Model (1)

Mechanics

First statics: Answer two only of the following questions

1. (a) If 3F, 5F and k Newtons are the magnitudes of three coplanar forces act at a point and the maximum and minimum value of their resultant equals 16 and 12 Newtons respectively, then find the value of F and k, given that the measure of the angle between the first and the second forces is 60°

(b) If $\vec{A} = 3\hat{i} - 4\hat{j}$, $\vec{B} = \hat{i} - 2\hat{j}$ and $\vec{C} = a\hat{i} + b\hat{j}$ where $\vec{A}$, $\vec{B}$ and $\vec{C}$ in the same plane, if $\vec{C} \times \vec{B} = 4\hat{k}$, then

(i) find the value of a and b

(ii) find the algebraic projection of $\vec{C}$ in direction of $\vec{A}$

2. (a) A body of weight " w " New is suspended by two strings, the first inclines by an angle of measure θ to the vertical passing over a smooth pulley and carries at its other end a body of weight 12 New, the other string form with the vertical 30° , passing over a smooth pulley and carries at its other end a body of weight 8 New, find w and θ

(b) ABCD is a rectangle in which AB = 8 cm, BC = 12 cm. X is the mid – point of $\overline{AD}$, $Y \in \overline{AB}$ where AY = 6 cm. forces of magnitude 5, $3\sqrt{2}$, 1, 6 Newtons acts a long $\overrightarrow{CX}$, $\overrightarrow{XY}$, $\overrightarrow{YB}$, $\overrightarrow{CB}$ respectively prove that the system of this forces equivalent to a couple and find the norm of its moment. also find the magnitude of the two forces act at A and C in direction parallel to $\overline{BD}$ which make the system in equilibrium

3. (a) ABCD is a trapezium in which $m(\hat{B}) = 90^\circ$, $\overline{AD} // \overline{BC}$, AB = 8cm BC = 15cm , AD = 9cm , forces of magnitude F , 44 , 68 New acts at $\overrightarrow{DA}$, $\overrightarrow{DC}$, $\overrightarrow{AC}$ respectively , if the line of action of resultant of this forces passes through B , find F

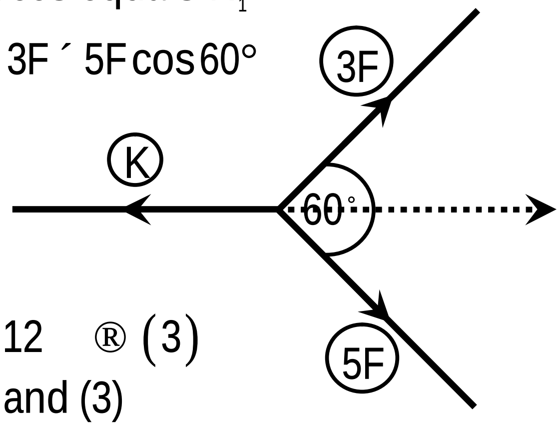
(b) AB is a rod of length 100cm and weight 10 New acting at its mid point rests in horizontal position on two supports one of them at A and the other at point 25cm from B what is the magnitude of the weight that should be suspended from the end [B] of the rod so that

	the reaction on the support nearer to this end will six times its value at A, what is the value of reactions of them
4.	<u>Second Dynamics: Answer two only of the following questions</u> (a) A body is moving in a straight line so that its displacement vector $\vec{S}$ is given as a function of the time t, by the relation $\vec{S} = \left(3t - \frac{1}{2}t^2\right)\hat{c}$ the magnitude of $\vec{S}$ is measured in meters and the time t in sec. prove that the motion is uniformly changing, and then find the distance covered by the body in the first nine seconds of its motion (b) A metal ball of mass 100 gm moves along a straight line with a uniform velocity 10 m/sec. in a dusty medium. if dust adher as to its surface at the rate of 0,06 gm per second. find the mass of the ball and the force acting on it at any time t, given that at the beginning of motion the ball was completely free from any dust.
5.	(a) A body whose weight 2 kg.wt ascends a distance of 120 cm along a line of greatest slope of smooth inclined plane of inclination 30° to the horizontal, calculate the increases in its potential energy (b) A particle was moving with uniform acceleration "a". it covered 400 cm in 10 sec. then it increased the acceleration to "2a". So it covered another 700 cm in 10 sec, and its velocity at the end of this distance was 90 cm / sec, then it moved with retardation "3a" until it came to rest. Evaluate (A) and the total distance covered by the particle
6.	(a) A car (A) moving on a straight way measured the relative velocity of another car (B) coming from the opposite direction it was 140km/h, when the car (A) reduced its velocity to its half and remeasured the relative velocity of a car (B) it found it 120km/h, find the actual velocity of the two cars ? (b) A train with 340 m length started its motion from rest with a uniform acceleration 6 m|sec^2, there is a man at the front of the train has a body, he project the body vertically upwards with velocity 49 m/sec in the same instant of train's motion, determine if the body meet the train or not and give the reasons.

Answers of model (1)

First statics

1. (a) let the resultant of the second forces equals R_1



$R_1^2 = F_1^2 + F_2^2 + 2F_1F_2\cos\alpha = 9F^2 + 25F^2 + 2 \times 3F \times 5F\cos 60°$

$R_1^2 = 49F^2 \quad \Rightarrow \quad \boxed{R_1 = 7F}$

$R_{max.} = R_1 + K \quad \Rightarrow \quad \boxed{7F + K = 16} \quad \rightarrow (1)$

$R_{min.} = |R_1 - K| \quad \Rightarrow \quad |7F - K| = 12$

$7F - K = 12 \quad \rightarrow (2) \qquad$ OR $\qquad 7F - K = -12 \quad \rightarrow (3)$

By adding (1) and (2)

$14F = 28$

$\boxed{F = 2}$ from (1)

$\boxed{K = 4}$

By adding (1) and (3)

$14F = 4$

$\boxed{F = \frac{2}{7}}$ from (1)

