

(Worksheet Solution For General Physics.

- ① Given

$$\text{Speed in (m/s)} = 38 \text{ m/s}$$

$$\text{Speed in (mi/hr)} = 75 \text{ mi/h}$$

Required

↳ compare speeds of car and argue that:-

$$\text{Yes, if } 38 \text{ m/s} > 75 \text{ mi/h}$$

$$\text{No, if } 38 \text{ m/s} \leq 75 \text{ mi/h}$$

SOLUTION: First convert mile to meter

$$1 \text{ mi} = 1.6 \text{ km}$$

$$75 \text{ mi} = x$$

$$\frac{1 \text{ mi} \cdot x}{1 \text{ mi}} = \frac{75 \text{ mi} \times 1.6 \text{ km}}{1 \text{ mi}}$$

$$x = 75 \times 1.6 \text{ km}$$

$$= 120 \text{ km} \dots \text{convert to meter}$$

$$1 \text{ km} = 1000 \text{ m}$$

$$120 \text{ km} = x$$

$$\frac{1 \text{ km} \cdot x}{1 \text{ km}} = \frac{120 \text{ km} \cdot 1000 \text{ m}}{1 \text{ km}}$$

$$x = \underline{\underline{120,000 \text{ m}}} = 75 \text{ mi}$$

↳ convert hour to seconds

$$1 \text{ hr} = 60 \text{ min} \dots \text{but}$$

$$1 \text{ min} = 60 \text{ s}$$

$$60 \text{ min} = x$$

$$\frac{1 \text{ min} \cdot x}{1 \text{ min}} = \frac{60 \text{ min} \times 60 \text{ s}}{1 \text{ min}}$$

$$x = \underline{\underline{3600 \text{ s}}}$$

↳ Now write in fraction form as:

$$75 \text{ mi/h} = \frac{120,000 \text{ m}}{3600 \text{ s}} = \underline{\underline{33.3 \text{ m/s}}}$$

↳ Now compare 33.3 m/s with 38 m/s .

$$38 \text{ m/s} > 33.3 \text{ m/s}, \text{ therefore}$$

$$38 \text{ m/s} > 75 \text{ mi/h}.$$

↳ Generally we conclude as:

$$\text{Yes, } 38 \text{ m/s} \text{ exceeding the car will move} \\ = \text{ with } 75 \text{ mi/h}$$

② Dimensional Expression for:

i) Energy: capacity to do work, but work

$$W = F \cdot d \quad \text{--- where } F \text{ is force}$$
$$d \text{ is displacement}$$

↳ Then dimensionally energy is defined as capacity of an exerted on an object to change the position of an object by some distance.

ii) Linear Momentum

↳ is symbolized by p is given by:

$$p = mv$$

↳ Then it can be expressed dimensionally as linear momentum is directly proportional to the velocity of an object. Since the mass of an object is kept constant.

iii) Power: Given by P is defined as

$$P = \frac{\Delta W}{\Delta t}$$

↳ Then dimensional expression of power is the rate of doing work.

③ How many significant figure do have?

a) 250.08

↳ can be written as 25.008×10^1 , in this expression zeros after point are not significant figure, therefore it have 3-significant figure

b) 0.200 → have only one significant figure

c) 12000 - can be written as 12×10^3
- it have two significant figure

d) 0.08043 - we can rewrite as 0.8043
- zeros b/n number are significant figure therefore, it have 4-significant figure

e) 45632 - all integers are considered as significant figure, therefore it have 5-significant figure.

④ → Eyo b measured the voltage resistor

$$R = 12.8 \Omega$$

→ John measured the resistor

$$R = 13 \Omega$$

consider $R = \frac{V}{I}$ but $V = 5.26 \text{ V}$
 $I = 0.41 \text{ A}$

→ The significant figure of Voltage is 3

→ The significant figure of current is 2

→ The significant figure of their quotient

R should be equal to the current's significant figure w/c is 2, then

$$R = \frac{V}{I} = \frac{5.26}{0.41} = \underline{\underline{13 \Omega}} \text{ have 2 s.f}$$

So that the John's Answer is true

⑤ ✓ The average velocity and instantaneous velocity are the same for an object moves linearly in a displacement-time plane

