H.W-04

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Section : 10

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Question - 01

(a) $W = \vec{F}.\vec{d}$

$= Fd\cos\theta = Fd\cos(30^\circ) = 0.866\, Fd,$

which is positive. So, positive work is done by the constant force. (Ans).

(b) $W = \vec{F}.\vec{d}$

$= Fd\cos\theta = Fd\cos(100^\circ) = -0.174\, Fd,$

which is negative. So, negative work is done by the constant force. (Ans).

(c) If, $\vec{F} = 2\hat{i} - 3\hat{j}$ and $\vec{d} = -4\hat{i}$

$\therefore W = \vec{F}\vec{d} = F_x dx + F_y dy = 2.(-4) + (-3).0$

$= -8\ J$

(Ans).

Question-02

We know,

$$W = KE - KE_i$$

$$W = \int_{x_i}^{x_f} F(x)\,dx$$

So,

$$\int_{x_i}^{x_f} F_1(x)\,dx = KE - KE_i$$

$$\Rightarrow \int_0^3 (cx - 3.00x^2)\,dx = 11 - 20$$

$$\Rightarrow \int_0^3 (cx - 3x^2)\,dx = -9$$

$$\Rightarrow \left[c\frac{x^2}{2} - x^3\right]_0^3 = -9$$

$$\Rightarrow \left[\left[c.\frac{(3)^2}{2} - (3)^3\right] - \left[c.\frac{(0)^2}{2} - (0)^3\right]\right] = -9$$

$$\Rightarrow \frac{9}{2}C - 27 - 0 = -9$$

$$\Rightarrow \frac{9}{2}C = 18$$

$$\Rightarrow C = 18 \times \frac{2}{9}$$

$$\therefore C = 4\,Nm^{-1}$$

(Ans).

Question -03

Given,

$U = 25J$

$x = 7.5cm = \frac{7.5}{100} m = 0.075m$

We know,

$$U = \frac{1}{2}kx^2$$

$$\Rightarrow k = \frac{2U}{x^2}$$

$$\Rightarrow k = \frac{2 \times 25}{(0.075)^2}\,Nm^{-1}$$

$$\therefore k = 8.89 \times 10^3\,Nm^{-1}$$ (Ans).

Question - 04

(a) Since, the force acting on the particle is conservative, the mechanical energy is conserved.

Given,

$U_A = 9.00J = 9J.$

$U_C = 20.00J = 20J.$

$U_D = 24.00J = 24J.$

$m = 0.200kg. = 0.2kg.$

$x = 3.5m.$

$\therefore ME_b = U_b + K_b = 12J + 4J = 16J$

When,

$x = 3.5m, \quad U_A = 9J.$

$\therefore K_A = ME_A - U_A = 16 - 9J = 7J$

So,

$$K_A = \frac{mv_A^2}{2}$$

$$\Rightarrow V_A^2 = \frac{2K_A}{m}$$

$$\Rightarrow V_A = \sqrt{\frac{2K_A}{m}}$$

$$\Rightarrow V_A = \sqrt{\frac{2 \times 7}{0.2}}\ ms^{-1}$$

$$\therefore V_A = 8.37\ ms^{-1}$$

(Ans).

(b) At the turning, the speed of the particle is zero. By proportional triangles on the right side:

$$\frac{16-0}{x_R - 7} = \frac{24-16}{8-x_R}$$

$$\Rightarrow \frac{16}{x_R - 7} = \frac{8}{8-x_R}$$

$$\Rightarrow 8x_R - 56 = 128 - 16x_R.$$

$$\Rightarrow 24x_R = 184$$

$$\Rightarrow x_R = \frac{184}{24} \text{ m}$$

$$\therefore x_R = 7.67 \text{ m}.$$

(Ans).

(C) By proportional triangles on the left side :

$$\frac{16-20}{x_L - 1} = \frac{9-16}{3-x_L}.$$

$$\Rightarrow \frac{-4}{x_L - 1} = \frac{-7}{3-x_L}$$

$$\Rightarrow -12 + 4x_L = -7x_L + 7.$$

$$\Rightarrow 11x_L = 19.$$

$$\Rightarrow x_L = \frac{19}{11} \text{ m}.$$

$$\therefore x_L = 1.73 \text{ m}$$ (Ans).

Question-05

(a) $W = \vec{F} \cdot \vec{d} = Fd\cos\theta = (7.68).(4.06).\cos(15^\circ).$

$= (7.68).(4.06).(0.966).$

$= 30.118 J$

(Ans).

(b). Since the block moves with constant speed then the pulling force is equal to the friction force.

$\therefore \Delta E_{th} = W = 30.118 J.$

(c). The coefficient of kinetic friction,

$F\cos\theta = \mu_k[mg - F\sin\theta]$

$\Rightarrow \mu_k = \dfrac{F\cos\theta}{mg - F\sin\theta}.$

$$\Rightarrow \mu_g = \frac{(7.68).\cos(15^\circ)}{(3.57).(9.8)-(7.68).\sin(15^\circ)}$$

$$\therefore \mu_g = 0.22$$

(Ans).