$\boxed{K = 14}$

(b) (i) $\because \vec{C} \parallel \vec{B} = 4\hat{k} \quad \Rightarrow \quad \vec{C} = m(1, -2) = (m, -2m)$

$\vec{C} \times \vec{A} = 4\hat{k} \quad \Rightarrow \quad (m, -2m) \times (3, -4) = 4\hat{k} \quad \Rightarrow \quad [-4m + 6m]\hat{k} = 4\hat{k}$

$2m\hat{k} = 4\hat{k} \quad \Rightarrow \quad 2m = 4 \quad \Rightarrow \quad \boxed{m = 2}$

$\vec{C} = (2, -4) \quad \Rightarrow \quad \boxed{a = 2}, \ \boxed{b = -4}$

(ii) The alg. comp. of $\vec{C}$ in direction of $\vec{A} = \dfrac{\vec{C} \cdot \vec{A}}{\|\vec{A}\|}$

The alg. comp. of $\vec{C}$ in direction of $\vec{A} = \dfrac{(2, -4) \cdot (3, -4)}{\sqrt{9 + 16}} = \dfrac{22}{5} = 4.4$

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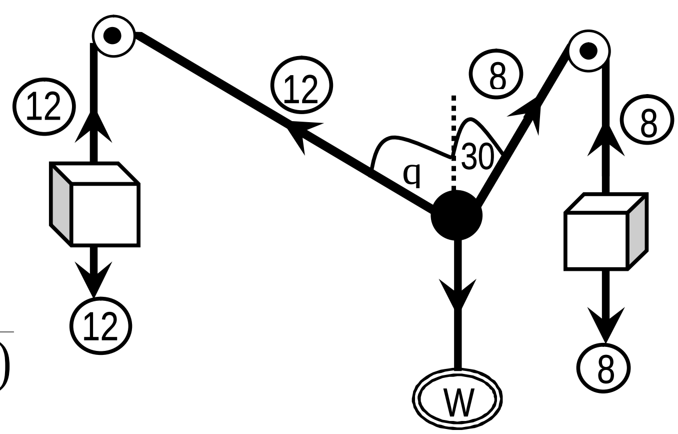
2. (a)



$\because$ A body is in equilibrium under the action of the forces 8,12,W.

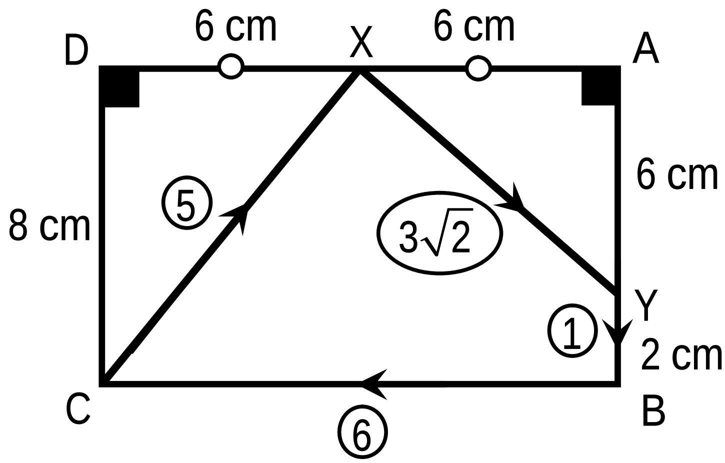
$\therefore$ We can use Lami's rule.

$$\frac{8}{\sin(180 - \theta)} = \frac{12}{\sin 150} = \frac{w}{\sin(\theta + 30)}$$

$$\frac{8}{\sin\theta} = \frac{12}{\sin 150} \Rightarrow \sin\theta = \frac{8\sin 150}{12} = \frac{1}{3}$$

$$\theta = 19^\circ 28' 17'' \Rightarrow \frac{12}{\sin 150} = \frac{w}{\sin\left(19^\circ 28' 17'' + 30\right)} \Rightarrow \boxed{w = 18.24\text{New}}$$

(b) <u>In ΔXDC</u>



$XC = \sqrt{36+64} = 10$ cm

<u>In ΔXAY</u>

$XY = \sqrt{36+36} = 6\sqrt{2}$ cm

the forces 5, $3\sqrt{2}$, 1, 6

in the same cyclic order

$$\left.\begin{aligned} \frac{F_1}{CX} &= \frac{5}{10} = \frac{1}{2} \\ \frac{F_2}{XY} &= \frac{3\sqrt{2}}{6\sqrt{2}} = \frac{1}{2} \\ \frac{F_3}{YB} &= \frac{1}{2} = \frac{1}{2} \\ \frac{F_4}{CB} &= \frac{6}{12} = \frac{1}{2} \end{aligned}\right\} \text{D. S.} = \frac{1}{2}$$

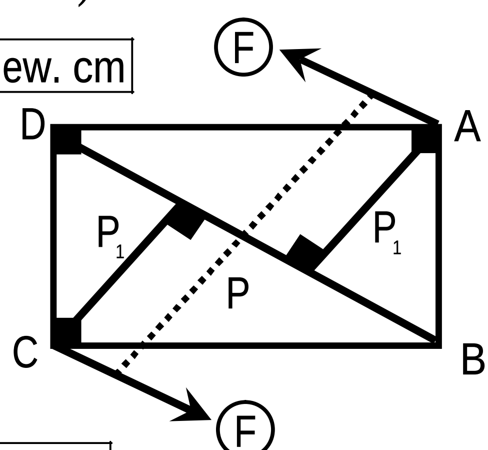
Then this system equivalent to a couple

Area of quad. XYBC = area of ABCD – area of ΔXDC – area of ΔAXY

$$\text{Area of quad. XYBC} = 8 \times 12 - \frac{1}{2} \times 6 \times 8 - \frac{1}{2} \times 6 \times 6 = \boxed{54\text{ cm}^2}$$

$$\text{The norm of its moment} = \left(2 \times \text{area of quad. XYBC}\right) \times \text{D. S.}$$

$$\text{The norm of its moment} = -2 \times 54 \times \frac{1}{2} = \boxed{-54\text{ New. cm}}$$