→ consider figure below

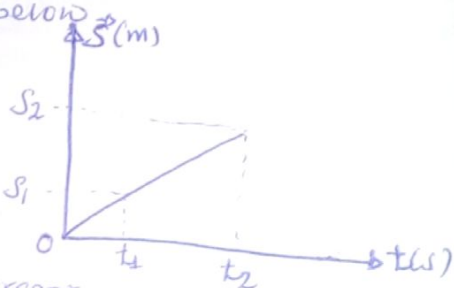
$$f(t) = at + b$$

where 'a' is the slope of $f(t)$

$$a = \frac{\Delta s}{\Delta t} = \frac{s_2 - s_1}{t_2 - t_1}$$

and 'b' is s intercept

$$b = \Delta s$$



→ $V_{av} = \frac{\Delta s}{\Delta t}$ and $V_{inst} = \lim_{\Delta t \rightarrow 0} f(t) = \lim_{\Delta t \rightarrow 0} (at + b)$

$$V_{av} = \frac{\Delta s}{\Delta t} \text{ \& } V_{inst} = \lim_{t \rightarrow 0} \left(\frac{d}{dt} f(t) \right) = \lim_{t \rightarrow 0} \left(\frac{d}{dt} (at + b) \right)$$

$$V_{inst} = \lim_{t \rightarrow 0} (a + 0) = a = \frac{\Delta s}{\Delta t}$$

$$V_{av} = V_{inst} = \frac{\Delta s}{\Delta t}$$

✓ The average & instantaneous acceleration of body is same, if it moves linearly in velocity-time plane (uniformly accelerated motion)

→ consider figure below

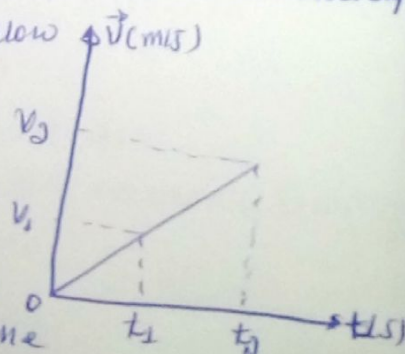
$$v(t) = at + b$$

where $a = \frac{\Delta v}{\Delta t}$ and

'b' is the velocity intercept $b = \Delta v$

→ it is also operated as above in s-t plane

$$a_{av} = a_{inst} = \frac{\Delta v}{\Delta t}$$



6) Given

$$A = 5\hat{i} + 3\hat{j}$$

$$B = -2\hat{i} + \hat{j}$$

Required

$$|A+B| = ?$$

$$\hat{U}_{A+B} = ?$$

Soln

$$A+B = (5\hat{i} + 3\hat{j}) + (-2\hat{i} + \hat{j})$$

$$= (3\hat{i} + 4\hat{j})$$

$$A+B = 3\hat{i} + 4\hat{j}$$

$$|A+B| = \sqrt{3^2 + 4^2}$$

$$= \sqrt{9+16}$$

$$= \sqrt{25}$$

$$= \underline{\underline{5}}$$

Unit Vector along $A+B$ is $\hat{U}_{A+B}$ is given as:

$$\hat{U}_{A+B} = \frac{A+B}{|A+B|} = \frac{3\hat{i} + 4\hat{j}}{5}$$

$$\hat{U}_{A+B} = \frac{3}{5}\hat{i} + \frac{4}{5}\hat{j}$$

7) Given

$$A = 2\hat{i} - 3\hat{j}$$

$$B = -3\hat{i} + 3\hat{j}$$

$$C = 6\hat{i} + 9\hat{j}$$

$$2A + bB + C = 0$$

Required

$$a \neq b$$

Solution

$$2A + bB + C = 0$$

Write vectors A, B, C in component form:

$$2(2, -3) + b(-3, 3) + (6, 9) = (0, 0)$$

$$(2a, -3a) + (-3b, 3b) + (6, 9) = (0, 0)$$

$$(2a - 3b + 6, -3a + 3b + 9) = (0, 0)$$

$$\left. \begin{array}{l} 2a - 3b + 6 = 0 \\ -3a + 3b + 9 = 0 \end{array} \right\}$$

$$+ \left. \begin{array}{l} 2a - 3b = -6 \\ -3a + 3b = -9 \end{array} \right\} \begin{array}{l} \text{Sum the two equations to get} \\ a \end{array}$$

$$-a + 0 = -15$$

$$-a = -15$$

$$a = 15$$

$$=$$

$$\hookrightarrow 2a - 3b = -6$$

$$2(15) - 3b = -6$$

$$30 - 3b = -6$$

$$-3b = -36$$

$$b = 12$$

<u>Given</u>	<u>Required</u>
$A = 3\hat{i} + 2\hat{j} - 5\hat{k}$	$ A + 2B = ?$
$B = \hat{i} + \hat{j} + 2\hat{k}$	

