Q-1 - 17091563

If a man of ,mass M jumps to the ground from a height h and his centre of mass noves a distance x in the time taken by him to 'hit' the ground the average force acting on him (assuming his retardation to be constant during his impact with the ground) is :

(A) Mgh/x

(B) Mgx/h

(C) $Mg(h/x)^2$

(D) $Mg(x/h)^2$

CORRECT ANSWER: A

Q-2 - 18710347

The potential energy function for the force between two atoms in a diatomic molecule is approximately given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$ where a and b are constant and x is the distance between the atoms. Find the dissoociation energy of the molecule which is given as $D = [U(x - \infty) - U_{atequilibrium}]$

Q-3 - 15822114

Work done in time t on a body of mass m which is accelerated from rest to a speed v in time t_1 as a function of time t is given b

(A) $\frac{1}{2}m\frac{v}{t_1}t^2$

(B) $m\frac{v}{t_1}t^2$

(C) $\frac{1}{2}\left(\frac{mv}{t_1}\right)^2 t^2$

(D) $\frac{1}{2}m\frac{v^2}{t_1^2}t^2$

CORRECT ANSWER: D

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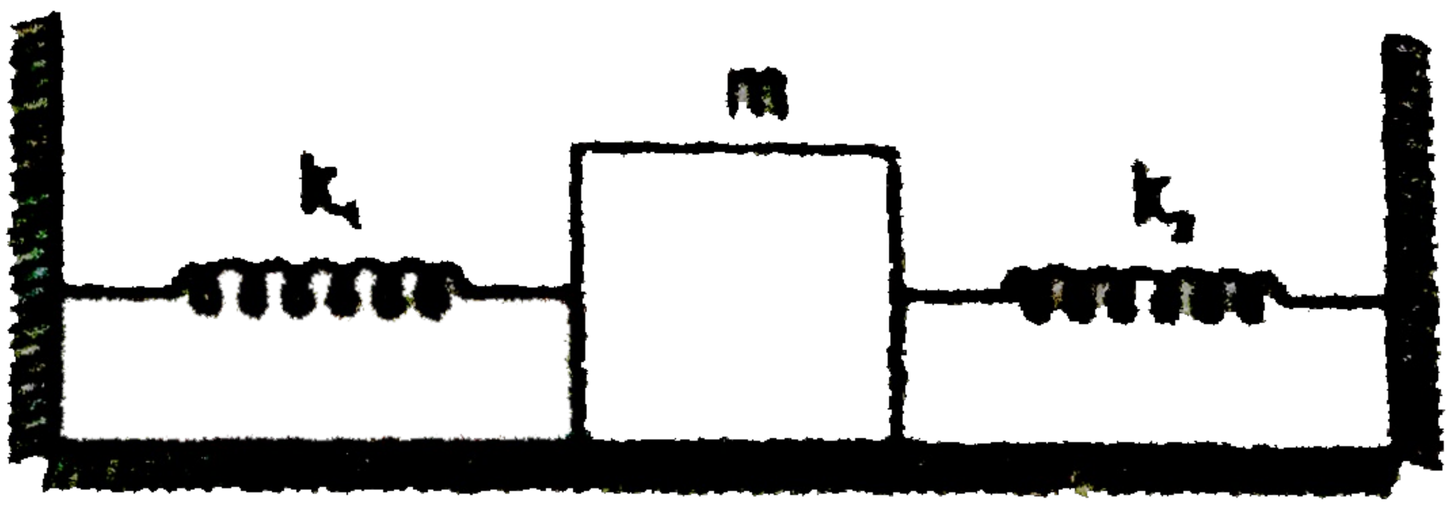
Q-4 - 14527358

A block of mass m is attached to two unstretched springs of springs constant k_1 and k_2 as shown in figure. The block is displaced towards right through a distance x and is released. Find the speed of the block as it passes through the mean position shown.



(A) $\sqrt{\dfrac{k_1+k_2}{m}}x$

(B) $\sqrt{\dfrac{k_1k_2}{m(k_1+k_2)}}x$

(C) $\sqrt{\dfrac{k_1^2k_2^2}{m(k_1^2+k_2^2)}}x$

(D) $\sqrt{\dfrac{k_1^3k_2^3}{m(k_1^3+k_2^3)}}$

CORRECT ANSWER: A

SOLUTION:

$$\frac{1}{2}K_2x^2+\frac{1}{2}K_1x^2$$
$$=\frac{1}{2}mv^2$$

$$v=\sqrt{\frac{K_1+K_2}{m}}x$$

Q-5 - 17458622

Suppose y represents the work done and x the power, then dimensions of $\frac{d^2y}{dx^2}$ will be

(A) $[M^{-1}L^{-2}T^4]$

(B) $[M^2L^{-3}T^{-2}]$

(C) $[M^{-2}L^{-4}T^4]$

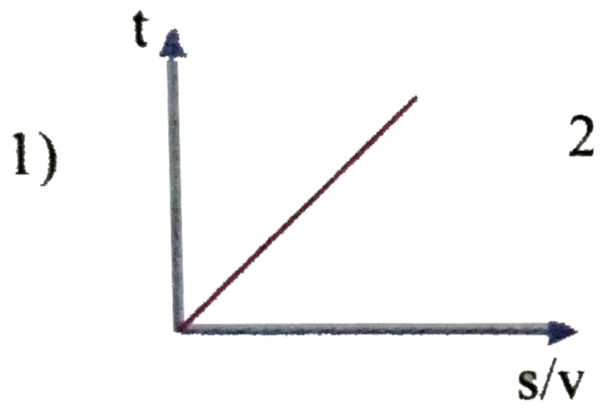
(D) $[ML^3T^{-6}]$

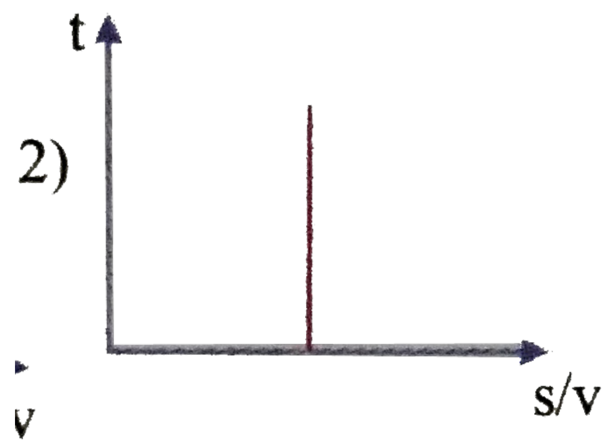
CORRECT ANSWER: A

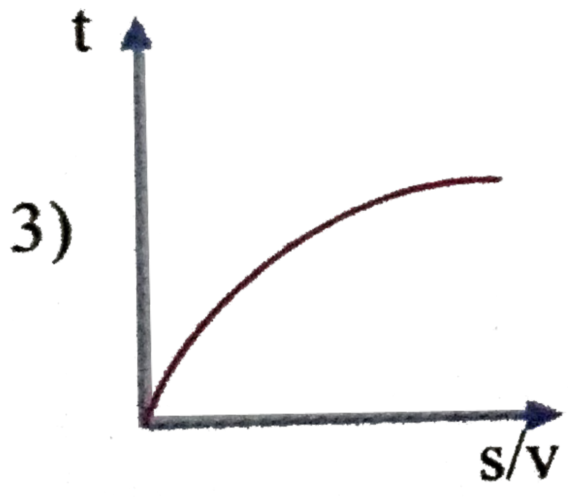
Q-6 - 13398769

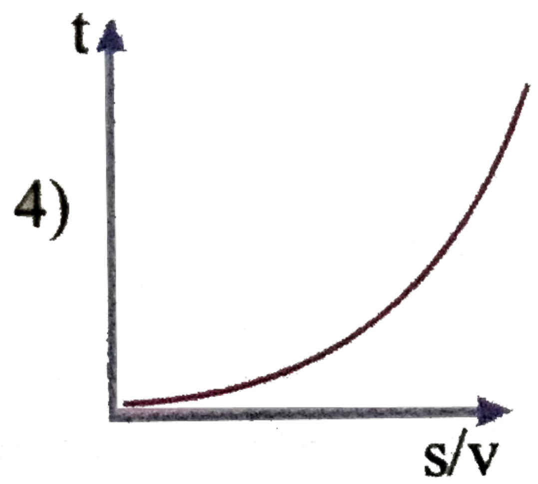
A body is moved from rest along a straight line by a machine delivering constant power. The ratio of displacement and velocity

$(s\,/\,v)$ varies with time t as

(A) 

(B) 

(C) 

(D) 

CORRECT ANSWER: A

SOLUTION:

$$w = \Delta K.E \Rightarrow Pt$$
$$= \frac{1}{2}mv^2, v = \sqrt{\frac{2Pt}{m}}$$

$$\frac{ds}{dt} = \sqrt{\frac{2P}{m}}t^{1/2}.$$

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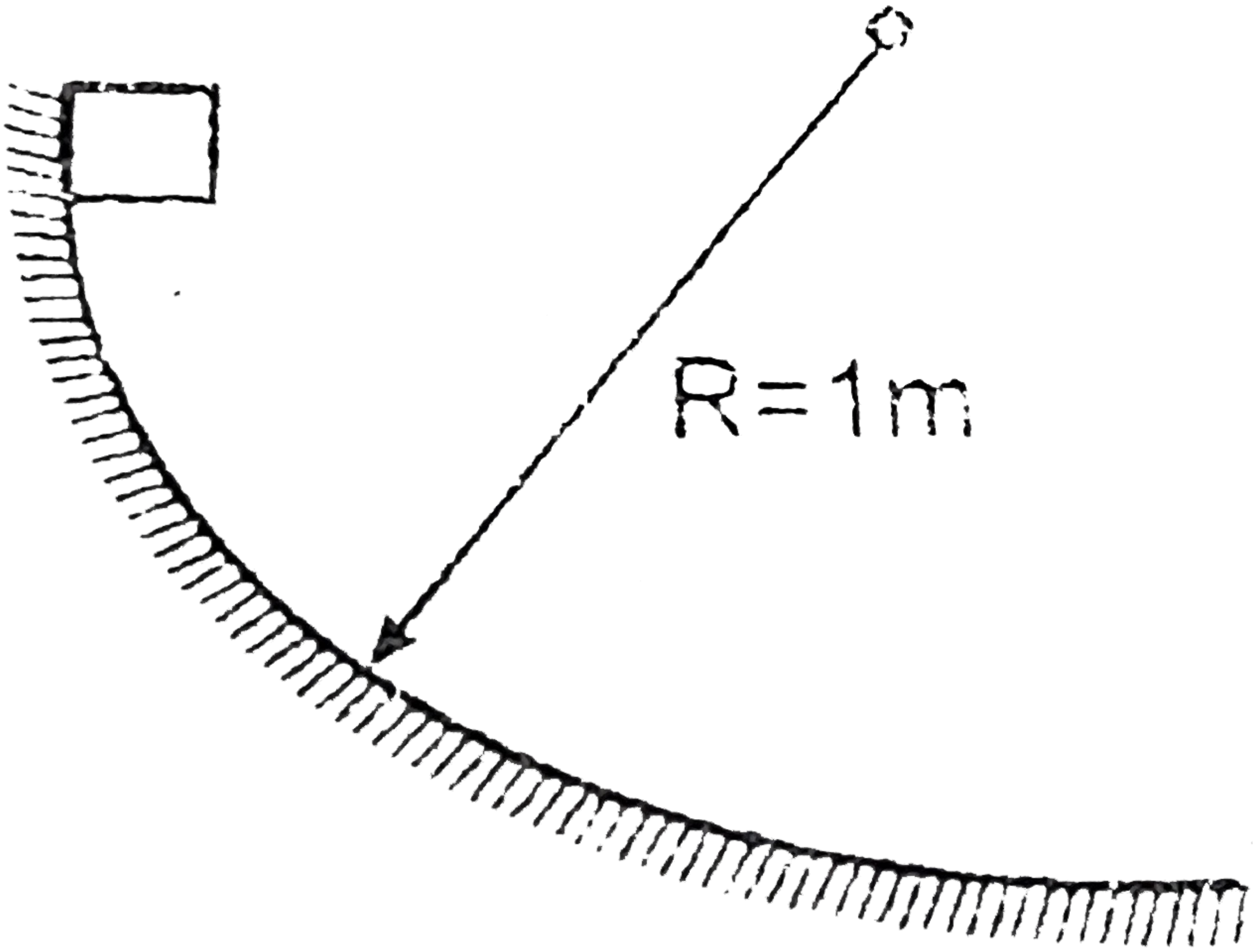
Q-7 - 14279581

A block of mass 1 kg slides down a vertical curved track that is one quadrant of a circle of radius 1m. Its speed ast the the bottom si $2m/s$. The work done by frictional force is :