Let the forces (F, F) from a couple

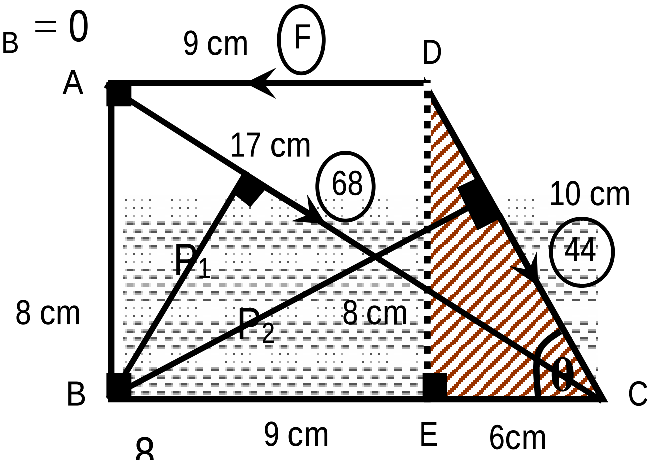
$$P = 2 \times P_1 = 2 \times \frac{8 \times 12}{4\sqrt{13}} = \boxed{\frac{48}{\sqrt{13}}\text{ cm}}$$

The system in equilibrium , then

$$M_1 + M_2 = 0 \Rightarrow -54 + M_2 = 0$$

$$M_2 = 54 \Rightarrow F \times \frac{48}{\sqrt{13}} = 54 \Rightarrow \boxed{F = \frac{9\sqrt{13}}{8}\text{ New}}$$

3. (a) $\vec{R}$ passes through B $\Rightarrow \sum M_B = 0$



About B:

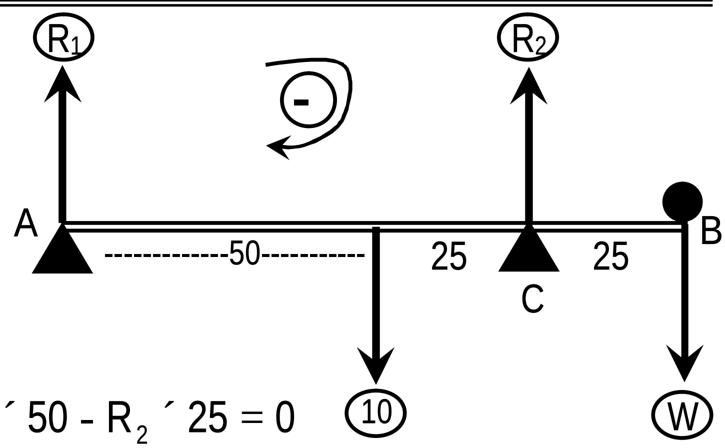
F	P
F	8
-68	72/17
-44	12

$$P_1 = \frac{9 \times 8}{17} = \frac{72}{17} \text{ cm, and } P_2 = 15\sin\theta = 15 \times \frac{8}{10} = 12 \text{ cm}$$

$$\sum M_B = 0 \quad \Rightarrow \quad 8F - 68 \times \frac{72}{17} - 44 \times 12 = 0$$

$$8F - 228 - 528 = 0 \quad \Rightarrow \quad 8F = 816 \quad \Rightarrow \quad \boxed{F = 102 \text{ New}}$$

(b) $R_2 = 6R_1 \quad \rightarrow (1)$



The rod in equilibrium

(1) R = 0

$$R_1 + R_2 = 10 + w$$

$$R_1 + 6R_1 = 10 + w$$

$$7R_1 = 10 + w \quad \rightarrow (2)$$

(2) $\sum M_B = 0 \quad \Rightarrow \quad -100R_1 + 10 \times 50 - R_2 \times 25 = 0$

But $R_2 = 6R_1$ then $-100R_1 + 500 - 6R_1 \times 25 = 0$

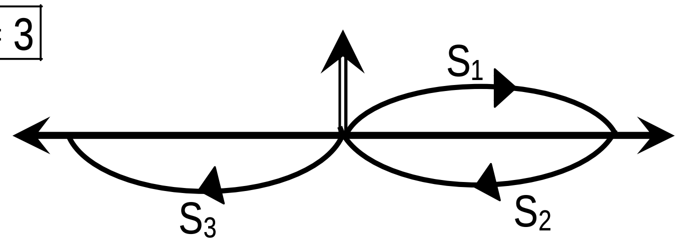
$250R_1 = 500 \Rightarrow R_1 = 2 \Rightarrow R_2 = 12,$ From (2) $\Rightarrow w = 7 \times 2 - 10 = 4$

Second Dynamics

4. (a) $\vec{S} = \left(3t - \frac{1}{2}t^2\right)\hat{c} \quad \Rightarrow \quad \vec{V} = \frac{d\vec{S}}{dx} = (3 - t)\hat{c} \quad \Rightarrow \quad \vec{a} = \frac{d\vec{V}}{dx} = -\hat{c}$

Then the motion is uniformly changing

$V = 0 \quad \Rightarrow \quad 3 - t = 0 \quad \Rightarrow \quad \boxed{t = 3}$



$\overrightarrow{S_{t=3}} = (9 - 4.5)\hat{c} = 4.5\hat{c}$

$\boxed{S_{t=3} = 4.5 \text{ m}}$

$\overrightarrow{S_{t=6}} = 0\hat{c} \quad \Rightarrow$ The body returns to the initial point after 6 sec. then

$\overrightarrow{S_{t=9}} = (27 - 40.5)\hat{c} = -13.5\hat{c} \Rightarrow \boxed{S_{t=9} = -13.5 \text{ m}}$