Solution

↳ For step 1 multiplying vector B with scalar 2.

$$2B = 2(\hat{i} + \hat{j} + 2\hat{k})$$

$$= 2\hat{i} + 2\hat{j} + 4\hat{k}$$

↳ find resultant of $A + 2B$

$$A + 2B = (3\hat{i} + 2\hat{j} - 5\hat{k}) + (2\hat{i} + 2\hat{j} + 4\hat{k})$$

$$= (3, 2, -5) + (2, 2, 4)$$

$$= (5, 4, -1)$$

$$= 5\hat{i} + 4\hat{j} - \hat{k}$$

↳ find the magnitude of $A + 2B$

$$|A + 2B| = \sqrt{5^2 + 4^2 + (-1)^2}$$

$$= \sqrt{25 + 9 + 1}$$

$$= \sqrt{35}$$

9) Given

$$A = 10 \rightarrow 0^\circ \quad B = 160^\circ \text{ --- } x\text{-axis}$$


Required

$$|A + B| = ?$$

angle w/c made b/w $A + B$ and positive x-axis

Solution

1) by resolving the given vectors

$$\vec{A} = A \cos \theta \hat{i} + A \sin \theta \hat{j}$$

$$= 10 \cos 0^\circ \hat{i} + 10 \sin 0^\circ \hat{j}$$

$$= 10(1) \hat{i} + 10(0) \hat{j}$$

$$= 10\hat{i}$$

$$\vec{B} = B \cos \theta \hat{i} + B \sin \theta \hat{j}$$

$$= B \cos 60^\circ \hat{i} + B \sin 60^\circ \hat{j}$$

$$= B \left(\frac{1}{2}\right) \hat{i} + B \left(\frac{\sqrt{3}}{2}\right) \hat{j}$$

$$= 4\hat{i} + 6.93\hat{j}$$

$$A + B = (10\hat{i}) + (4\hat{i} + 6.93\hat{j})$$

$$= (10, 0) + (4, 6.93)$$

$$= (14, 6.93)$$

$$= 14\hat{i} + 6.93\hat{j}$$

$$|A + B| = \sqrt{14^2 + 6.93^2}$$

$$= \sqrt{196 + 48.02}$$

$$= 15.62$$

Q10) Given that the magnitude of A and B are equal

$$\text{Let } |A| = |B|$$

Q11) Given that:

$$|A+B| = 2|A|$$

by using cosine law. The resultant vector magnitude $R = |A+B|$ is given by

$$R^2 = |A|^2 + |B|^2 - 2|A||B|\cos\theta$$

where θ is the angle made by the two vectors A and B, then solve for R.

$$R = \sqrt{|A|^2 + |B|^2 - 2|A||B|\cos\theta}$$

$$R^2 = |A|^2 + |B|^2 - 2|A||B|\cos\theta$$

$$|A+B|^2 = |A|^2 + |B|^2 - 2|A||B|\cos\theta$$

but we have $|A+B| = 2|A|$
substitute in above equation

$$[2|A|]^2 = |A|^2 + |B|^2 - 2|A||B|\cos\theta$$

$$\dots \text{but } |A| = |B|$$

$$(2|A|)^2 = |A|^2 + |A|^2 - 2|A||A|\cos\theta$$

$$4|A|^2 = 2|A|^2 - 2|A|^2\cos\theta$$

$$4|A|^2 - 2|A|^2 = -2|A|^2\cos\theta$$

$$2|A|^2 = -2|A|^2\cos\theta$$

$$-1 = \cos\theta$$

$$\cos^{-1}(-1) = \theta$$

$$180^\circ = \theta$$

↳ The magnitude of ^{sum of} two vectors is ~~not~~ ^{equal to}

↳ The magnitude of sum of two vectors is equal to magnitude of vector, if and only if ^{twice}

if the angle between the vectors is 180° or if the vectors have the same magnitude but different in direction

