WORK POWER ENERGY

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

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

(3) $\tan^{-1}\left(\frac{1}{2}\right)$ (4) $2\tan^{-1}\left(\frac{1}{\sqrt{5}}\right)$

2. The potential energy function (in J) of a particle in a region of space is given as $U = (2x^2 + 3y^3 + 2z)$. Here x, y and z are in meter. The magnitude of x - component of force (in N) acting on the particle at point P (1, 2, 3) m is :

(1) 2 (2) 6

(3) 4 (4) 8

3. A block of mass 100 kg slides over a distance of 10 m on a horizontal surface. If the co-efficient of friction between the surfaces is 0.4, then the work done against friction (in J) is :

(1) 4200 (2) 3900

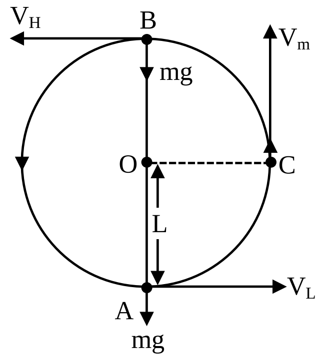
(3) 4000 (4) 4500

4. The bob of a pendulum was released from a horizontal position. The length of the pendulum is 10m. If it dissipates 10% of its initial energy against air resistance, the speed with which the bob arrives at the lowest point is : [Use, g : 10 ms^{-2}]

(1) $6\sqrt{5}\ ms^{-1}$ (2) $5\sqrt{6}\ ms^{-1}$

(3) $5\sqrt{5}\ ms^{-1}$ (4) $2\sqrt{5}\ ms^{-1}$

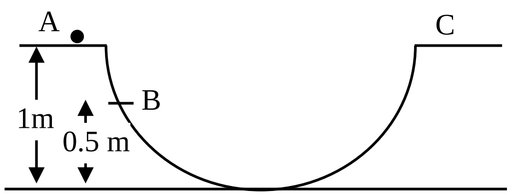
5. A bob of mass 'm' is suspended by a light string of length 'L'. It is imparted a minimum horizontal velocity at the lowest point A such that it just completes half circle reaching the top most position B. The ratio of kinetic energies $\frac{(K.E.)_A}{(K.E.)_B}$ is :



(1) 3 : 2 (2) 5 : 1

(3) 2 : 5 (4) 1 : 5

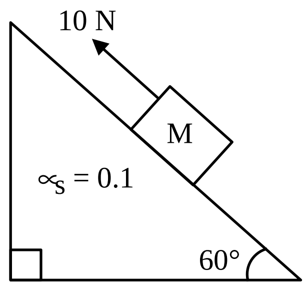
6. A particle is placed at the point A of a frictionless track ABC as shown in figure. It is gently pushed toward right. The speed of the particle when it reaches the point B is :
(Take g = 10 m/s^2).



(1) 20 m/s (2) $\sqrt{10}$ m / s

(3) $2\sqrt{10}$ m / s (4) 10 m/s

7. A block of mass 1 kg is pushed up a surface inclined to horizontal at an angle of 60° by a force of 10 N parallel to the inclined surface as shown in figure. When the block is pushed up by 10 m along inclined surface, the work done against frictional force is : [g = 10 m/s^2]



(1) $5\sqrt{3}$ J (2) 5 J

(3) 5×10^3 J (4) 10 J

8. A body of mass 2 kg begins to move under the action of a time dependent force given by $F = \left(6t\,\hat{i} + 6t^2\,\hat{j}\right)N$. The power developed by the force at the time t is given by:

(1) $\left(6t^4 + 9t^5\right)W$ (2) $\left(3t^3 + 6t^5\right)W$

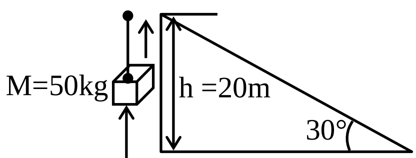
(3) $\left(9t^5 + 6t^3\right)W$ (4) $\left(9t^3 + 6t^5\right)W$