The distance $= 2 \times 4.5 + 13.5 = 22.5$ m

(b) $u = 1000$ cm/sec , $\frac{dm}{dt} = 0.06$ gm per. sec. , $m(t) = 100 + 0.06t$

the body moves with uniform acceleration

$$F = \frac{d}{dt}\left[m(t) \times V\right]$$

$$F = \frac{d}{dt}\left[(100 + 0.06t) \times 1000\right] = 1000 \times 0.06 = \boxed{60 \text{ dyne}}$$

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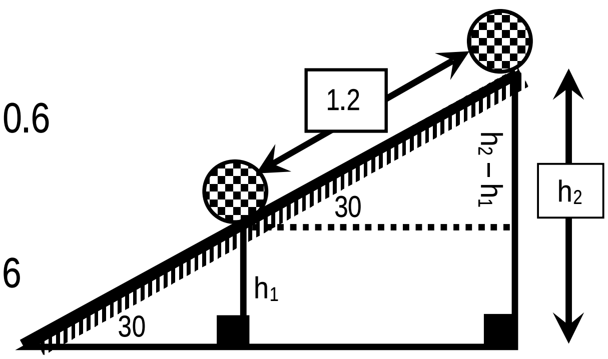
5. (a)



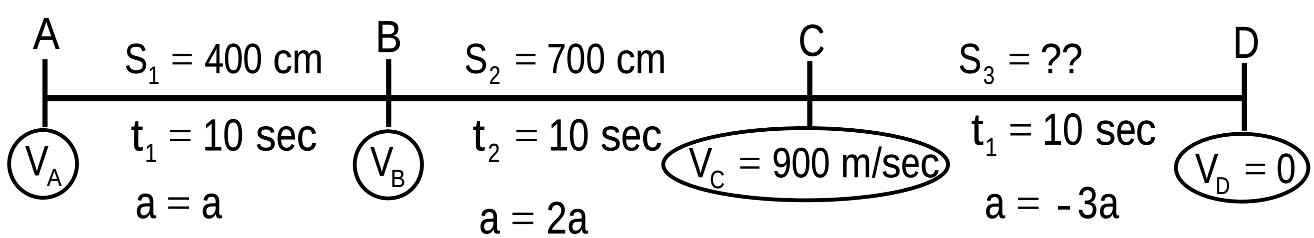
$\sin 30 = \frac{h_2 - h_1}{1.2} \Rightarrow h_2 - h_1 = 1.2 \times \frac{1}{2} = 0.6$

$w = 2 \times 9.8$ New

increases of p. e. $= mg(h_2 - h_1) = 19.6 \times 0.6$

increases of p. e. $= 11.76$ joules

(b)



<u>motion at $\overline{AB}$</u>

$S = ut + \frac{1}{2}at^2 \Rightarrow 400 = V_A \times 10 + \frac{1}{2}a \times 100$

$V_A + 5a = 40 \rightarrow (1)$ But $V = u + at$

$V_B = V_A + a \times 10 \Rightarrow V_A = V_B - 10a$

$(V_B - 10a) + 5a = 40 \Rightarrow V_B - 5a = 40 \rightarrow (2)$

<u>motion at $\overline{BC}$</u>

$S = ut + \frac{1}{2}at^2 \Rightarrow 700 = V_A \times 10 + \frac{1}{2}(2a) \times 100$

$V_B + 10a = 70 \rightarrow (3)$ mult (2) by $\boxed{2}$ and add to (3)

$2V_B - 10a = 80$

$V_B - 10a = 70$

- - - - - - - - - add

$3V_B = 150 \Rightarrow V_B = 50$ cm/sec, from $(2) \Rightarrow 50 - 5a = 40 \Rightarrow a = 2$ cm/sec^2

<u>motion at $\overline{CD}$</u>

$a = -3 \times 2 = -6$ cm/sec^2 , $u = 90$ cm/sec , $V = 0$

$V^2 = u^2 + 2aS \Rightarrow 0 = (90)^2 + 2(-6) \times S \Rightarrow S = 675$

Total direction = 700 + 400 + 675 = 1775 cm

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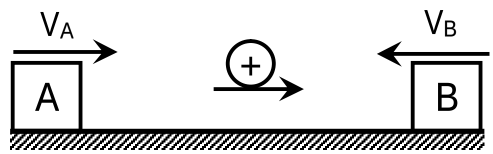
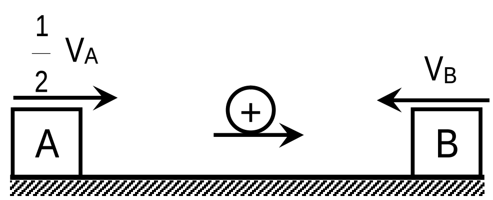
6. (a) <u>1st case:</u>



$v_{BA} = -140$, $v_{BA} = v_B - v_A = -140 \rightarrow (1)$

<u>2nd case:</u>



$v_{BA} = -120$, $v_B - \frac{1}{2} v_A = -120 \quad (\times 2)$

$2v_B - v_A = -240 \rightarrow (2)$

Mult. $(1) \times (-1)$ And add

$-v_B + v_A = 140$

$2v_B - v_A = -240$

- - - - - - - - $\rightarrow$ add $\Rightarrow v_B = -100$ km/h , $\xrightarrow{\text{from (1)}} v_A = -100 + 140 = 40$ km/h

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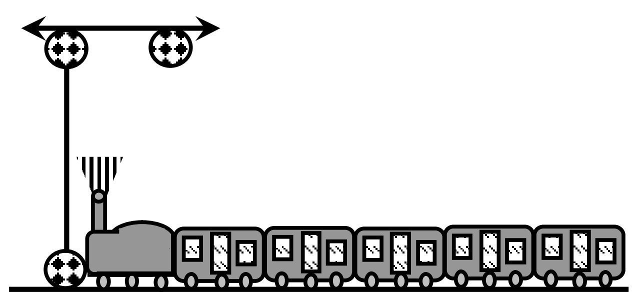
(b)

