

विघ्न विचारत भीरु जन, नहीं आरम्भे काम, विपति देख छोड़े तुरंत मध्यम मन कर श्याम।
पुरुष सिंह संकल्प कर, सहते विपति अनेक, 'बना' न छोड़े ध्येय को, रघुबर राखे टेक।।

रचित: मानव धर्म प्रणेता

सद्गुरु श्री रणछोड़दासजी महाराज

Subject : PHYSICS

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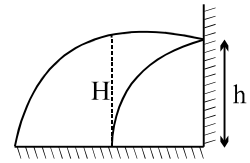
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Q.1 A particle moves in space along the path $z = ax^3 + by^2$ in such a way that $\frac{dx}{dt} = c = \frac{dy}{dt}$. Where a, b and c are constants. The acceleration of the particle is
 (A) $(6ac^2x + 2bc^2)\hat{k}$ (B) $(2ax^2 + 6by^2)\hat{k}$ (C) $(4bc^2x + 6ac^2)\hat{k}$ (D) $(bc^2x + 2by)\hat{k}$

Q.2 A stone is projected from a horizontal plane. It attains maximum height 'H' & strikes a stationary smooth wall & falls on the ground vertically below the maximum height. Assume the collision to be elastic the height of the point on the wall where ball will strike is:
 (A) H/2 (B) H/4
 (C) 3H/4 (D) none of these

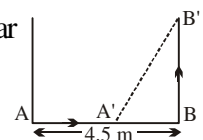


Q.3 A man in a balloon rising vertically with an acceleration of 4.9 m/s^2 releases a ball 2 seconds after the balloon is let go from the ground. The greatest height above the ground reached by the ball is ($g = 9.8 \text{ m/s}^2$)
 (A) 14.7 m (B) 19.6 m (C) 9.8 m (D) 24.5 m

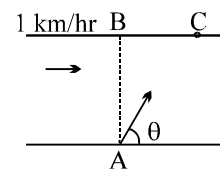
Q.4 A particle is projected at an angle of 45° from a point lying 2 m from the foot of a wall. It just touches the top of the wall and falls on the ground 4 m from it. The height of the wall is
 (A) 3/4 m (B) 2/3 m (C) 4/3 (D) 1/3 m

Q.5 The velocity at the maximum height of a projectile is half its initial velocity of projection. Its range on the horizontal plane is
 (A) $\frac{\sqrt{3}u^2}{2g}$ (B) $\frac{u^2}{2g}$ (C) $\frac{3u^2}{2g}$ (D) $\frac{3u^2}{g}$

Q.6 Two particles instantaneously at A & B respectively 4.5 meters apart are moving with uniform velocities as shown in the figure. The former towards B at 1.5 m/sec and the latter perpendicular to AB at 1.125 m/sec. The instant when they are nearest is:
 (A) 2 sec (B) 3 sec (C) 4 sec (D) $1\frac{23}{25}$ sec



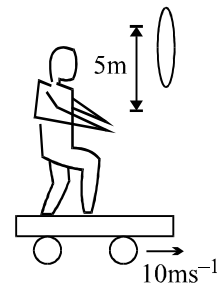
Q.7 A river is flowing with a speed of 1 km/hr. A swimmer wants to go to point 'C' starting from 'A'. He swims with a speed of 5 km/hr, at an angle θ w.r.t. the river. If $AB = BC = 400 \text{ m}$. Then the value of θ is:
 (A) 37° (B) 30° (C) 53° (D) 45°



Q.8 A boat is moving towards east with velocity 4 m/s with respect to still water and river is flowing towards north with velocity 2 m/s and the wind is blowing towards north with velocity 6 m/s. The direction of the flag blown over by the wind hoisted on the boat is:
 (A) north-west (B) south-east (C) $\tan^{-1}(1/2)$ with east (D) north