(A) $8J$

(B) $-8J$

(C) $4J$

(D) $-4J$

CORRECT ANSWER: B

SOLUTION:

$$mg1 + W_k = \frac{1}{2}(M)2_2$$
$$= 0$$

$$W_{fk} = 2 - 10.$$

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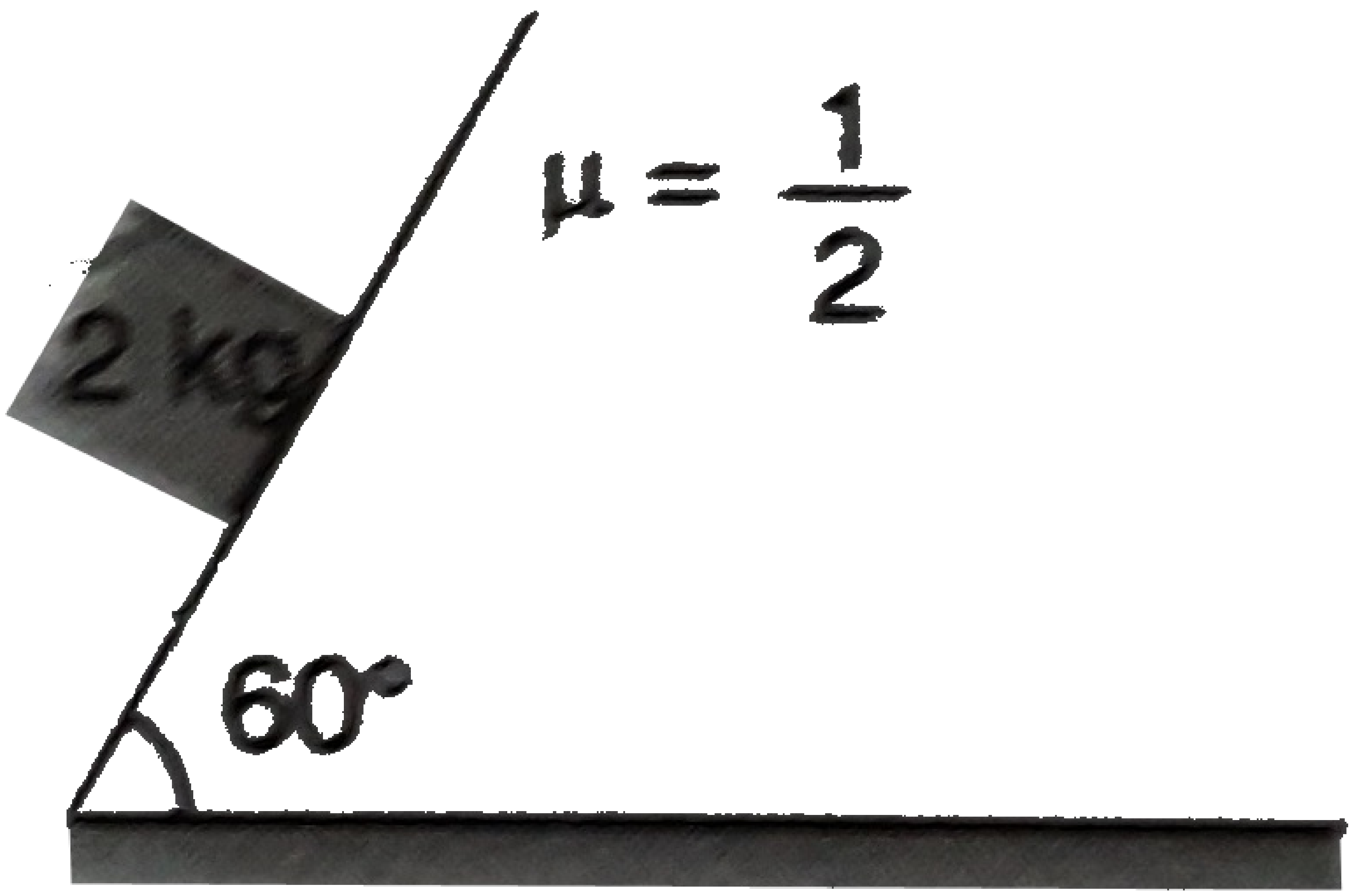
Q-8 - 10956184

A block of mass $2kg$ is released from rest on a rough inclined ground as shown in figure. Find the work done on the block by.



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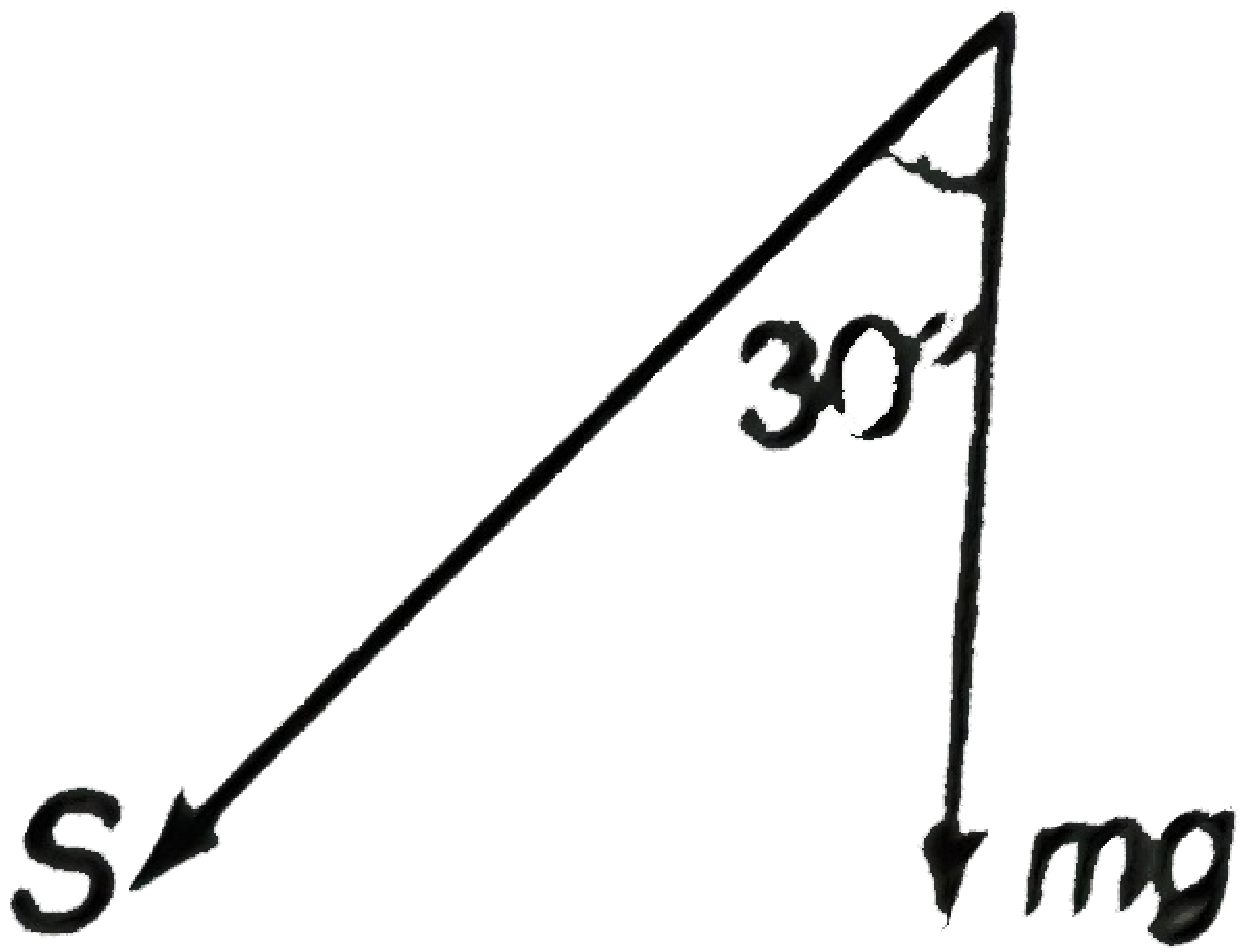
(Take $g10m / s^2$).

CORRECT ANSWER: A::B::C::D

SOLUTION:

$$W_{mg} = (mg)(S)\cos 30$$
$$= (20)(2)\left(\sqrt{3/2}\right)$$
$$= 34.6J$$



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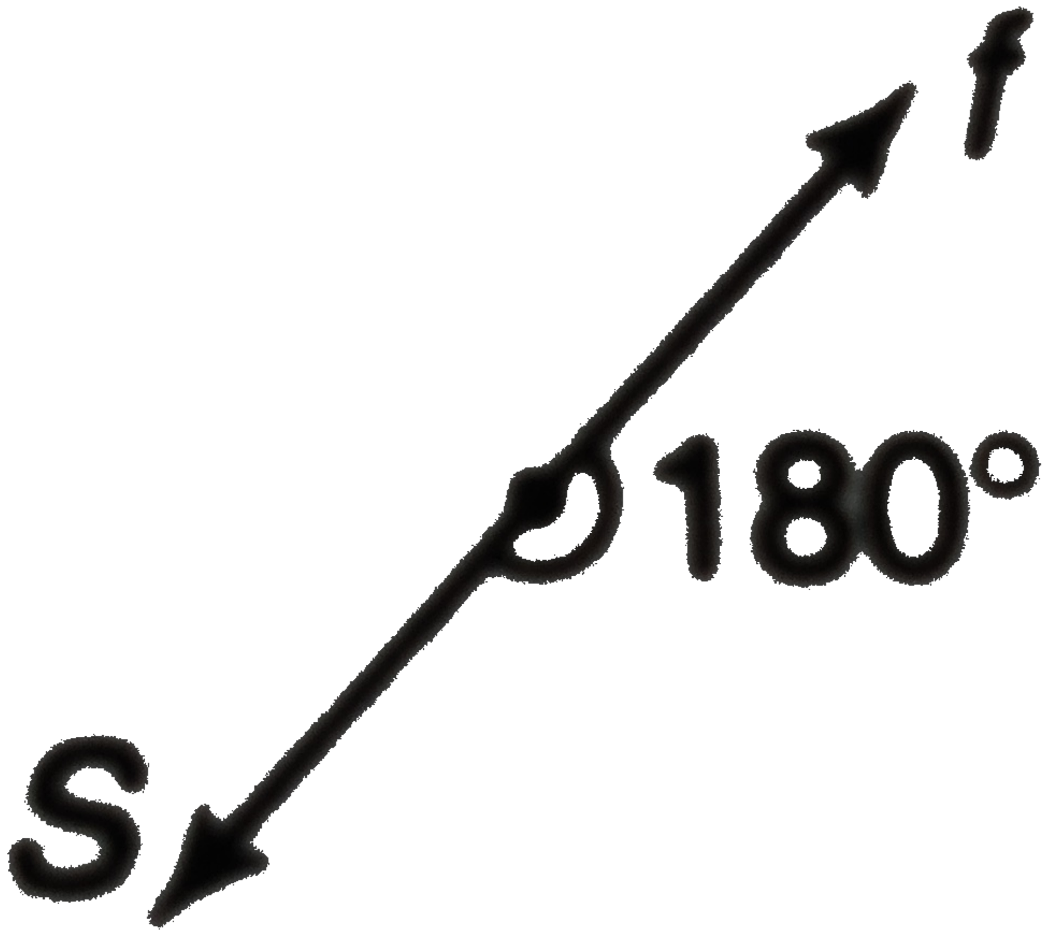
(b) $W_f S\cos 180$
$$= (\mu mg\cos\theta)(S)(-1)$$



$$= -\left(\frac{1}{2}\right)(20)\left(\cos 60^{\square}\right)(2)$$

$$= -10J.$$

Q-9 - 11297829

The potential energy of a particle is determined by the expression $U = \alpha\left(x^2 + y^2\right)$, where α is a positive constant. The particle begins to move from a point with coordinates $(3, 3)$, only under the action of potential field force. Then its kinetic energy T at the instant when the particle is at a point with the coordinates $(1, 1)$ is

(A) (a) 8α

(B) (b) 24α

(C) (c) 16α

(D) (d) Zero

CORRECT ANSWER: C

SOLUTION:

As the particle moves only under the action of conservative force, its mechanical energy must be conserved. So

$\Delta T + \Delta U = 0$ (T stands for kinetic energy)

or

$\Delta T = -\Delta U = U_i - U_f$

$= \alpha(3^2 + 3^2) - \alpha(1^2 + 1^2) = 16\alpha$

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Q-10 - 11746564

A body of mass m is moving in a circle of radius r with a constant speed v, The force on the body is $\frac{mv^2}{r}$ and is directed towards the centre what is the work done by the from in moving the body over half the circumference of the circle?

(A) $\frac{mv^2}{\pi r^2}$

(B) zero

(C) $\frac{mv^2}{r^2}$

(D) $\dfrac{\pi r^2}{mv^2}$

CORRECT ANSWER: B

SOLUTION:

Work done by centripetal force is alwase zero because force and instantaneous displacement are always perpendicular

$$W = \overrightarrow{F} - \overrightarrow{S}$$
$$= Fs\cos\theta s\cos(90)$$
$$= 0$$

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Q-11 - 17458619

A uniform flexible chain of mass m and length 2l hangs in equilibrium over a smooth horizontal pin of negligible diameter. One end of the chain is given a small vertical displacement so that the chain slips over the pin. The speed of chain when it leaves the pin is

(A) $\sqrt{2gl}$

(B) $\sqrt{gl}$

(C) $\sqrt{4gl}$

(D) $\sqrt{3gl}$

CORRECT ANSWER: B

Q-12 - 11297801

The potential energy of a particle of mass m free to move along the x-axis is given by $U = (1/2)kx^2$ for $x < 0$ and $U = 0$ for $x \geq 0$ (x denotes the x-coordinate of the particle and k is a positive constant). If the total mechanical energy of the particle is E, then its speed at $x = -\sqrt{2E/k}$ is

(A) (a) Zero

(B) (b) $\sqrt{\frac{2E}{m}}$

(C) (c) $\sqrt{\frac{E}{m}}$

(D) (d) $\sqrt{\frac{3E}{2m}}$

CORRECT ANSWER: A

SOLUTION:

From the conservation of energy

$KE + PE = E$ or $KE = E - \frac{1}{2}kx^2$

KE at $x = -\sqrt{\frac{2E}{k}}$ is $E - \frac{1}{2}k\left(\frac{2E}{k}\right) = 0$

The speed of particle at $x = -\sqrt{\frac{2E}{k}}$ is zero.

Q-13 - 11746581

A mass M is lowered with the help of a string by a distance h at a constant acceleration $g/2$ .The work done by the string will be :

(A) $\frac{Mgh}{2}$

(B) $-\frac{Mgh}{2}$

(C) $\frac{3Mgh}{2}$

(D) $-\frac{Mgh}{2}$

CORRECT ANSWER: B

SOLUTION:

Tension in the string :

$$T = M(g - a)$$

$$= M(g - g/2) = Mg/2$$

$W = F \text{ or } ce$
$\times Displacement =$
$- M(g/2)h$

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Q-14 - 11746601

Is the work required to be done by an external force on an object on a frictionless , horizontal surface to accelerate it from a speed v to a speed $2y$

(A) equal to the work required to accelerate the object from $t = 0$ to v.

(B) twice the work required to accelerate the object from $v = 0$ to v.

(C) three time the work required to accelerate the object from $v = 0$ to v.

(D) four time the work required to accelerate the object from 0 to v. Or

---

CORRECT ANSWER: C

SOLUTION:

The net work needed to accelerate the object from

$v = 0$ to v is

$$W_1 = KE_{1f} - KE_{1i}$$
$$= \frac{1}{2}mv^2 - \frac{1}{2}m(0)^2$$
$$= \frac{1}{2}mv^2$$

The work required to accelerate the object from speed v

to speed $2v$ is

$$W_2 = KE_{2f} - KE_{2i}$$
$$= \frac{1}{2}m(2v)^2 - \frac{1}{2}mv^2$$

$$= \frac{1}{2}m(4v^2 - v^2)$$

$$= 3\left(\frac{1}{2}mv^2\right) = 3W_1$$

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Q-15 - 15085061

A particle is moving on a straight line and all the forces acting on it produce a constant power P calculate the distance travelled by the particle in the interval its speed increase from V to 2V.