<u>The motion of the body:</u>



At the max. Height V = 0 then

$V = u + gt \Rightarrow 0 = 49 - 9.8t \Rightarrow \boxed{t = 5 sec}$

the body returned to the ground after 10 sec

<u>The motion of the train:</u>

$S = ut + \frac{1}{2}at^2 \Rightarrow S = 0 + \frac{1}{2} \times 6 \times 100 \Rightarrow \boxed{S = 300m}$

Then the body meet the train after the train cuts 300 m, and the left length of the train= 350 – 300= 50 m

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Model (2)

Mechanics

First statics: Answer two only of the following questions

1. (a) Two forces of magnitude F and $F\sqrt{2}$ New act at a body and their resultant perpendicular to the first forces, find the angle between the two forces and prove that the magnitude of their resultant is F

(b) If $\vec{F}_1 = \hat{i} - 2\hat{j}$, $\vec{F}_2 = 3\hat{i} - \hat{j}$ and $\vec{F}_3 = -2\hat{i} + 5\hat{j}$, are three forces act at the points $A = (5, -1)$, $B = (3, 2)$ and $C = (-2, 5)$ respectively, where $\vec{F}_1$, $\vec{F}_2$, $\vec{F}_3$ are measured by Newtons, find :

(i) the magnitude and the direction of their resultant

(ii) the distance between the line of action of their resultant and the point $D = (-4, 1)$

2. (a) A uniform ladder AB of weight 24kg.wt, rests with its end A against a vertical smooth wall and with its other end B on a rough horizontal ground the ladder is in equilibrium when the end A is at a distance of 2.4 meters from the ground , and the end B at 2 meters from the wall , find the reaction of each of the wall and the ground.

(b) $\overline{AB}$ is a uniform rod of length 120cm and of weight 84 New, the rod can rotate easily in a vertical plane about a fixed horizontal pin passing through a small hole in the rod at point C where AC = 30cm, a force of magnitude 84 New acts vertically upwards on the rod at A find the magnitude of force which acts at B indirection perpendicular to the rod which makes the rod in equilibrium such that the rod inclines at an angle 30 to the vertical and B above A

3. (a) ABCD is a parallelogram in which $m(BDA) = 90^\circ$, $m(A) = 45^\circ$, AD = 6 cm, forces of magnitude $50\sqrt{2}$, 20 , $30\sqrt{2}$, F New. act at $\overrightarrow{AB}$, $\overrightarrow{DA}$, $\overrightarrow{DC}$, $\overrightarrow{DB}$ respectively

(i) find the magnitude of F, given that the line of action of their resultant passes through the point A.

(ii) find the magnitude of their resultant, then prove that their resultant is parallel to $\overline{BD}$

(b) AB is a rod of length 120cm and weight 60 New acting at its mid point, rests in a horizontal position on a support at B and is kept in equilibrium by means of string attached to a point of the rod 40cm from the end A and carries a weight of magnitude 20 New at a point 20cm from (A), find the tension in the string and the pressure on the support, what is the magnitude of weight that should be suspended from (A) in the order that the rod is about to separate from the support and what is the magnitude of tension in string at this instant?

Second Dynamics: Answer two only of the following questions

4. (a) A particle of unit of mass is moving so that velocity vector is given as a function of the time "t" in the form $\vec{V} = \left(At^2 + Bt\right)\hat{i}$ where $\hat{i}$ is a constant unit vector. find the constants A, B if the force acting on this particle is constant and is given by the relation $\vec{F} = 5\hat{i}$

(b) A steamer moves on a straight way towards a part when it is 45 km a part from the port an aeroplane passed over it in the opposite direction with velocity 250 km / h it observed the steamer which seemed to the aeroplane as it is moving with velocity 256 km / h. calculate the time elased from the moment that the aeroplane observed the steamer till it reaches the port.

5. (a) A cyclist moved towards east with a velocity of 4 m/sec for 30 sec. then he stopped for 10 sec. then moved towards west with a velocity of 5 m/sec for another 60 sec. calculate the average velocity during the whole Journey as well its direction.

(b) A body fall from a height of 40 m from the ground surface, and in the same instant another body is projected vertically up wards with a velocity of 20 m / sec from the ground surface, then the two bodies met after [t] sec. find:

(i) The time [t]   (ii) The distance covered by each body

6. (a) If $\vec{r} = (\frac{3}{2}t^2 - 2t)\hat{c}$, find the displacement vector $[\vec{S}]$ and find when this vector vanishes. Prove that the motion is retarded when $t > \frac{2}{3}$ and accelerated when $t < \frac{2}{3}$

(b) Find in kg. wt. m the work done by a force to move a body of mass 49 kg from rest with acceleration 5 cm/sec^2 in one minutes

Answers of model (2)

First statics

1. (a) $F_1 = F$, $F_2 = F\sqrt{2}$, $\alpha = ?$, $R = ?$, $\theta_1 = 90^\circ$

(i) $\vec{R} \perp \vec{F_1} \Rightarrow \theta_1 = 90^\circ \Rightarrow F_1 + F_2 \cos\alpha = 0$

$F + F\sqrt{2}\cos\alpha = 0 \quad (\div F)$

$1 + \sqrt{2}\cos\alpha = 0 \Rightarrow \cos\alpha = \dfrac{-1}{\sqrt{2}} \Rightarrow \alpha = 135^\circ$

(ii) $R^2 = F_1^2 + F_2^2 + 2F_1F_2\cos\alpha$

$R^2 = F^2 + 2F^2 + 2F \times \sqrt{2}F \times \dfrac{-\sqrt{2}}{2}$

$R^2 = F^2 + 2F^2 - 2F^2 = F^2 \Rightarrow \boxed{R = F}$

(b) (i) $\vec{R} = \vec{F_1} + \vec{F_2} + \vec{F_3} = (1,-2) + (3,-1) + (-2,5) = \boxed{(2,2)}$