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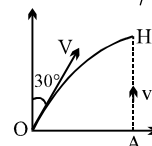
Q.9 A girl is riding on a flat car travelling with a constant velocity 10 ms^{-1} as shown in the fig. She wishes to throw a ball through a stationary hoop in such a manner that the ball will move horizontally as it passes through the hoop. She throws the ball with an initial speed $\sqrt{136} \text{ ms}^{-1}$ with respect to car. The horizontal distance in front of the hoop at which ball has to be thrown is



- (A) 1m (B) 2m (C) 4m (D) 16m

Q.10 A particle is projected with a speed V from a point O making an angle of 30° with the vertical. At the same instant, a second particle is thrown vertically upward from a point A with speed v . The two particles reach H , the highest point on the parabolic path of the first particle simultaneously, then the ratio V/v

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

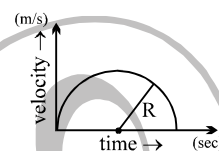


Q.11 A particle is projected with a certain velocity at an angle θ above the horizontal from the foot of a given plane inclined at an angle of 45° to the horizontal. If the particle strikes the plane normally then θ equals

- (A) $\tan^{-1}(1/3)$ (B) $\tan^{-1}(1/2)$ (C) $\tan^{-1}(1/\sqrt{2})$ (D) $\tan^{-1} 3$

Q.12 Velocity time graph of a particle is in shape of a semicircle of radius R as shown in figure. Its average acceleration from $T = 0$ to $T = R$ is:

- (A) 0 m/s^2 (B) 1 m/s^2
(C) $R \text{ m/s}^2$ (D) $2R \text{ m/sec}^2$



Q.13 A car is moving with uniform acceleration along a straight line between two stops X and Y . Its speed at X and Y are 2 m/s and 14 m/s . Then

- (A) Its speed at mid point of XY is 15 m/s
(B) Its speed at a point A such that $XA : AY = 1 : 3$ is 5 m/s
(C) The time to go from X to the mid point of XY is double of that to go from mid point to Y .
(D) The distance travel in first half of the total time is half of the distance travelled in the second half of the time.

Q.14 A particle having a velocity $v = v_0$ at $t = 0$ is decelerated at the rate $|a| = \alpha\sqrt{v}$, where α is a positive constant.

- (A) The particle comes to rest at $t = \frac{2\sqrt{v_0}}{\alpha}$
(B) The particle will come to rest at infinity.
(C) The distance travelled by the particle is $\frac{2v_0^{3/2}}{\alpha}$
(D) The distance travelled by the particle is $\frac{2}{3} \frac{v_0^{3/2}}{\alpha}$

Q.15 Two towns A and B are connected by a regular bus service with a bus leaving in either direction every T minutes. A man cycling with speed of 20 km/h in the direction A to B , notices that a bus goes past him every $t_1 = 18$ minutes in the direction of motion, and every $t_2 = 6$ minutes in the opposite direction. What is the period T of the bus service? Assume that velocity of cyclist is less than velocity of bus

- (A) 4.5 minutes (B) 24 minutes (C) 9 minutes (D) 12 minutes

Q.16 A body starts from rest with uniform acceleration. Its velocity after $2n$ second is v_0 . The displacement of the body in last n seconds is

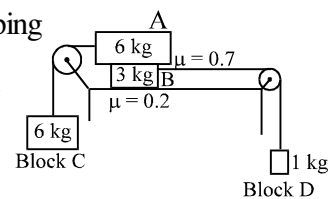
- (A) $\frac{v_0(2n-3)}{6}$ (B) $\frac{v_0}{4n}(2n-1)$ (C) $\frac{3v_0n}{4}$ (D) $\frac{3v_0n}{2}$

Q.17 An airplane pilot wants to fly from city A to city B which is 1000 km due north of city A. The speed of the plane in still air is 500 km/hr. The pilot neglects the effect of the wind and directs his plane due north and 2 hours later find himself 300km due north-east of city B. The wind velocity is

- (A) 150km/hr at 45° N of E (B) 106km/hr at 45° N of E
(C) 150 km/hr at 45° N of W (D) 106 km/hr at 45° N of W

Q.18 An arrangement of the masses and pulleys is shown in the figure. Strings connecting masses A and B with pulleys are horizontal and all pulleys and strings are light. Friction coefficient between the surface and the block B is 0.2 and between blocks A and B is 0.7. The system is released from rest (use $g = 10 \text{ m/s}^2$).

