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PHYSICS

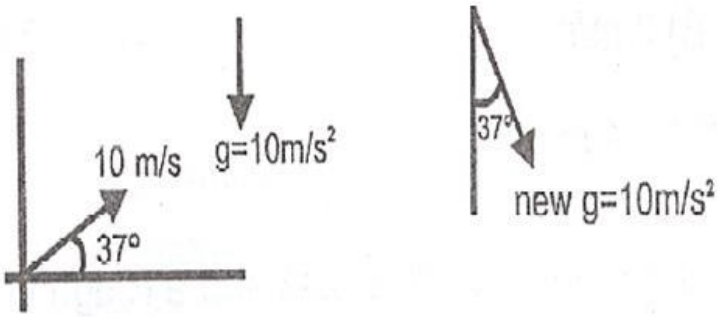
TARGET : JEE- Advanced 2023

CAPS-2

PROJECTILE MOTION
RELATIVE MOTION

SCQ (Single Correct Type) :

1. A particle is projected with a velocity 10 m/s at an angle 37º with the horizontal. It reaches to a point P in 1 sec. Now the direction of gravity is changed by 37º with the vertical as shown.



The new projection velocity (may be at a different angle) so that the particle reaches the same point P in 1 sec, is:

(A) $\sqrt{10}\,m/s$ (B) 20 m/s (C) $5\sqrt{2}\,m/s$ (D) $10\sqrt{3}$

2. The current velocity (V) of a river is directly proportional with the distance (x) from its bank. V is maximum in the middle and equals to v_0. A boat is moving on the river with a constant velocity μ relative to the water and perpendicular to the current. Find the drift of the boat when reaches from mid point of river to other bank of river. Width of the river is 'C'

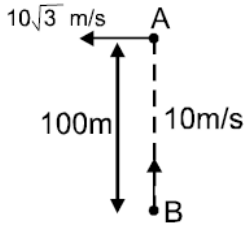
(A) $\frac{v_0 C}{2\mu}$ (B) $\frac{v_0 C}{4\mu}$ (C) $\frac{v_0 C}{\mu}$ (D) $\frac{v_0 C}{3\mu}$

MCQ (One or more than one correct) :

3. At what angle should a body be projected with a velocity 24 ms^{-1} just to pass over the obstacle 14 m high at a distance of 24 m. [Take g = 10 ms^{-2}]

(A) $\tan\theta = 19/5$ (B) $\tan\theta = 1$ (C) $\tan\theta = 3$ (D) $\tan\theta = 2$

4. Consider two cars moving perpendicular to each other as shown. Initially distance between them is 100 m. Velocity of A is $10\sqrt{3}\,m/s$ and velocity of B is 10 m/s. Then :



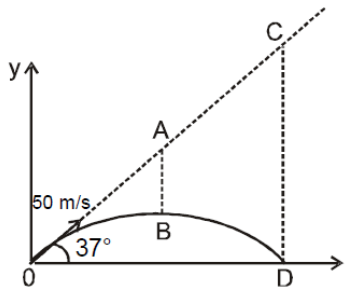
(A) magnitude of velocity of A w.r.t. B is 20 m/s

(B) minimum distance between them is 50 m

(C) minimum distance between them is $50\sqrt{3}\,m$

(D) at t = 2 sec. they will be nearest to each other

5. A particle is projected with speed 50m/s at angle 37°° with horizontal from ground as shown. AB and CD are parallel to y-axis and B is highest point of trajectory of particle. Choose the correct options :



(A) AB = 45m (B) BC = 90 m (C) AB = 90 m (D) CD = 180m

6. A helicopter takes off along the vertical with an acceleration a = 3 m/s^2 and zero initial velocity. In a certain time t_1 pilot switches off the engine. At the point of take off, the sound dies away in a time t_2 = 30 sec. Speed of sound is 320 m/s. Choose the correct option(s).

(A) Pilot switches off the engine at height $h = \frac{4200}{3} m$

(B) Pilot switches off the engine in time $t_1 = \frac{80}{3} sec$

(C) Pilot switches off the engine at height $h = \frac{3200}{3} m$

(D) Speed of helicopter at the moment when pilot switches off the engine is 80 m/s

7. Two particle A and B are located in x-y plane at points (0, 0) and (0, 4 m). They simultaneously start moving with velocities. $\vec{v}_A = 2\hat{j} m/s$ and $\vec{v}_B = 2\hat{i}\, m/s$. Select the correct alternative(s).

