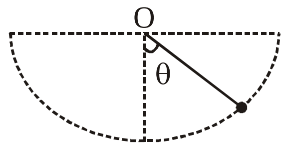
SOLVED EXAMPLES

Example 1.

A simple pendulum is oscillating with an angular amplitude of 90° as shown in figure.



The value of θ for which the resultant acceleration of the bob is directed horizonally is

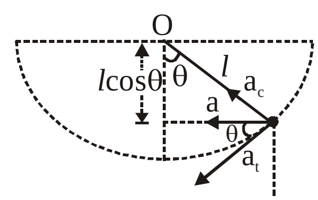
(1) 0° (2) 90°

(3) $\sin^{-1}\left(1/\sqrt{3}\right)$ (4) $\cos^{-1}\left(1/\sqrt{3}\right)$

Solution :

(4) As, $a_t = g\sin\theta$

and $a_c = \frac{\upsilon^2}{l} = \frac{2gl\cos\theta}{l} = 2g\cos\theta$



$\therefore \quad \tan\theta = \frac{a_c \sin 90^\circ}{a_t + a_c\cos 90^\circ} = \frac{2g\cos\theta}{g\sin\theta} = \frac{2}{\tan\theta}$

or $\tan^2\theta = 2$ or $\sec^2\theta = 3$ or $\cos\theta = \frac{1}{\sqrt{3}}$

$\therefore \quad \theta = \cos^{-1}\left(1/\sqrt{3}\right)\cdot$

Example 2.

A particle is moving along a circular path of radius 5 m and with uniform speed 5 m/s. What will be the average acceleration when the particle completes half revolution

(1) zero (2) 10 m/s^2 (3) 10π m/s^2 (4) $10/\pi$ m/s^2

Solution :

(4) The change in velocity when the particle completes, half revolution is given by

Δv = 5 m/s – (– 5 m/s) = 10 m/s

Time taken to complete half revolution

$t = \frac{\pi r}{v} = \frac{\pi \times 5}{5} = \pi$

$\therefore$ Average acceleration

$$= \frac{\Delta v}{t} = \frac{10}{\pi}\left(\frac{m/s}{s}\right) = \frac{10}{\pi} m/s^2$$

Example 3.

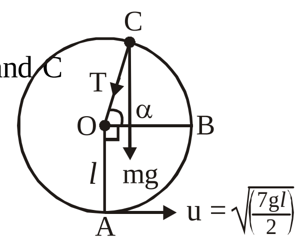
A particle hanging by a light string of length l is projected horizontally from its lowest point with velocity $\sqrt{(7g\,l/2)}$. The string slackens after swinging through

(1) 45° (2) 60° (3) 120° (4) 145°

Solution :

(3) Suppose the velocity at point C be v. Then

$$T + mg\sin\alpha = \frac{mv^2}{l} \qquad \text{...(i)}$$



Applying the law of conservation of energy at A and C

$$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mg\left(l + l\sin\alpha\right)$$

$$\frac{7gl}{2} = v^2 + 2gl + 2gl\sin\alpha$$

$$\therefore \quad v^2 = \frac{3gl}{2} - 2gl\sin\alpha \qquad \text{...(ii)}$$

Using T = 0 and substituting the value of v^2 from eq.(2) in eq. (1), we get

$$mg\sin\alpha = \frac{m}{l}\left[\frac{3gl}{2} - 2gl\sin\alpha\right]$$

$$gl\sin\alpha = \left(3gl/2\right) - 2gl\sin\alpha$$

$$3gl\sin\alpha = 3gl/2 \quad \text{or} \quad \sin\alpha = 1/2$$

$$\therefore \quad \alpha = \sin^{-1}\left(1/2\right) = 30^\circ$$

So, the angle at which the particle leaves is 90 + 30 = 120°.

Example 4.

A particle is moving in a circle of radius R in such a way that at any instant the normal and tangential components of its acceleration are equal. If its speed at t = 0 is v_0. The time taken to complete the first revolution is

(1) R/v_0 (2) v_0/R (3) $\frac{R}{v_0}\left(1-e^{-2\pi}\right)$ (4) $\frac{R}{v_0}e^{-2\pi}$

Solution :

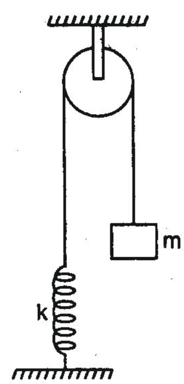
(3) Give that $a_n = a_t$

$$\therefore \quad R\omega^2 = R\alpha \quad \text{or} \quad \omega^2 = \alpha = \frac{d\omega}{dt} \quad \text{or} \quad \frac{d\omega}{\omega^2} = dt$$

Integrating this expression, we get

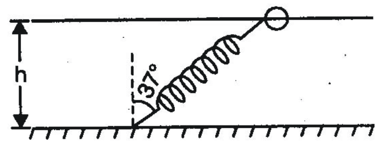
$$\int_{\omega_0}^{\omega}\frac{d\omega}{\omega^2} = \int_0^t dt \quad \text{or} \quad \omega = \frac{\omega_0}{1-\omega_0 t}$$