- (A) The magnitude of acceleration of the system is 2 m/s^2 and there is no slipping between block A and block B
(B) The magnitude of friction force between block A and block B is 42 N
(C) Acceleration of block C is 1 m/s^2 downwards
(D) Tension in the string connecting block B and block D is 12 N

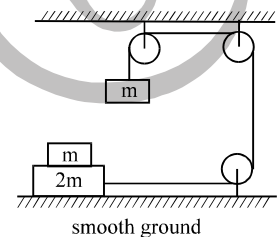


Q.19 A body of mass 2 kg is placed on a horizontal surface having kinetic friction 0.4 and static friction 0.5. If the force applied on the body is 2.5 N, the frictional force acting on the body will be ($g = 10 \text{ m/s}^2$)

- (A) 8 N (B) 10 N (C) 20 N (D) 2.5 N

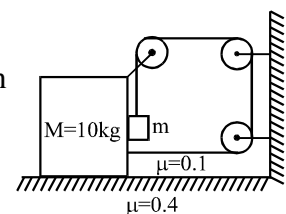
Q.20 In the arrangement shown in figure, there is friction between the blocks of masses m and $2m$ which are in contact. The ground is smooth. The mass of the suspended block is m . The block of mass m which is kept on mass $2m$ is stationary with respect to block of mass $2m$. The force of friction between m and $2m$ is (pulleys and strings are light and frictionless) :

- (A) $\frac{mg}{2}$ (B) $\frac{mg}{\sqrt{2}}$ (C) $\frac{mg}{4}$ (D) $\frac{mg}{3}$



Q.21 The maximum value of m (in kg) so that the arrangement shown in the figure is in equilibrium is given by

- (A) 2 (B) 2.5 (C) 3 (D) 3.5



Q.22 Two blocks, A and B, of same masses, are resting in equilibrium on an inclined plane having inclination with horizontal $= \alpha (>0)$. The blocks are touching each other with block B higher than A. Coefficient of static friction of A with incline $= 1.2$ and of B $= 0.8$. If motion is not imminent,

- (A) $\alpha < 30^\circ$ (B) $(\text{Friction})_A > (\text{Friction})_B$
(C) $\alpha < 45^\circ$ (D) $(\text{Friction})_A = (\text{Friction})_B$

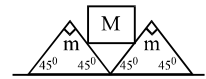
Q.23 A rope of length L and mass M is being pulled on a rough horizontal floor by a constant horizontal force $F = Mg$. The force is acting at one end of the rope in the same direction as the length of the rope. The coefficient of kinetic friction between rope and floor is $1/2$. Then, the tension at the midpoint of the rope is

- (A) $Mg/4$ (B) $2Mg/5$ (C) $Mg/8$ (D) $Mg/2$

Successful People Replace the words like; "wish", "try" & "should" with "I Will". Ineffective People don't.

- Q.24 A plank of mass 2kg and length 1 m is placed on a horizontal floor. A small block of mass 1 kg is placed on top of the plank, at its right extreme end. The coefficient of friction between plank and floor is 0.5 and that between plank and block is 0.2. If a horizontal force = 30 N starts acting on the plank to the right, the time after which the block will fall off the plank is ($g = 10 \text{ m/s}^2$)
 (A) $(2/3) \text{ s}$ (B) 1.5 s (C) 0.75 s (D) $(4/3) \text{ s}$

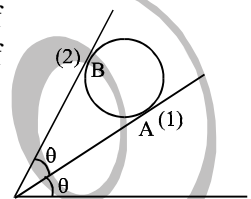
- Q.25 Two wedges, each of mass m , are placed next to each other on a flat floor. A cube of mass M is balanced on the wedges as shown. Assume no friction between the cube and the wedges, but a coefficient of static friction $\mu < 1$ between the wedges and the floor. What is the largest M that can be balanced as shown without motion of the wedges?