Q) Given that the magnitude of A and B are equal

$|A| = |B|$ and again the magnitude of the sum of A & B is same as magnitude of A

$$|A+B| = |A|$$

↳ by using cosine law. The resultant vector magnitude can be found as:

$$R^2 = |A+B|^2 = |A|^2 + |B|^2 - 2|A||B|\cos\theta$$

$$|A+B|^2 = |A|^2 + |B|^2 - 2|A||B|\cos\theta$$

--- but we now that $|A+B| = |A|$

Substitute in equation above

$$(|A|)^2 = |A|^2 + |B|^2 - 2|A||B|\cos\theta$$

--- but we now that $|A| = |B|$

Substitute $|A|$ in $|B|$, then

$$(|A|)^2 = |A|^2 + |A|^2 - 2|A||A|\cos\theta$$

$$|A|^2 = 2|A|^2 - 2|A|^2\cos\theta$$

$$|A|^2 - 2|A|^2 = -2|A|^2\cos\theta$$

$$-|A|^2 = -2|A|^2\cos\theta$$

$$\frac{1}{2} = \cos\theta$$

$$\cos^{-1}\left(\frac{1}{2}\right) = \theta$$

$$60^\circ = \theta$$

→ We conclude that the magnitude of sum of A and B is equal to the magnitude of A ($|A|$), when vector A and B makes 60° between them.

$$(11) \text{ let: } V_1 = \frac{x}{t_1} \dots t_1 = \frac{x}{V_1}$$

$$V_2 = \frac{x}{t_2} \dots t_2 = \frac{x}{V_2}$$

→ Then average speed of a body is given by:

$$V_{av} = \left(\frac{V_1 + V_2}{2} \right) \dots \text{substitute above equations}$$

$$V_{av} = \left[\frac{\frac{x}{t_1} + \frac{x}{t_2}}{2} \right] \dots \text{but } t_1 = \frac{x}{V_1} \quad t_2 = \frac{x}{V_2}$$

$$V_{av} = \left[\frac{\frac{x}{\frac{x}{V_1}} + \frac{x}{\frac{x}{V_2}}}{2} \right]$$

$$V_{av} = \left[\frac{\frac{1}{\frac{1}{V_1}} + \frac{1}{\frac{1}{V_2}}}{2} \right]$$

$$V_{av} = \left[\frac{1}{\left(\frac{1}{V_1} + \frac{1}{V_2} \right)} \right]$$

$$V_{av} = \frac{2}{\frac{1}{V_1} + \frac{1}{V_2}}$$

$$V_{av} = \frac{2}{\frac{V_1 + V_2}{V_1 V_2}}$$

$$\boxed{V_{av} = \frac{2 V_1 V_2}{V_1 + V_2}}$$

(12) Given

$$x(t) = t^2 - 12t + 6 \dots x \text{ is displacement}$$

a) $\vec{V}_{av}$ b/w $t = 0 \text{ sec}$ and $t = 2 \text{ sec}$

$$\vec{V}(t) = \frac{dx(t)}{dt} = \frac{d}{dt} [t^2 - 12t + 6]$$

$$\vec{V}(t) = 2t - 12$$

$$\vec{V}_{av}(t) = (2t - 12) \Big|_0^2$$

$$= [2(2) - 12] - [2(0) - 12]$$

0

$$\begin{aligned}\vec{V}_{av}(t) &= [2(2) - 12] - [2(0) - 12] \\ &= [4 - 12] - [0 - 12] \\ &= -8 + 12 \\ &= \underline{\underline{4 \text{ m/s}}}\end{aligned}$$

$$\begin{aligned}\textcircled{b} \vec{V}(t) &= \frac{d}{dt} x(t) = \frac{d}{dt} (t^2 - 12t + 6) \\ &= 2t - 12\end{aligned}$$

$$\vec{V}(t) = 2t - 12 \quad \text{--- when } t = 3 \text{ sec}$$

$$\begin{aligned}\vec{V}(3) &= 2(3) - 12 \\ &= 6 - 12 \\ &= \underline{\underline{-6 \text{ m/s}}}\end{aligned}$$

$$\textcircled{c} \vec{a}_{av} = \frac{\Delta V}{\Delta t} = \frac{\vec{V}_{av}(t)}{\Delta t}$$