	$\therefore \quad \frac{d\theta}{dt} = \frac{\omega_0}{1-\omega_0 t}$ or $d\theta = \frac{\omega_0 dt}{1-\omega_0 t}$ Further integrating, we get $\int_0^{2\pi} d\theta = \int_0^T \frac{\omega_0 dt}{(1-\omega_0 t)}$ Solving we get $(1-\omega_0 T) = e^{-2\pi}$ or $T = \frac{l}{\omega_0}\left(1-e^{-2\pi}\right) = \frac{R}{v_0}\left(1-e^{-2\pi}\right)$
Example 5.	A uniform chain of length L and mass M overhangs a horizontal table with its two third part on the table. The friction coefficient between the table and the chain is μ. The work done by the friction during the period the chain slips off the table is (1) $-\frac{1}{4}\mu MgL$ (2) $-\frac{2}{9}\mu MgL$ (3) $-\frac{4}{9}\mu MgL$ (4) $-\frac{6}{7}\mu MgL$
Solution :	(2) $dW = -\mu\left[\frac{M}{L}\right] gl\, dl$ $W = \int_0^{\frac{2L}{3}} -\frac{\mu Mg}{L}\, l\, dl$ or $W = -\frac{\mu Mg}{L}\left\|\frac{l^2}{2}\right\|^{\frac{2L}{3}}$ or $W = -\frac{\mu Mg}{2L}\left[\frac{4L^2}{9} - 0\right]$ or $W = -\frac{2}{9}\mu MgL.$
Example 6.	A 1 kg block is attached (and held at rest with outside support) to the free end of a vertically hanging spring of force constant 10 N cm^{-1}. When the block is released, what maximum extension does it cause when it comes to rest instantaneously? [g = 10 ms^{-2}] (1) 1 cm (2) 2 cm (3) 3 cm (4) 4 cm
Solution :	(2) Equating gain of elastic poential energy with loss of gravitational potential energy, we get $\frac{1}{2}kx^2 = mgx$; x is the maximum extension in vertical direction downward. or $x = \frac{2mg}{k} = \frac{2\times1\times10}{1000} m$ $= \frac{1}{50} m = \frac{1}{50} \times 100\ cm = 2\ cm.$

Example 7.	A man throws a piece of stone to a height of 12 m where it reaches with a speed of 12 ms^{-1}. If he throws the same stone such that it just reaches this height, the percentage of energy saved is nearly (1) 19% (2) 38% (3) 57% (4) 76%
Solution :	(2) Percentage of energy saved is $$\frac{\frac{1}{2}mv^2 \times 100}{\frac{1}{2}mv^2 + mgh}$$ or $\frac{v^2 \times 100}{v^2 + 2gh}$ i.e. $\frac{12 \times 12 \times 100}{12 \times 12 + 2 \times 10 \times 12}$ or $\frac{14400}{144 + 240}$ or $\frac{14400}{384}$ or 37.5.
Example 8.	Consider the situation shown in figure. Initially the spring is unstretched when the system is released from rest. Assuming no friction in the pulley, the maximum elongation of the spring is  (1) $\frac{mg}{k}$ (2) $\frac{2mg}{k}$ (3) $\frac{3mg}{k}$ (4) $\frac{4mg}{k}$
Solution :	(2) Equating gain of elastic energy with loss of gravitational potential energy, we get $\frac{1}{2}kx^2 = mgx$ or $x = \frac{2mg}{k}$; x is the extension in spring = distance by which mass m comes down.
Example 9.	One end of a spring of natural length h and spring constant k is fixed at the ground and the other is fitted with a smooth ring of mass m which is allowed to slide on a horizontal rod fixed at a height h. Initially, the spring makes an angle of 37° with the vertical when the system is released from rest. The

speed of the ring when the spring becomes vertical is

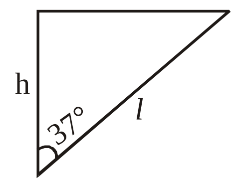
$[\tan 37° = \frac{3}{4}]$



(1) $\sqrt{\frac{k}{m}}$ (2) $\frac{h}{2}\sqrt{\frac{k}{m}}$ (3) $\frac{h}{3}\sqrt{\frac{k}{m}}$ (4) $\frac{h}{4}\sqrt{\frac{k}{m}}$

Solution :

(4) $\cos 37° = \frac{h}{l}$ or $l = \frac{h}{\cos 37°}$



or $l = 1.25h$

Extension $= l - h = 1.25h - h = 0.25\ h$

Equating kinetic energy with potential energy,

$$\frac{1}{2}mv^2 = \frac{1}{2}k(0.25h)^2 \quad \text{or} \quad v^2 = \frac{k}{m} \times \frac{h^2}{16} \quad \text{or} \quad v = \frac{h}{4}\sqrt{\frac{k}{m}}.$$

Example 10.

A mass 2 m is tied to one end of a light rod of length *l*. What horizontal velocity should be imparted to the lower end so that it may just take up the horizontal position?

(1) $\sqrt{2gl}$ (2) $\sqrt{gl}$ (3) $2\sqrt{gl}$ (4) $4\sqrt{gl}$

Solution :

(1) Loss of kinetic energy = $\frac{1}{2} \times 2m \times v^2 = mv^2$

Gain of gravitational potential energy = $(2m)gl$

Equating, $mv^2 = 2mgl$ or $v = \sqrt{2gl}$

Example 11.

Water is drawn from a well in a 5 kg drum of capacity 55 litre by two ropes connected to the top of the drum. The linear mass density of each rope is 0.5 kg m^{-1}. The work done in lifting water to the ground from the surface of water in the well 20 m below is [g = 10 m s^{-2}]

(1) 1.4×10^4 J (2) 1.5×10^4 J (3) $9.8 \times 10 \times 6$ J (4) 18 J

Solution :

(1) Work done in lifting water and drum = 60 × 10 × 20 J = 12000 J, mass of (water + drum) = 60 kg.