- (A) $\frac{m}{\sqrt{2}}$ (B) $\frac{\mu m}{\sqrt{2}}$ (C) $\frac{2\mu m}{1-\mu}$ (D) All M will balance
- Q.26 A force F acting on a particle of mass 5 kg placed on a smooth horizontal surface. $F = 40 \text{ N}$ remains constant but its vector rotates in a vertical plane at an angular speed 2 rad/sec . If at $t = 0$, vector F is horizontal, find the velocity of block at $t = \pi/4\omega \text{ sec}$.

- (A) 1 m/s (B) $\sqrt{2} \text{ m/s}$ (C) 2 m/s (D) $2\sqrt{2} \text{ m/s}$

- Q.27 A sphere of mass m is kept between two inclined walls, as shown in the figure. If the coefficient of friction between each wall and the sphere is zero, then the ratio of normal reaction (N_1/N_2) offered by the walls 1 and 2 on the sphere will be



- (A) $\tan\theta$ (B) $\tan 2\theta$
 (C) $2\cos\theta$ (D) $\cos 2\theta$

- Q.28 A particle is projected horizontally from the top of a tower with a velocity v_0 . If v be its velocity at any instant, then the radius of curvature of the path of the particle at the point (where the particle is at that instant) is directly proportional to:

- (A) v^3 (B) v^2 (C) v (D) $1/v$

- Q.29 There are two massless springs A and B of spring constant K_A and K_B respectively and $K_A > K_B$. If W_A and W_B be denoted as work done on A and work done on B respectively, then

- (A) If they are compressed to same distance, $W_A > W_B$
 (B) If they are compressed by same force (upto equilibrium state) $W_A < W_B$
 (C) If they are compressed by same distance, $W_A = W_B$
 (D) If they are compressed by same force (upto equilibrium state) $W_A > W_B$

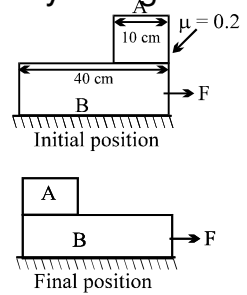
- Q.30 A uniform chain of length L and mass M is lying on a smooth table and one third of its length is hanging vertically down over the edge of the table. If g is acceleration due to gravity, the work required to pull the hanging part on to the table is

- (A) mgL (B) $\frac{mgL}{3}$ (C) $\frac{mgL}{9}$ (D) $\frac{mgL}{18}$

- Q.31 Power delivered to a body varies as $P = 3t^2$. Find out the change in kinetic energy of the body from $t = 2$ to $t = 4 \text{ sec}$.

- (A) 12 J (B) 56 J (C) 24 J (D) 36 J

Q.32 A block 'A' of mass 45 kg is placed on a block 'B' of mass 123 kg. Now block 'B' is displaced by external agent by 50 cm horizontally towards right. During the same time block 'A' just reaches to the left end of block B. Initial & final position are shown in figure. Refer to the figure & find the workdone by frictional force on block A in ground frame during above time.



- (A) - 18 Nm (B) 18 Nm (C) 36 Nm (D) - 36 Nm

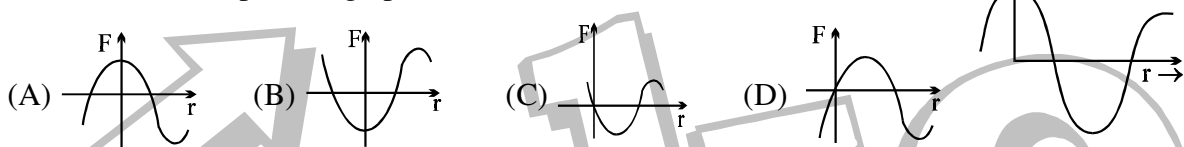
Q.33 A spring of force constant k is cut in two part at its one third length. when both the parts are stretched by same amount. The work done in the two parts, will be

- (A) equal in both (B) greater for the longer part
(C) greater for the shorter part (D) data insufficient.

