WORK, POWER & ENERGY

1. A force acts on a 2 kg object so that its position is given as a function of time as $x = 3t^2 + 5$. What is the work done by this force in first 5 seconds ?

(1) 850 J (2) 900 J

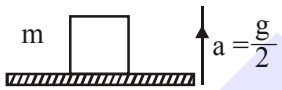
(3) 950 J (4) 875 J

2. A particle which is experiencing a force, given by $\vec{F} = 3\vec{i} - 12\vec{j}$, undergoes a displacement of $\vec{d} = 4\vec{i}$. If the particle had a kinetic energy of 3 J at the beginning of the displacement, what is its kinetic energy at the end of the displacement ?

(1) 15 J (2) 10 J

(3) 12 J (4) 9 J

3. A block of mass m is kept on a platform which starts from rest with constant acceleration g/2 upward, as shown in fig. Work done bv normal reaction on block in time t is :



(1) 0 (2) $\frac{3mg^2t^2}{8}$

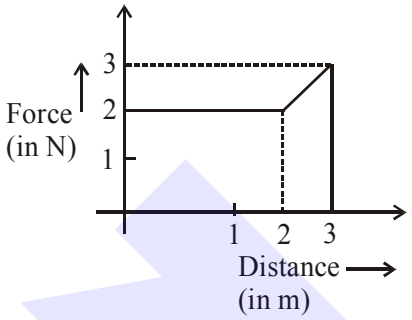
(3) $-\frac{mg^2t^2}{8}$ (4) $\frac{mg^2t^2}{8}$

4. A body of mass 1 kg falls freely from a height of 100 m on a platform of mass 3 kg which is mounted on a spring having spring constant $k = 1.25 \times 10^6$ N/m. The body sticks to the platform and the spring's maximum compression is found to be x. Given that $g = 10\ ms^{-2}$, the value of x will be close to :

(1) 4 cm (2) 8 cm

(3) 80 cm (4) 40 cm

5. A particle moves in one dimension from rest under the influence of a force that varies with the distance travelled by the particle as shown in the figure. The kinetic energy of the particle after it has travelled 3m is :



(1) 6.5 J (2) 2.5 J

(3) 4 J (4) 5 J

6. A uniform cable of mass 'M' and length 'L' is placed on a horizontal surface such that its $\left(\frac{1}{n}\right)^{th}$ part is hanging below the edge of the surface. To lift the hanging part of the cable upto the surface, the work done should be :

(1) $\frac{MgL}{n^2}$ (2) $\frac{MgL}{2n^2}$

(3) $\frac{2MgL}{n^2}$ (4) nMgL

SOLUTION

1. Ans. (2)

$x = 3t^2 + 5$

$v = \frac{dx}{dt}$

$v = 6t + 0$

at $t = 0$ $\quad v = 0$

$t = 5$ sec $\quad v = 30$ m/s

W.D. $= \Delta KE$

$\text{W.D.} = \frac{1}{2}mv^2 - 0 = \frac{1}{2}(2)(30)^2 = 900J$

2. Ans. (1)

Work done $= \vec{F}\cdot\vec{d}$

$= 12J$

work energy theorem

$w_{net} = \Delta K.E.$

$12 = K_f - 3$

$K_f = 15J$

3. Ans. (2)

$N - mg = \frac{mg}{2} \Rightarrow N = \frac{3mg}{2}$

Now, work done $W = \vec{N}\vec{S} = \left(\frac{3mg}{2}\right)\left(\frac{1}{2}gt^2\right)$

$\Rightarrow W = \frac{3mg^2t^2}{4}$

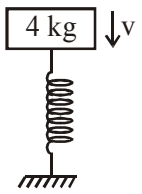
4. Ans. (Bonus)

According to JEE-Mains Ans. key (Bonus)

Velocity of 1 kg block just before it collides with 3kg block $= \sqrt{2gh} = \sqrt{2000}$ m/s

Applying momentum conversation just before and just after collision.

$1\times\sqrt{2000} = 4v \Rightarrow v = \frac{\sqrt{2000}}{4}$ m/s



initial compression of spring

$1.25 \times 10^6\, x_0 = 30 \Rightarrow x_0 \approx 0$

applying work energy theorem,

$W_g + W_{sp} = \Delta KE$

$\Rightarrow 40 \times x + \frac{1}{2}\times 1.25\times 10^6(0^2 - x^2)$

$= 0 - \frac{1}{2}\times 4\times v^2$

solving $x \approx 2$ cm

5. Ans. (1)

Sol. According to work energy theorem

Work done by force on the particle = Change in KE

Work done = Area under F-x graph

$= \int F.dx$

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

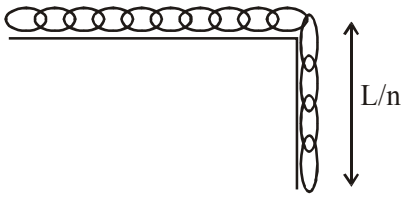
$W = KE_{final} - KE_{initial} = 6.5$

$KE_{initial} = 0$

$KE_{final} = 6.5$ J

6. Ans. (2)

Sol. Mass of the hanging part $= \frac{M}{n}$



$h_{COM} = \frac{L}{2n}$

work done

$W = mgh_{COM} = \left(\frac{M}{n}\right)g\left(\frac{L}{2n}\right) = \frac{MgL}{2n^2}$

Option (2)