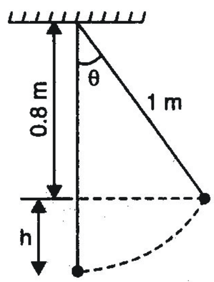
Total mass of ropes = 40 × 0.5 kg = 20 kg

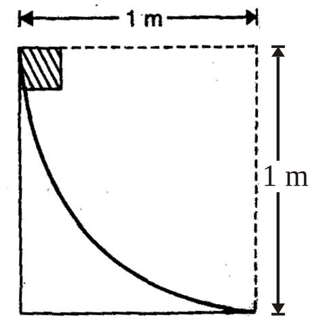
Work done in the case of ropes = 20 × 10 × 10 = 2000 J

Total work done = 14000 J.

Example 12.

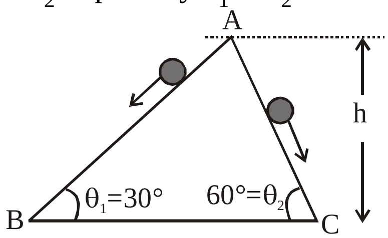
A rope ladder with a length *l* carryng a man with a mass *m* at its end is attached to the basket of balloon with a mass M. The entire system is in equilibrium in the air. As the man climbs up the ladder into the ablloon, the balloon descends by a height h. Then the potential energy of the man

	(1) increases by mg (l – h) (2) increases by mg$l$ (3) increases by mgh (4) increases by mg(2l – h)
Solution :	(1) Effective height through which man moves up = l – h Gain in potential energy = mg(l – h).
Example 13.	The velocity of the bob of an oscillating simple pendulum of length 1 m is 2 ms^{-1} at the lowest position. When the bob is at the extreme position, the angle made by the string of the pendulum with the vertical is [g = 10 ms^{-2}] (1) $\cos^{-1}(0.4)$ (2) $\cos^{-1}(0.6)$ (3) $\cos^{-1}(0.8)$ (4) 30°
Solution :	(3) $mgh = \frac{1}{2}mv^2$ or $h = \frac{v^2}{2g} = \frac{2\times 2}{2\times 10} = 0.2\,m$ $\cos\theta = \frac{0.8}{1}$ or $\theta = \cos^{-1}(0.8)$ 
Example 14.	At a certain instant, a 0.3 kg body has a velocity of $(4\hat{i} + 3\hat{j})\,ms^{-1}$. The kinetic energy of the body is (1) 3.75 J (2) 4.75 J (3) 9 J (4) 0 J
Solution :	(1) $v = \sqrt{4^2 + 3^2} = \sqrt{16+9} = \sqrt{25} = 5\,ms^{-1}$. Kinetic energy $= \frac{1}{2}\times 0.3\times 5\times 5 = 3.75\,J$.
Example 15.	A block of mass m slides down along the surface of the bowl (radius R) from the rim to the bottom. The velocity of the block at the bottom will be (1) $\sqrt{gR}$ (2) $\sqrt{2Rg}$ (3) $2\sqrt{\pi Rg}$ (4) $\sqrt{\pi Rg}$
Solution :	(2) $\frac{1}{2}m\upsilon^2 = mgR$ or $\upsilon = \sqrt{2gR}$
Example 16.	A man 1.5 m tall raises a load of 80 kg in 2 second from the ground to his head and then walks a distance of 40 m in another 2 second. The power developed by the man is [g = 10 ms^{-2}] (1) 0.2 kW (2) 0.4 kW (3) 0.6 kW (4) 0.8 kW
Solution :	(3) $P = \frac{mgh}{t} = \frac{80\times 10\times 1.5}{2}W$ = 600 W = 0.6 kW.
Example 17.	A 10 m long iron chain of linear mass density 0.8 kg m^{-1} is hanging freely from a rigid support. If g = 10 ms^{-2}, then the power required to lift the chain upto the point of support in 10 second is (1) 10 W (2) 20 W (3) 30 W (4) 40 W
Solution :	(4) m = 10 × 0.8 kg = 8 kg, h = 5 m

	$P = \frac{mgh}{t} = \frac{8 \times 10 \times 5}{10} W = 40 W.$
Example 18.	A body of mass 2 kg slides down a curved track which is quadrant of a circle of radius 1 m. All hte sufaces are frictionless. If the body starts from rest, its speed at the bottom of the track is  (1) $4.43\ ms^{-1}$ (2) $2\ ms^{-1}$ (3) $0.5\ ms^{-1}$ (4) $19.6\ ms^{-1}$
Solution :	(1) Equating gain of kinetic energy with loss of gravitational potential energy, we get $\frac{1}{2}mv^2 = mgh$ or $v = \sqrt{2gh}$ or $v = \sqrt{2 \times 9.8 \times}\ ms^{-1}$ $= \sqrt{19.6}\ ms^{-1} = 4.43\ ms^{-1}$.

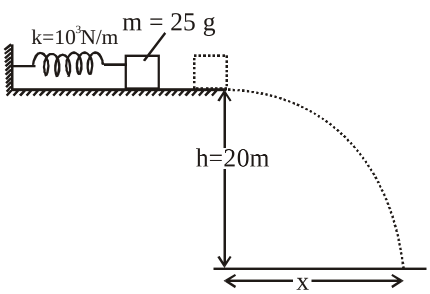
MULTIPLE CHOICE QUESTIONS

1. Two inclined friction less tracks, one gradual and other steep meet at 'A' from where two stones are allowed to slide down from rest, one on each track as shown in figure. The speed of two stones on reaching at bottom are v_1 and v_2 respectively. v_1 & v_2 are related as



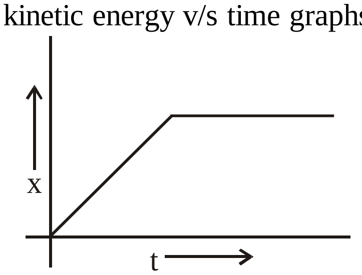
(1) $v_1 > v_2$ (2) $v_1 < v_2$
(3) $v_1 = v_2$ (4) Data insufficient

