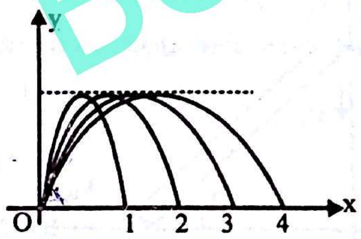
PART A - PHYSICS

A particle is projected at an angle θ above the horizontal with a speed u. After some time the direction of its velocity makes an angle ϕ above the horizontal. The speed of the particle at this instant is

(1) $u\cos\theta$ (2) $\dfrac{u\cos\theta}{\cos\phi}$

(3) $\dfrac{u\sin\theta}{\sin\phi}$ (4) $\dfrac{u\cos\phi}{\cos\theta}$

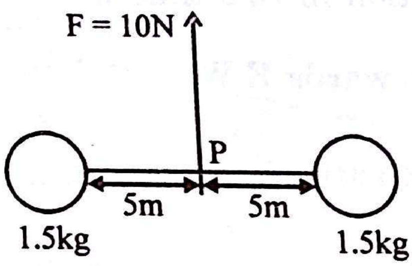
Figure shows four possible trajectories of a kicked football. Ignoring air resistance, rank the curves according to the initial horizontal velocity component the highest first



(1) 1, 2, 3, 4 (2) 1, 3, 2, 4

(3) 3, 4, 1, 2 (4) 4, 3, 2, 1

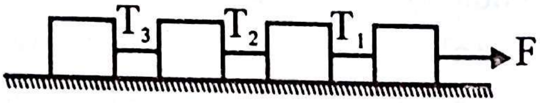
3. Two particles of mass 1.5 kg each are tied at the ends of a light string of length 10m. The whole system is kept on a frictionless horizontal surface with the string held tight so that each mass is at a distance 5m from the centre P (as shown in figure). Now the mid point of the string is pulled vertical upwards with a constant force of 10N. As a result, the particles move towards each other on the surface. The magnitude o relative acceleration, when the separatio between them becomes 6m, is



(1) 2.5 m/s^2 (2) 5 m/s^2

(3) 10 m/s^2 (4) 20 m/s^2

An arrangement shown in figure has four identical blocks connected with horizontal strings being pulled by a force F on one side. Tension in the various strings are T_1, T_2 & T_3 and surface is smooth. Choose the correct option.



(1) $T_1 + T_2 + T_3 = F$

(2) $T_1 + T_2 + T_3 = 2F$

(3) $2(T_1 + T_2 + T_3) = F$

(4) $2(T_1 + T_2 + T_3) = 3F$

A particle is moving eastwards with a velocity of 5 m/s. In 10s the velocity changes to 5 m/s northwards. The average acceleration in this time is

(1) $\sqrt{2}$ towards E-W

(2) $\sqrt{2}$ towards N-W

(3) $\frac{1}{\sqrt{2}}$ towards N-W

(4) $\frac{1}{\sqrt{2}}$ towards E-W

6. The co-ordinates of a particle moving in a plane are given by $x = a\cos\omega t$ and $y = a\sin\omega t$ then distance travelled by the particle in time interval $t = 0$ to $t = \frac{\pi}{2\omega}$ is

(1) π (2) $a\pi$ (3) $\frac{a}{2}\pi$ (4) $3a\pi$

7. Choose incorrect statement

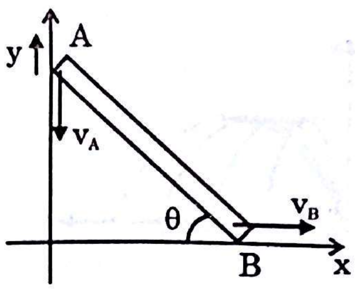
(1) If two balls of different masses are thrown in same direction with same speed then they follow same parabolic path.

(2) A dimensionless quantity must have unit

(3) A dimensionless quantity must be unitless

(4) A unitless quantity must be dimensionless

8. A ladder is resting on two mutually perpendicular walls. If ladder starts to slide and velocity of point B at a certain point when θ is 37°, is 3 m/sec then velocity of point A at this moment is



(1) 4 m/s (2) 6 m/s

(3) 8 m/s (4) None of these

ROUGH WORK

Two transparent elevator cars A and B are moving in front of each other. Car A is moving up and retarding at a_1, while car B is moving down and retarding at a_2. Person in car A drops a coin inside the car. What is the acceleration of coin observed by person in car B.