Q.34 The horsepower of a pump of efficiency 80%, which sucks up water from 10 m below ground and ejects it through a pipe opening at ground level of area 2 cm² with a velocity of 10 m/s, is about

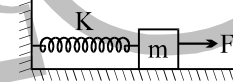
- (A) 1.0 hp (B) 0.5 hp (C) 0.75 hp (D) 4.5 hp

Q.35 Potential energy and position for a conservative force are plotted in graph shown. Then force position graph can be



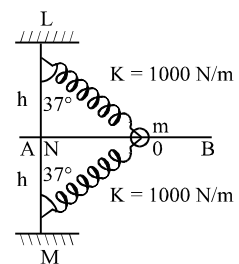
Q.36 A constant force produces maximum velocity V on the block connected to the spring of force constant K as shown in the fig. When the force constant of spring becomes 4K, the maximum velocity of the block is

- (A) $\frac{V}{4}$ (B) 2V (C) $\frac{V}{2}$ (D) V



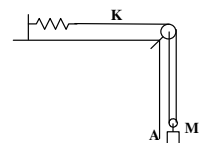
Q.37 A bead of mass 5kg is free to slide on the horizontal rod AB. They are connected to two identical springs of natural length h ms. as shown. If initially bead was at O & M is vertically below L then, velocity of bead at point N will be

- (A) 5h m/s (B) $40h/3$ m/s
(C) 8h m/s (D) none of these



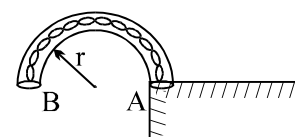
Q.38 Block A in the figure is released from rest when the extension in the spring is x_0 . The maximum downwards displacement of the block is

- (A) $\frac{Mg}{2K} - x_0$ (B) $\frac{Mg}{2K} + x_0$ (C) $\frac{2Mg}{K} - x_0$ (D) $\frac{2Mg}{K} + x_0$



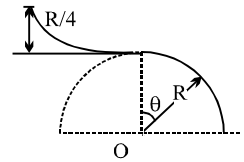
Q.39 A smooth semicircular tube AB of radius r is fixed in a vertical plane and contains a heavy flexible chain of length πr and weight $W = \pi r$ as shown. Assuming a slight disturbance to start the chain in motion, the velocity v with which it will emerge from the open end B of the tube is

- (A) $\frac{4gr}{\pi}$ (B) $\frac{2gr}{\pi}$ (C) $\sqrt{2gr\left(\frac{2}{\pi} + \pi\right)}$ (D) $\sqrt{2gr\left(\frac{2}{\pi} + \frac{\pi}{2}\right)}$



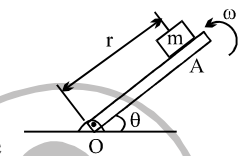
- Q.40 A heavy particle hanging from a string of length l is projected horizontally with speed \sqrt{gl} . The speed of the particle at the point where the tension in the string equals weight of the particle is:
 (A) $\sqrt{2gl}$ (B) $\sqrt{3gl}$ (C) $\sqrt{gl/2}$ (D) $\sqrt{gl/3}$

- Q.41 A skier plans to ski a smooth fixed hemisphere of radius R . He starts from rest from a curved smooth surface of height $(R/4)$. The angle θ at which he leaves the hemisphere is
 (A) $\cos^{-1}(2/3)$ (B) $\cos^{-1}(5/\sqrt{3})$
 (C) $\cos^{-1}(5/6)$ (D) $\cos^{-1}(5/2\sqrt{3})$