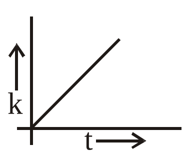
2. A block of mass 25g is connected with spring as shown in figure. It is compressed by 5cm and released. Horizontal range (x) on the ground is (g = 10 m/s^2)

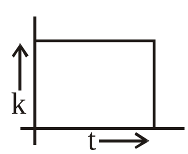


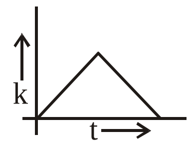
(1) 25 m (2) 23 m
(3) 20 m (4) 19 m

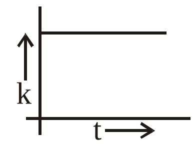
3. A body of mass m = 2kg is moving in straight line . Its distance time graphs is shown in figure. Its kinetic energy v/s time graphs is given by



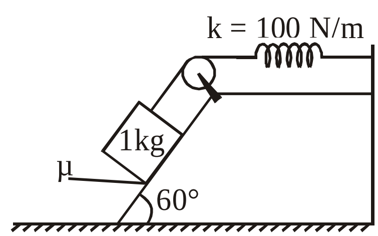
(1) 

(2) 

(3) 

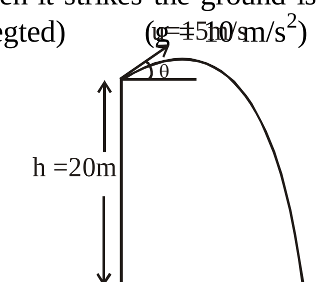
(4) 

4. A 1kg block situated on a rough incline is connected to a spring of spring constant 100 N/m as shown in figure. The block is released from rest with the spring in the unstretched position. The block moves 10 cm down the incline before coming to rest. The coefficient of friction between the block and the incline is (spring is massless and pulley is frictionless)



(1) 0.3
(2) 0.5
(3) 0.7
(4) 0.125

5. A particle is projected from top of tower (height h = 20m) with initial velocity 15 m/s making an angle 'θ' with the horizontal. The velocity of the particle when it strikes the ground is (air friction is neglegted) (g = 10 m/s^2)



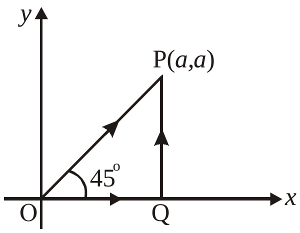
(1) 15 m/s
(2) 25 m/s
(3) 30 m/s
(4) 10 m/s

6. A block of mass m is pulled by a constant power 'P' placed on a rough horizontal plane. The friction coefficient between the block and the surface is μ. Maximum velocity of the block will be

(1) $\frac{P}{\mu mg}$ (2) $\frac{\mu mg}{P}$

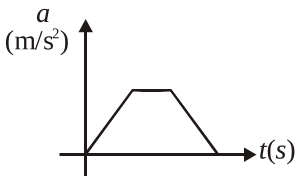
(3) $\frac{\mu P}{mg}$ (4) $\frac{P}{mg}$

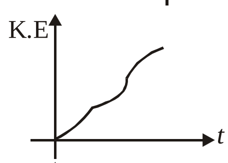
7. A particle is moved from (0,0) to (a,a) under a force $\vec{F} = (3\hat{i} + 4\hat{j})$ by two different paths. Path 1 is OP and path 2 is OQP. Let W_1 and W_2 be the work done by this force in these two paths. Then



(1) $W_1 = W_2$ (2) $W_1 = 2W_2$
(3) $W_2 = 2W_1$ (4) $W_1 = 4W_2$

8. Acceleration versus time graph of a particle moving in a straight line is as shown in figure. If initially particle was at rest, the corresponding kinetic energy versus time graph will be



(1)


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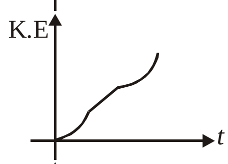

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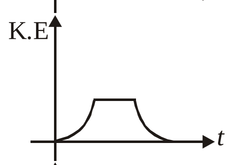

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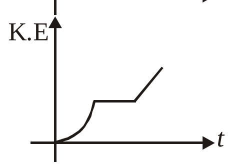
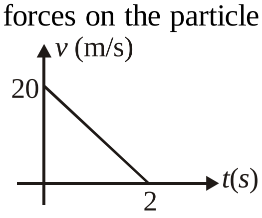


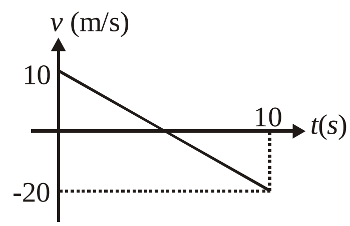
9. Velocity-time graph of particle of mass 2 kg moving in a straight line is as shown in figure. Work done by all the forces on the particle is



(1) 400 J
(2) –400 J
(3) –200 J
(4) 200 J

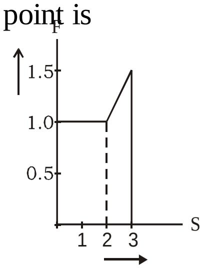
10. A force F acting on a body depends on its displacement S as $F \propto S^{-1/3}$. The power delivered will depend on displacement as
(1) $S^{2/3}$ (2) $S^{-5/3}$
(3) $S^{1/2}$ (4) S^0

11. Velocity-time graph of particle moving in a straight line is as shown in figure. Mass of the particle is 2 kg. Work done by the all the forces acting on the particle in time interval between $t = 0$ to $t = 10s$ is