(1) $g + a_2$ downward

(2) $g - a_1 - a_2$ downward

(3) $g - a_1 + a_2$ downward

(4) None of these

Two cars A and B travels along x-axis. The distance of A & B from the starting point is given as a function of time $x_A = 4t + t^2$ & $x_B = 2t^2 + 2t^3$ (here x is in meter & t is in sec.). At what times is the distance from A to B neither increasing nor decreasing

(1) $\frac{1}{3}$ sec.　(2) $\frac{2}{3}$ sec

(3) $\frac{5}{6}$ sec.　(4) none

A perfectly straight portion of a uniform rope has mass M and length L. At end A of the segment, the tension in the rope is T_A; at end B it is T_B (> T_A). The tension in the rope at a distance $L/5$ from end A is

(1) $T_B - T_A$　(2) $(T_A + T_B)/5$

(3) $(4T_A + T_B)/5$　(4) $(T_B - T_A)/5$

23. A uniform thick string of length 5 m is resting on a horizontal frictionless surface. It is pulled by a horizontal force of 5 N from one end . The tension in the string at 1m from end where force is applied, is :

(1) zero　(2) 5 N

(3) 4 N　(4) 1 N

24. A particle is projected vertically upward with velocity 50 m/s from a height of 100 m tower at t = 0. t = 2 sec later another particle is thrown vertically upwards from ground with same velocity. At what time, they are at the same level.

(1) 11 sec　(2) 10 sec

(3) 5 sec　(4) 15 sec

25. In a two-dimensional motion, instantaneous speed v_0 is a positive constant. Then, which of the following are necessarily true?

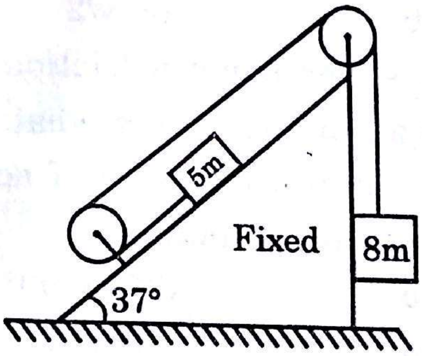
(1) The acceleration of the particle is zero.

(2) The acceleration of the particle must be constant.

(3) The acceleration of the particle is neccessarily in the plane of motion.

(4) Theparticle must be undergoing a uniform circular motion.

In the system shown in figure, all surfaces are smooth, pulley and string are massless. The string between two pulley & between pulley and block of mass 5m is parallel to inclined surface If system is released from rest then acceleration of the wedge is



(1) $\frac{11g}{13}$ m/sec^2 (2) $\frac{440}{205}$ m/sec^2

(3) $\frac{5g}{13}$ m/sec^2 (4) None of these

A body is projected at time (t = 0) from a certain point on a planet's surface with a certain velocity at a certain angle with the planet's surface (assumed horizontal). The horizontal and vertical displacements x & y (in meter) respectively vary with time t in second as, $x = 10\sqrt{3}\ t$ and $y = 10t - t^2$. Then the maximum height attained by the body is :

(1) 200 m (2) 100 m

(3) 50 m (4) 25 m

17. If R is the range of a projectile o horizontal plane and h its maxim height, then maximum horizontal ra with the same speed of projection is

(1) 2h (2) $\frac{R^2}{8h}$

(3) $2R + \frac{h^2}{8R}$ (4) $2h + \frac{R^2}{8h}$

18. Two particles, one with constant veloc 50m/s and the other with unifor acceleration 10m/s^2, start movi simultaneously from the same place in t same direction. They will be at a distan of 125m from each other after

(1) 5 sec. (2) $5(1 - \sqrt{2})$ sec.

(3) 10sec. (4) $10(\sqrt{2} + 1)$sec.

19. A boat is moving towards east with veloci 4 m/s with respect to still water and riv is flowing towards north with velocity 2 m and the wind is blowing towards nor with velocity 6 m/s. The direction of t flag blown over by the wind hoisted on t boat is:

(1) north-west

(2) south-east

(3) $\tan^{-1}(1/2)$ with east

(4) north

A helicopter is rising vertically up with constant velocity of 5 m/s. A ball is projected vertically up from the helicopter with velocity v(relative to ground). If ball crosses the helicopter 3 sec after it's projection then v is ($g = 10\ m/s^2$)

(1) 80 m/sec (2) 20 m/sec

(3) 70 m/sec (4) 50 m/s

Acceleration of a particle as seen from two refrence frame 1 & 2 has magnitude $3 m/sec^2$ & $4\ m/s^2$ respectively. The magnitude of acceleration of frame-2 with respect to frame-1 can not be possible

(1) $8\ m/s^2$ (2) $6\ m/s^2$

(3) $2\ m/s^2$ (4) $5\ m/s^2$

An observer on ground sees a boat cross a river of width 800 m perpendicular to its stream in 200 seconds. He also finds a man on a raft floating at speed of 3 m/s with river. The distance travelled by boat as seen by man on the raft in crossing the river is-