9. If a rubber ball falls from a height h and rebounds upto the height of h/2. The percentage loss of total energy of the initial system as well as velocity ball before it strikes the ground, respectively, are :

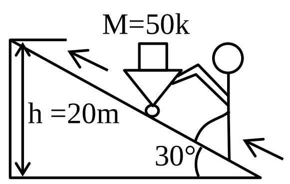
(1) 50%, $\sqrt{\frac{gh}{2}}$ (2) 50%, $\sqrt{gh}$

(3) 40%, $\sqrt{2gh}$ (4) 50%, $\sqrt{2gh}$

10. A body of mass 50 kg is lifted to a height of 20 m from the ground in the two different ways as shown in the figures. The ratio of work done against the gravity in both the respective cases, will be:



Case-1: Pulled straight up



Case-2: Along the ramp

(1) 1 : 1   (2) 2 : 1

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

11. A body is moving unidirectionally under the influence of a constant power source. Its displacement in time t is proportional to :

(1) t^2 (2) $t^{2/3}$

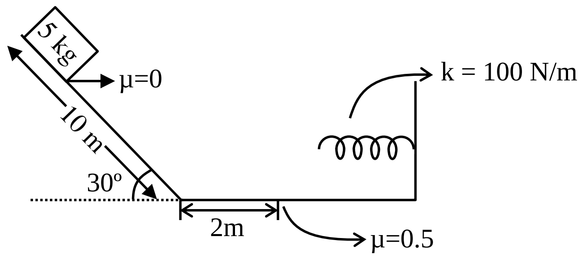
(3) $t^{3/2}$ (4) t

12. A bullet of mass 50 g is fired with a speed 100 m/s on a plywood and emerges with 40 m/s. The percentage loss of kinetic energy is :

(1) 32%   (2) 44%

(3) 16%   (4) 84%

13. A block is simply released from the top of an inclined plane as shown in the figure above. The maximum compression in the spring when the block hits the spring is :



(1) $\sqrt{6}$m   (2) 2 m

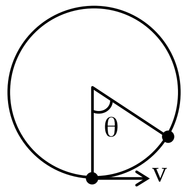
(3) 1 m   (4) $\sqrt{5}$m

14. A force $(3x^2 + 2x - 5)$ N displaces a body from x = 2 m to x = 4m. Work done by this force is …………J.

SOLUTIONS

1. Ans. (2)

Sol.



Loss in kinetic energy = Gain in potential energy

$$\Rightarrow \frac{1}{2}mv^2 = mg\ (1 - \cos\theta)$$

$$\Rightarrow \frac{v^2}{\ } = 2g(1 - \cos\theta)$$

Acceleration at lowest point = $\frac{v^2}{\ }$

Acceleration at extreme point = gsinθ

Hence, $\frac{v^2}{\ } = g\sin\theta$

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

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

2. Ans. (3)

Sol. Given U = $2x^2 + 3y^3 + 2z$

$$F_x = -\frac{\partial U}{\partial x} = -4x$$

At x = 1 magnitude of F_x is 4N

3. Ans. (3)

Sol. Given m = 100 kg

s = 10 m

∝ = 0.4

As f = ∝mg = 0.4 × 100 × 10 = 400 N

Now W = f.s = 400 ×10 = 4000 J

4. Ans. (1)

Sol. = 10 m,

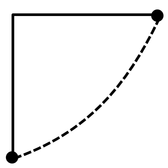
Initial energy = mg

So, $\frac{9}{10}mg = \frac{1}{2}mv^2$

$$\Rightarrow \frac{9}{10} \cdot 10 \cdot 10 = \frac{1}{2}v^2$$

$v^2 = 180$

$v = \sqrt{180} = 6\sqrt{5}\ m/s$



5. Ans. (2)

Sol. Apply energy conservation between A & B

$$\frac{1}{2}mV_L^2 = \frac{1}{2}mV_H^2 + mg(2L)$$

$\because V_L = \sqrt{5gL}$

So, $V_H = \sqrt{gL}$

$$\frac{(K.E)_A}{(K.E)_B} = \frac{\frac{1}{2}m\left(\sqrt{5gL}\right)^2}{\frac{1}{2}m\left(\sqrt{gL}\right)^2} = \frac{5}{1}$$

