PHY 111
Assignment – 3 (Makeup)

1. A 45.0-kg girl is standing on a 150-kg plank. Both are originally at rest on a frozen lake that constitutes a frictionless, flat surface. The girl begins to walk along the plank at a constant velocity of 1.50 $\hat{i}$ m/s relative to the plank.

(a) What is the velocity of the plank relative to the ice surface? 6

(b) What is the girl's velocity relative to the ice surface? 4

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Assignment-3 (Bonus)

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② ⓐ ~~we know~~

$M_g = 45$

$V_{g|P} = 15$

$M_P = 150$

$$V_{g|I} = V_{g|P} + V_{P|I}$$

$$V_{g|I} = 1.5 + V_{P|I} \quad \text{--- (1)}$$

Now,

$$M_g V_{g|I} + M_P V_{P|I} = 0$$

$$45 V_{g|I} + 150 V_{P|I} = 0$$

$$V_{g|I} + \frac{150}{45} V_{P|I} = 0$$

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$$V_{g|I} + \frac{10}{3} V_{P|I} = 0 \quad \text{--- (2)}$$

From, (1) and (2) —

$$V_{g|I} + \frac{10}{3} V_{P|I} - V_{g|I} = 0 - 1.5 - V_{P|I}$$

$$\frac{10}{3} V_{P|I} = -1.5 - V_{P|I}$$

$$\frac{13}{3} v_{P/I} = -1.5$$

$$v_{P/I} = -1.5 \times \frac{3}{13}$$

$$= -0.346 \, ms^{-1}$$

Nagative sign means that, The plank is moving opposite to the girl.

∴ (a) valocity of plank relative to the ice surface is 0.346 ms^{-1}

(b) $V_{g/I} = ?$

From eqution (2) $\rightarrow$

$$V_{g/I} + \frac{10}{3} V_{P/I} = 0$$

$$V_{g/I} = -\frac{10}{3} V_{P/I} = \frac{-10}{3} \times (-0.346)$$

ans $= 1.15 ms^{-1}$

2. A 7.80-g bullet moving at 575 m/s strikes the hand of a superhero, causing the hand to move 5.50 cm in the direction of the bullet's velocity before stopping.

(a) Use work and energy considerations to find the average force that stops the bullet.

(b) Assuming the force is constant, determine how much time elapses between the moment the bullet strikes the hand and the moment it stops moving.

(a)

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(2) For bullet, $m = 7.8\,g = 7.8 \times 10^{-3}\,kg$

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$V_b = 575$

change position of hand, $\Delta x = 5.5\,cm$

$= 5.5 \times 10^{-2}\,m$

Now, considering work-energy th. →

$$\frac{1}{2} m v^2 = F x$$

$$\Rightarrow \frac{1}{2} m_b V_b^2 = F \Delta x$$

$$F = \frac{1}{2} \frac{M_b V_b^2}{\Delta x}$$

$$= \frac{7.80 \times 10^{-3} \times 575^2}{2 \times 5.50 \times 10^{-2}}$$

$= 23444.318\,N$ (Ans.)

(2) (b) we know,

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$$F \cdot \Delta t = mV$$

$$\Delta t = \frac{m_b V_b}{F}$$

$$= \frac{7.8 \times 10^{-3} \times 575}{F}$$

$$= \frac{7.8 \times 10^{-3} \times 575}{23444.3189}$$

$$= 1.91 \times 10^{-4} \text{ sec}$$

so the time to stop the bullet by superhero, $t = 1.9 \times 10^{-4}$ sec.