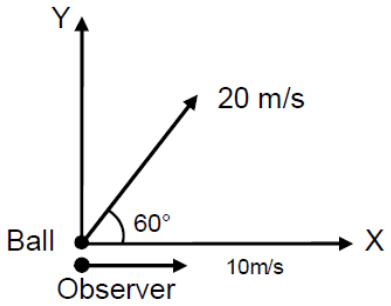
(A) The distance between them is constant

(B) The distance between them first decreases and then increases

(C) The shortest distance between them is $2\sqrt{2}\,m$

(D) Time after which they are at minimum distance is 1s

8. A football is kicked with a speed of 20 m/s at an angle of 60° to the positive x direction taken along horizontal. At that instant, an observer moves past the football who moves with a constant speed of 10 m/s in the positive x direction. Take +ve y direction vertically upwards. ($g = 10\ m/s^2$)



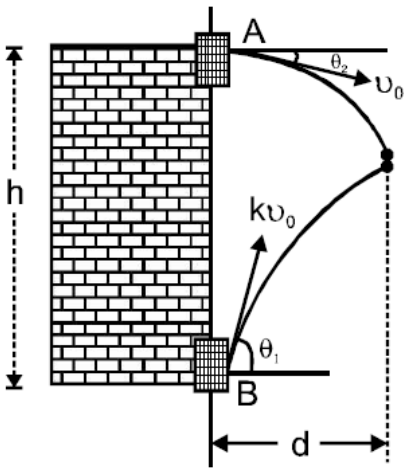
(A) The initial velocity of the ball relative to the observer is $10\sqrt{3}\,m/s$ in the +y direction

(B) The initial velocity of the ball relative to the observer is 17 m/s at 60°° to the +x direction.

(C) According to the observer the ball will follow a path that is straight up and down in the y direction.

(D) According to the observer the ball will follow a straight line that is angled (less than 90º) with respect to the observer.

9. At the same instant, two boys throw balls A and B from the window with speeds υ_0 and $k\upsilon_0$ respectively, where k is constant. They collide in air at time t. Which of the following options is/are correct.



(A) $k = \dfrac{\cos\theta_2}{\cos\theta_1}$

(B) $k = \dfrac{\sin\theta_2}{\sin\theta_1}$

(C) $t = \dfrac{h}{(kv_0\sin\theta_1 + v_0\sin\theta_2)}$

(D) $t = \dfrac{h}{(kv_0\cos\theta_1 + v_0\cos\theta_2)}$

Comprehension Type Question:

A circus wishes to develop a new clown act. Fig. (1) shows a diagram of the proposed setup. A clown will be shot out of a cannon with velocity v_0 at a trajectory that makes an angle $\theta = 45°$ with the ground. At this angle, the clown will travel a maximum horizontal distance. The cannon will accelerate the clown by applying a constant force of 10,000N over a very short time of 0.24s. The height above the ground at which the clown begins his trajectory is 10m.

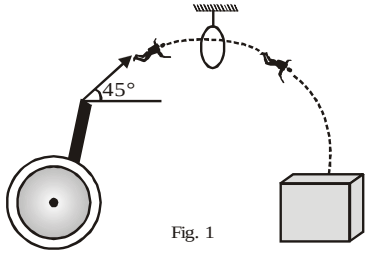


Fig. 1

A large hoop is to be suspended from the ceiling by a massless cable at just the right place so that the clown will be able to dive through it when he reaches a maximum height above the ground. After passing through the hoop he will then continue on his trajectory until arriving at the safety net. Fig. (2) shows a graph of the vertical component of the clown's velocity as a function of time between the cannon and the hoop. Since the velocity depends on the mass of the particular clown performing the act, the graph shows data for several different masses.

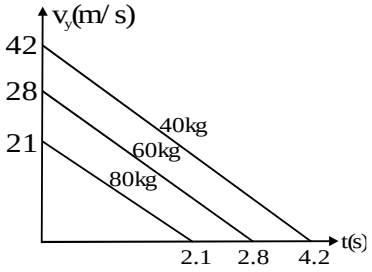


Fig. 2

10. If the angle the cannon makes with the horizontal is increased from 45°, the hoop will have to be :-

(A) Moved farther away from the cannon and lowered

(B) Moved farther away from the cannon and raised

(C) Moved closer to the cannon and lowered

(D) Moved closer to the cannon and raised

11. If the clown's mass is 80 kg, what initial velocity v_0 will he have as he leaves the cannon ?

(A) 3 m/s (B) 15 m/s (C) 30 m/s (D) 300 m/s

12. The slope of the line segments plotted in figure 2 is a constant. Which one of the following physical quantities does this slope represent ?

(A) – g (B) v_0 (C) $y - y_0$ (D) $\sin\theta$

13. From figure 2, approximately how much time will it take for clown with a mass of 60 kg to reach the safety net located 10 m below the height of the cannon ?

