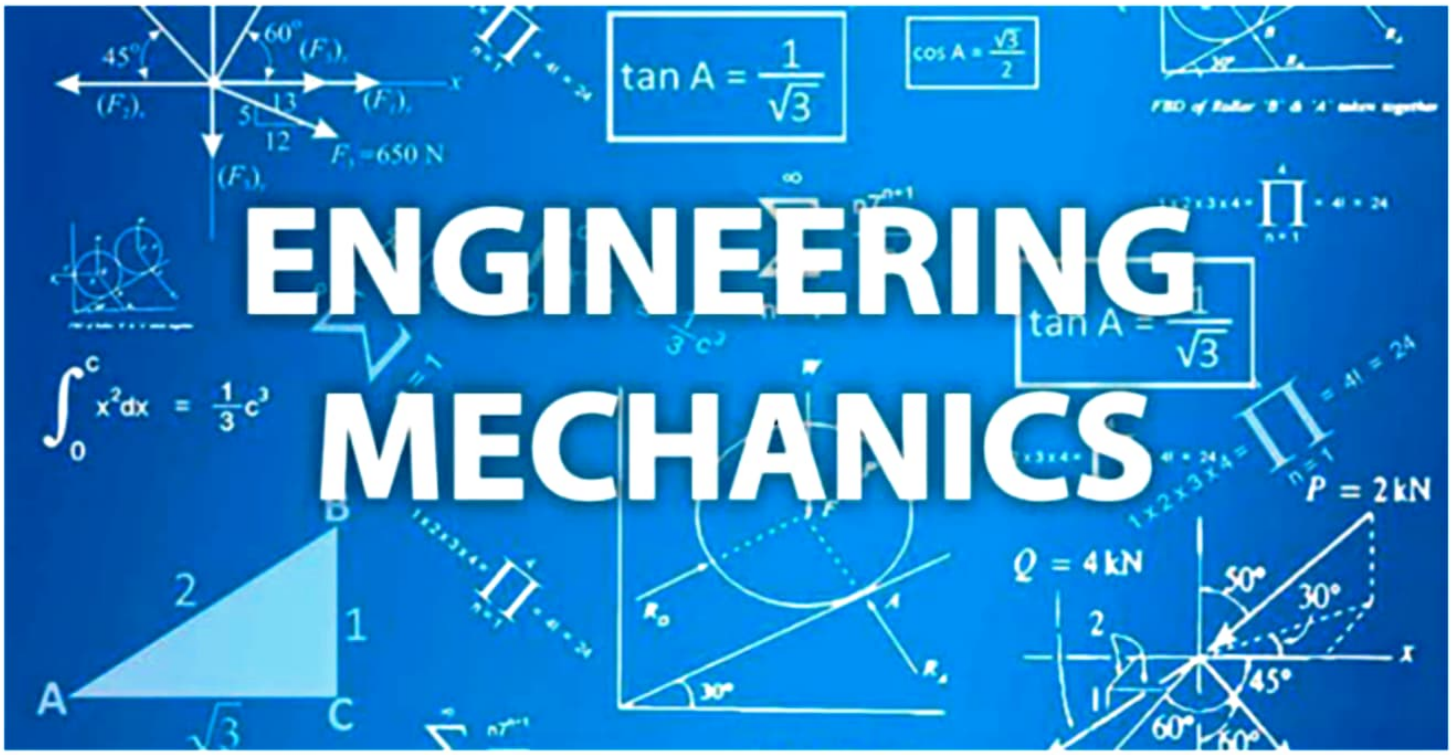
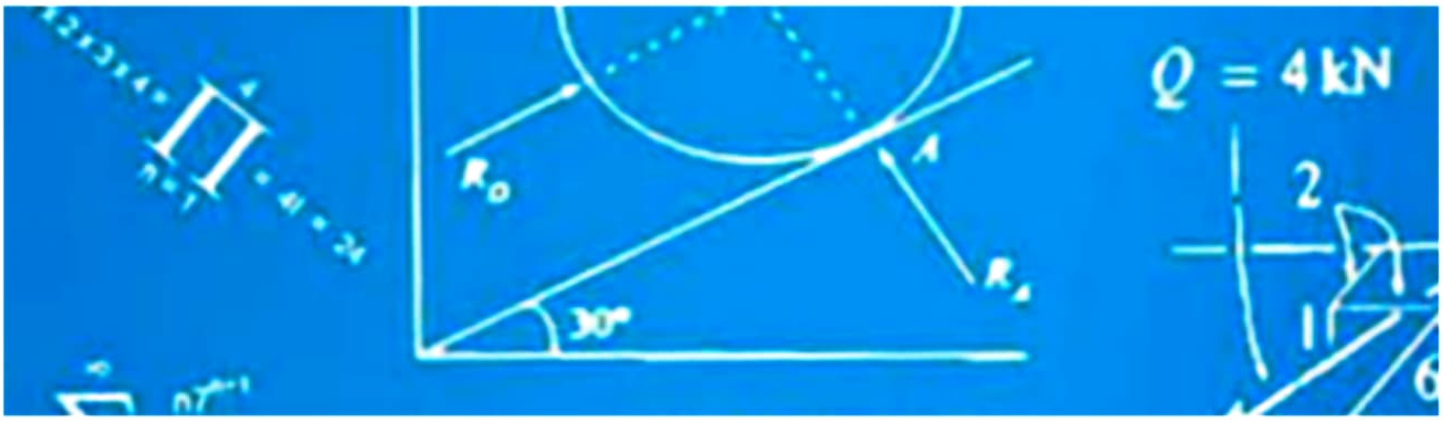