↳ when time changes from (0-2) sec

$$\vec{a}(t) = \frac{d}{dt} \vec{V}(t) = \frac{d}{dt} (2t - 12)$$

$$\vec{a}(t) = \underline{\underline{2 \text{ m/s}^2}}$$

↳ ~~the~~ The average acceleration from $t = 0 \text{ sec}$ to $t = 2 \text{ sec}$

$$\vec{a}_{av}(t) = 2 \Big|_{t=0}^n$$

$$\vec{a}_{av}(t) = 2 \Big|_{t=0}^2$$

$$\vec{a}_{av}(t) = [2 - 2] = \underline{\underline{0 \text{ m/s}^2}}$$

④ The acceleration when $t = 3 \text{ sec}$

$$\vec{a}(t) = 2 \Big|_{t=n} \quad \dots n = 0, 1, 2, \dots$$

$$\vec{a}(3) = 2 \Big|_{t=3}$$

$$\vec{a}(3) = \underline{\underline{2 \text{ m/s}^2}}$$

⑤ The body have no average acceleration and rather it have constant acceleration of 2 m/s^2 . Therefore the body is uniform ly accelerated body

⑬ Given

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

$$V_f = \text{take-off velocity} = 90 \text{ m/s}$$

$$a = 3 \text{ m/s}^2$$

Solution

↳ by using 4th uniformly accelerated motion equation.

$$V_f^2 = V_i^2 + 2as$$

$$V_f^2 - V_i^2 = 2as$$

$$\frac{V_f^2 - V_i^2}{2a} = s$$

$$\frac{(90)^2 - (10)^2}{2(3)} = s$$

$$\frac{8100 - 100}{6} = s$$

$$\frac{8000}{6} = s$$

$$\underline{\underline{1333.3 \text{ m} = s}}$$

⑭ Given

$$\text{Speed of tortoise} = 10 \text{ cm/s} = 10^{-2} \times 10 \text{ m/s} \\ = 0.1 \text{ m/s}$$

$$\text{Speed of hare} = 2 \text{ m/s}$$

$$\text{Let Speed of tortoise} = V_{1i} = 0.1 \text{ m/s}$$

$$\text{Speed of hare} = V_{2i} = 2 \text{ m/s}$$

$$V_{2f} = 0 \text{ m/s}$$

$$V_{1e} = 0.1 \text{ m/s}$$

$$V_{2i} = 2 \text{ m/s}$$

$$V_{2f} = 0 \text{ m/s}$$

$$t_2 = 2 \text{ min} = 120 \text{ sec}$$

↳ by using second equation

$$S = \left(\frac{V + V}{2} \right) t = \left(\frac{2 + 0}{2} \right) [120] = \underline{\underline{120 \text{ m}}}$$

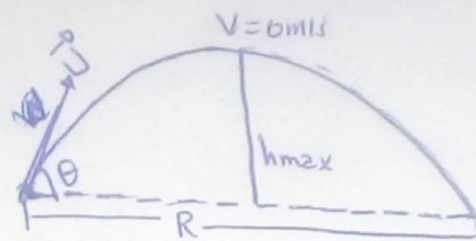
↳ The race is 120 m long

Q5) Given

$$R = 4h_{\max} \quad \text{--- when } R \text{ is Range}$$

$h_{\max} = \text{Max. height}$

→ To find the Range and maximum height assume the projectile as below:



$$R = V_x t_T$$

$= U \cos \theta \cdot t_T$ --- but total can also be determined by using equation one (1)

$$V = U - gt \quad \text{--- } V \text{ at maximum height is zero}$$

$$0 = U - gt$$

$$-U = -gt$$

$$\frac{U}{g} = t$$

$$\frac{U \sin \theta}{g} = t$$

→ This time is the time w/c the body cover 1 half of projectile. Therefore the total time of projectile is twice t

$$t_T = \frac{2U \sin \theta}{g}$$

$$R = U \cos \theta \cdot \frac{2U \sin \theta}{g} = \frac{2U^2 \sin \theta \cos \theta}{g} \quad \text{--- (1)}$$