(1) 300 J (2) –300 J
(3) 400 J (4) –400 J

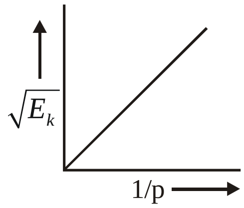
12. Figure shows force-distance graph of a particle moving along a straight line due north. The kinetic energy of the particle at a distance of 3 m from the starting point is

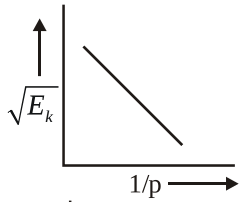


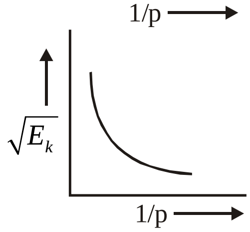
(1) 3.25 J
(2) 5.75 J
(3) 8.0 J
(4) 9.0 J

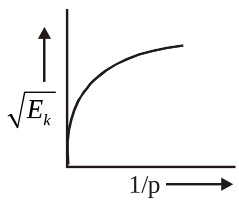
13. A man is holding a uniform rod of mass m and length L in the vertical direction keeping the lower end fixed at ground, he slowly allows the rod to become inclined at 30° wrt to horizontal. Work done by man and gravity are respectively.
(1) $\frac{mgL}{4}, \frac{mgL}{2}$ (2) $mgL, -mgL$
(3) $-\frac{mgL}{4}, \frac{mgL}{4}$ (4) $-\frac{mgL}{2}, \frac{mgL}{2}$

14. The graph between $\sqrt{E_k}$ and $\frac{1}{P}$ is (E_k = kinetic energy and P = momentum)

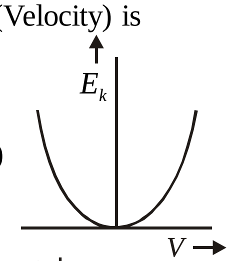
(1) 

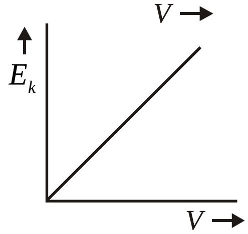
(2) 

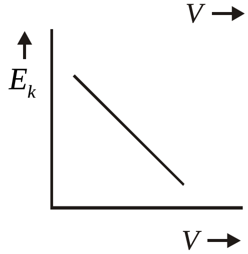
(3) 

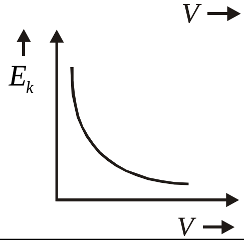
(4) 

15. The graph between E_k (Kinetic energy) and V (Velocity) is

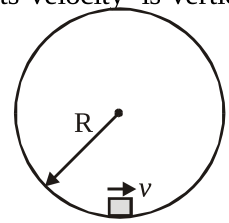
(1) 

(2) 

(3) 

(4) 

16. A particle is given an initial speed u inside and at the bottom of a smooth spherical shell of radius R = 1 m such that it is just able to complete a circular path inside it. Acceleration of the particle when its velocity is vertical is



(1) $g\sqrt{10}$

(2) g

(3) $g\sqrt{2}$

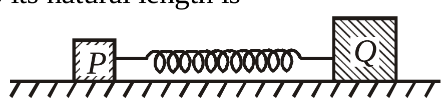
(4) $g\sqrt{6}$

17. A cannon of mass 2 m located at the base of an inclined plane shoots a shell of mass m in horizontal direction with velocity v_0. The angle of inclination of plane is 45° and the coefficient of friction between the cannon and the plane is 0.5. The height to which cannon ascends the plane as a result of recoil is

(1) $\frac{v_0^2}{2g}$ (2) $\frac{v_0^2}{12g}$

(3) $\frac{v_0^2}{6g}$ (4) $\frac{v_0^2}{g}$

18. Two blocks P and Q of mass m and $2m$ are connected by a massless spring of force constant k. They are placed on a smooth horizontal plane. Spring is stretched by an amount x and then released. The relative velocity of the blocks when the spring comes to its natural length is

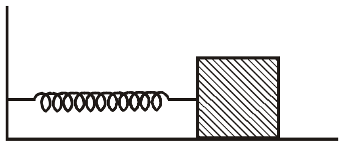


(1) $\left(\sqrt{\frac{3k}{2m}}\right)x$ (2) $\left(\sqrt{\frac{2k}{3m}}\right)x$

(3) $\left(\sqrt{\frac{2kx}{m}}\right)$ (4) $\left(\sqrt{\frac{3km}{2x}}\right)$

19. The spring shown in the figure has a force constant of 24N/m. The mass of the block attached to the spring is 4kg. Initially, the block is at rest and spring is unstretched. The horizontal surface is frictionless. If a constant horizontal force of 10N is applied on the block, then what is the speed of the block when it

has been moved through a distance of $\frac{1}{2}$ meter?



(1) 2 m/s (2) 1 m/s

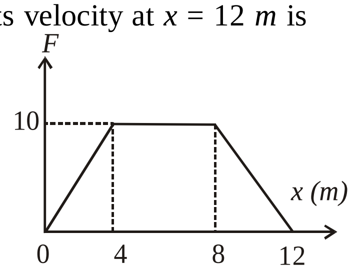
(3) zero (4) $\frac{1}{2}$ m/s

20. An elastic string of unstretched length l and force constant k is stretched by a small amount x. It is further stretched by another small length y. What is the work done in second stretching?