6. Ans. (2)

Sol. By COME

$KE_A + U_A = KE_B + U_B$

$$0 + mg(1) = \frac{1}{2}mv^2 + mg \cdot 0.5$$

$v = \sqrt{g} = \sqrt{10}\ m/s$

7. Ans. (2)

Sol. Work done again frictional force

$= \propto N \cdot 10$

$= 0.1 \cdot 5 \cdot 10 = 5J$

8. Ans. (4)

Sol. $F = \left(6t\,\hat{i} + 6t^2\,\hat{j}\right)N$

$$F = ma = \left(6t\hat{i} + 6t^2\hat{j}\right)$$

$$a = \frac{F}{m} = \left(3t\hat{i} + 3t^2\hat{j}\right)$$

$$v = \int_0^t a\,dt = \frac{3t^2}{2}\hat{i} + t^3\hat{j}$$

$$P = F.v = \left(9t^3 + 6t^5\right)W$$

9. Ans. (4)

Sol. Velocity just before collision = $\sqrt{2gh}$

Velocity just after collision = $\sqrt{2g\left(\frac{h}{2}\right)}$

$$\therefore \Delta\ KE = \frac{1}{2}m(2gh) - \frac{1}{2}mgh$$

$$= \frac{1}{2}mgh$$

∴ % loss in energy

$$= \frac{\Delta KE}{KE_i} \cdot 100 = \frac{\frac{1}{2}mgh}{\frac{1}{2}mg2h} \cdot 100 = 50\%$$

Hence option (4)

10. Ans. (1)

Sol. Work done by gravity is independent of path. It depends only on vertical displacement so work done in both cases will be same.

Option (1) is correct

11. Ans. (3)

Sol. P = costant ⇒ FV = constant

$$\Rightarrow m\frac{dV}{dt}V = \text{constant}$$

$$\int_0^V VdV = (C)\int_0^t dt \;;\; \left(\frac{V^2}{2}\right) = Ct$$

$$V \propto t^{1/2} ; \frac{ds}{dt} \propto t^{1/2}$$

$$\int_0^S ds = K\int_0^t t^{1/2}dt$$

$$S = K\cdot\frac{2}{3}t^{3/2}$$

$$S \propto t^{3/2}$$

∴ displacement is proportional to $(t)^{3/2}$

12. Ans. (4)

Sol. $K_i = \frac{1}{2}m(100)^2 ;\; K_f = \frac{1}{2}m(40)^2$

$$\%\text{loss} = \frac{|K_f - K_i|}{K_i} \times 100$$

$$= \frac{\left|\frac{1}{2}m(40)^2 - \frac{1}{2}m(100)^2\right|}{\frac{1}{2}m(100)^2}\cdot 100$$

$$= \frac{|1600 - 100\cdot 100|}{100} = 84\%$$

13. Ans. (2)

Sol. $w_g + w_{Fr} + w_s = \Delta KE$

$$5 \times 10 \times 5 - 0.5 \times 5 \times 10 \times x - \frac{1}{2}Kx^2 = 0 - 0$$

$$250 = 25x + 50x^2$$

$$2x^2 + x - 10 = 0$$

$$x = 2$$

14. Ans. (58)

Sol. $W = \int_{x_1}^{x_2} Fdx \;;\; W = \int_2^4 (3x^2 + 2x - 5)dx$

$$W = \left[x^3 + x^2 - 5x\right]_2^4$$

$$W = [60 - 2]J = 58J$$