. In which of the following, it is possible to separate and isolate different forms?

(a) Conformational isomers of ethane **(b)** Geometrical isomers of 2-butene

(c) Positional isomers of chloropropane **(d)** Optical isomers of 2-chlorobutane

(A) Only a **(B)** a and d **(C)** a, b and d **(D)** b, c and d

15. Which of the following property of benzene can be explained by using concept of oscillating nature of double bonds in benzene?

(A) Unusual stability of benzene

(B) Preference to substitution reactions than addition reactions

(C) Formation of only one mono substituted derivative

(D) Formation of only one ortho disubstituted derivative

SPACE FOR ROUGH WORK

16. Identify major product (P) and (Q).

$$(Q) \xleftarrow[NH_3(\ell)]{Na} CH_3 - C \equiv C - CH_3 \xrightarrow[\text{Lindlar's catalyst}]{H_2} (P)$$

	(P)		**(Q)**
(A)	trans-2-Butene	;	cis-2-Butene
(B)	cis-2-Butene	;	trans-2-Butene
(C)	cis-2-Butene	;	$CH_3CH_2C \equiv CNa$
(D)	Butane	;	$CH_3CH_2C \equiv CNa$

17. The best and latest technique for isolation, purification and separation of amino acids is:

(A) Fractional distillation **(B)** Sublimation

(C) Differential extraction **(D)** Chromatography

18. Which of the following is necessary to use for acidification of sodium extract for testing sulphur by lead acetate test?

(A) Sulphuric acid **(B)** Nitric acid **(C)** Acetic acid **(D)** Hydrochloric acid

SPACE FOR ROUGH WORK

19. Which of the following are correct for electromeric effect?

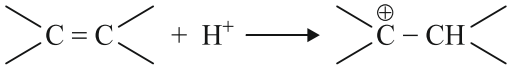
a. The organic compounds having a multiple bond show this effect in the presence of an attacking reagent only.

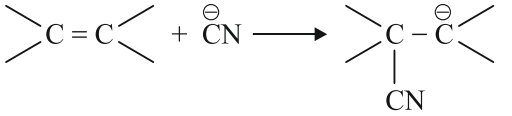
b. It involve complete transfer of a shared pair of π-electrons to one of the atoms joined by a multiple bond even in the absence of an attacking reagent.

c. It is a permanent effect and called as polarizability effect.

d. It is annulled as soon as the attacking reagent is removed from the domain of the reaction.

e. When inductive and electromeric effects operate in opposite directions, the electromeric effect predominates.

f.  : Negative electromeric effect

g.  : Positive electromeric effect

(A) a, d, e, f, g **(B)** b, c, f, g **(C)** a, d, e **(D)** c, d, e, g

20. Match the List-I and List-II.

List-I		List-II	
(I)	B_2	**(P)**	Only pi-bonds
(II)	C_2	**(Q)**	Two nodal planes in HOMO
(III)	N_2	**(R)**	Four nodal planes in HOMO
(IV)	O_2	**(S)**	s-p mixing

(A) (I)-P, Q, S; (II)-P, Q, S; (III)-Q, S; (IV)-Q, S

(B) (I)-P, Q, S; (II)-P, Q, S; (III)-Q, S; (IV)-R

(C) (I)-P, Q, S; (II)-P, Q, S; (III)-P; (IV)-R

(D) (I)-Q; (II)-P, Q; (III)-Q, S; (IV)-R

SPACE FOR ROUGH WORK

SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted. The answer to each question should be **rounded off to the nearest integer**.

1. The ionization constant of dimethylamine is 5.4×10^{-4}. The $x\times10^{-2}\%$ of 0.02 M dimethylamine is ionized if the solution is also 0.1 M in NaOH. What is value of x?

2. In a process, 701 J of heat is absorbed by system and 394 J of work is done by the system. What is the change (in J) in internal energy for the process?

3. A hydrocarbon (A) of molecular weight 54 g/mole gives white precipitate with ammonical $AgNO_3$ solution. (A) reacts with an excess of Br_2 in CCl_4 to give a compound (B) whose molecular weight is x% more than that of (A). However, on catalytic hydrogenation with excess of hydrogen, (A) forms (C) whose molecular weight is only y% more than that of (A). Find the value of sum of x and y.
[Nearest integer]

4. A certain particle carries $2.5\times10^{-16}C$ of static electric charge. Calculate the number of electrons present in it. [Nearest integer]

SPACE FOR ROUGH WORK

5. How many different isomers (including stereoisomers) corresponding to the 5^{th} member of alkyne series are possible?

6. A sample of hard water contain 183 ppm HCO_3^- ions and 96 ppm SO_4^{2-} ions and Ca^{2+} as the only cation. The concentration of Ca^{2+} ion is x ppm. Find the value of x.

7. Find the sum of number of σ-bonds and number of π-bonds in ethene-1, 1, 2, 2-tetracarbonitrile.

8. The subshell that will come after 'f' subshell is called the 'g' subshell. Find the maximum number of electrons that can be accommodated in 'g' subshell.