→ To find maximum height we use 4th eqn

$$V^2 = U^2 - 2gh_{\max}$$

$$0 = U^2 - 2gh_{\max}$$

$$-U^2 = -2gh_{\max}$$

$$\frac{U^2}{2g} = h_{\max}$$

$$\left(\frac{U \sin \theta}{g}\right)^2 = \frac{U^2 \sin^2 \theta}{g^2} = h_{\max} \quad \text{--- (2)}$$

→ now Equating (1) and (2) $\frac{4h_{\max}}{4h_{\max}}$

$$\frac{2U^2 \cos \theta \sin \theta}{g} = \frac{4U^2 \sin^2 \theta}{2g}$$

$$4 \cos \theta \sin \theta = 4 \sin^2 \theta$$

$$\frac{4 \cos \theta}{4 \cos \theta} = \frac{4 \sin \theta}{4 \cos \theta} \quad \dots \tan \theta = \frac{\sin \theta}{\cos \theta}$$

$$\tan \theta = 1$$

$$\theta = \tan^{-1}(1) = \underline{\underline{45^\circ}}$$

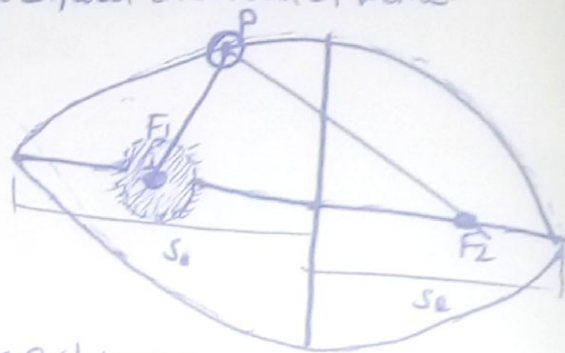
16) Three Kepler's Law

i) Kepler's first law

States that the orbit of each planet in the solar system is an ellipse with two foci (F_1, F_2), the sun will be on one focus.

ii) Kepler's second law

States that "the radius vector connecting the centers of the sun and a planet sweeps out equal areas in equal interval of time."



iii) Kepler's third law

States that "the square of the orbital period of a planet is proportional to the cube of the average distance b/w the center of the planet and the sun."

B) Kinetic AND Static friction

Kinetic friction

Is the resistive force to the motion of an object occur when an object is in motion, given by $f_k = \mu_k F_N$

Static friction

Is the resistance force that exist in between two stationary objects in contact to each other. ~~It~~ given by $f_s = \mu_s F_N$

C) Weightlessness

Is a sensation experienced by an individual when there are no external objects touching one's body and ~~person~~ exerting a push or pull force upon it.

<u>Given</u>	<u>Required</u>
$v_i = 0 \text{ m/s}$	a) $v_f = ?$
$m = 2 \text{ kg}$	b) $a = ?$
$F = 12 \text{ N}$	c) $t = ?$
$s = 3 \text{ m}$	

Solution

→ $F = ma$ --- applying Newton's 2nd law

$$12 = 2a$$

$$a = \underline{\underline{6 \text{ m/s}^2}}$$

b) by using 4th equation WAM.

$$v_f^2 = v_i^2 + 2as$$

$$v_f = \sqrt{v_i^2 + 2as} \text{ --- but } v_i = 0$$

$$v_f = \sqrt{2as}$$

$$= \sqrt{2 \times 6 \times 3}$$

$$= \underline{\underline{6 \text{ m/s}}}$$

↳ by using either 2nd or 3rd law, we can find time 't'