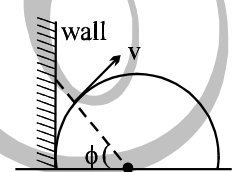


- Q.42 A simple pendulum swings with angular amplitude θ . The tension in the string when it is vertical is twice the tension in its extreme position. Then, $\cos \theta$ is equal to
 (A) $1/3$ (B) $1/2$ (C) $2/3$ (D) $3/4$

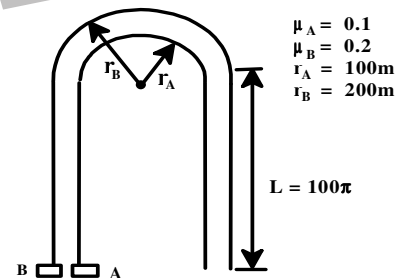
- Q.43 The inclined plane OA rotates in vertical plane about a horizontal axis through O with a constant counter clockwise velocity $\omega = 3$ rad/sec. As it passes the position $\theta = 0$, a small mass $m = 1$ kg is placed upon it at a radial distance $r = 0.5$ m. If the mass is observed to be at rest with respect to inclined plane. The value of static friction force at $\theta = 37^\circ$ between the mass & the incline plane.
 (A) 1.5 N (B) 3.5 N (C) 2.4 N (D) none



- Q.44 On a particle moving on a circular path with a constant speed v , light is thrown from a projector placed at the centre of the circular path. The shadow of the particle is formed on the wall. the velocity of shadow up the wall is
 (A) $v \sec^2 \phi$ (B) $v \cos^2 \phi$ (C) $(A) v \cos \phi$ (D) none

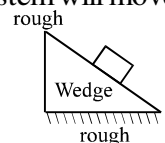


- Q.45 Two cars A and B start racing at the same time on a flat race track which consists of two straight sections each of length 100π and one circular section as in Fig. The rule of the race is that each car must travel at constant speed at all times without ever skidding
 (A) car A completes its journey before car B
 (B) both cars complete their journey in same time
 (C) velocity of car A is greater than that of car B
 (D) car B completes its journey before car A.



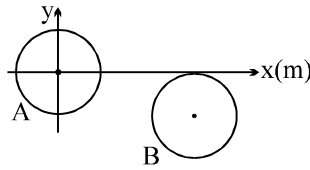
- Q.46 A horizontal curve on a racing track is banked at a 45° angle. When a vehicle goes around this curve at the curve's safe speed (no friction needed to stay on the track), what is its centripetal acceleration?
 (A) g (B) $2g$ (C) $0.5g$ (D) none

- Q.47 When a block is placed on a wedge as shown in figure, the block starts sliding down and the wedge also start sliding on ground. All surfaces are rough. The centre of mass of (wedge + block) system will move
 (A) leftward and downward (B) rightward and downward
 (C) leftward and upward (D) only downward



Question No. 48 to 50 (3 questions)

Two smooth balls A and B, each of mass m and radius R , have their centres at $(0,0,R)$ and at $(5R,-R,R)$ respectively, in a coordinate system as shown. Ball A, moving along positive x axis, collides with ball B. Just before the collision, speed of ball A is 4 m/s and ball B is stationary. The collision between the balls is elastic.



