ASSIGNMENT 4

PHY 111

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sec : 17

Ans to the qr no 1(a)

Work done by friction = $\mu_k m g x$

distance, x = 8 cm = 0.08 m

coefficient of kinetic friction, μ_K = 0.12

Mass of block, M = 2.3 kg

$\therefore \mu_K m g x = (0.12 \times 2.3 \times 9.8 \times 0.08)$ J

$= 0.216$ J

$\therefore$ work done by friction on the block of mass M 0.216 J

Ans to the qr no 1 (b)

Change of potential energy = $2Mgh$

height, $h = 8\,cm = 0.08\,m$

work done by friction, $= \mu_k mgh$

reserved potential energy of spring $= \frac{1}{2}kh^2$

$\therefore$ kinetic energy, $E_k = 2Mgh - \frac{1}{2}kh^2 - \mu_k mgh$

$\Rightarrow E_k = (2 \times 2.3 \times 9.8 \times 0.08) - \{\frac{1}{2} \times 180 \times (0.08)^2\} - (0.12 \times 2.3 \times 9.8 \times 0.08)$

$\Rightarrow E_k = (3.6064 - 0.576 - 0.216384)$

$\Rightarrow E_k = 2.814\ J$

$\therefore$ The combined kinetic energy of the two blocks when the hanging block has fallen 8 cm is, $E_k = 2.814\ J$.

Ans to the qr no 1 (c)

According to the energy conservation principal at any distance coverd by block M or 2M, the following equation should hold,

$$\frac{1}{2}Kx^2 + \mu_K Mgx + \frac{1}{2}(2M)v^2 + \frac{1}{2}Mv^2 = 2Mgx$$

$$\Rightarrow \frac{1}{2}Kx^2 + (\mu_K Mg - 2Mg)x + \frac{1}{2}(2M)v^2 + \frac{1}{2}Mv^2 = 0$$

$\Rightarrow$ When the bigger block momentarily stops v becomes zero.

$$\therefore \frac{1}{2}Kx^2 + (\mu_K Mg - 2Mg)x + 0 + 0 = 0$$

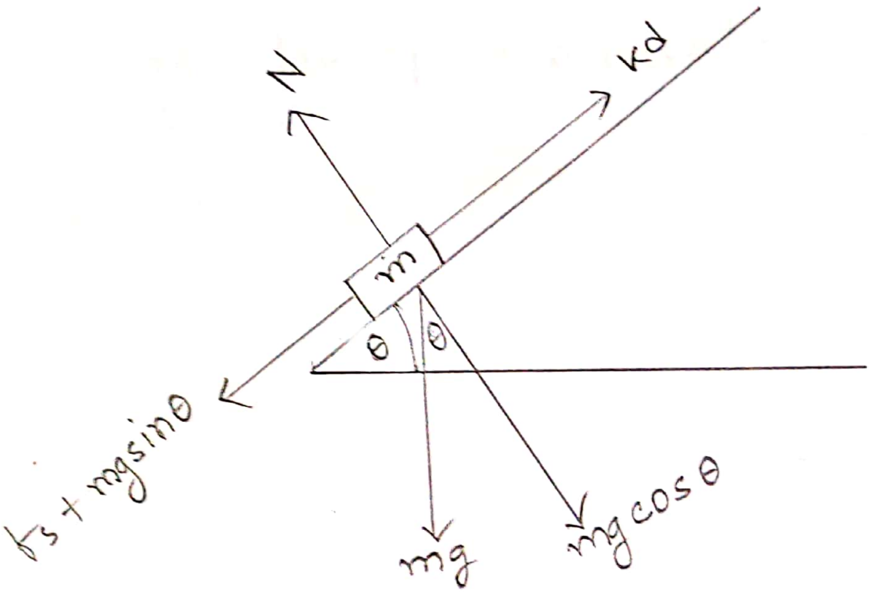
$$\Rightarrow x = 0 \quad \text{or} \quad x = \frac{2Mg(2 - \mu_K)}{K}$$

$$\Rightarrow x = \frac{2 \times 2.3 \times 9.8 (2 - 0.12)}{180}$$

$$\Rightarrow x = 0.45 \text{ m}$$

$\therefore$ maximum distance 0.45 m $= 950$ cm

Ans to the qr no 2(a)



From the above figure we get,

Normal force, $N = mg\cos\theta$

∴ Force due to the static friction, $f_s = \mu_s N$

$= \mu_s mg\cos\theta$

At equilibrium,

$$kd = f_s + mg\sin\theta$$

$$\Rightarrow d = \frac{\mu_s mg\cos\theta + mg\sin\theta}{k}$$

∴ Expression for the extension d of the spring is, $d = \dfrac{\mu_s mg\cos\theta + mg\sin\theta}{k}$

Ans to the qr no 2 (b)

According to law of conservation of energy,
spring energy = potential energy + work done due to friction

$$\Rightarrow \frac{1}{2}kd^2 = mgh + f_k d$$

$$\Rightarrow \frac{1}{2}kd^2 = mgd\sin\theta + f_k d$$

$$\Rightarrow \frac{1}{2}kd = mg\sin\theta + f_k$$

$$\Rightarrow \frac{1}{2}kd = mg\sin\theta + \mu_k mg\cos\theta \quad [\because f_k = \mu_k N = mg\cos\theta]$$

$$\Rightarrow \frac{1}{2} \cdot d\left(\frac{\mu_s mg\cos\theta + mg\sin\theta}{d}\right) = mg\sin\theta + \mu_k mg\cos\theta$$

$$\Rightarrow \frac{1}{2}mg(\mu_s \cos\theta + \sin\theta) = mg(\sin\theta + \mu_k \cos\theta)$$

$$\Rightarrow \frac{1}{2}\mu_s\cos\theta = \frac{1}{2}\sin\theta + \mu_k\cos\theta$$

$$\Rightarrow \mu_k\cos\theta = \frac{1}{2}(\mu_s\cos\theta - \sin\theta)$$

$$\Rightarrow \mu_k = \frac{\mu_s\cos\theta - \sin\theta}{2\cos\theta}$$

$$\Rightarrow \mu_k = \frac{1}{2}(\mu_s - \tan\theta)$$

$$\therefore \mu_k = \frac{1}{2}(\mu_s - \tan\theta)$$