(1) $\frac{1}{2}ky^2$ (2) $\frac{1}{2}k\ (x^2+y^2)$

(3) $\frac{1}{2}k\ (y^2-x^2)$ (4) $\frac{1}{2}ky(2x+y)$

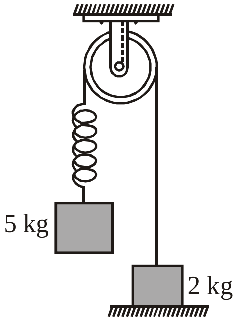
21. A particle of mass 0.1 kg is subjected to a force which varies with distance as shown in figure. If it starts its journey from rest at $x = 0$, its velocity at $x = 12\ m$ is



(1) zero (2) $20\sqrt{2}$ *m/s*

(3) $20\sqrt{3}$ *m/s* (4) 40 *m/s*

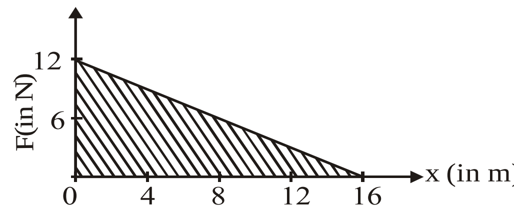
22. System shown in figure is released from rest. Pulley and spring is massless and friction is absent everywhere. The speed of 5 kg block when 2 kg block leaves the contact with ground is (Take force constant of spring k = 40 *N*/*m* and g = 10 m/s^2)



(1) $\sqrt{2}$ m/s (2) $2\sqrt{2}$ m/s

(3) 2 m/s (4) $4\sqrt{2}$ m/s

23. The graph below represents the relation between displacement x and force F. The work done in displacing an object from $x = 8$ m to $x = 16\ m$ *is* approximately :

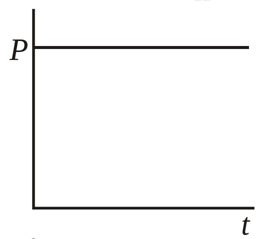


(1) 24 J (2) 40 J

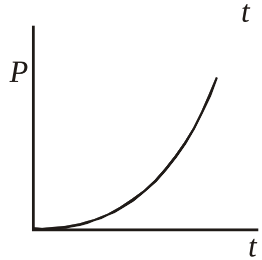
(3) 8 J (4) 16 J

24. A motor drives a body along a straight line with a constant force. The power P developed by the motor must vary with time t according to **[]**

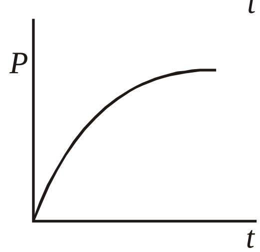
(1)



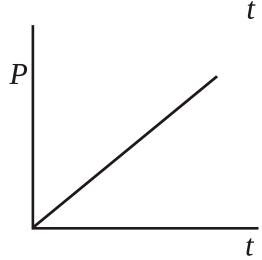
(2)



(3)



(4)



25. A chain is held on a frictionless table with one-third of its length hanging over the edge. If the chain has a length L and mass M, how much work is required to pull the hanging part back on the table

(1) MgL (2) $MgL/3$
(3) $MgL/9$ (4) $MgL/18$

26. A long spring is stretched by x cm its PE is U. If the spring is stretched by Nx cm the PE stored in it will be :
(1) U/N (2) NU
(3) N^2U (4) U/N^3

27. A particle moves along the x-axis from x = 5m under the influence of a force given by $F = 7 - 2x + 3x^2$. The work done in the process is :
(1) 70 (2) 270
(3) 35 (4) 135

28. A body is moved along a straight line by a machine delivering constant power. The distance moved by the body in time t is proportional to :
(1) $t^{1/2}$ (2) $t^{3/4}$
(3) $t^{3/2}$ (4) t^2

29. A force $\vec{F} = K\left(y\hat{i} + x\hat{j}\right)$ (where K is a positive constant) acts on a particle moving in the xy-plane. Starting from the origin, the particle is taken along the positive x-axis to the point (a, 0), and then parallel to the y-axis to the point (a,a). The total work done by the force $\vec{F}$ on the particle is :
(1) $-2ka^2$ (2) $2ka^2$
(3) $-ka^2$ (4) ka^2

30. The elastic potential energy of a spring

(1) increases only when it is stretched
(2) decreases only when it is stretched
(3) decreases only when it is compressed
(4) increases whether stretched or compressed

31. A stone tied to a string of length L is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at its lowest position, and has a speed u. The magnitude of the change in its velocity as it reaches a position where the string is horizontal is :
(1) $\sqrt{u^2 - 2gL}$ (2) $\sqrt{2gL}$
(3) $\sqrt{u^2 - gL}$ (4) $\sqrt{2\left(u^2 - gL\right)}$

32. A particle is displaced from a position $2\hat{i} - \hat{j} + \hat{k}$ to another position $3\hat{i} + 2\hat{j} - 2\hat{k}$ under the action of a force $2\hat{i} + \hat{j} - \hat{k}$. The work done by the force (in arbitrary units) is

(1) 8 (2) 10
(3) 12 (4) 36

33. Power applied to a particle varies with time as $p = (3t^2 - 2t + 1)$ watt, where 't' is in second. find the change in its K.E. between time interval t = 2 sec to t = 4 sec
[
(1) 32 J (2) 46 J
(3) 61 J (4) 102 J

34. A force F acting on a body depends on its displacement S as $F \propto S^{-1/3}$. The power delivered by F will depend on displacement as
(1) $S^{2/3}$ (2) $S^{1/2}$
(3) S (4) S^0

35. The upper half of an inclined plane with inclination ϕ is perfectly smooth while the lower half is rough. A body starting from rest at the top will again come to rest at the bottom if the coefficient of friction for the lower half is given by]
(1) 2 sin ϕ (2) 2 cos ϕ
(3) 2 tan ϕ (4) tan ϕ

