

1. (a) Distance = 12.0 m

Velocity = 4.50 m/s

Time = ?

$$\text{Time} = \frac{\text{Distance}}{\text{speed}}$$

$$= \frac{12}{4.5} = 2.6667$$

$$\approx 2.7$$

ANSWER

(b) We use the equation

$$S = Ut + \frac{1}{2}at^2$$

but our $U = 0 \Rightarrow Ut = 0$

$$\text{So, } S = \frac{1}{2}at^2$$

$$= \frac{1}{2} \times 9.8 \times 2.6666^2$$

$$= 34.844 \text{ m/s}$$

$$\approx 35 \text{ m}$$

ANSWER

2. Initial horizontal velocity

$$285 \cos 42$$

$$= 211.8 \text{ km/h}$$

Initial vertical velocity

$$285 \sin 42$$

$$= 190.7 \text{ km/h}$$

$$d = V_i t + \frac{1}{2}at^2$$

$$0 = 190.7t + \frac{1}{2}(-9.8)t^2$$

$$t = 38.9 \text{ sec}$$

Now, $d = V_i t + \frac{1}{2}at^2$

$$d = 211.8 \times 38.9 + \frac{1}{2}(0)t^2$$

$$= 8239 \text{ m}$$

$$= 8.2 \text{ km}$$

ANSWER

3. (a)

Initial vertical speed is given as

$$V_i = 128 \sin 60$$

$$= 110.9 \text{ m/s}$$

$$V_f = V_i + at$$

$$= 110.9 + (-9.8 \times 2)$$

$$= 91.3 \text{ m/s}$$

$$\approx 91 \text{ m/s}$$

3(b) Speed of projectile after two seconds

$$V_x = 128 \cos 60 \\ = 64$$

$$\Rightarrow \sqrt{(V_x)^2 + (V_y)^2} \\ = \sqrt{64^2 + 91.3^2}$$

$$= \sqrt{12431.69}$$

$$= 111.5 \text{ m/s}$$

$$\approx \underline{112 \text{ m/s}}$$

ANSWER

4. $AB = -8y$ (+x = east, +y = North)

$$BC = 0.848(-x - y)$$

$$CD = 0.354(-x + y)$$

Adding, $-1.202x - 8.494y$

So, $AD = \sqrt{1.202^2 + 8.494^2}$

$$= \sqrt{73.59284}$$

$$= 8.57 \text{ m/s}$$

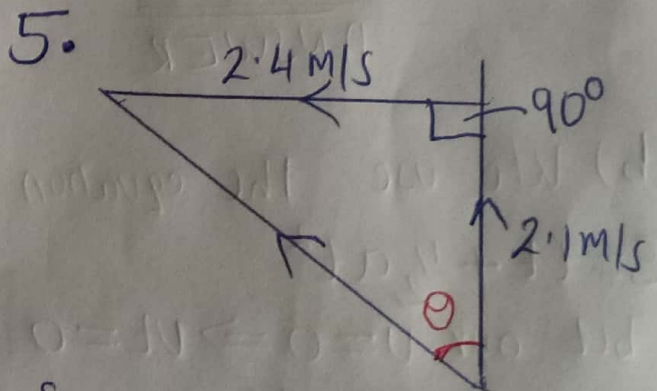
$$\approx \underline{8.6 \text{ m/s}} = \text{ANSWER}$$

$$\tan^{-1} \left(\frac{1.202}{8.494} \right)$$

$$= \tan^{-1} 0.141511655$$

$$\therefore \theta = 8.0^\circ$$

$$= \underline{8.0 \text{ degrees West of South.}} \quad \text{ANSWER}$$



So we find hypotenuse speed.

$$\Rightarrow \sqrt{2.1^2 + 2.4^2} \\ = \sqrt{10.17} \\ = 3.189 \text{ m/s.}$$

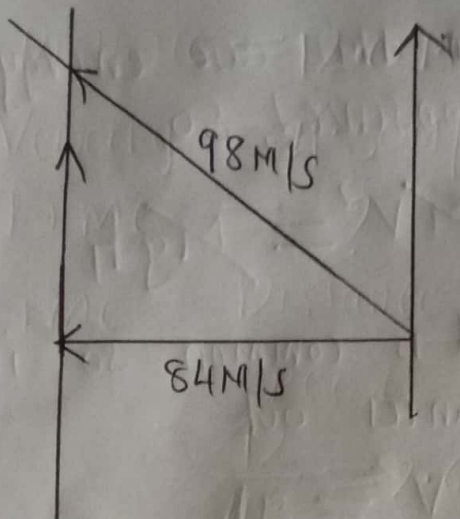
Next, we calculate the direction, given by angle θ .

$$\cos \theta = \frac{2.1}{3.189} = 0.6585$$

$$\cos^{-1} \theta = 48.8^\circ$$

$$\approx \underline{49^\circ \text{ W of N}} \\ \text{ANSWER}$$

6.