CORRECT ANSWER: $X = \frac{7MV^3}{3P}$

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Q-16 - 9519343

A particle of mass m moves on a straight line with its velocity varying with the distance travelled according to the equation

$v = a\sqrt{x}$, wher ea is a constant. Find the total work done by all the forces during a displacement from $x = 0 \rightarrow x = d$.

CORRECT ANSWER: A::B::D

SOLUTION:

Given
v
$= a\sqrt{x(un \quad \text{if} \quad \text{or} \ mlyae \leq ratedmotion)}$

dispacement $s = d - 0 = d$
$pu \in gx = 0, v_1 = 0,$
$v_2 = a\sqrt{d}$

$$a = \frac{v_2^2 - v_1^2}{2S} = \frac{a^2 d}{2d}$$
$$= \frac{a^2}{2}$$

forfe $F = ma = \frac{ma^2}{2}$

Work done $w = Fs\cos\theta$

$$= \frac{ma^2}{2} \times d = \frac{ma^2 d}{2}$$

Q-17 - 18710318

A force varying with distance is given as $F = ae^{-bx}$ acts on a particle of mass m moving in a straight line. Find the work done on the particle in its displacement from origin to a distance d.

Q-18 - 11747864

A vertical spring with force constant k is fixed on a table. A ball of mass m at a height h above the free upper end of the spring falls vertically on the spring , so that the spring is compressed by a distance d. The net work done in the process is

(A) $mg(h+d)+\frac{1}{2}kd^2$

(B) $mg(h+d)-\frac{1}{2}kd^2$

(C) $mg(h-d)-\frac{1}{2}kd^2$

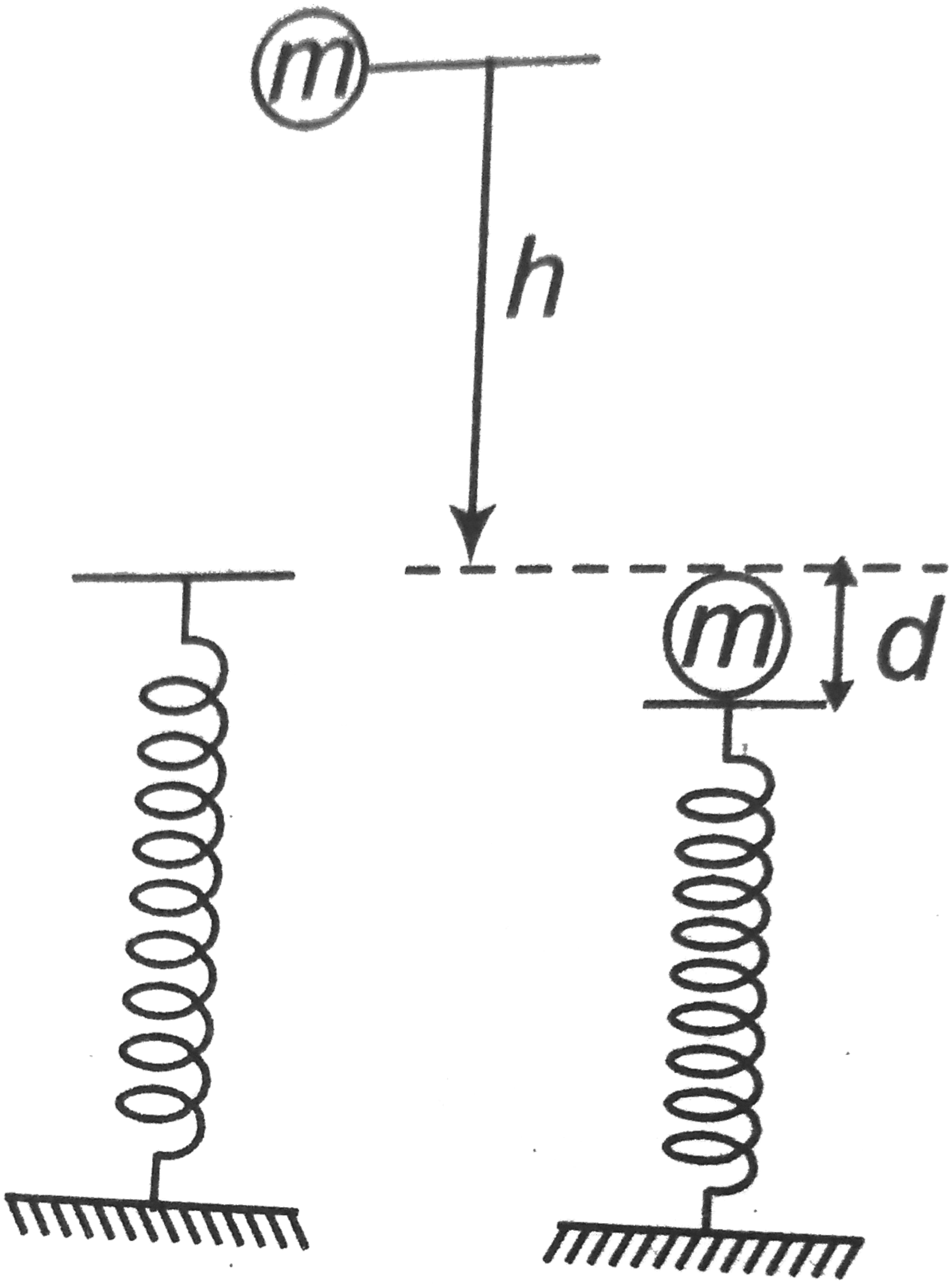
(D) $mg(h-d)+\frac{1}{2}kd^2$

SOLUTION:

Work done is equal to change in energy of body.

Situation is done in the figure. When mass m falls vertically on spring then spring is compresed by distance d.

Hence net work done in the process is



$W =$ Potential energy stored in the spring

$+$ Loss of potential energy

$$= mg(h + d) - \frac{1}{2}kd^2$$

Q-19 - 18710662

The resistance to motion of an automobile depends on road friction, which is almost independent of speed, and on air drag, which is proportional to speed squared. For a car with a weight of 12000 N, the total resistance force F is given by $F = 300 + 1.8v^2$ where F is in newtons and v is in meters per second. Calculate the power required to accelerate the car at $0.92m / s^2$ when the speed is 80 kph

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CORRECT ANSWER: A

Q-20 - 11746631

A shell esplodes and many pieces fly off in different direction , directions.Which of the following is conserved?

(A) kinetic energy

(B) Momentum

(C) Neither momentum nor KE

(D) Momentum and KE

CORRECT ANSWER: B

SOLUTION:

Because during explosion of shell .$F_{ext} = 0$ hence

according to law of coservation of momentum

$\overrightarrow{p}_{system} = \text{ constant}$

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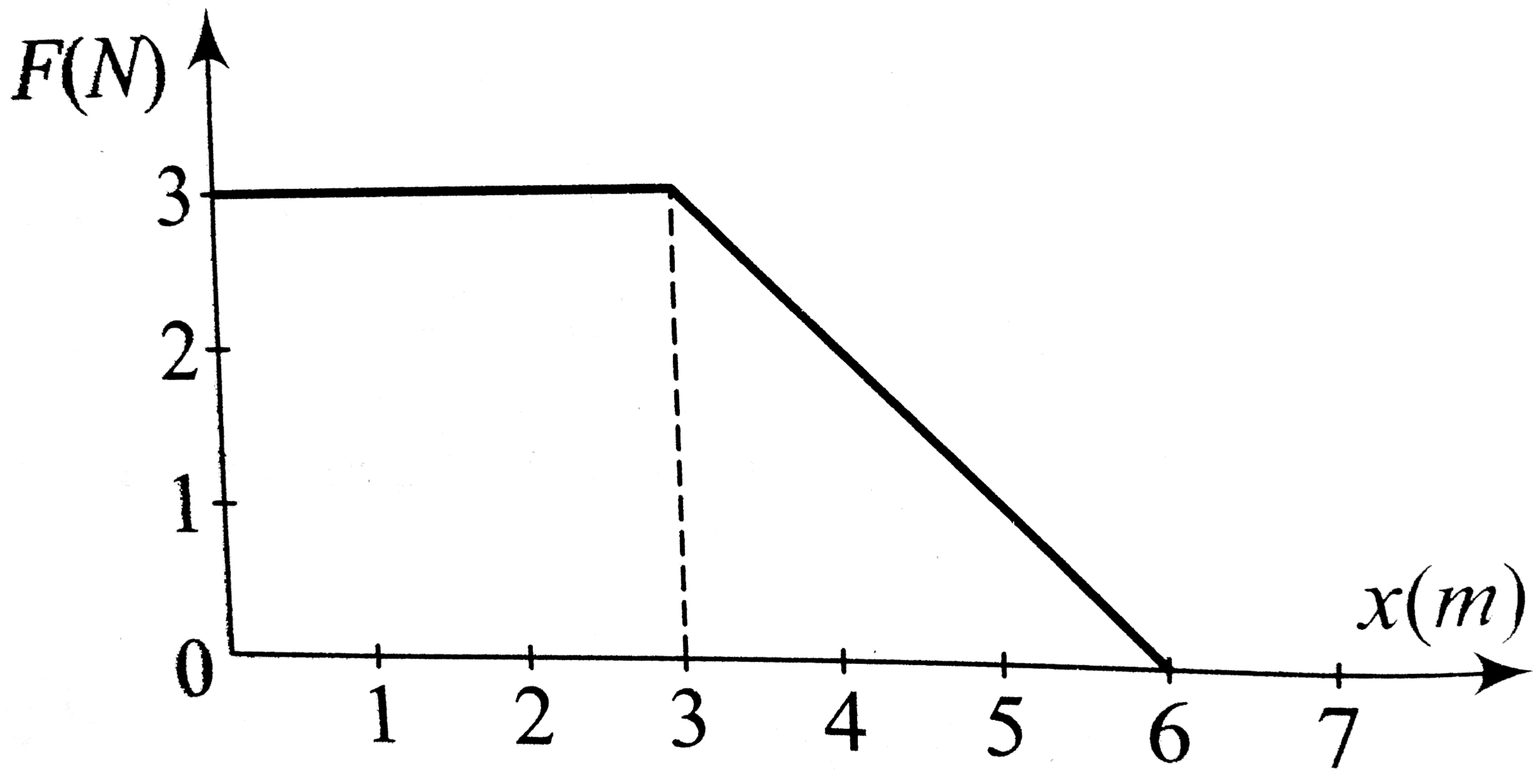
Q-21 - 11747860

A Force F acting on an object varies with distance x as shown in the here . The force is in newton and x in metre. The work done by the force in moving the object from $x = 0$ to $x = 6m$ is



(A) $4.5J$

(B) $13.5J$

(C) $9.0J$

(D) $18.0J$

SOLUTION:

Work done = Area enclosed by $F - x$ graph

$$= \frac{1}{2} \times (3 + 6) \times 3$$

$$= 13.5J$$

Q-22 - 11300782

A body of mass $1kg$ initially at rest, explodes and breaks into three fragments of masses in the ratio $1:1:3$. The two pieces of equal mass fly off perpendicular to each other with a speed of $15ms^{-1}$ each. What is the velocity of the heavier fragment?

(A) $10\sqrt{m}s^{-1}$

(B) $5\sqrt{3}ms^{-1}$

(C) $10\sqrt{3}ms^{-1}$

(D) $5\sqrt{2}ms^{-1}$

CORRECT ANSWER: D

SOLUTION:

Conservation of momentum during explosion yields

$$\Rightarrow \overrightarrow{P}_1 + \overrightarrow{P}_2 + \overrightarrow{P}_3 = 0 \Rightarrow \overrightarrow{P}_3 = \left|\overrightarrow{P}_1 + \overrightarrow{P}_2\right|$$

$$\Rightarrow m_3 \overrightarrow{v}_3 = \left|m_1 \overrightarrow{v}_1 + m_2 \overrightarrow{v}_2\right|$$

since

$$\overrightarrow{v}_1 \perp \overrightarrow{v}_2 \Rightarrow \overrightarrow{v}_3 = \sqrt{\frac{m_1^2 v_1^2 + m_2^2 v_2^2}{m_3}}$$

$$\Rightarrow \overrightarrow{v}_3 = \sqrt{\left(\frac{m_1}{m_3}\right)^2 + v_1^2 + \left(\frac{m_2}{m_3}\right)^2 v_2^2}$$

$$\Rightarrow \sqrt{\left(\frac{1}{3}\right)^2 (15)^2 + \left(\frac{1}{3}\right)^2 (15)^2} \quad (\because m_1, m_2 : m_3 = 1 : 1 : 3)$$

$$\Rightarrow v_3 = 5\sqrt{2} m s^{-1}$$

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Q-23 - 15084883

A ball is projected vertically up from the floor of a room. The ball experiences air resistance that is proportional to speed of the ball. Just before hitting the ceiling the speed of the ball is 10 m/s and its retardation is 2g. The ball rebounds from the ceiling without any loss of speed and falls on the floor 2s after making impact with the ceiling. How high is the ceiling? Take $g = 10 m / s^2$.