36. A bullet fired into a fixed target loses half of its velocity after penetrating 3 cm.
How much further it will penetrate before coming to rest assuming that it faces constant resistance to motion ?
(1) 3.0 cm (2) 2.0 cm
(3) 1.5 cm (4) 1.0 cm

37. A body of mass m is accelerated uniformly from rest to a speed v in a time T. The instantaneous power delivered to the body as a function of time is given by

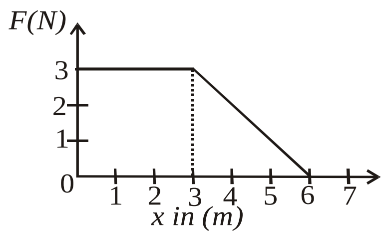
(1) $\frac{mv^2}{T^2}.t$ (2) $\frac{mv^2}{T^2}.t^2$

(3) $\frac{1}{2}\frac{mv^2}{T^2}.t$ (4) $\frac{1}{2}\frac{mv^2}{T^2}.t^2$

38. A bomb of mass 30 kg at rest explodes into two pieces of masses 18 kg and 12 kg. The velocity of 18 kg mass is 6 ms^{-1}. The kinetic energy of the other mass is

(1) 486 J (2) 524 J
(3) 256 J (4) 324 J

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



(1) 4.5 J (2) 18.0 J
(3) 13.5 J (4) 9.0 J

40. A block of mass 10 kg is moving in x-direction with a constant speed of 10 m/s. It is subjected to a retarding force $F = 0.1\ x$ joule/metre during its travel from $x = 20\ m$ to $x = 30\ m$. Its final K.E. will be
(1) 475 J (2) 450 J
(3) 275 J (4) 250 J

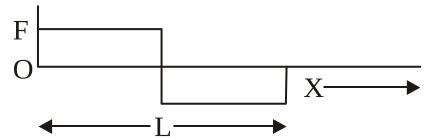
41. A body of mass 3 kg is under a constant force which causes a displacement s in metres in it, given by the relation $s = \frac{1}{3}t^2$, where t is in seconds. Work done by the force in 2 seconds is **[CBSE 2006]**

(1) $\frac{3}{8}$ J (2) $\frac{8}{3}$ J

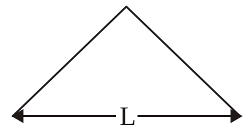
(3) $\frac{19}{5}$ J (4) $\frac{5}{19}$ J

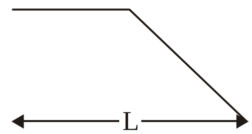
42. 300 J of work is done in sliding a 2 kg block up an inclined plane of height 10 m. Taking g = 10 m/s^2, work done against friction is
(1) 100 J (2) Zero
(3) 1000 J (4) 200

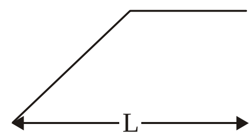
43. A person used force (F), shown in figure to move a load with constant velocity on given surface.



Identify the correct surface profile.

(1)


(2)


(3)


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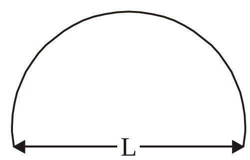


44. A vertical spring with force constant K is fixed on a table. A ball of mass m at a height h above the free upper end of the spring falls vertically on the spring so that the spring is compressed by a distance d. The net work done in the process is : **[**

(1) $m\,g\,(h - d) + \frac{1}{2}Kd^2$

(2) $m\,g\,(h + d) + \frac{1}{2}Kd^2$

(3) $m\,g\,(h + d) - \frac{1}{2}Kd^2$

(4) $m\,g\,(h - d) - \frac{1}{2}Kd^2$

45. A 2 kg block slides on a horizontal floor with a speed of 4 m/s. It strikes a uncompressed spring, and compresses it till the block is motionless. The kinetic friction force is 15 N and spring constant is 10,000 N/m. The spring compresses by

(1) 11.0 cm (2) 8.5 cm
(3) 5.5 cm (4) 2.5 cm

46. A body of mas 1 kg is thrown upwards with a velocity 20 m/s. It momentarily comes to rest after attaining a height of 18 m. How much energy is lost due to air friction? ($g = 1\ m/s^2$)

(1) 20 J (2) 30 J
(3) 40 J (4) 10 J

47. An engine pumps water continuously through a hose. Water leaves the hose with a velocity *v* and m is the mass per unit length of the water jet. What is the rate at which kinetic energy is imparted to water?

(1) $\frac{1}{2}mv^3$ (2) mv^3
(3) $\frac{1}{2}mv^2$ (4) $\frac{1}{2}m^2v^2$

48. A block of mass M is attached to the lower end of a vertical spring. The spring is hung from a ceiling and has force constant value k. The mass is released from rest with the spring initially unstretched. The maximum extension produced in the length of the spring will be

(1) Mg/k (2) 2 Mg/k
(3) 4 Mg/k (4) Mg /2k

49. A rain drop with radius 1.5 mm falls from a cloud at a height 1200 m from ground. The density of water is 1000 kg/m^3 and density of water is 1.2 kg/m^3 **(It should have been air instead of water)**. Assume the drop was spherical throughout the fall and there is no air drag. The impact speed of the drop will be:

(1) 27 km/h (2) 550 km/h
(3) Zero (4) 129 km/h

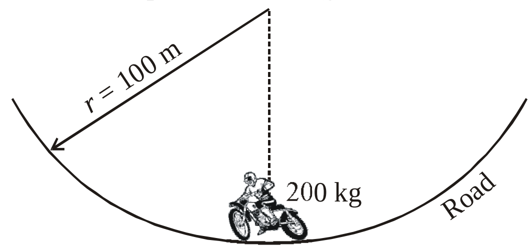
50. A ball moves in a frictionless inclined table without slipping. The work done by the table surface on the ball is
(1) Positive (2) Negative
(3) Zero (4) None of these