$R = \sqrt{4+4} = \boxed{2\sqrt{2}\ \text{New}}$

$\tan\theta = \left|\dfrac{Y}{X}\right| = \dfrac{2}{2} = 1 \Rightarrow \theta = 45^\circ$

then the magnitude of their resultant equals $2\sqrt{2}$ New and makes angle of measure 45° with positive direction of X – axis

(ii) Let the length of perpendicular segment between their resultant and the point D = X cm

$\sum \overrightarrow{M_D} = \overrightarrow{AD} \times \vec{F_1} + \overrightarrow{BD} \times \vec{F_2} + \overrightarrow{CD} \times \vec{F_3}$

$\sum \overrightarrow{M_D} = (-9,2) \times (1,-2) + (-7,-1) \times (3,-1) + (-2,-4) \times (-2,5)$

$\sum \overrightarrow{M_D} = [18-2]\hat{k} + [7+3]\hat{k} + [-10-8]\hat{k} = 8\hat{k}$

$\left\|\sum \overrightarrow{M_D}\right\| = 8 \Rightarrow R \times X = 8 \Rightarrow 2\sqrt{2} \times X = 8 \Rightarrow \boxed{X = 2\sqrt{2}\ \text{cm}}$

then the distance between the line of action of their resultant and the point D = $2\sqrt{2}$ cm

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2. (a) $\overline{ED} \parallel \overline{AC}$ and $AE = EB$, $CD = DB = 1$ m

DBML is a rectangle , $ML = BD = 1$ m

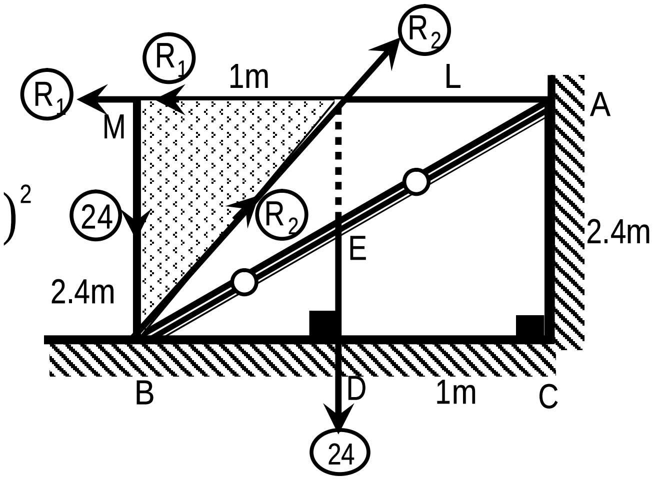
$MB = LD = AC = 2.4\ m$

In ΔLMB:

$m(\hat{M}) = 90^\circ$

$(LB)^2 = (MB)^2 + (ML)^2 = (1)^2 + (2.4)^2$

$\therefore LB = 2.6\ m$



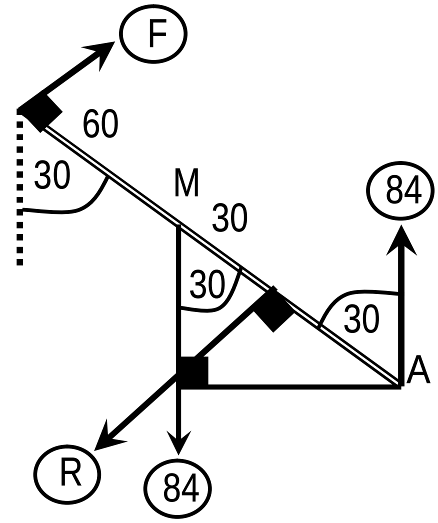
The ladder in equilibrium under the forces R_1, R_2, W

ΔLBM Is a triangle of forces

$\frac{R_1}{1} = \frac{R_2}{2.6} = \frac{24}{2.4} \Rightarrow$ $\boxed{R_1 = 10\ New}$, $\boxed{R_2 = 26\ New}$

(b) Forces 84, 84 form couple

$C_1(84,84) \Rightarrow M_1 = 84 \times 30 = 2520$



The rod in equilibrium then F, R must form a couple

Where (F = R) then

$C_2(F,F) \Rightarrow M_2 = -F \times 90 = -90\ F$

C_1, C_2 Are in equilibrium $\Rightarrow M_1 + M_2 = 0$

$2520 - 90\ F = 0 \Rightarrow 90\ F = 2520$

$F = 28 \Rightarrow$ $\boxed{F = R = 28\ New}$

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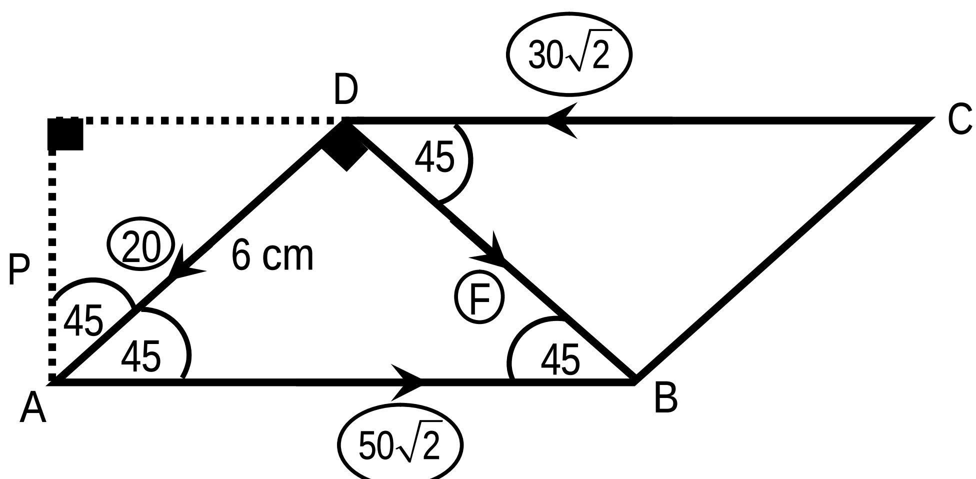
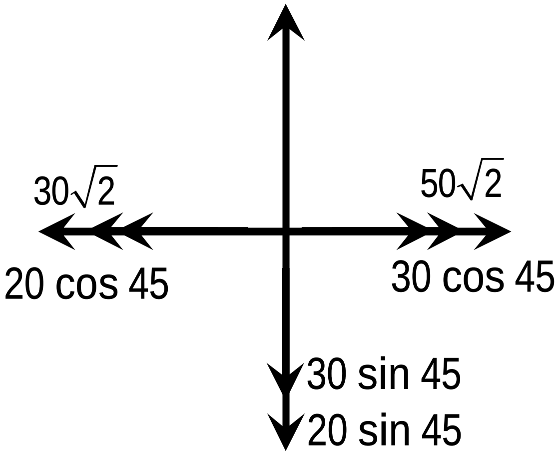
3. (a)