CORRECT ANSWER: 20 M

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Q-24 - 17458602

A ball is released from the top of a tower. The ratio of work done by force of gravity in 1st second, 2nd second and 3rd second of the motion of ball is

(A) $1:2:3$

(B) $1:4:16$

(C) $1:3:5$

(D) $1:9:25$

CORRECT ANSWER: C

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Q-25 - 15085072

A particle of mass m = 100 g is projected vertically up with a kinetic energy of 20 J form a position where its gravitational potential energy is 50 J. Find the maximum height to which the particle will rise above its point of projection. $[g = 10m/s^2]$

CORRECT ANSWER: 20 M

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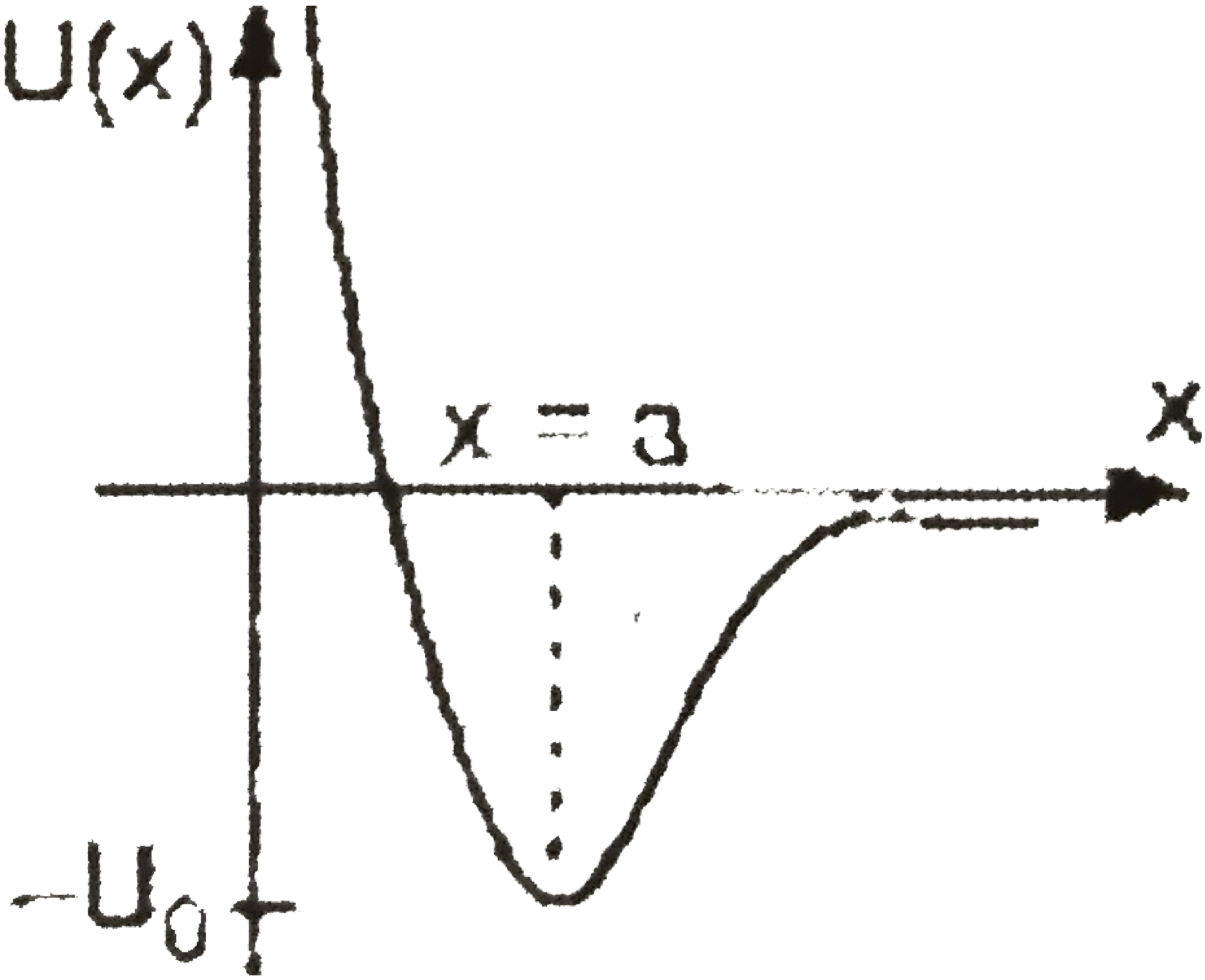
Q-26 - 16968551

The force between two atoms in a diatomic molecule can be represented approaximately by the potential energy function

$$U = U_0\left[\left(\frac{a}{x}\right)^{12} - 2\left(\frac{a}{x}\right)^6\right]$$

where U_0 and a are constant (a) At what value of x is the potential energy zero ?

(b) Fidn teh force F_x. (c) At what value of X is the potential energy a minmum ?



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Q-27 - 15599819

A body of mass (4m) is laying in xy-plane at rest. It suddenly explodes into three pieces. Two pieces each mass (m) move perpedicular to each other with equal speeds (v). Total kinetic energy generated due to explosion is

(A) mv^2

(B) $\frac{3}{2}mv^2$

(C) $2mv^2$

(D) $4mv^2$

CORRECT ANSWER: B

Q-28 - 13398695

A rubber ball falling from a height of $5m$ rebounds from hard floor to a height of $3.5m$. The $\%$ loss of energy during the impact is

(A) 20%

(B) 30%

(C) $43\ \%$

(D) $50\ \%$

CORRECT ANSWER: B

SOLUTION:

percentage loss of energy $= \frac{h_1 - h_2}{h_1} \times 100\ \%$.

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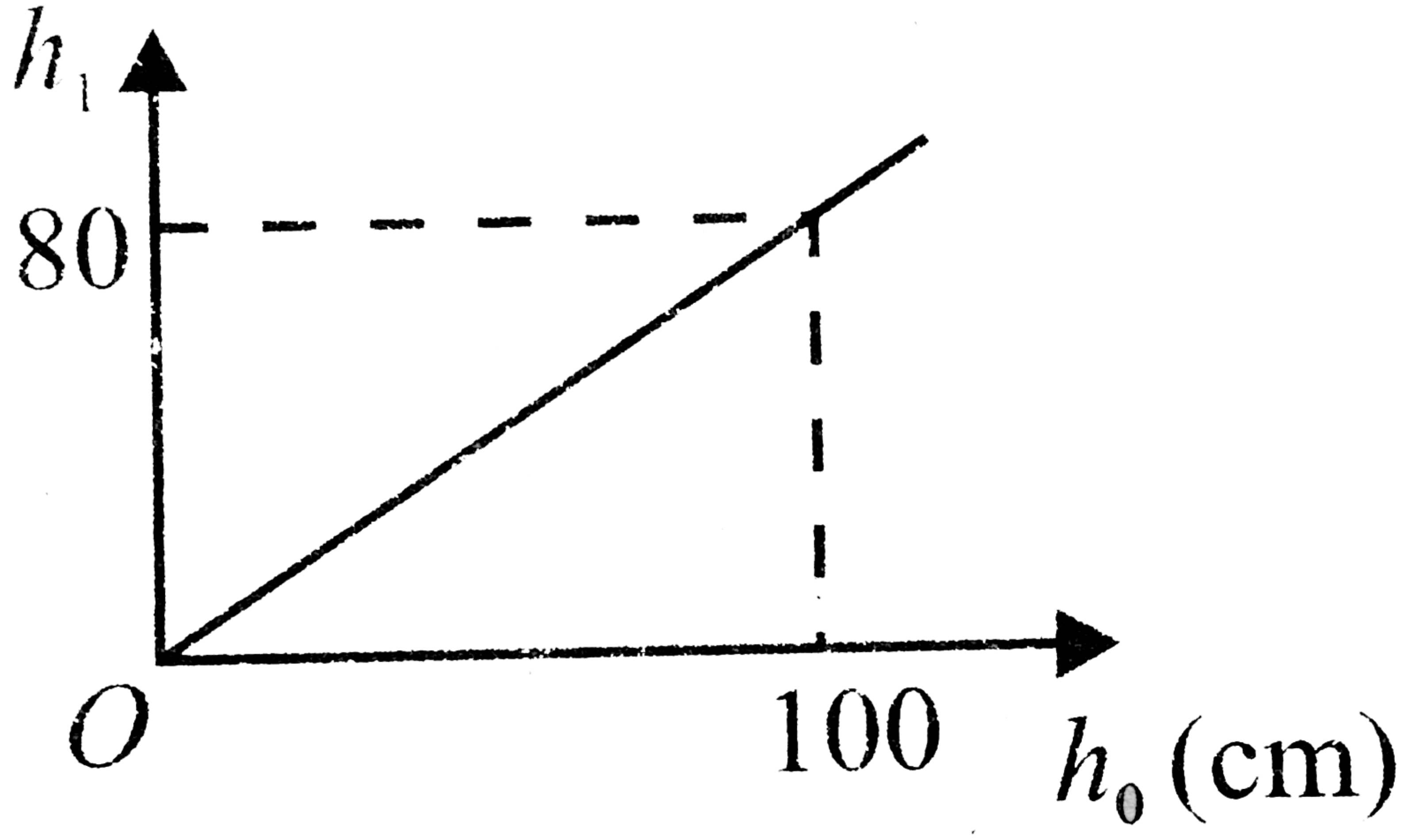
Q-29 - 11300736

A ball released from a height ho above a horizontal surface rebounds to a height h_1, after one bounce. The graph that relates h_0 to h_1 is shown Fig. If the ball (of the mass m) was dropped from an initial height h and made three bounces, the kinetic energy of the ball immediately after the third impact with the surface was



(A) $(0.8)^3 mgh$

(B) $(0.8)^2 mgh$

(C) $0.8mg(h/3)$

(D) $\left[1-(0.8)^3\right]mgh$

CORRECT ANSWER: A

SOLUTION:

$$\frac{h_1}{h_0}=e^2 \Rightarrow \frac{80}{100}=e^2$$
$$\Rightarrow e=\sqrt{0.8}$$

velocity before the first impact $u = \sqrt{2gh}$

velocity after the third impact $v_3 = e^3\sqrt{2gh}$

$$KE = \frac{1}{2}mv_3^2$$
$$= e^6 mgh$$
$$= (0.8)^3 mgh$$

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Q-30 - 14796801

A tennis ball dropped from a height of 2 m rebounds only 1.5 metre after hitting the ground. What fraction of energy is lost in the impact?

(A) $1/2$

(B) $1/4$

(C) $1/8$

(D) $1/16$

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Q-31 - 15085091

A particle of mass m is suspended by a string of length l from a fixed rigid support. Particle is imparted a horizontal velocity $u = \sqrt{2gl}$. Find the angle made by the string with the vertical when the acceleration of the particle is inclined to the string by 45?

CORRECT ANSWER: $TAN^{-1}2$

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Q-32 - 11746680

A partical of mass m moving with velocity V_0strick a simple pendulum of mass m and strick to it. The maximum height attained by the pendulum will be

(A) $h = \dfrac{V_0^{\,2}}{8g}$

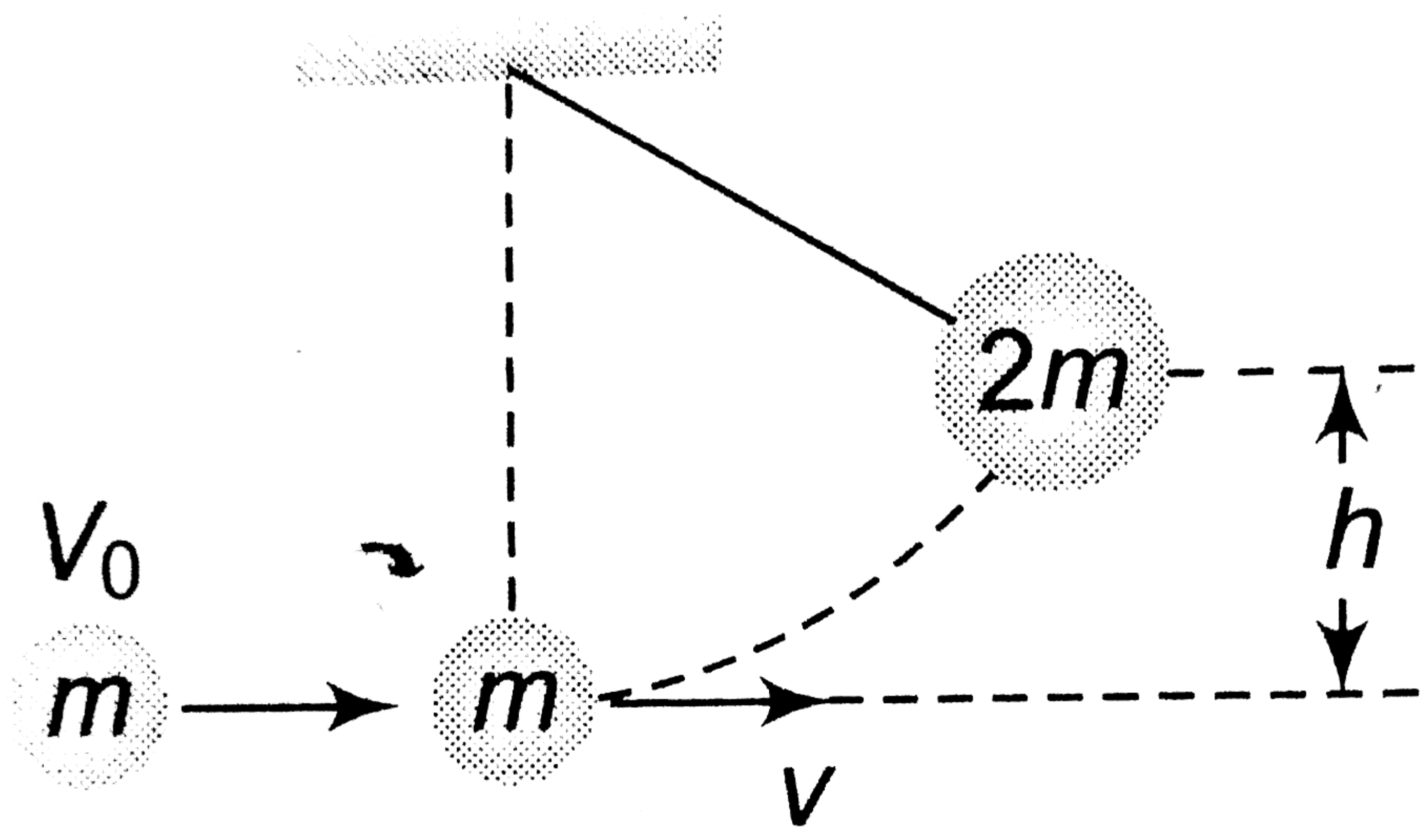
(B) $\sqrt{V_0 g}$

(C) $2\sqrt{\dfrac{V_0}{g}}$

(D) $\dfrac{V_0^{\,2}}{4g}$

CORRECT ANSWER: A

SOLUTION:



Initial momentum of partical $= mV_0$

Final momentum of system (partical + pendulum)

$= 2mv$

By the law of conservation of momentum .

$\Rightarrow mV_0 = 2mv \Rightarrow$ Initial velocity of system $v = \dfrac{V_0}{2}$

: . Initial K.E. of the system

$$= \frac{1}{2}(2m)v^2$$

$$= \frac{1}{2}(2m)\left(\frac{V_0}{2}\right)^2$$

If the system risews up to height h then $P.E. = 2mgh$

By the law of conservation of energy

$$\frac{1}{2}(2m)\left(\frac{V_0}{2}\right)^2$$

$$= 2mgh \Rightarrow h = \frac{V_0}{8g}$$

Q-33 - 15821966

A body of mass m moving with velocity v makes a head-on collision with another body of mass 2 m which is initially at rest.