3. A 5.00-kg block is set into motion up an inclined plane with an initial speed of $v_i = 8.00$ m/s (Fig. 1). The block comes to rest after traveling $d = 3.00$ m along the plane, which is inclined at an angle of $\theta = 30.0°$ to the horizontal. For this motion, determine

(a) the change in the block's kinetic energy. 2

(b) the change in the potential energy of the block– Earth system, and 2

(c) the friction force exerted on the block (assumed to be constant). 3

(d) What is the coefficient of kinetic friction? 3

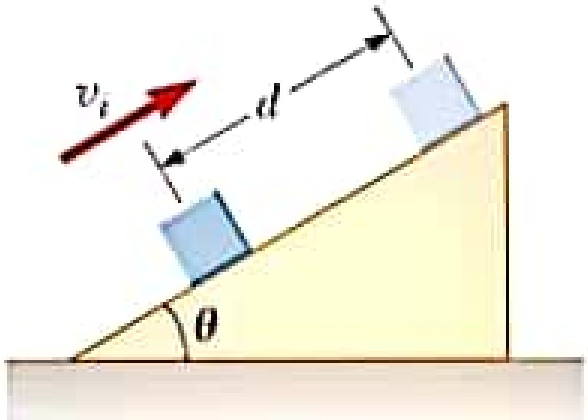
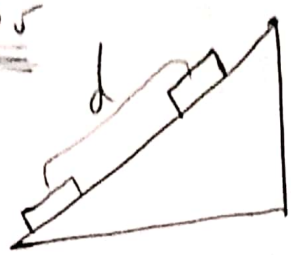


Fig. 1

Ans to Q-3:



$m = 5\ kg$

$V_1 = 8\ ms^{-1}$

$V_F = 0$

3(a) $d = 3$

Change of kinetic energy $= \frac{1}{2} m V_F^2 - \frac{1}{2} m V_i^2$

$= \frac{1}{2} m(0^2) - \frac{1}{2} m(8)^2$

$= -\frac{1}{2} \times 5 \times 64$

$= -160\ j$

(-) sign show → kinetic energy decrease.

③ (b) take at surface of earth, $E_p = 0$

at, h, $E_p = mgh$

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at hight $(h+d\sin\theta)$, E_p of block is

$$E_{P_F} = mg(h+d\sin\theta)$$

then change in E_p of block,

$$\Delta E_p = E_{P_s} - E_{P_i}$$

$$= mg(h+d\sin\theta) - mgh$$

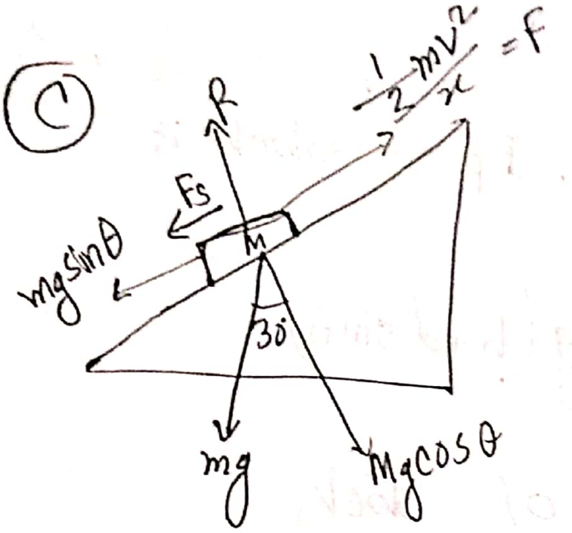
$$= mgd\sin\theta$$

$$= 5 \times 9.8 \times 3 \times \sin 30^\circ$$

$$= 73.5 \text{ J}$$

(+) sign says potential energy increases.

(c)



F_s = Frictional force

Now,

$$R = mg\cos\theta \quad \text{———} \quad (i)$$

$$\sum F = ma$$

$$\Rightarrow F - (mg\sin\theta + f_s) = 0 \quad [a=0]$$

$$\Rightarrow \frac{\frac{1}{2}mv^2}{x} = mg\sin\theta + f_s$$

$$\therefore F_s = \frac{1}{2}\frac{mv^2}{x} - mg\sin\theta$$

$$= \frac{1}{2}\frac{5\times 8^2}{3} - 5\times 9.8\times \sin 30^\circ$$

$$= 53.33 - 24.5$$

$$= 28.83\text{ N. } \text{Ans}$$

(d) Co-efficient of kinetic friction, $\mu_s = \frac{f_s}{R}$

$$= \frac{28.83}{mg\cos\theta}$$

$$= \frac{28.83}{42.843}$$

$$= 0.665$$

(Ans)