51. The string of a pendulum is of length *l*. It is made horizontal and then left. A nail is located at a distance d below the point of suspension. For the ball to completely swing around in a circle centred on the nail, the value of d in terms of length *l* is
(1) $0.5l$ (2) $0.6l$
(3) $0.4l$ (4) $0.25l$

52. A mass m moving horizontaly with velocity v_0 strikes a pendulum of mass m. If the two masses stick together after the collision, then the maximum height reached by the pendulum is

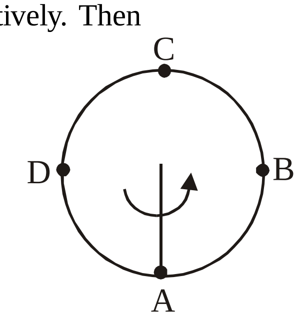
(1) $v_0^2/8g$ (2) $v_0^2/2g$
(3) $\sqrt{2v_0g}$ (4) $\sqrt{v_0g}$

53. A bike of mass 200 kg (with rider) is running on the road with constant speed 5 m/s, the reaction exerted on the bike by the road at the lowest point will be ($g = 10\ m/s^2$)



(1) 200 N (2) 2050 N
(3) 1950 N (4) None of these

54. A particle tied to one end of a string is being rotated in a vertical circle with constant frequency. The tension in the string at points , A, B, C and D are T_1, T_2, T_3 and T_4 respectively. Then



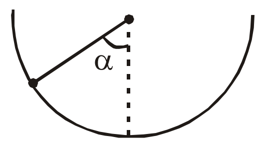
(1) $T_1 + T_2 = T_3 + T_4$
(2) $T_1 + T_3 = T_2 + = T_4$
(3) $T_1 > T_2 > T_3$, $T_2 = T_4$
(4) $T_1 < T_2 < T_3$, $T_2 = T_4$

55. A cord is tied to pail of water and the pail is swung in a vertical circle of radius 1 m. What must be the minimum velocity of the pail at the highest point of the circle if no water is to spill from the pail
(1) 3.13 ms^{-1} (2) 5 ms^{-1}
(3) 9.2 ms^{-1} (4) None of these

56. A body is moving in a circular path of radius r with uniform speed of V m/s. The average acceleration during on quarter of the motion is.

(1) $2\sqrt{2}\,(v^2/r)$ (2) $(v^2/r)\,2\sqrt{2}/\pi$
(3) zero (4) $2/(v^2/r)$

57. An insect crawls up a hemispherical surface very slowly, as shown in the figure. The coefficient of friction between the insect and the surface is 1/3. If the line joining the centre of the hemispherical surface to the insect makes an angle α with the vertical, the maximum possible value of α is given by



(1) $\cot\alpha = 3$
(2) $\sec\alpha = 3$
(3) $\operatorname{cosec}\alpha = 3$
(4) None of these

58. A particle of mass m_1 is moving with a velocity v_1 and another particle of mass m_2 is moving with a velocity v_2. Both of them have the same momentum but their different kinetic energies are E_1 and E_2 respectively. If $m_1 > m_2$, then

(1) $E_1 > E_2$ (2) $E_1 = E_2$
(3) $E_1 < E_2$ (4) $\frac{E_1}{E_2} = \frac{m_1}{m_2}$

59. A particle moves in a circular parth with decreasing speed. Choose the correct statements.

(1) Angular momentum remains constant.
(2) Acceleration ($\vec{a}$) is towards the centre
(3) Particle moves in a spiral path with decreasing radius
(4) The direction of angular momentum remains constant

60. A tube of length L is filled completely with an incompressible liquid of mass M and closed at both, the ends. The tube is then rotated in a horizontal plane about one of its ends with a uniform angular velocity ω. The force exerted by the liquid at the other end is

(1) $\frac{ML^2\omega}{2}$ (2) $ML^2\omega$
(3) $\frac{ML^2\omega^2}{2}$ (4) $\frac{ML\omega^2}{2}$

61. A body projected vertically from the earth reaches a height equal to earth's radius before returning to the earth. The power exerted by the gravitational force is greatest:

(1) It remains constant all through
(2) at the instant just after the body is projected
(3) at the highest position of the body
(4) at the instant just before the body hits the earth

62. The potential energy of a system increases work is done:

(1) by the system against a nonconservative force.
(2) upon the system by a conservative force.
(3) upon the system by a nonconservative force.
(4) by the system against a conservative force.

ANSWERS

1.	(3)	13.	(3)	25.	(4)	37.	(3)	49.	(2)
2.	(3)	14.	(3)	26.	(3)	38.	(1)	50.	(3)
3.	(2)	15.	(1)	27.	(4)	39.	(3)	51.	(1)
4.	(3)	16.	(1)	28.	(3)	40.	(1)	52.	(2)
5.	(2)	17.	(2)	29.	(4)	41.	(2)	53.	(2)
6.	(1)	18.	(1)	30.	(4)	42.	(1)	54.	(3)
7.	(1)	19.	(2)	31.	(1)	43.	(1)	55.	(1)
8.	(1)	20.	(4)	32.	(1)	44.	(3)	56.	(2)
9.	(2)	21.	(4)	33.	(2)	45.	(3)	57.	(1)
10.	(4)	22.	(1)	34.	(4)	46.	(1)	58.	(3)
11.	(1)	23.	(1)	35.	(3)	47.	(1)	59.	(4)
12.	(1)	24.	(1)	36.	(4)	48.	(2)	60.	(4)
								61.	(4)
								62.	(4)