The loss of kinetic energy of the colliding body (mass m) is

(A) $\frac{1}{2}$ of its intial kinetic energy

(B) $\frac{1}{9}$ of its initial kinetic energy

(C) $\frac{8}{9}$ of its initial kinetic energy

(D) $\frac{1}{4}$ of its initial kinetic energy

CORRECT ANSWER: C

Q-34 - 13398924

The coefficient of friction between a particle moving with some velocity V_0 and the rough horizontal surface is $\left(\frac{V_0}{2gt_0}\right)$. Find how much kinetic energy is lost in time t_0 due to friction :

(A) $1/4$

(B) $1/2$

(C) $3/4$

(D) $2/3$

CORRECT ANSWER: C

SOLUTION:

$v^1 = v_0 - (\mu g)t_0$

=

$v_0 - \left(\frac{v_0}{2gt_0}\right)gt_0 = v_0$

$/2$

ltMbrgt velocity left $= v_0/2$

$K.E$ left =

$\frac{1}{2}m\left(\frac{v_0}{2}\right)^2$

$= \frac{1}{4}\left(\frac{1}{2}mv_0^2\right)$

$$= \frac{1}{4} \text{ of initial } K.E.$$

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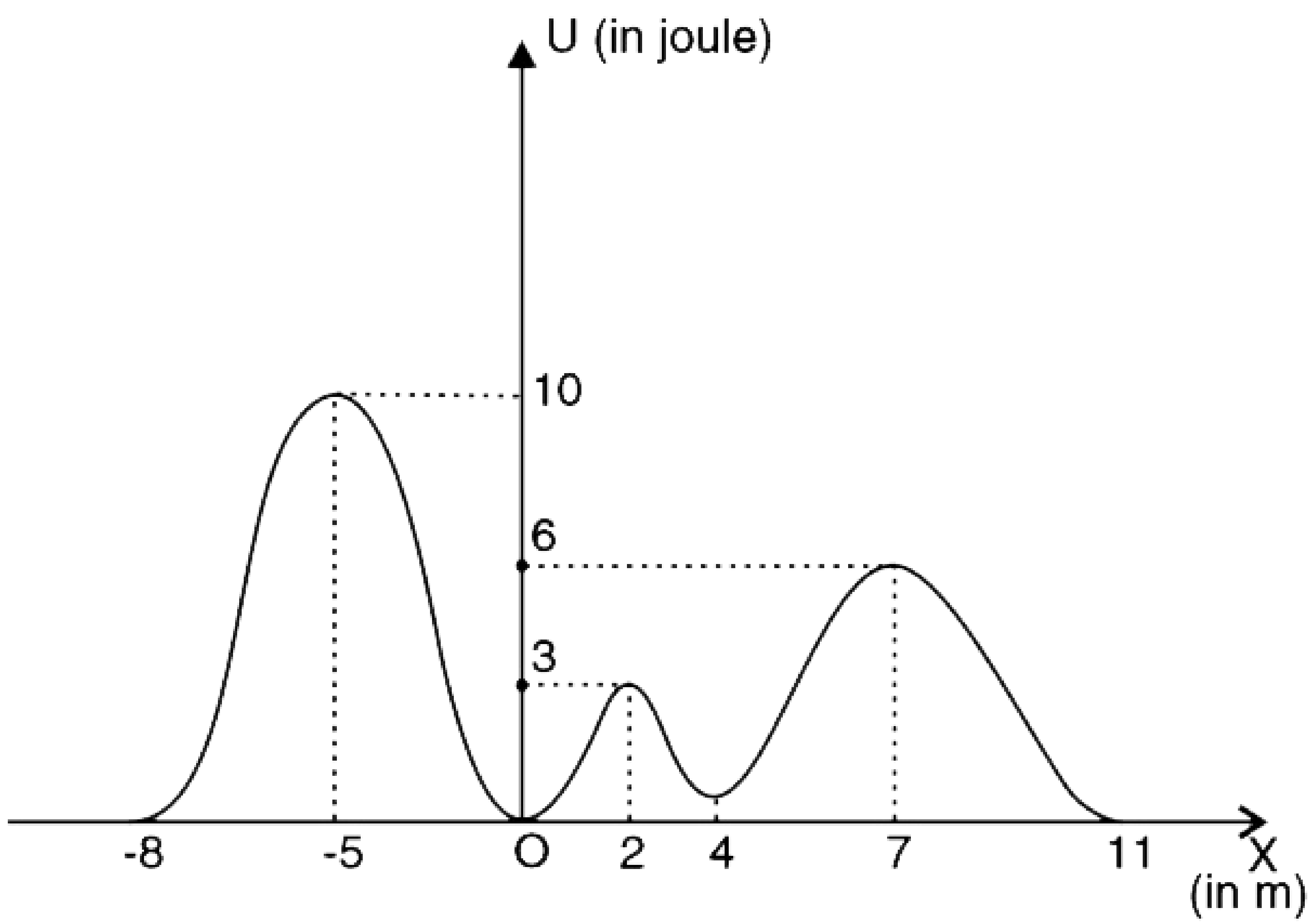
Q-35 - 15085128

A particle of mass m = 1.0 kg is free to move along the x axis. It is acted upon by a force which is described by the potential energy function represented in the graph below. The particle is projected towards left with a speed v, from the origin. Find minimum value of v for which the particle will escape far away from the origin.



CORRECT ANSWER: $2SQRT(3)M/S$

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Q-36 - 13398661

A body of mass m moving at a constant velocity v hits another body of the same mass moving with a velocity $v/2$ but in the opposite direction and sticks to it. The common velocity after collision is

(A) v

(B) $v/4$

(C) $2v$

(D) $v/2$

CORRECT ANSWER: B

SOLUTION:

$$m_1u_1 - m_2u_2$$
$$= (m_1 + m_2)v$$

.

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Q-37 - 15821736

The kinetic energy passessed by a body of mass m moving with a velocity v is equal to $\frac{1}{2}mv^2$, provided

(A) The body moves with velocities comparable to that of light.

(B) The body moves with velocities negligible compared to the speed of light

(C) The body moves with velocities greater than that of light

(D) None of the above statement is correcst

CORRECT ANSWER: B

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Q-38 - 10956149

A mass of $0.5kg$ moving with a speed of $1.5m/s$ on a horizontal smooth surface, collides with a nearly weightless spring of force constant $k=50N/m$ The maximum compression of the spring would be.

(A) $0.15m$

(B) $0.12m$

(C) $0.5m$

(D) $0.25m$

CORRECT ANSWER: A

SOLUTION:

$$\frac{1}{2}mv^2 = \frac{1}{2}kX_m^2$$

$$\therefore X_m = \sqrt{\frac{m}{k}}.v$$

$$\sqrt{\frac{0.5}{50}} \times 1.5$$

$$= 0.15m.$$

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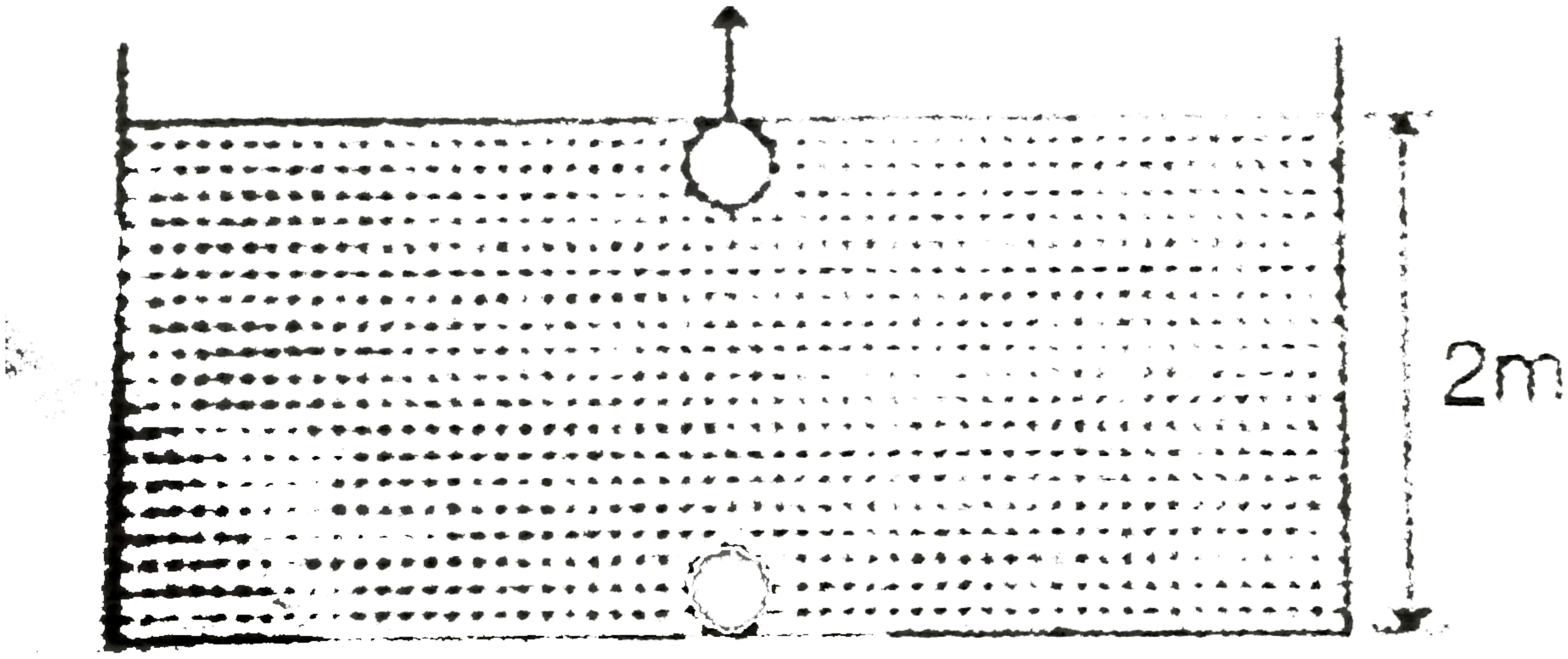
Q-39 - 17458724

A ball is released from the bottom of a tank filled with water up to 2m. On reaching the top its kinetic energy is found to be 16 J. Mass of the ball is 2 kg.

Ignoring the viscosity, let W_1 be the work done by upthrust and W_2 the work done by gravity, then $\left(g = 10m/s^2\right)$



(A)

$W_1 = 32J, W_2 = -16J$

(B)

$W_1 = -16J, W_2 = 32J$

(C)

$W_1 = -56J, W_2 = -40J$

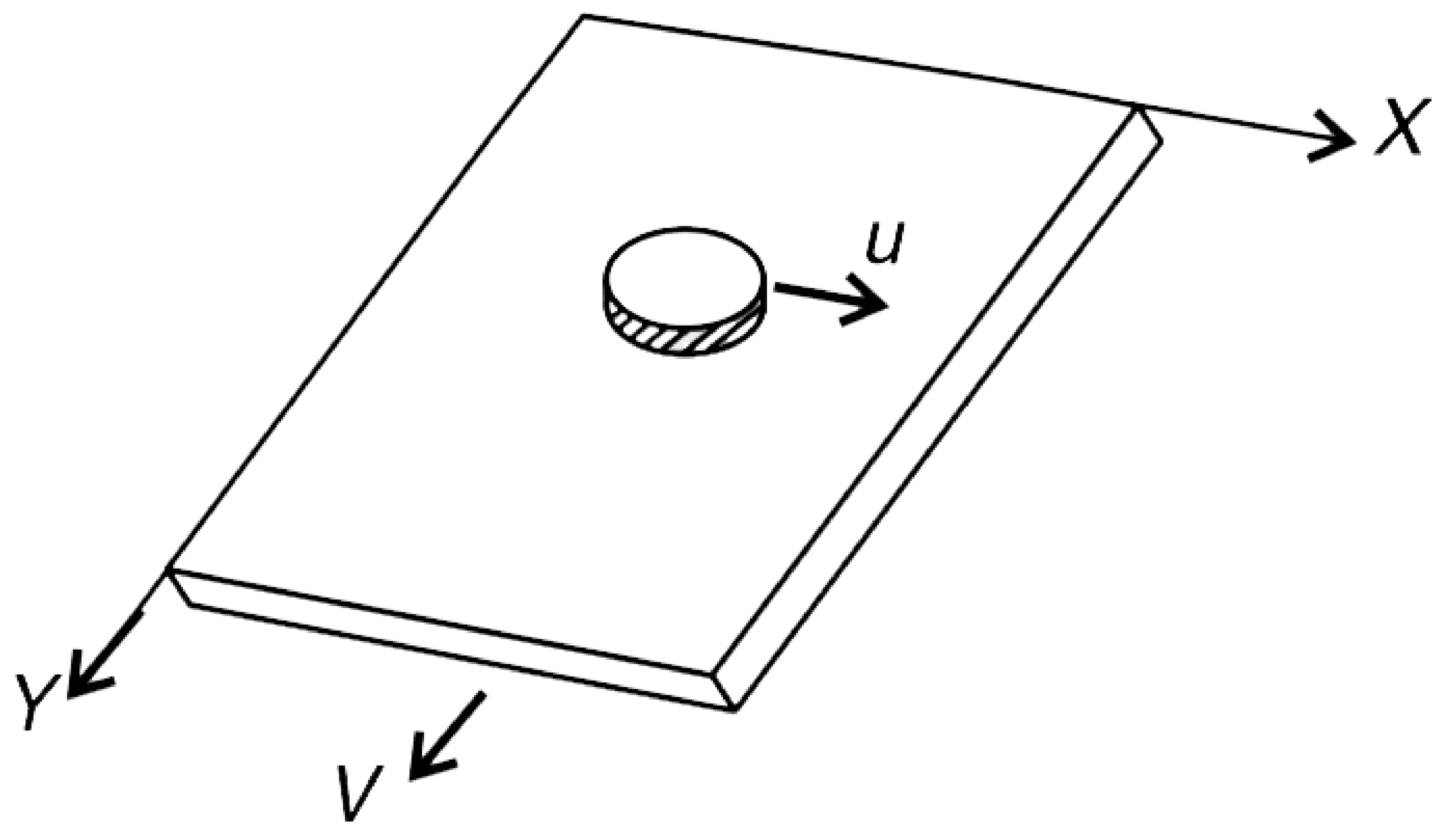
(D)