ASSIGNMENT - 1

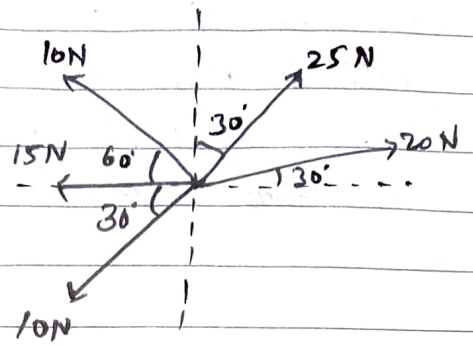
By : Naveen Sharma

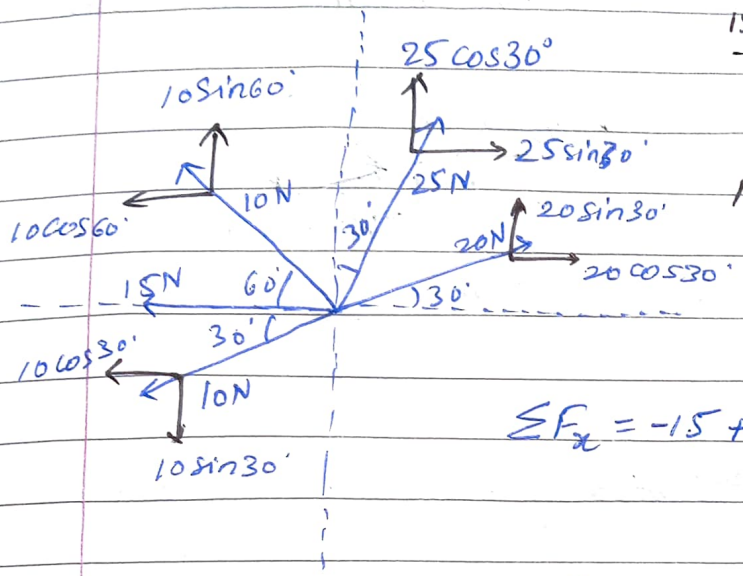
IIoT B1

Application No. : 131220028552



Q1. Find the Resultant for the given force system. Also find the direction and position.





$$\Sigma F_x = -15 + 20\cos 30^\circ + 25\sin 30^\circ - 10\cos 30^\circ - 10\cos 60^\circ$$

$$\Sigma F_x = 1.16\ N \quad \text{—①}$$

and $\Sigma F_y = 25\cos 30^\circ + 20\sin 30^\circ + 10\sin 60^\circ - 10\sin 30^\circ$

$$\Sigma f_y = 25(0.86) + 20(0.5) + 10\left(\frac{\sqrt{3}}{2}\right) - 10(0.5)$$

$$\Sigma f_y = 35.31\ N \quad \text{—②}$$

~~from~~ ① & ②

$$R = \sqrt{\Sigma f_x^2 + \Sigma f_y^2}$$

$$R = \sqrt{(1.16)^2 + (35.31)^2}$$

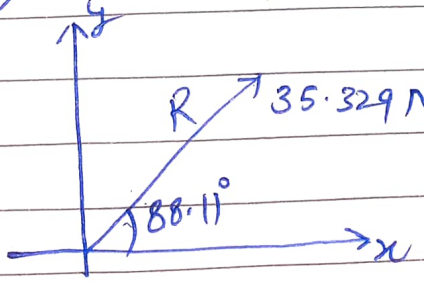
$$R = 35.329\ N$$

$$\phi = \tan^{-1}\left|\frac{\Sigma f_y}{\Sigma f_x}\right|$$

$$= \tan^{-1}\left|\frac{35.31}{1.16}\right|$$

$$\phi = 88.11^\circ$$

Since Σf_x & Σf_y both are (+ve) so Resultant lies in 1st quadrant.