9. How many of the following will give positive Lassaigne's test for both nitrogen and halogen?
$CH_3NH_2 \cdot HCl$; NH_4Cl; $NH_2OH \cdot HCl$; $N_2H_4 \cdot HCl$; NCl_3; N-Bromosuccinamide (NBS); $NH_2CONHNH_2 \cdot HBr$

10. Organic compound $P(C_5H_8)$ on complete reductive ozonolysis gives formaldehyde and 2-ketopropanal. Find the maximum number of atoms in (P) that are lying in the same plane.

SPACE FOR ROUGH WORK

PART - III: MATHEMATICS 100 MARKS

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

1. The harmonic mean of x and y equal to 6^{20}. If $\left(x-2^{19}3^{20}\right)\left(y-2^{19}3^{20}\right)=3^{\alpha\cdot}2^{\beta}$, then $\frac{(\alpha+1)(\beta+1)-1}{2}$ is equals to: (where $\alpha,\beta\in N$)

(A) 1599 **(B)** 800 **(C)** 799 **(D)** 1518

2. If $(1-i)$ is a root of the equation $z^3-2(2-i)z^2+(4-5i)z-1+3i=0$ where $i=\sqrt{-1}$, then other two roots are:

(A) 1 and $2+i$ **(B)** 2 and $1+i$ **(C)** $1-i$ and $1+i$ **(D)** 1 and $2-i$

3. Two values of x for which sixth term of the expansion of $E=\left[3^{\log_3\sqrt{9^{|x-2|}}}+7^{\frac{1}{5}\log_7\left(4.3^{|x-2|}-9\right)}\right]^7$ is 567, is:

(A) 3,4 **(B)** 3,1 **(C)** 2,7 **(D)** 3,5

4. The coefficient of x^{25} in the expansion of $(1+x)^{1000}+x(1+x)^{999}+x^2(1+x)^{998}+\ldots+x^{1000}$ is:

(A) ${}^{1001}C_{25}$ **(B)** ${}^{1002}C_{25}$ **(C)** ${}^{1000}C_{25}$ **(D)** ${}^{1000}C_{26}$

SPACE FOR ROUGH WORK

5. If $\left(5+2\sqrt{6}\right)^n = I + f$ when $I \in N, n \in N$ and $0 \le f < 1$, then:

(A) $I = -f + 1 + \frac{1}{f}$ **(B)** $I = -f + 1 - \frac{1}{f}$

(C) $I = \frac{1}{1-f} + f$ **(D)** $I = \frac{1}{1-f} - f$

6. If L is the line whose equation is $ax + by = c$. Let M be the reflection of L through the y-axis and let N be the reflection of L through x-axis. Which of the following must be true about M and N for all choices of a, b and c?

(A) The x intercepts of M and N are equal

(B) The y-intercepts of M and N are equal

(C) The slopes of M and N are equal

(D) The slopes of M are N are reciprocals of each other

7. Line $\frac{x}{c} + \frac{y}{d} = 1$ cuts the coordinates axes at $P(c,0)$ and $Q(0,d)$. Another line $d'x - cy + cd' = 0$ cuts coordinates axis at $R(-c,0)$ and $S(0,d')$. If the points P, Q, R, S are concyclic then the orthocentre of ΔPQR is:

(A) (0,0) **(B)** $(0,-d')$ **(C)** (0, c) **(D)** $\left(0, \frac{dd'}{c}\right)$

8. Let L be the line belonging to the family of straight lines $(a+2b)x + (a-3b)y + a - 8b = 0$, $a, b \in R$, which is farthest from the point (2, 2). Area of triangle formed by line L with coordinates axes is:

(A) $\frac{4}{3}$ sq.units **(B)** $\frac{9}{2}$ sq.units **(C)** $\frac{49}{8}$ sq.units **(D)** 4 sq. units

SPACE FOR ROUGH WORK

9. The locus of centre of all circles passing through (1,2) and cutting circle $x^2+y^2=16$ orthogonally is:

(A) $4x-2y+21=0$ **(B)** $x+2y+11=0$

(C) $2x+4y-21=0$ **(D)** $2x-y+11=0$

10. Let $C_1: x^2+y^2=10$ and $C_2: x^2+y^2=16$. The tangent at point (1,3) on C_1 meets the circle C_2 at points A and B. The tangents drawn at A and B to C_2 meets in T, then the coordinate of T is:

(A) $\left(\frac{9}{5},\frac{18}{5}\right)$ **(B)** (4,5) **(C)** (8, 24) **(D)** $\left(\frac{8}{5},\frac{24}{5}\right)$

11. If the circle $x^2+y^2+2gx+2fy+c=0$ cuts each of the circles $x^2+y^2=9, x^2+y^2-4x+2y+4=0$ and $x^2+y^2+2x-6y+6=0$ in such a way that it bisects the circumference of each of them. Then:

(A) $g=-\frac{2}{5}$ **(B)** $g=\frac{2}{5}$ **(C)** $f=\frac{7}{10}$ **(D)** $f=\frac{7}{5}$