$W_1 = -40J, W_2 = -24J$

CORRECT ANSWER: C

Q-40 - 15085099

A large flat board is lying on a smooth ground. A disc of mass m = 2 kg is kept on the board. The coefficient of friction between the disc and the board is m = 0.2 . The disc and the board are moved with velocity $\overrightarrow{u} = 2\hat{i}ms^{-1}$ and $\overrightarrow{V} = 2\widehat{J}ms^{-1}$ respectively [in reference frame of the ground]. Calculate the power of the external force applied on the disc and the force applied on the board. At what rate heat is being dissipated due to friction between the board and the disc? $[g = 10ms^2]$



CORRECT ANSWER:

$4SQRT(2)W,$

$4SQRT(2)W;$

$8SQRT(2)W$

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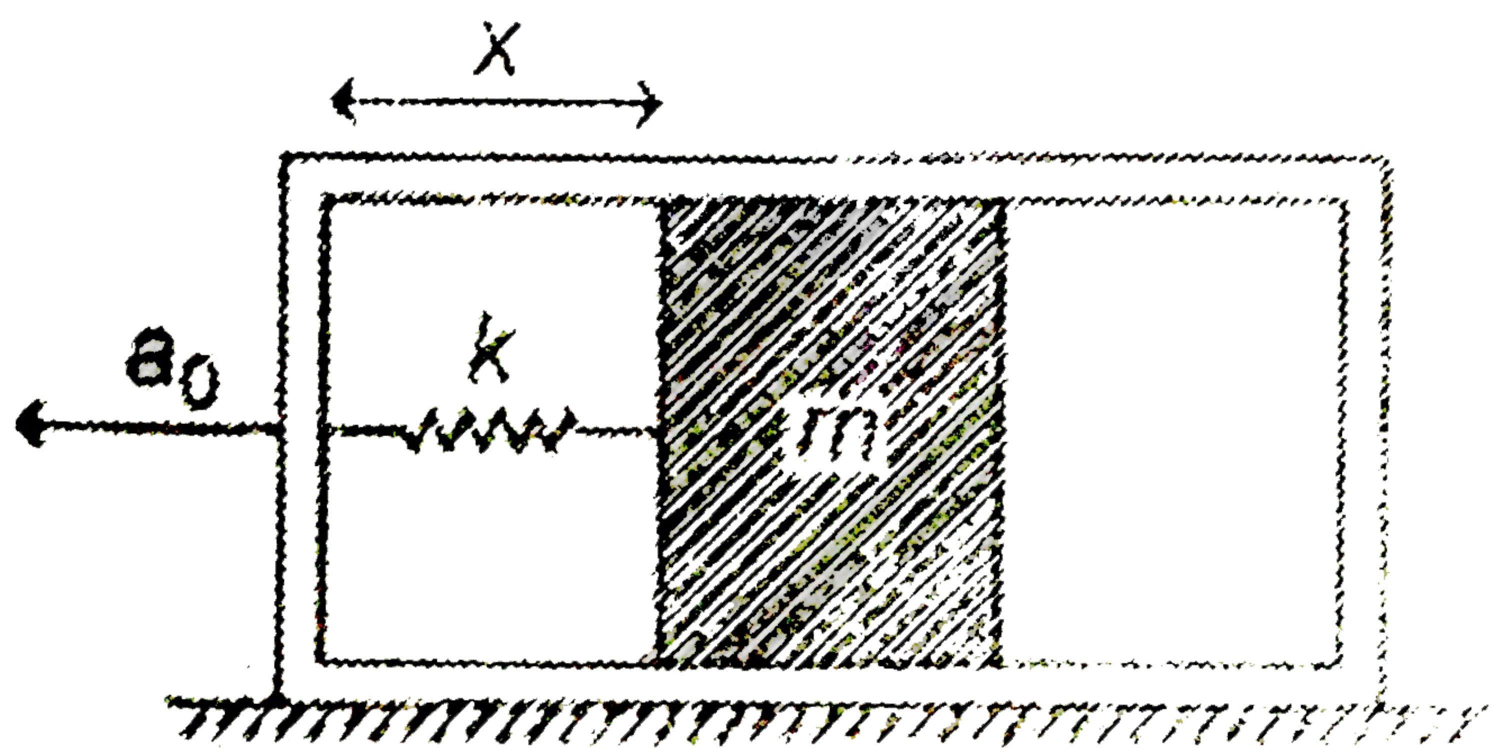
Q-41 - 17458675

A block of mass m is attached to a frame by a light spring of force constant k. The frame and block are initially at rest with $x = x_0$, the natural length of the spring. If the frame is given a constant horizontal accelration a_0 towards left, determine the maximum velocity of the block relative to the frame (block is free to move inside frame). Ignore any friction.



(A) $a_0\sqrt{\frac{m}{2k}}$

(B) $a_0\sqrt{\frac{2m}{k}}$

(C) $a_0\sqrt{\frac{m}{k}}$

(D) $\frac{1}{2}a_0\sqrt{\frac{m}{k}}$

CORRECT ANSWER: C

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Q-42 - 11746569

A cart is set rolling across a level table , at the same speed on every trial. If it runs into a patch of sand, the cart exerts on the sand an average horizontal force of $6N$ and travels a distance of $6cm$ through the sand as it comes to a stop. If instead the cart runs inton a patch of gravel on which the cart exerts an average horizontal force of $9N$ how far into the gravel will the cart roll before stopping?

(A) $9cm$

(B) $6cm$

(C) $4cm$

(D) $3cm$

CORRECT ANSWER: C

SOLUTION:

The system consisting of the cart 's fixed , initial kinetic energy is the mechanical energy that can be transformed due to friction from the surface . Therefore , the loss of mechanical energy is

$$\Delta E_{mech} = -f_k d = -(6N)(0.06m) = 0.376J$$

. The procuct must remain the same in all cases . For the cart rolling through gravel, $-(9N)(d) = 0.36J$ rells us $d = 4cm$.

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Q-43 - 15518883

A body is acted upon by a force which is inversely proportional to the distance covered. The work done will be proportional to

(A) s

(B) s^2

(C) $\sqrt{s}$

(D) $k \ln(s / s_1)$

SOLUTION:

$$W = \int \vec{F} \, . \, d\vec{s} =$$

$$\int_{s_1}^{s} \frac{k}{s} ds = k \ln(s / s_1)$$

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Q-44 - 14527341

A chain is held on a frictionless table with L/4 hanging over. Knowing total mass of the chain is M and total length L, the minimum work required to pull hanging part back to the table is :

(A) $\frac{MgL}{16}$

(B) $\frac{MgL}{8}$

(C) $\frac{MgL}{32}$

(D) $\frac{MgL}{24}$

CORRECT ANSWER: C

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Q-45 - 13398563

Two springs have their force constants K_1 and K_2 and they are stretched to the same extension. If $K_2 > K_1$ work done is

(A) same in both the springs

(B) more in springs K_1

(C) more in springs K_2

(D) independent of spring constant K

CORRECT ANSWER: C

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Q-46 - 11746608

A bullet when fixed at a target with a velocity of $100ms^{-1}$, penetrates one metre into it. If the bullet is fired with the same velocity as a similar target with a thickness 0.5 metre, then it will emerge from it with a velocity of

(A) $50\sqrt{2}ms^{-1}$

(B) $\frac{50}{\sqrt{2}}ms^{-1}$

(C) $50ms^{-1}$

(D) $10ms^{-1}$

CORRECT ANSWER: A

SOLUTION:

$\frac{1}{2}m \times 100 \times 100 = f$
$\times 1 \text{ or } f = 5000mN$

Again

$$\frac{1}{2}mv^2 - \frac{1}{2}mv^2 = f \times 0.5$$

or $m\left[v^2 - v'^2\right] = f \times 1$

or $v'^2 = v'^2 - 5000$

or $v'^2 = 10000 - 5000$

or $v'^2 = 5000$

or $v'^2 = 2500$

or $v'^2 = 50\sqrt{2}ms^{-1}$

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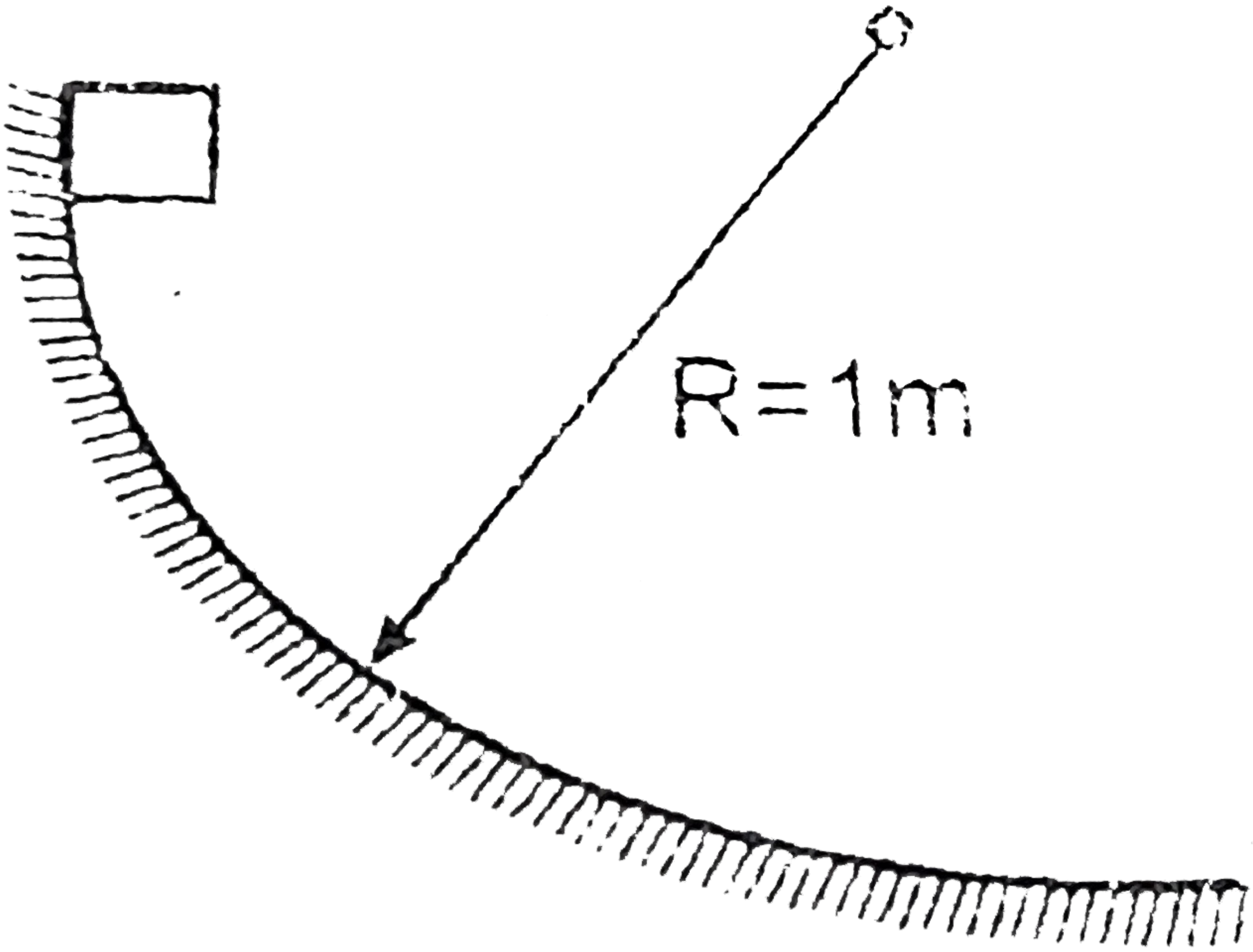
Q-47 - 14279581

A block of mass 1 kg slides down a vertical curved track that is one quadrant of a circle of radius 1m. Its speed ast the the bottom si $2m/s$. The work done by frictional force is :



(A) $8J$

(B) $-8J$

(C) $4J$

(D) $-4J$

CORRECT ANSWER: B

SOLUTION:

$$mg1 + W_k = \frac{1}{2}(M)2_2$$
$$= 0$$

$$W_{fk} = 2 - 10.$$

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Q-48 - 11746680

A partical of mass m moving with velocity V_0strick a simple pendulum of mass m and strick to it. The maximum height attained by the pendulum will be

(A) $h = \frac{V_0^2}{8g}$

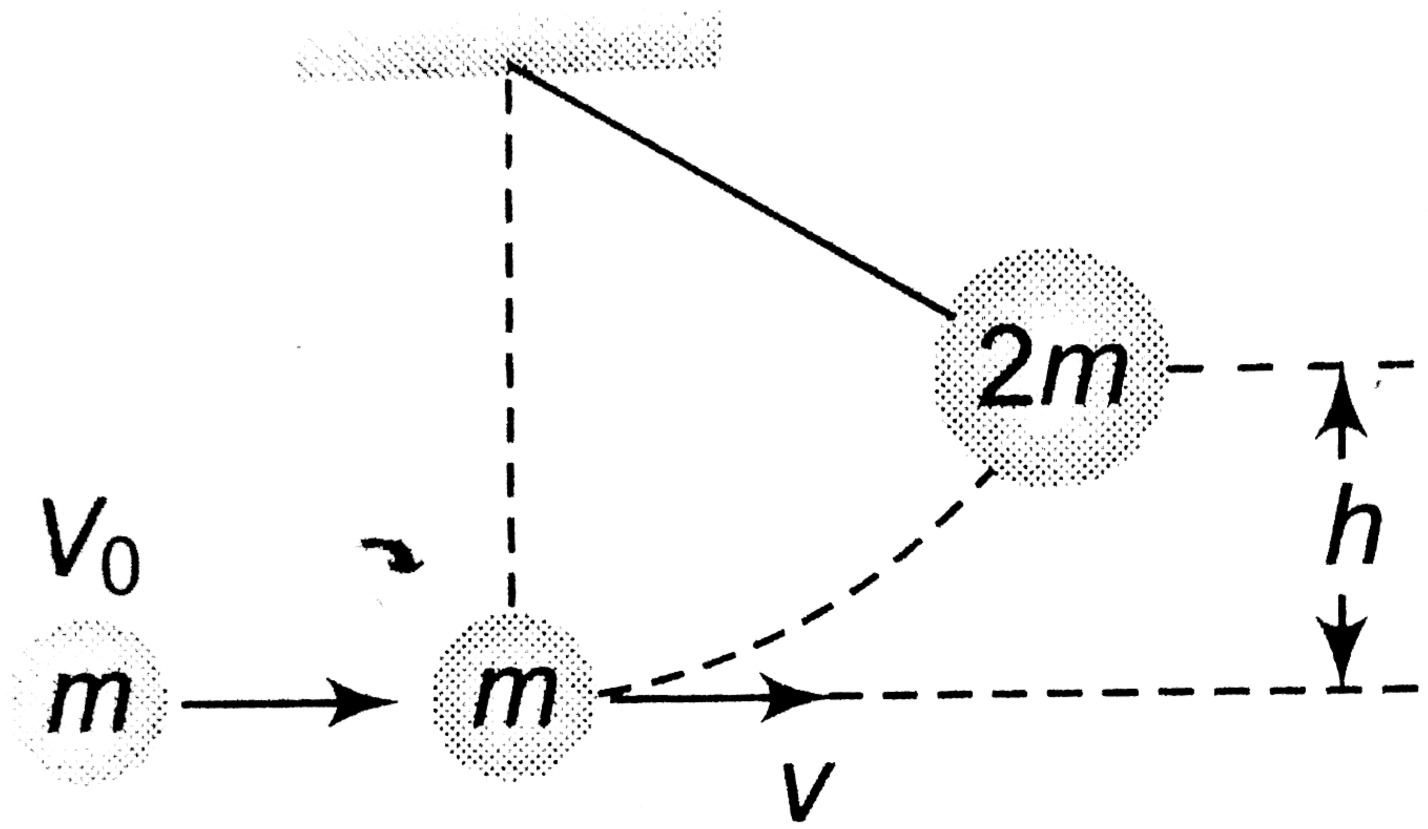
(B) $\sqrt{V_0 g}$

(C) $2\sqrt{\frac{V_0}{g}}$

(D) $\frac{V_0^2}{4g}$

CORRECT ANSWER: A

SOLUTION:



Initial momentum of partical $= mV_0$

Final momentum of system (partical + pendulum)

$= 2mv$

By the law of conservation of momentum .