⇒ We calculate speed of the vertical line using Pythagoras theorem,

$$\Rightarrow \sqrt{98^2 - 84^2}$$

$$= \sqrt{2548}$$

$$= \underline{\underline{50.48 \text{ m/s}}}$$

North

ANSWER

7. Now, 15 N is at 90° to the string.

$$\Rightarrow F_g = Mg, \quad g = 9.8 \text{ m/s}^2$$

$$F_g = \text{Vertical Component} = H$$

$$\sin 32 = \frac{15}{H}, \quad H = \frac{15}{\sin 32}$$

$$= 28.3 \text{ N}$$

$$\text{Mass} = \frac{F_g}{g} = \frac{28.3}{9.8} = 2.88 \text{ kg}$$

$$\approx \underline{\underline{2.9 \text{ kg}}}$$

ANSWER

8.

$$\text{Load} \times 2.1 = 1.5 \times 50 \sin 30$$

$$\text{Load} = \frac{1.5 \times 50 \sin 30}{2.1}$$

$$= \frac{1.5 \times 25}{2.1}$$

$$= \underline{\underline{17.857 \text{ N}}}$$

ANSWER

9. Weight acts clockwise i.e.

$$W \cos 60 \times 1.5$$

Tension acts anti-clockwise

$$840 \times 2$$

This two balances, hence,

$$W \cos 60 \times 1.5 = 840 \times 2$$

$$W = \frac{840 \times 2}{1.5 \cos 60}$$

$$= 2240 \text{ N}$$

$$= \underline{\underline{2.24 \times 10^3 \text{ N}}}$$

ANSWER

$$10. \text{ Power} = \frac{\text{Work}}{\text{Time}}$$

$$\text{Power} = 6.0 \times 10^3 \text{ Watt}$$

$$\text{Work} = (5.0 \times 10^3 \times 9.8 \times 2.5)$$

$$= 122500 \text{ Joules}$$

$$\Rightarrow \text{Time} = \frac{\text{Work}}{\text{Power}}$$

$$= \frac{122500}{6000}$$

$$= 20.4 \text{ seconds}$$

$$\approx \underline{\underline{20 \text{ sec}}}$$

ANSWER

$$11. \text{ Work} = u F d$$

~~$$W = 500 \text{ N}$$~~

$$W = 1.5 \times 10^3 \text{ J}$$

$$F = 500 \text{ N}$$

$$d = 5 \text{ m}$$

$$\text{Now, } u = \frac{\text{Work}}{F d}$$

$$= \frac{1.5 \times 10^3}{500 \times 5}$$

$$= \frac{1500}{2500}$$

$$= \underline{\underline{0.6}}$$

ANSWER

~~13.~~

12. In this case energy is conserved, so,

~~$$\frac{1}{2} M V^2 = M g h$$~~

M is common so it cancel out

$$\frac{1}{2} V^2 = g h$$

$$\therefore V^2 = 2 g h$$

$$= 2 \times 9.81 \times 32$$

$$= 627.84$$

$$V = \sqrt{627.84} = 25.05 \text{ m/s}$$

$$\approx \underline{\underline{25 \text{ m/s}}}$$

ANSWER

13. Option a is the answer.
ie total energy, momentum
and translational kinetic energy.

$$14. \text{ Power} = \frac{\text{Work}}{\text{Time}}$$

$$\text{Work} = (60 \times 25 \times 9.81 \times 3)$$

$$= 44145 \text{ J}$$

$$\text{Time} = 49 \text{ sec}$$

$$\text{Power} = \frac{44145}{49}$$

$$= 900.9 \text{ Watts}$$

$$= \underline{\underline{9.0 \times 10^2 \text{ Watts}}}$$

ANSWER

15.

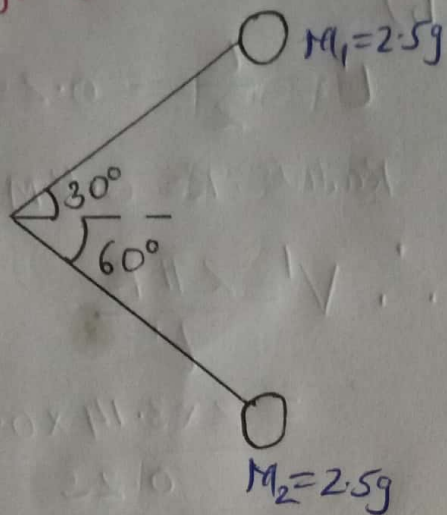
(a)

$$U_1 = 0.4 \text{ m/s}$$

$$M_1 = 2.5 \text{ g}$$

$$U_{12} = 0 \text{ m/s}$$

$$M_2 = 2.5 \text{ g}$$



$$M_1 U_1 + M_2 U_{12} = M_1 V_1 + M_2 V_2$$

Mass cancel out because it is common.