12. If from the point P (2,3), Q (5,6), R (99,100) tangents are drawn to a circle $x^2+y^2=1$, then area of Δ formed by their chord of contacts is:

(A) 5 sq. units **(B)** 9 sq. units **(C)** 7 sq. units **(D)** zero

13. A tangent to the ellipse $E_1: x^2+9y^2=9$ meets the ellipse $E_2: x^2+3y^2=12$ at A and B. Angle between the tangents at A and B to the ellipse E_2 is:

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

SPACE FOR ROUGH WORK

14. Let P(5,6), Q(3,2) be the points on a parabola, where tangents are drawn and intersect at $R(-2,3)$,then slope of axis of parabola is:

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

15. If inside the ellipse $\frac{x^2}{16}+\frac{y^2}{4}=1,$ a light ray emerges from point $A\left(2\sqrt{3},0\right),$ after four internal reflections, vanishes at A itself, then the distance travelled by ray is:

(A) 32 **(B)** 30 **(C)** 36 **(D)** 24

16. If tangent at point $P\left(3t,\frac{3}{t}\right)$ on hyperbola $xy = 9$ is a normal to the parabola $y^2=8x,$ then t is:

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

SPACE FOR ROUGH WORK

17. The length of latus rectum of curve given by $289\left\{(x-3)^2+(y-1)^2\right\}=(15x-8y+13)^2$ is:

(A) $\frac{50}{17}$ **(B)** $\frac{100}{17}$ **(C)** $\frac{150}{17}$ **(D)** $\frac{25}{17}$

18. If image of $\frac{x^2}{25}+\frac{y^2}{9}=1$ with respect of $y=x$ is curve $ax^2+by^2=225$, then value of $a+b$ is:

(A) 8 **(B)** 34 **(C)** 16 **(D)** 24

19. If α be a root of equation $x^2-x-3=0$, then the value of $\frac{\alpha^3+1}{\alpha^5-\alpha^4-\alpha^3+\alpha^2}$ is equal to:

(A) $\frac{2}{3}$ **(B)** $\frac{4}{9}$ **(C)** $\frac{3}{4}$ **(D)** $\frac{9}{16}$

20. For a natural number *n*, let $\alpha_n=a^n-b^n$ where *a* and *b* are roots of $x^2-9x+18=0$. Then the value of $\frac{9\alpha_9-\alpha_{10}}{6\alpha_8}$ equals to:

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

SPACE FOR ROUGH WORK

SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted. The answer to each question should be **rounded off to the nearest integer**.

1. If z_1, z_2 and z_3 be three complex number such that $|z_1+1|\le 1, |z_2+2|\le 2, |z_3+4|\le 4$, then the maximum value of $|z_1|+|z_2|+|z_3|$ is _____.

2. Let $z=\left(\cos 12^\circ + i\sin 12^\circ + \cos 48^\circ + i\sin 48^\circ\right)^2$, then lm (z) is equal to $\sqrt{\lambda}\cos^2 18^\circ$ then λ is ____ .

3. If the pair of straight line $x^2-2pxy-y^2=0$ and $x^2-2qxy-y^2=0$ bisect angle between each other of and *pq* is equal to k, then $|k|$ is _____.

4. If circles have radii 2 and 5 with distance between centres are 6, then the acute angle between the direct common tangents is $\frac{a\pi}{b}$, then value of $|a+b|$ is equal to (a, b are relative prime) _____.

5. An incident ray hits the line $x=-2$ at $(-2,-4)$ and after getting reflected it is tangent to the circle $x^2+y^2=4$. If slope of incident ray is k, then |16 *k*| is _____ .

SPACE FOR ROUGH WORK

6. For parabola $y^2 = 4x$, length of chord of contact of a pair tangents drawn from point $(-4, 0)$ is____.

7. Two points P and Q on hyperbola $\frac{x^2}{3} - \frac{y^2}{6} = 1$ with centre C are such that CP is perpendicular to CQ. If value of $\left|\frac{1}{CP^2} + \frac{1}{CQ^2}\right| = \lambda$, then $\frac{1}{\lambda}$ is _____.

8. If equation of hyperbola whose asymptotes are $2x - y = 3$ and $3x + y - 7 = 0$, passing through (1,1) is $6x^2 - xy + ay^2 + bx + cy + d = 0$, then $|a + b + c + d|$ is _____.

9. The range of $f(x) = \frac{x^2 - 3x + \lambda}{x - 2}$ is *R*, then the exhaustive set of values of λ is $(-\infty, k)$ then *k* is____.

10. If $\cot 7\frac{1}{2}^\circ = \sqrt{n_1} + \sqrt{n_2} + \sqrt{n_3} + \sqrt{n_4}$, where $n_1, n_2, n_3, n_4 \in N$ then $n_1 + n_2 + n_3 + n_4$ is equal to_____.

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••• End of JEE Main Full Length Test – 1 [JEE - 2024] •••