$\Rightarrow mV_0 = 2mv \Rightarrow$ Initial velocity of system $v = \dfrac{V_0}{2}$

: . Initial K.E. of the system

$= \dfrac{1}{2}(2m)v^2$

$= \dfrac{1}{2}(2m)\left(\dfrac{V_0}{2}\right)^2$

If the system risews up to height h then $P.E. = 2mgh$

By the law of conservation of energy

$$\frac{1}{2}(2m)\left(\frac{V_0}{2}\right)^2$$

$$= 2mgh \Rightarrow h = \frac{V_0}{8g}$$

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Q-49 - 10956220

A particle free to move along x-axis is acted upon by a force

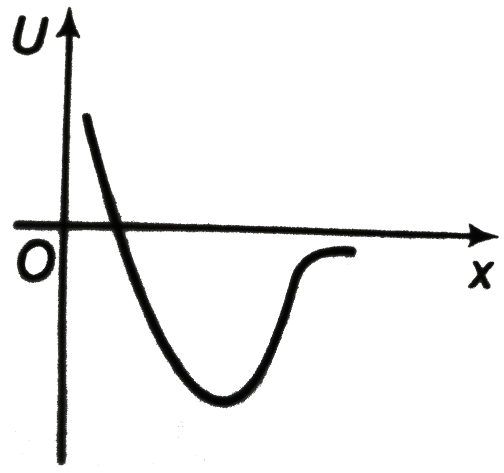
$F = -ax + bx^2 whrtea$

and $barepositivecons\tan ts$

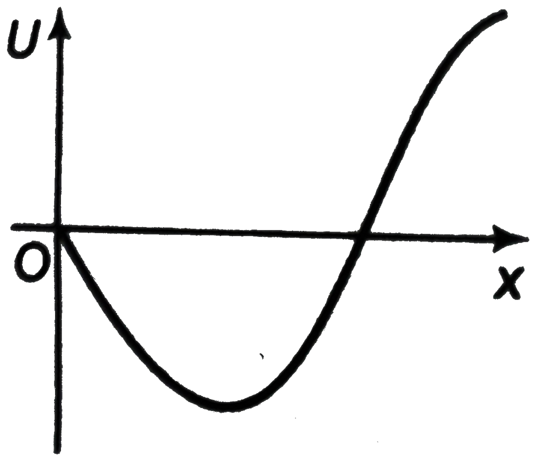
.

For ximplies0` , the correct variation of potential energy function

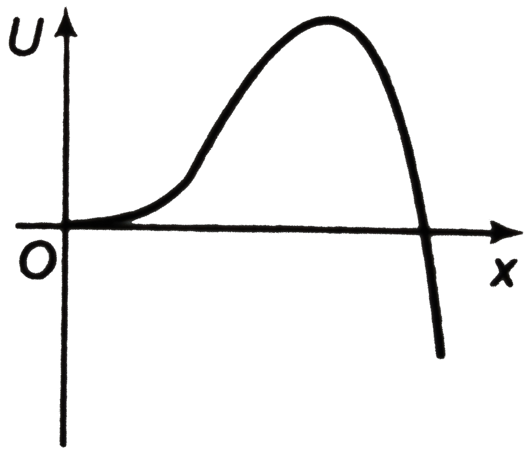
U(x) is best represented by.

(A) 

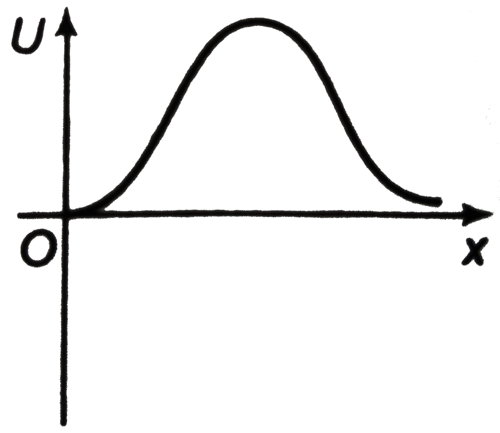
(a)

(B) 

(b)

(C) 

(c)

(D) 

(d)

CORRECT ANSWER: C

SOLUTION:

$$F = \frac{dU}{dx} \text{ or}$$
$$dU = -Fdx$$
$$= \left(ax = bx^2\right)dx$$

Assuning $U = 0$ at $x = 0$, and integrating the above equation we get,

$$U = \frac{ax^2}{2} - \frac{bx^3}{3}$$
$$U - 0 \text{ at } x = 0 \text{ and } x = \frac{3a}{2b}$$

For $x > \frac{3a}{2b}, b\frac{x^3}{3} > a\frac{x^2}{2}$ and U will become negative. So, option (c) is the most approprite answer.

Q-50 - 17458681

A ball of mass m is thrown upward with a velocity v. If air exerts an average resisting force F, the velocity with which the ball returns to the thrower is

(A) $v\sqrt{\dfrac{mg}{mg+F}}$

(B) $v\sqrt{\dfrac{F}{mg+F}}$

(C) $v\sqrt{\dfrac{mg-F}{mg+F}}$

(D) None of these

CORRECT ANSWER: C

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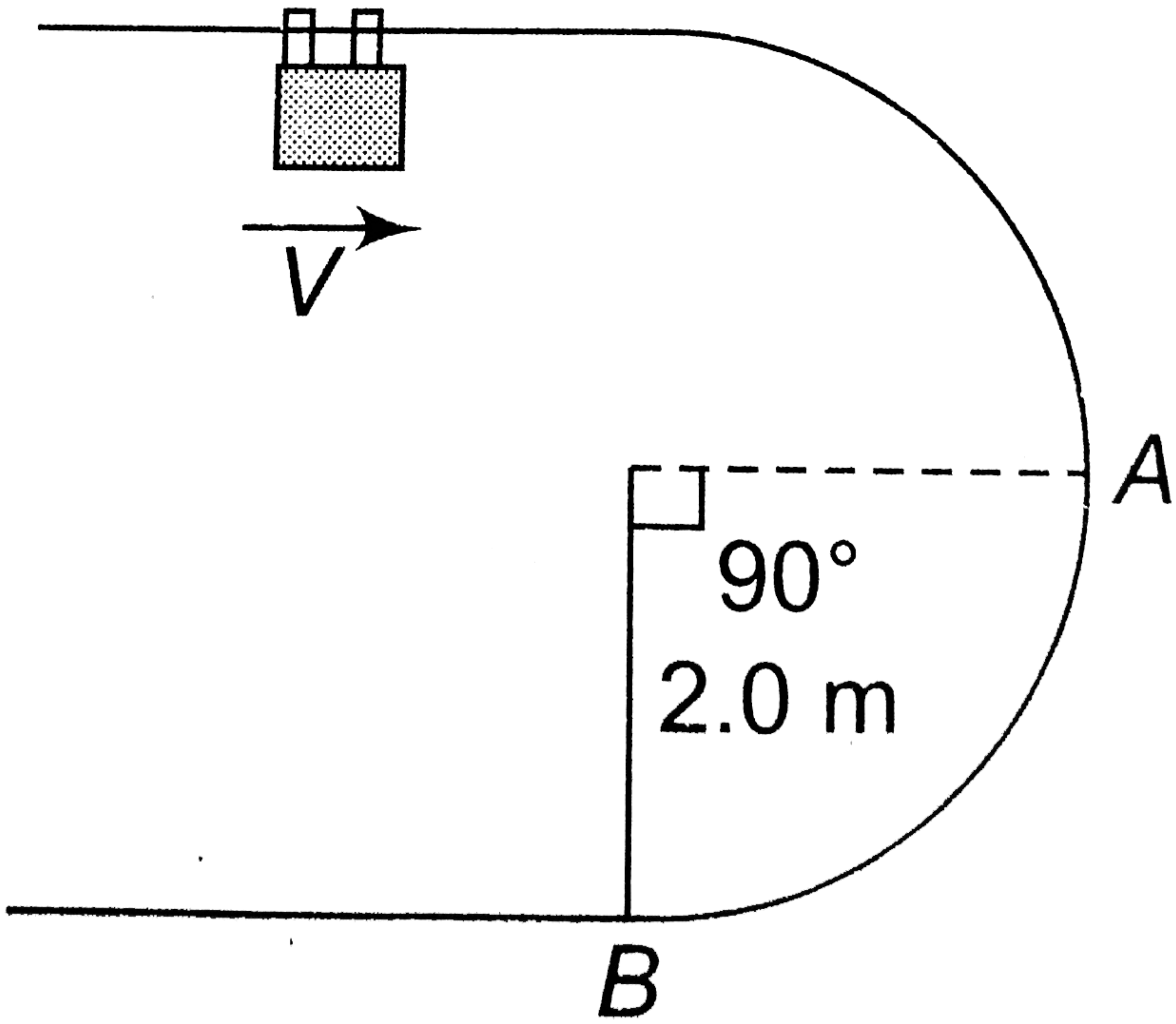
Q-51 - 11746673

A $1kg$ mass is projected down a rough circule track $(redius = 2.0m)$ placed in vertical plane as shown. The speed of the massat point A is $3m/s$ and at point B, it is $6.0m/s$. How much is work is done on the mass between A and B by the force of friction?



(A) $-7.5J$

(B) $-8.5J$

(C) $-6.5J$

(D) $-24J$

CORRECT ANSWER: C

SOLUTION:

Conservation of energy principal

KE = at

$$A = \frac{1}{2} \times 1.0 \times 3.0^2$$
$$= 4.5J$$

Loss in PE between A and

$$B = 1.0 \times 10 \times 2$$
$$= 20J$$

Gain in KE from A to B if there had been no friction =

$20J$

total KE at B if there had been no friction

$$= 4.5 + 20 = 24.5J$$

Los in energy due to friction $= 24.5 - 18 = m6.5J$.

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Q-52 - 18247112

A ball suspended by a thread swings ia a vertical plane so that its acceleration in the extreme position and lowest position are equal. The angle θ of thread deflection in the extreme position will be

(A) $\tan^{-1}(2)$

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

(C) $\tan^{-1}\left(\frac{1}{2}\right)$

(D) $2\tan^{-1}\left(\frac{1}{2}\right)$

CORRECT ANSWER: D

SOLUTION:

$$g\sin\theta = \frac{v^2}{R} = \frac{2gh}{R}$$
$$= \frac{2gR(1-\cos\theta)}{R}$$

or $\sin\theta = 2(1 - \cos\theta)$

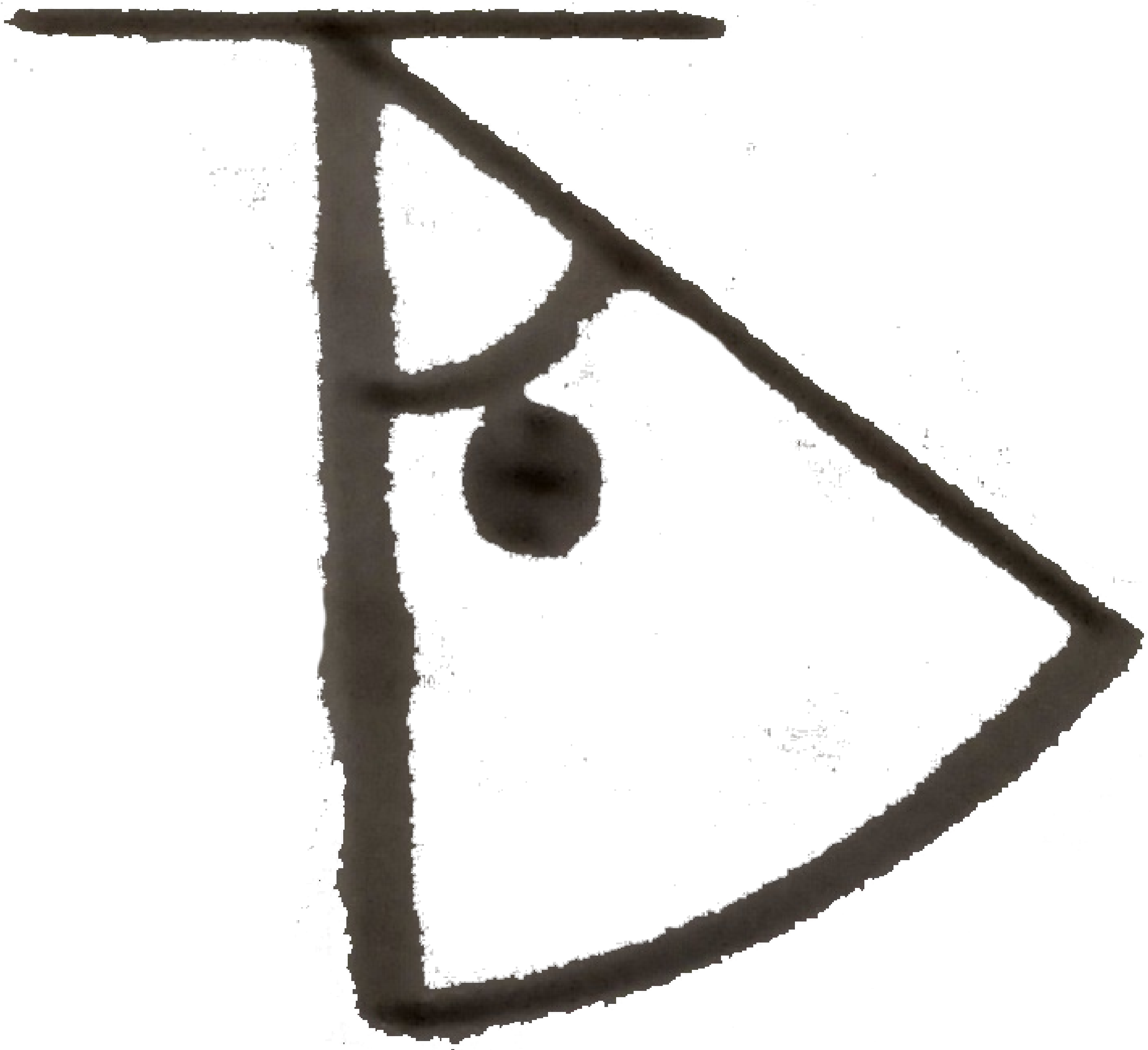
$$2\sin.\frac{\theta}{2}\cos.\frac{\theta}{2}$$