$$s = \left(\frac{v_i + v_f}{2} \right) t \text{ --- 2nd law}$$

$$s = \left(\frac{0 + 6}{2} \right) t$$

$$2s = 6t$$

$$2(3) = 6t$$

$$t = \underline{\underline{1 \text{ sec}}}$$

$$s = ut + \frac{1}{2}at^2 \text{ --- by 3rd law}$$

$$s = ut + \frac{1}{2}at^2 \rightarrow u = 0$$

$$s = 0 + \frac{1}{2}at^2$$

$$2s = at^2$$

$$2(3) = 6t^2$$

$$t^2 = \sqrt{1}$$

$$= \underline{\underline{1 \text{ sec}}}$$

48) Given

$$V_E = 15 \text{ m/s}$$

$$V_f = 3 \text{ m/s}$$

$$m = 1500 \text{ kg}$$

$$\Delta t = 0.15 \text{ sec}$$

Required

a) $\Delta p = ?$

b) $F = ?$

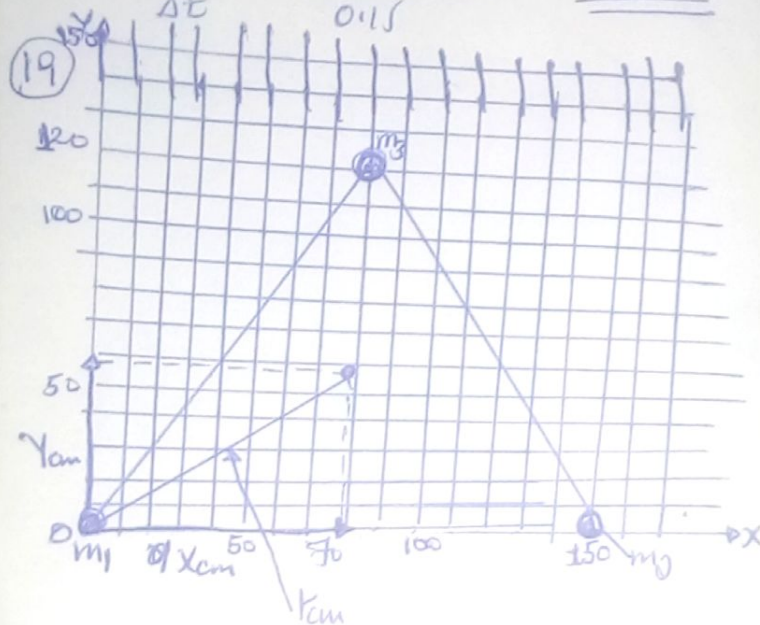
Solution

$$1) \Delta p = m \Delta v = m (V_f - V_E) = 1500 [3 - 15]$$

$$\Delta p = 1500 [-12 \text{ m/s}]$$

$$= -18000 \text{ kg m/s}$$

$$2) F = \frac{\Delta p}{\Delta t} = \frac{-18000 \text{ kg m/s}}{0.15} = -12 \times 10^4 \text{ N}$$



$$x_{cm} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3}{m_1 + m_2 + m_3}$$
$$= \frac{[1.2 \times 0] + [2.5 \times 150] + [3.4 \times 70]}{1.2 + 2.5 + 3.4}$$
$$= \frac{[0] + [375] + [238]}{7.1}$$

$$x_{cm} = 86.34 \text{ cm}$$

$$y_{cm} = \frac{m_1 y_1 + m_2 y_2 + m_3 y_3}{m_1 + m_2 + m_3}$$
$$= \frac{[1.2 \times 0] + [2.5 \times 0] + [3.4 \times 120]}{1.2 + 2.5 + 3.4}$$
$$= \frac{408}{7.1} = 57.46 \text{ cm}$$

$$r_{cm} = (86.34\hat{i} + 57.46\hat{j}) \text{ cm}$$

20) The distance b/w moon and earth is $3.84 \times 10^5 \text{ km}$ ^{moon} Complete one cycle by 27.3 days implies that:

$$\begin{aligned} 1 \text{ rev} &= 2\pi r \\ &= 2\pi [3.84 \times 10^5 \text{ km}] \\ &= 7.68\pi \times 10^5 \text{ km} \end{aligned}$$

↳ This is circumference of circle, so moon completes this in 27.3 day

2nd — The distance b/w artificial satellite and the earth is 1500 km

$$\begin{aligned} 1 \text{ rev} &= 2\pi r \\ &= 2\pi [1500 \text{ km}] \\ &= 3000\pi \text{ km} \\ &= 3\pi \times 10^3 \text{ km} \end{aligned}$$

↳ Circumference of an orbit the artificial satellite moves around, then by what time or period do the artificial satellite is may calculated as:

$$\begin{aligned} 7.6\pi \times 10^5 \text{ km} &= 27.3 \text{ day} \\ 3\pi \times 10^3 \text{ km} &= x \end{aligned}$$

$$\frac{7.6\pi \times 10^5 \text{ km} \times x}{7.6\pi \times 10^5 \text{ km}} = \frac{3\pi \times 10^3 \text{ km} \times 27.3 \text{ days}}{7.6\pi \times 10^5 \text{ km}}$$

$$x = 10.77 \times 10^2 \text{ day}$$

$$x = 0.11 \text{ day}$$

$$1 \text{ day} = 24 \text{ hr}$$

$$\begin{aligned} x &= 0.11 [24 \text{ hr}] \\ &= 2.64 \text{ hr} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{60 \text{ s}}{1 \text{ min}} \\ &= 9504 \text{ sec} \end{aligned}$$

→ The period of satellite is 2.64 hr or 9504 sec

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→ The both moves away the higher speed of because of weightlessness.