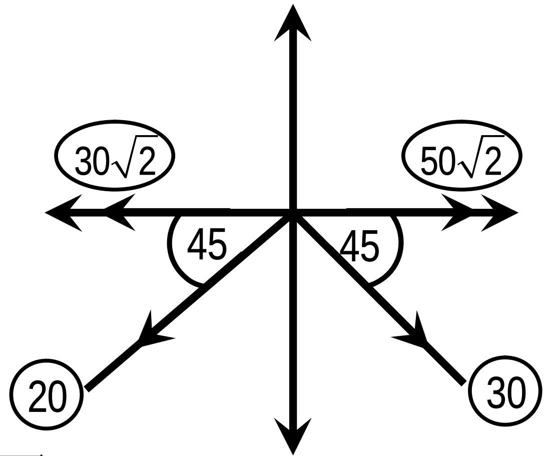


(i) $\because \vec{R}$ passes through the point A

$\therefore \sum M_A = 0 \Rightarrow -F \times 6 + 30\sqrt{2} \times 3\sqrt{2} = 0$

$\boxed{F = 30\ New}$





$X = 50\sqrt{2} + 15\sqrt{2} - 30\sqrt{2} - 10\sqrt{2} = \boxed{25\sqrt{2}}$

$Y = -15\sqrt{2} - 10\sqrt{2} = \boxed{-25\sqrt{2}}$

$R = \sqrt{X^2 + Y^2} = \sqrt{1250 + 1250} = \boxed{50 \text{ New}}$

$\tan\theta = \left|\frac{Y}{X}\right| = 1 \Rightarrow \theta = 45°$ where θ lies in 4^{th} quad.

$\theta = 360° - 45° = 315°$ with $\overrightarrow{DC}$ then $\vec{R} \,//\, \overline{DB}$

(b) <u>1st case:</u>

The rod in equilibrium

(1) $R = 0$

$R + T = 20 + 60$

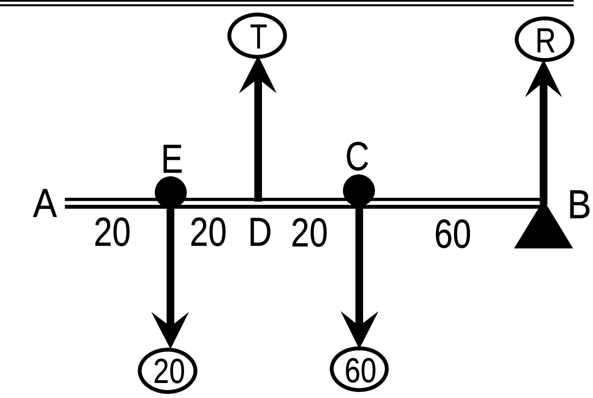
$R + T = 80 \rightarrow (1)$

(2) $\sum M_B = 0$

$20 \times 100 + 60 \times 60 - T \times 80 = 0$

$\boxed{T = 70 \text{ New}}$

from (1): $\Rightarrow \boxed{R = 10 \text{ New}}$



<u>2nd case:</u>

The rod in equilibrium

(1) $R = 0$

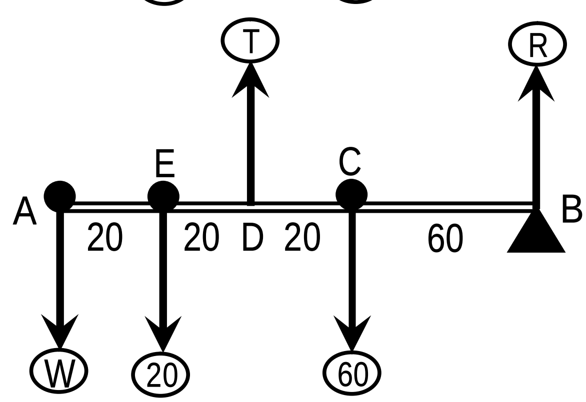
$T = w + 20 + 60 \Rightarrow T = w + 80 \rightarrow (1)$

(2) $\sum M_D = 0$

$w \times 40 + 20 \times 20 - 60 \times 20 = 0$

$\boxed{w = 20 \text{ New}}$

from (1): $\Rightarrow \boxed{T = 100 \text{ New}}$



4. (a) $\vec{V} = \left(At^2 + Bt\right)\hat{i} \quad \Rightarrow \quad V = At^2 + Bt \quad \Rightarrow \quad \boxed{a = 2At + B}$

but the body moves with uniform acceleration then

$a = \text{constant} \quad \Rightarrow \quad \boxed{A = 0} \quad \Rightarrow \quad \therefore \boxed{a = B}$ and $F = 5$

the equation of motion:

$ma = F \quad \Rightarrow \quad 1 \times B = 5 \quad \Rightarrow \quad B = 5$

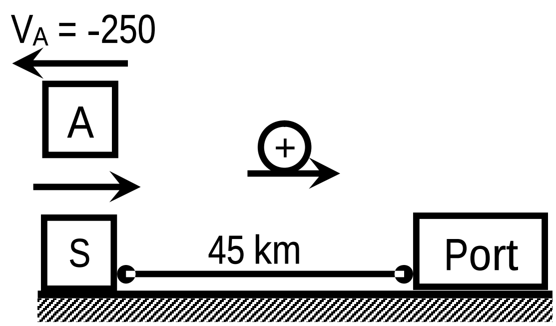
(b) $v_{SA} = 256\ km/h$

$v_S - v_A = 256$

$v_S + 250 = 256$

$\boxed{v_S = 6\ km/h}$

$T = \frac{S}{v} = \frac{45}{6} = 7.5\ h$



5. (a)

1st stage:

$S_1 = V_1 \times t_1 = 4 \times 30 = 120\ m$

2nd stage:

$S_2 = V_2 \times t_2 = -5 \times 60 = -300\ m$

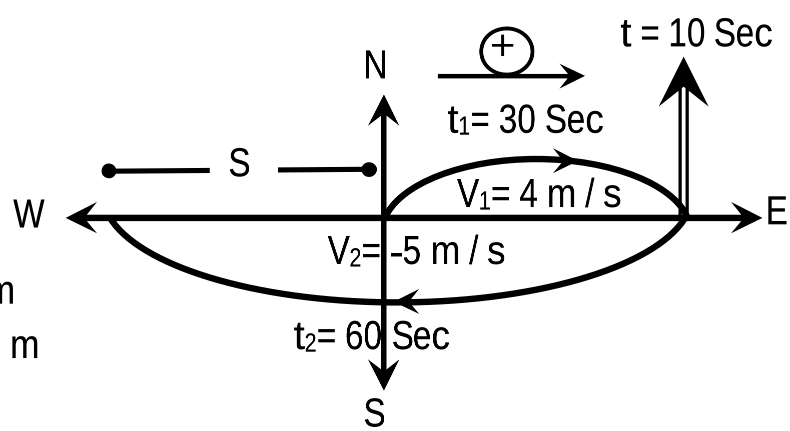
$S = S_1 + S_2 = 120 - 300 = -180\ m$

T = 30 + 10 + 60 = 100 sec.

$V_a = \frac{\text{resultant of desplacement}}{\text{total time}} = \frac{-180}{100} = \boxed{-1.8\ m/sec}$

The average velocity during the whole Journey = 1.8 m / sec

In west direction



(b) $S = ut + \frac{1}{2}gt^2$

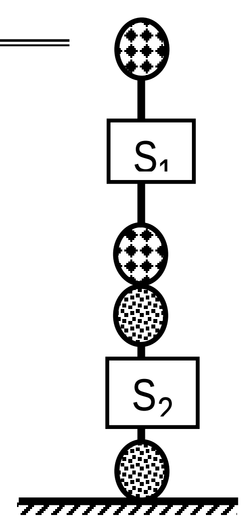
$S_1 = 0 + \frac{1}{2} \times 9.8t^2 \quad \Rightarrow \quad \boxed{S_1 = 4.9t^2}$

$\boxed{S_2 = 20t - 4.9t^2}$

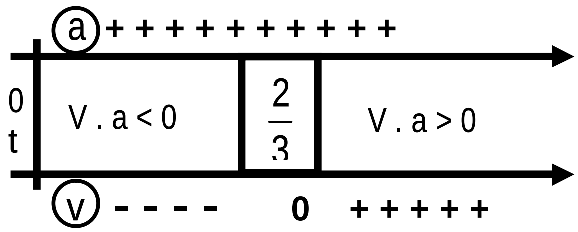
But $S_1 + S_2 = 40 \quad \Rightarrow \quad \cancel{4.9t^2} + 20t - \cancel{4.9t^2} = 40$

$\boxed{t = 2\ \text{sec}}$

$S_1 = 4.9t^2 = 4.9 \times 4 = 19.6m, \ S_2 = 20 \times (2) - 4.9(2)^2 = \boxed{20.4\ m}$



6. (a) (i) $\vec{r} = (\frac{3}{2}t^2 - 2t)\hat{c}$



$\vec{r} = (\frac{3}{2}t^2 - 2t)\hat{c}$, $\vec{r}_o = (0)\hat{c}$

$\vec{S} = \vec{r} - \vec{r}_o = (\frac{3}{2}t^2 - 2t)\hat{c}$

$\vec{S} = 0 \Rightarrow \frac{3}{2}t^2 - 2t = 0 \Rightarrow t(\frac{3}{2}t - 2) = 0$

$t = 0$ or $t = \frac{4}{3}$

(ii) $\vec{v} = \frac{d\vec{r}}{dt} = (3t - 2)\hat{c} \Rightarrow v = 3t - 2\ \vec{a} = \frac{d\vec{v}}{dt} = (3)\hat{c} \Rightarrow \boxed{a = 3}$

$v = 0 \Rightarrow 3t - 2 = 0 \Rightarrow t = \frac{2}{3}$

(a) $V . a < 0$ when $t < \frac{2}{3}$ then the motion is retarded

(b) $V . a > 0$ when $t > \frac{2}{3}$ then the motion is accelerated

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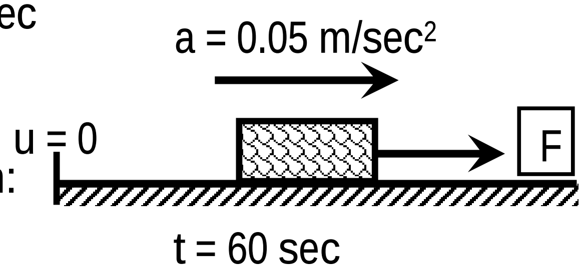
(b) $u = 0$, $a = 0.05\ m/sec^2$, $t = 60$ sec

$S = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2}0.05 \times (60)^2 = 90$ m



The body move with uniform acceleration:

$ma = F \Rightarrow F = 49 \times 0.05 = 2.45$ N

$w = FS = 2.45 \times 90 = \frac{220.5}{9.8} \Rightarrow \boxed{w = 22.5\ kg.wt.m}$