(1) 800 m

(2) 1000m

(3) 1200m

(4) 1600m

12. A stone is projected horizontally with speed u from the top of a tower of height h and it strikes the ground at angle θ with horizontal then it's minimum speed in it's journey, is

(1) ucosθ (2) u

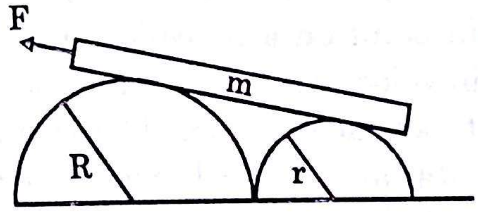
(3) usinθ (4) v/2

13. A block slides down a frictionless plane inclined at an angle θ.For what value of θ, the horizontal component of acceleration of the block is maximum.

(1) θ = 45° (2) θ = 90°

(3) θ = 53° (4) θ = 75°

14. A rod of length ℓ & mass m rests on two hemispherical balls of radius R & r, which fixed on horizontal table. Assuming the surface is frictionless then find minimum value of F so that rod will be at rest



(1) $mg\left(\frac{R-r}{R+r}\right)$ (2) $mg\left(\frac{R+r}{R-r}\right)$

(3) $\frac{mgr}{R}$ (4) $\frac{mgR}{r}$

26. A man starts running along a straight road with uniform velocity $u\hat{i}$, observes that the rain is falling vertically downward. If he doubles his speed, he finds that the rain is coming at an angle θ to the vertical. The velocity of rain with respect to the ground is (take vertically upward direction as $\hat{j}$) :

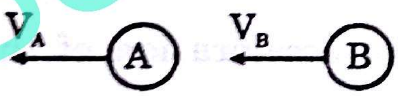
(1) $u\hat{i} - u\tan\theta\hat{j}$

(2) $u\hat{i} - u\cot\theta\hat{j}$

(3) $u\hat{i} + u\cot\theta\hat{j}$

(4) $\frac{u}{\tan\theta}\hat{i} - u\hat{j}$

. Two particles are moving along a straight line as shown . The velocity of B as seen from the reference frame of A, is



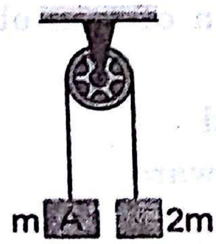
(1) $V_A + V_B$

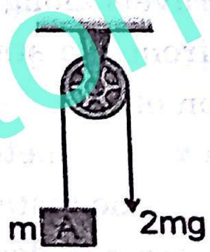
(2) $| V_A - V_B |$

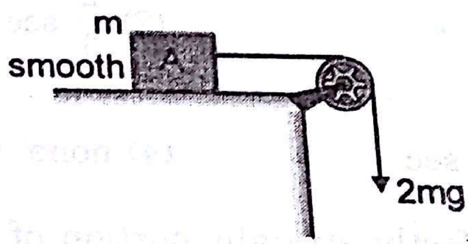
(3) $V_A - V_B$

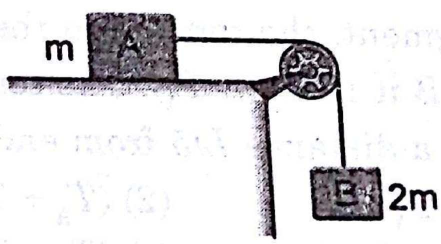
(4) $V_B - V_A$

28. In which of the following cases magnitude of acceleration of the bloc will be maximum (Neglection frict mass of pulley and string)

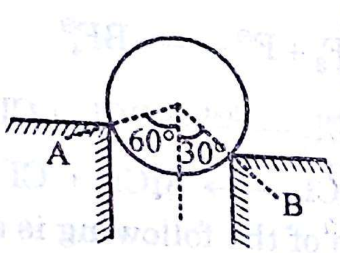
(1)


(2)


(3)


(4)


A smooth cylinder is resting on two corner edges A and B as shown in figure. The normal reaction at the edges A and B are N_A and N_B respectively then:



(1) $N_A = \sqrt{2}N_B$

(2) $N_B = \frac{2\sqrt{3}N_A}{5}$

(3) $N_A = \frac{N_B}{2}$

(4) $N_B = \sqrt{3}N_A$

30. The force exerted by a special compression device is given as function of compression x as $F_x(x) = kx(x-\ell)$ for $0 \le x \le \ell$, where ℓ i the maximum possible compression and k is a constant. The force exerted by th device under compression is maximum when compression is :

(1) 0

(2) $\ell/4$

(3) $\ell/\sqrt{2}$

(4) $\ell/2$