27 Given

$$(v_i)_1 = 120 \text{ m/s}, (v_i)_2 = 0 \text{ m/s}$$

$$(v_f)_{12} = 10 \text{ m/s}$$

$$m_1 = 0.2 \text{ kg}$$

$$m_2 = ?$$

Solution

↳ By using conservation of linear momentum.

$$(m_1 v_1 + m_2 v_2)_i = (m_1 v_1 + m_2 v_2)_f \quad \text{--- } v_1 = v_2 = v_f$$

$$(120 \times 0.2 + m_2(0))_i = (v_f(m_1 + m_2))_f$$

$$(24 + 0)_i = v_f(m_1 + m_2)_f$$

$$\frac{24}{10} = \frac{10(0.2 + m_2)}{10}$$

$$2.4 = 0.2 + m_2$$

$$2.4 - 0.2 = m_2$$

$$\underline{\underline{2.2 \text{ kg} = m_2}}$$

↳ The mass of block is 2.2 kg. and

↳ The collision is perfectly elastic

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Given

Required

$$(v_1)_i = 120 \text{ m/s}$$

$$(v_1)_f = ? \quad \left. \begin{array}{l} (v_1)_f = ? \\ (v_2)_f = ? \end{array} \right\} a)$$

$$(v_2)_i = 0.6 \text{ m/s}$$

$$(v_2)_f = ?$$

$$m_1 = 0.1 \text{ kg}$$

$$(v)_{cm} = ? \quad b)$$

$$m_2 = 0.2 \text{ kg}$$

→ Collision is elastic

Solution

a) → Apply both conservation of linear momentum and kinetic energy, since the collision is elastic

$$(m_1 v_1 + m_2 v_2)_i = (m_1 v_1 + m_2 v_2)_f \quad \text{--- (1)}$$

$$(v_1 + v_2)_i = (v_1 + v_2)_f \quad \text{--- (2)}$$

↳ from equation one (1)

$$(m_1 v_1 + m_2 v_2)_i = (m_1 v_1 + m_2 v_2)_f$$

$$[0.1 \times 120] + [0.2 \times 0.6] = 0.1 v_1 + 0.2 v_2$$

$$12 + 0.12 = 0.1 v_1 + 0.2 v_2$$

$$12.12 = 0.1 v_1 + 0.2 v_2 \quad \text{--- (a)}$$

↳ from equation two (2)

$$(V_1 + V_2) \rho = (V_1 + V_2) t$$

$$120 + 0.6 = V_1 + V_2$$

$$120.6 = V_1 + V_2 \text{ ---- (b)}$$

↳ combine equation (a) & (b) To find the value of V_1 & V_2 simultaneously as:

$$\begin{cases} 0.1V_1 + 0.2V_2 = 12.2 \\ -0.1(V_1 + V_2) = -120.6 \end{cases} \text{ -- multiply by } -0.1 \text{ both side}$$

$$\begin{array}{r} + \quad 0.1V_1 + 0.2V_2 = 12.2 \\ -0.1V_1 - 0.1V_2 = -12.06 \end{array}$$

$$0.1V_2 = 0.14$$

$$V_2 = \frac{0.14}{0.1}$$

$$V_2 = \underline{\underline{1.4 \text{ m/s}}}$$

↳ substitute V_2 in equation (a)

$$0.1V_1 + 0.2V_2 = 12.2$$

$$0.1V_1 + 0.2(1.4) = 12.2$$

$$0.1V_1 + 0.28 = 12.2$$

$$0.1V_1 = 12.2 - 0.28$$

$$0.1V_1 = 11.92$$

$$V_1 = \underline{\underline{119.2 \text{ m/s}}}$$

DO ONE
BY BEKI
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