- Q.48 Velocity of the ball A just after the collision is
 (A) $(i + \sqrt{3}j)$ m/s (B) $(i - \sqrt{3}j)$ m/s (C) $(2i + \sqrt{3}j)$ m/s (D) $(2i + 2j)$ m/s
- Q.49 Impulse of the force exerted by A on B during the collision, is equal to
 (A) $(\sqrt{3}mi + 3mj)$ kg-m/s (B) $(\frac{\sqrt{3}}{2}mi - \sqrt{3}mj)$ kg-m/s
 (C) $(3mi - \sqrt{3}mj)$ kg-m/s (D) $(2\sqrt{3}mi + 3mj)$ kg-m/s
- Q.50 Coefficient of restitution during the collision is changed to $1/2$, keeping all other parameters unchanged. What is the velocity of the ball B after the collision?
 (A) $\frac{1}{2}(3\sqrt{3}i + 9j)$ m/s (B) $\frac{1}{4}(9i - 3\sqrt{3}j)$ m/s (C) $(6i + 3\sqrt{3}j)$ m/s (D) $(6i - 3\sqrt{3}j)$ m/s
- Q.51 A particle of mass $m = 0.1$ kg is released from rest from a point A of a wedge of mass $M = 2.4$ kg free to slide on a frictionless horizontal plane. The particle slides down the smooth face AB of the wedge. When the velocity of the wedge is 0.2 m/s the velocity of the particle in m/s relative to the wedge is:
 (A) 4.8 (B) 5 (C) 7.5 (D) 10
-
- Q.52 A bullet of mass 0.01 kg and travelling at a speed of 500 m/s strike a block of mass of 2 kg which is suspended by a string of length 5 m. The centre of gravity of the block is found to rise a vertical distance of 0.1 m. What is the speed of the bullet after it merge from the block:
 (A) 780 m/s (B) 220 m/s (C) 1.4 m/s (D) 7.8 m/s
- Q.53 A ball is dropped from a height h . As it bounces off the floor, its speed is 80 percent of what it was just before it hit the floor. The ball will then rise to a height of most nearly
 (A) $0.80 h$ (B) $0.75 h$ (C) $0.64 h$ (D) $0.50 h$
- Q.54 In a one-dimensional collision, a particle of mass $2m$ collides with a particle of mass m at rest. If the particles stick together after the collision, what fraction of the initial kinetic energy is lost in the collision?
 (A) $\frac{1}{4}$ (B) $\frac{1}{3}$ (C) $\frac{1}{2}$ (D) none
- Q.55 A particle is projected from ground towards a vertical wall 80 m away at an angle of 37° with horizontal with initial velocity of 50 m/s. After its collision with wall & then once with ground find at what distance from wall will it strike the ground again if coefficient of restitution for both collisions is equal to $1/2$.
 (A) 70 m (B) 120 m (C) 140 m (D) none

Successful People Replace the words like; "wish", "try" & "should" with "I Will". Ineffective People don't.

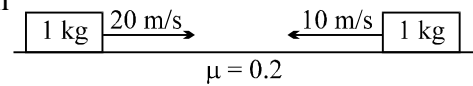
Question No.56 to 57 (2 questions)

A projectile of mass "m" is projected from ground with a speed of 50 m/s at an angle of 53° with the horizontal. It breaks up into two equal parts at the highest point of the trajectory. One particle coming to rest immediately after the explosion.

- Q.56 The ratio of the radii of curvatures of the moving particle just before and just after the explosion are:
 (A) 1 : 4 (B) 1 : 3 (C) 2 : 3 (D) 4 : 9
- Q.57 The distance between the pieces of the projectile when they reach the ground are:
 (A) 240 (B) 360 (C) 120 (D) none

Question No. 58 & 59 (2 Questions)

Two blocks (from very far apart) are approaching towards each other with velocities as shown in figure. The coefficient of friction for both the blocks is $\mu = 0.2$



- Q.58 Linear momentum of the system is
 (A) conserved all the time (B) never conserved
 (C) is conserved upto 5 seconds (D) none of these
- Q.59 How much distance will centre of mass travel before coming permanently to rest
 (A) 25 m (B) 37.5 m
 (C) 42.5 m (D) 50 m
- Q.60 From a thin circular disc of radius R, a circular hole of radius $4R/5$ is cut as shown. The distance of the centre of mass of remaining disc, from the centre of the original disc is
 (A) $15R/40$ (B) $R/3$
 (C) $R/4$ (D) $16R/45$