(A) 4.3s (B) 6.4s (C) 5.9s (D) 7.2s

14. If the mass of a clown doubles, his initial kinetic energy, $mv_0^2/2$, will :-

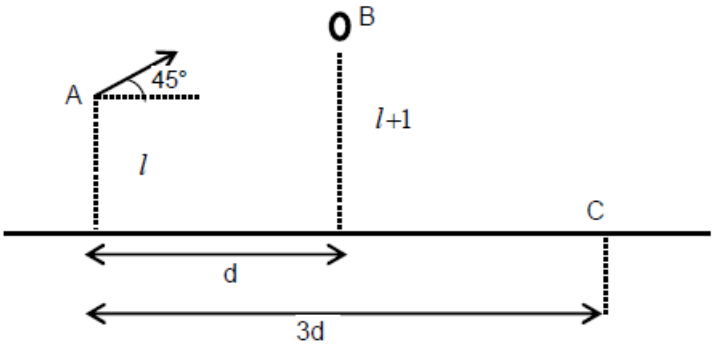
(A) Remain the same (B) Be reduce to half (C) Double (D) Four times

15. If a clown holds on to hoop instead of passing through it, what is the position of the cable so that he doesn't hit his head on the ceiling as he swings upward ?

(A) $\frac{2v_0^2}{g}$ (B) $\frac{v_0^2}{g}$ (C) $\frac{v_0^2}{2g}$ (D) $\frac{v_0^2}{4g}$

Numerical based Questions :

16. A projectile is launched at time t = 0 from point 'A' which is at height ℓ meters above the floor at an angle of $\theta = 45^o$ with the floor. It passes through a hoop at B which is 1 meter above A where as B is the highest point of the trajectory. The horizontal distance between A and B is d meters. If projectile then falls into a basket, hitting the floor at C which is at a horizontal distance of 3d meters from A then the value ℓ (in meters) is ?



17. Particle A starts from rest at t = 0 from x = 0 with constant acceleration to reach x = 1m at t = 1s. Particle B starts with uniform velocity at t = 0 from x = 1 m to reach x = 2m at t = 1s. The distance covered by particle B in the frame of reference attached to particle A from t = 0 to t = 1 sec is 1/K meter. Then find the value of K.

18. A swimmer crosses the river along the line making an angle of 45º with the direction of flow. Velocity of the river water is 5 m/s. Swimmer takes 12 seconds to cross the river of width 60 m. The velocity of the swimmer with respect to water in m/s will be:

19. An elastic ball thrown with a speed v_0 from ground level collides with a vertical wall when it is moving at right angles to its initial direction of motion and subsequenctly strikes the ground after a time $\frac{1}{2\sqrt{3}}$ of the maximum possible time of its motion for the given speed of projection. If the angle of projection (in degrees) is 15x. Then fill the value of x.

20. A cannon fires successively two shells with velocity v_0= 250 m/s; the first at the angle θ_1 = 53° and the second at the angle θ_2 = 37° to the horizontal, in the same vertical plane, neglecting the air drag, find the time interval (in sec) between firings leading to the collision of the shells. (g = 10 m/s^2).

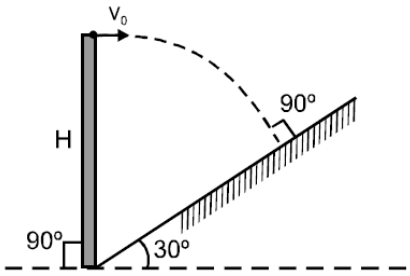
21. A boat has to cross a river as soon as possible. In doing so it takes 4 sec less than if it travels by shortest path. Let the width of the river is 'd'. Velocity of river water is 8 m/s and boat can travel in still water with a velocity of 17 m/s. Find the value of $\frac{d}{170}$

Subjective Type Questions :

22. Two swimmers start from point A on one bank of a river to reach point B on the other bank, lying directly opposite to point A. One of them crosses the river along the straight line AB, while the other swims at right angles to the stream and then walks the distance which he has been carried away by the stream to get to point B. What was the velocity (assumed uniform) of his walking if both the swimmers reached point B simultaneously. Velocity of each swimmer in still water is 2.5 km h^{-1} and the stream velocity is 2 km h^{-1}.

23. A ball is thrown from the roof of a building of height 44m with speed v_0 at an angle θ below the horizontal. It lands 2 seconds later at a point 30m from the base of the building. If $\tan\theta = \frac{X}{10}$ then, find the value of X. (Take g = 10 m/s^2)

24. If the projectile hits the inclined plane perpendicularly when thrown horizontally with v_0 from a tower of height H as shown then the value of $\frac{2gH}{(v_0)^2}$ is



25. Two points A and B are moving with the same speed $u = 4\sqrt{2}\,m/s$ in the positive direction of x–axis and y–axis respectively. Find the magnitude of relative velocity of C w.r.to A (where C is the mid point of AB).