$$\Rightarrow U_1 + U_{12} = V_1 + V_2$$

$$\Rightarrow U_1 + U_{12} = V_1 \cos 30 + V_2 \cos 60$$

$$0.4 + 0 = V_1 \cos 30 + V_2 \cos 60$$

$$0.866 V_1 + 0.5 V_2 = 0.4 \dots \dots \textcircled{1}$$

$$\Rightarrow 0 = V_1 \sin 30 - V_2 \sin 60$$

$$0.5 V_1 - 0.866 V_2 = 0 \dots \dots \textcircled{2}$$

By solving equation 1 and 2 simultaneously,

$$\text{(b) } V_1 = 0.346 \text{ m/s}$$

$$\approx 0.35 \text{ m/s, } 30^\circ \text{ to incident direction}$$

ANSWER

$$\text{(c) } V_2 = 0.2 \text{ m/s, } 60^\circ \text{ to incident ball direction.}$$

ANSWER

16. The sum of momentum will be equal to zero.

Momentum of each piece

$$X \Rightarrow (6 \times 3) = 18 \text{ kgm/s}$$

$$Y \Rightarrow (1.5 \times 8) = 12 \text{ kgm/s}$$

Since X and Y are moving at 90° , we have,

$$\sqrt{18^2 + 12^2} = \sqrt{468} = 21.63$$

Now, the remaining Z must have this momentum but in the opposite direction.

$$\Rightarrow \cancel{21.63 \times 4} =$$

$$\frac{21.63}{4} = 5.4 \text{ m/s}$$

$$= \underline{5.4 \text{ m/s}}$$

ANSWER

17.

$$M_{xi} = (1.2 \times 6.8) = 8.16 \text{ kgm/s}$$

$$M_{yi} = (3.6 \times 4.2) = 15.12 \text{ kgm/s}$$

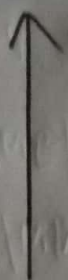
$$\theta_i = \tan^{-1} \left(\frac{M_{xi}}{M_{yi}} \right) = \frac{8.16}{15.12} = 28.4^\circ$$

But θ_i and θ_f are equal

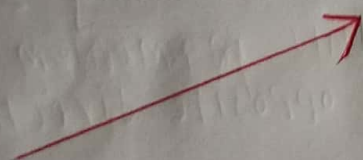
$$\underline{\underline{\theta_i = \theta_f = 28.4^\circ}}$$

ANSWER

18. Choice A



19. Choice B



20. Given,

$$m = 0.20 \text{ kg}$$

$$R = 0.8 \text{ m}$$

$$(a) T = 25 \text{ N}$$

$$\Rightarrow \frac{mv^2}{R} = 25$$

$$v = \sqrt{\frac{25 \times 0.8}{0.2}}$$

$$v = 10 \text{ m/s}$$

$$\text{Period } t = \frac{2\pi \cdot R}{v}$$

$$= \frac{2 \times 3.14 \times 0.8}{10}$$

$$= 0.5 \text{ sec}$$

ANSWER

(b)

$$t' = \frac{t}{2} = 0.25 \text{ sec}$$

$$\text{Radius, } R = 0.8 \text{ m}$$

$$\therefore v' = \frac{2\pi R}{t'}$$

$$= \frac{2 \times 3.14 \times 0.8}{0.25}$$

$$= 20 \text{ m/s}$$

Hence, tension in the string

$$T' = \frac{m(v')^2}{R} = \frac{0.2 \times 20^2}{0.8}$$

$$\Rightarrow T' = 100 \text{ N}$$

ANSWER

21. (a)

$$v = \sqrt{\frac{GM}{r}}$$

$$= 6.6$$

$$= \sqrt{\frac{6.67408 \times 10^{-11} \times 5.972 \times 10^{24}}{1.5 \times 10^4 \times 1000}}$$

$$= \sqrt{26571737.17}$$

$$= 5154.778$$

$$\approx 5200 \text{ m/s} \Rightarrow \text{ANSWER}$$

$$21(b) \quad g = \frac{GM_e}{r^2}$$

$$= \frac{6.67408 \times 10^{-11} \times 5.972 \times 10^{24}}{(1.5 \times 10^4 \times 1000)^2}$$

$$= 1.7714 \text{ m/s}^2$$

$$\approx 1.8 \text{ m/s}^2$$

ANSWER

21(c) No effect on the above results. This is because M will cancel out.

22. (a)

$$g = \frac{GM}{r^2}$$

$$= \frac{6.673 \times 10^{-11} \times 1.54 \times 10^{23}}{(2.64 \times 10^6)^2}$$

$$= 1.47 \text{ m/s}^2$$

ANSWER

$$(b) \quad V = \sqrt{\frac{2GM}{r}}$$

$$= \sqrt{\frac{2 \times 6.673 \times 10^{-11} \times 1.54 \times 10^{23}}{2.64 \times 10^6}}$$

$$= 2790 \text{ m/s}$$

$$\approx 2.79 \times 10^3 \text{ m/s}$$

ANSWER