$$= 2\left(2\sin^2.\frac{\theta}{2}\right)$$

$$\Rightarrow \qquad \tan.\frac{\theta}{2} = \frac{1}{2}$$

$$\Rightarrow \frac{\theta}{2} = \tan^{-1}\left(\frac{1}{2}\right)$$

$$\text{or } \theta = 2\tan^{-1}\left(\frac{1}{2}\right)$$



Note In extreme position of pendulum, only tangential componet of acceleration $(a_t = g\sin\theta)$ is present. In lowest position, only normal acceleration $\left(a_n = v^2 / R\right)$ is present.

Q-53 - 13025527

An object of mass 4 kg falls from rest through a vertical distance of

20 m and reaches with velocity of 10 $(m)/(s)$ on ground. How much work is done by air friction?

SOLUTION:

By the work $-$ energy theorem

$$K_1 + U_1 = K_2 + U_2 + W_f$$

$$mgh = \frac{1}{2}mv^2 + W_f$$

$$4 \times 10 \times 20 = \frac{1}{2} \times 4 \times (10)^2 + W_f$$

$$W_f = 600J$$

Work done by friction

$$W'_f = -W_f = -600J$$

Q-54 - 11746684

A shere of mass m , moving with velocity V, enters a hanging bag of sand and stop. If the mass of the bag is M and it is reised by height h, then the velocity of the sphere will be

(A) $\frac{M+m}{m}\sqrt{2gh}$

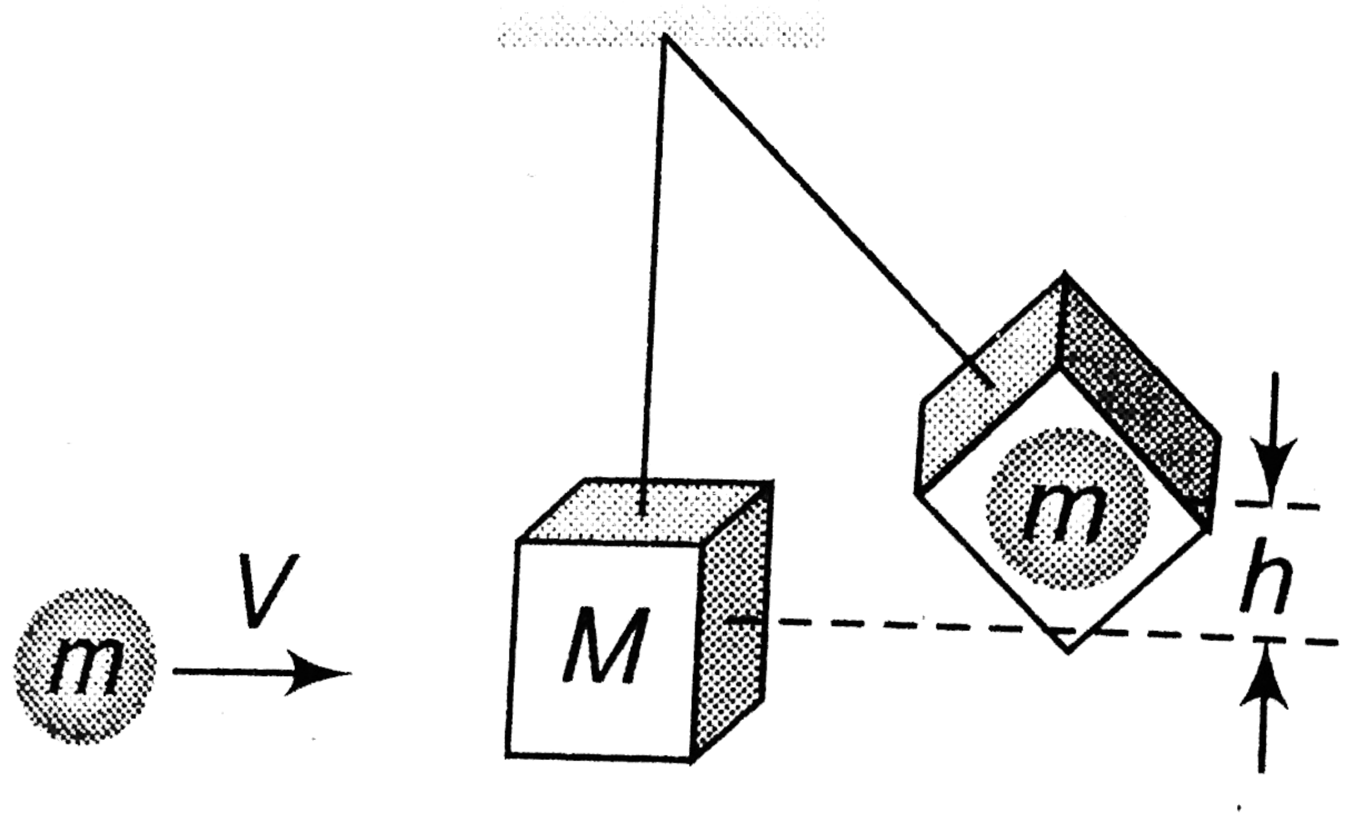
(B) $\frac{M}{m}\sqrt{2gh}$

(C) $\frac{m}{M+m}\sqrt{2gh}$

(D) $\frac{m}{M}\sqrt{2gh}$

CORRECT ANSWER: A

SOLUTION:



By the conservation of linear momentum

Initial momentum of sphere = Final momentum system

$$mV = (m+M)v_{sys}$$

If the system rises up to height h then by conservation of energy

$$\frac{1}{2}(m+M)v_{sys}^2 = (m+M)gh$$

$$\Rightarrow v_{sys} = \sqrt{2gh}$$

Subtituting this value in equition (i)

$$V = \left(\frac{m+M}{m}\right)\sqrt{2gh}$$

Q-55 - 15821758

Two bodies of different masses m_1 and m_2 have equal momenta. Their kinetic energies E_1 and E_2 are in the ratio

(A) $\sqrt{m_1} : \sqrt{m_2}$

(B) $m_1 : m_2$

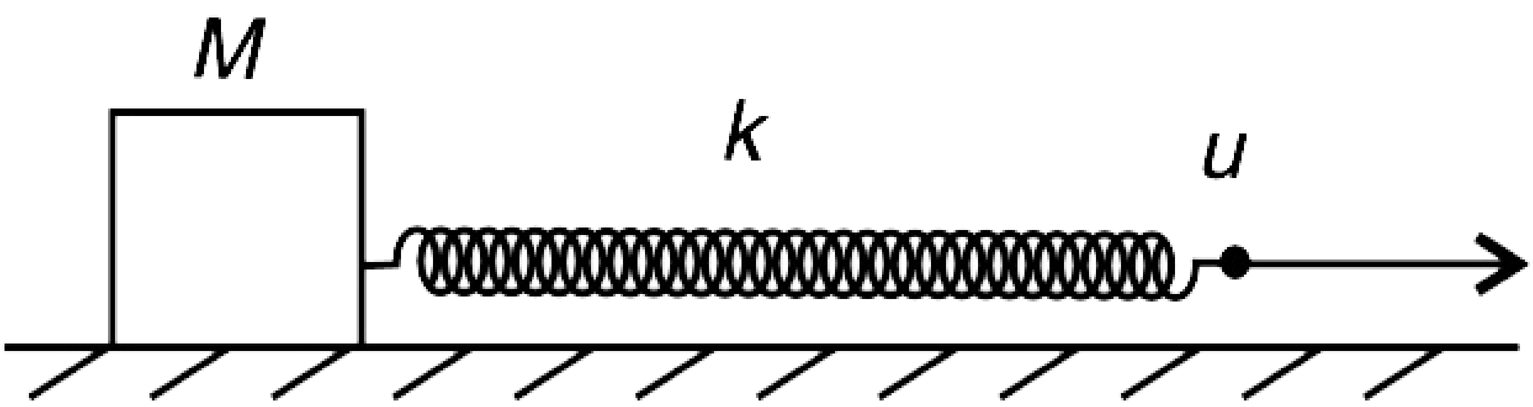
(C) $m_2 : m_1$

(D) $m_1^2 : m_2^2$

CORRECT ANSWER: C

Q-56 - 15085108

A block of mass M is placed on a horizontal smooth table. It is attached to an ideal spring of force constant k as shown. The free end of the spring is pulled at a constant speed u. Find the maximum extension (x_0) in the spring during the subsequent motion.



CORRECT ANSWER: $X_0 = SQRT\left(\frac{M}{K}\right)U$

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Q-57 - 11746690

A constant power P is applied to a partical of mass m. The distance travelled by the partical when its velocity increases from v_1 to v_2 is (neglect friction):

(A) $\frac{m}{3P}\left(v_2^3 - v_1^3\right)$

(B) $\frac{m}{3P}\left(v_2 - v_1\right)$

(C) $\frac{3p}{m}\left(v_2^2 - v_1^2\right)$

(D) $\frac{m}{3P}\left(v_2^2 - v_1^2\right)$

CORRECT ANSWER: A

SOLUTION:

$$P = Fv = mav \Rightarrow a = \frac{P}{mv}$$

$$\Rightarrow \frac{dv}{ds} = \frac{p}{mv}$$

$$\Rightarrow v^2 dv = \frac{P}{m} dx$$

$$\Rightarrow \frac{P}{m}\int_0^s ds = \int_{v_1}^{v2} v^2 dv$$

$$\Rightarrow \frac{P}{m} s = \frac{1}{3}\left(v_2^3 - v_1^3\right)$$

$$\Rightarrow s = \frac{m}{3p}\left(v_2^3 - v_1^3\right)$$

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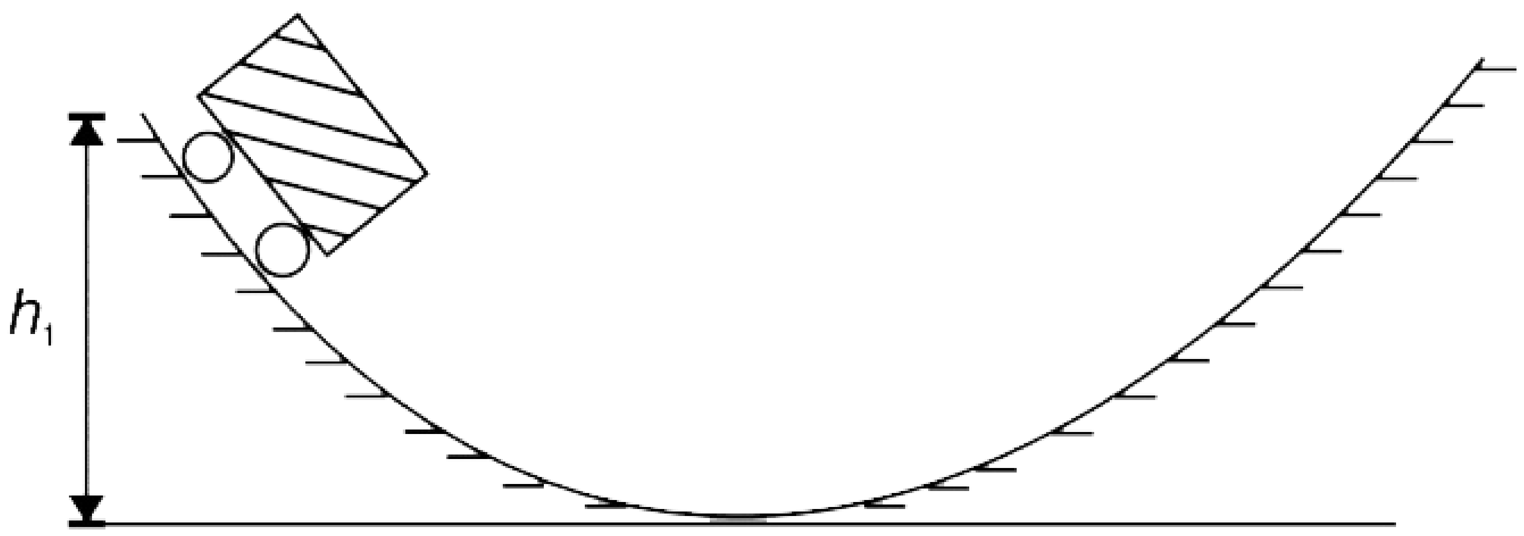
Q-58 - 15085076

A tanker filled with water starts at rest and then rolls, without any energy loss to friction, down a valley. Initial height of the tanker is h_1. The tanker, after coming down, climbs on the other side of the valley up to a height h_2. Throughout the journey, water leaks from the bottom of the tanker. How does h_2 compare with h_1?



CORRECT ANSWER: $H_2 = H_1$

Q-59 - 17458757

A block of mass m moving at a speed v compresses a spring through a distance x before its speed is halved. The spring constant of the spring is $\frac{6mv^2}{nx^2}$. Find value of n.

CORRECT ANSWER: 8