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Q2. Two forces of 100N and 150N are acting simultaneously at a point. What is the resultant of these two forces, if the angle between them is 45°?

Soln ⇒ Given: $F_1 = 100N$

$F_2 = 150N$

Angle b/w F_1 & F_2 (θ) = 45°

$$\therefore R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$$

$$= \sqrt{(100)^2 + (150)^2 + 2 \times 100 \times 150 \cos 45^\circ}$$

$$= \sqrt{10000 + 22500 + (30000 \times 0.707)}$$

$$= 232\ N$$

Ans

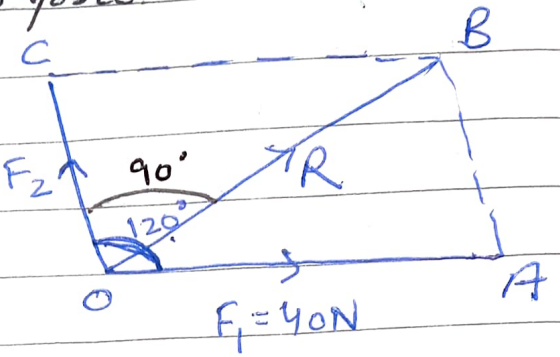
Q3. Two forces act at an angle of 120°. The bigger force is of 40N and the resultant is ⊥r to smaller one. find the smaller force.

Sol^{n} ⇒ Given:

Angle b/w two forces = ∠AOC = 120°

$F_1 = 40N$

Angle b/w Resultant and small force = 90°



from geometry ∠AOB = α = 120 − 90 = 30°

also we know that $\tan\alpha = \frac{F_2 \sin\theta}{F_1 + F_2\cos\theta}$

$$\tan 30^\circ = \frac{F_2 \sin 120^\circ}{40 + F_2 \cos 120^\circ}$$

$$\tan 30^\circ = \frac{F_2 \sin 60^\circ}{40 + F_2(-\cos 60^\circ)}$$

$$0.577 = \frac{F_2 \times 0.866}{40 - F_2 \times 0.5} = \frac{0.866\,F_2}{40 - 0.5F_2}$$

$$40 - 0.5F_2 = \frac{0.866\,F_2}{0.577} = 1.5F_2$$

$$2F_2 = 40$$

$$\Rightarrow \boxed{F_2 = 20}$$ Ans

Q4 Find the magnitude of the two forces, such that if they act at right angles, their resultant is $\sqrt{10}$ N. But if they Act at 60°, their Resultant is $\sqrt{13}$ N.

Soln:

Case I: Forces acting at right angles

$$R = \sqrt{F_1^2 + F_2^2}$$

$$\sqrt{10} = \sqrt{F_1^2 + F_2^2}$$

Sq. both side:

$$10 = F_1^2 + F_2^2 \quad \text{—(1)}$$

Case II: force acting at 60° angle

$$\sqrt{13} = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos 60^\circ}$$

$$13 = F_1^2 + F_2^2 + 2F_1F_2 \times 0.5$$

$$-F_1F_2 = F_1^2 + F_2^2 - 13$$

$$-F_1F_2 = 10 - 13 \quad \text{(from (1))}$$

$$F_1F_2 = 3$$

now,

$$(F_1 + F_2)^2 = F_1^2 + F_2^2 + 2F_1F_2 = 10 + 6 = 16$$

$$\therefore F_1 + F_2 = \sqrt{16} = 4 \quad \text{—(2)}$$

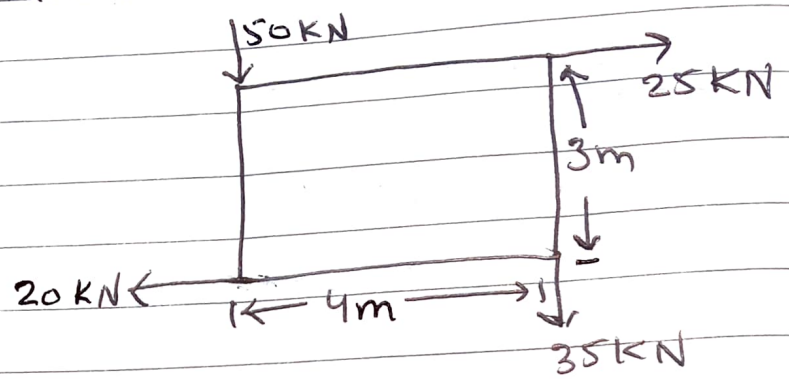
Similarly, $(F_1 - F_2)^2 = F_1^2 + F_2^2 - 2F_1F_2 = 10 - 6 = 4$

$$\therefore F_1 - F_2 = \sqrt{4} = 2 \quad \text{—(3)}$$

Solving eq (2) & (3),

$F_1 = 3$N and $F_2 = 1$N.

Q5 A system of forces are acting at the corners of a rectangular block as shown in fig. 2.4. Determine the magnitude and direction of the resultant force.



Soln:

$$\Sigma f_x = 25 - 20$$
$$= 5\ KN$$

$$\Sigma f_y = -50 + (-35) = -85\ N$$

∴ magnitude of Resultant force

$$R = \sqrt{(\Sigma f_x)^2 + (\Sigma f_y)^2} = \sqrt{(5)^2 + (-85)^2}$$

$$R = 85.15\ KN$$

now, $$\tan\theta = \frac{\Sigma f_y}{\Sigma f_x} = \frac{-85}{5} = -17$$

$$\theta = 86.6^\circ$$

Since Σf_x is positive & Σf_y is negative,
∴ resultant lies b/w 270° & 360°, Thus actual angle of the resultant force

$$\theta = 360^\circ - 86.6^\circ$$

$$\theta = 273.4^\circ$$ Ans

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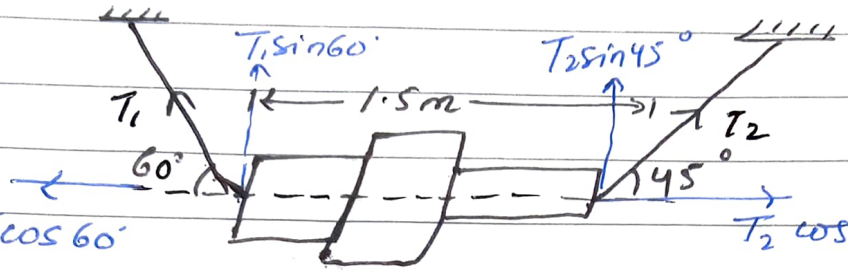
Q6. A maschine component 1·5m long and weight 1000N is supported by two ropes AB and CD as shown in fig given below. Calculate the tensions T_1 and T_2 in the ropes AB and CD.



Soln ⇒ Given: Weight of component = 1000N

→ Horizontal components of T_1 & T_2 are equal

$$\therefore T_1 \cos 60° = T_2 \cos 45°$$

$$T_1 = \frac{\cos 45°}{\cos 60°} \times T_2 = \frac{0.707}{0.5} \times T_2 = 1.414\, T_2$$

→ Vertical components:

$$T_1 \sin 60° + T_2 \sin 45° = 1000$$

$$(1.414 T_2)\, 0.866 + T_2 \times 0.707 = 1000$$

$$1.93\, T_2 = 1000$$

$$\therefore T_2 = \frac{1000}{1.93} = 518.1\,N$$

and $T_1 = 1.414 \times 518.1$

$= 732.6\,N$ ✓

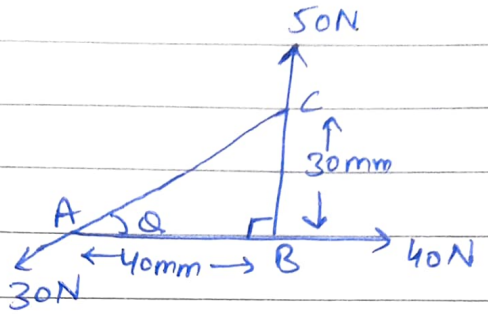
Q7. A ΔABC has its side AB = 40 mm along +ve x-axis and side BC = 30 mm along +ve y-axis. Three forces of 40N, 50N and 30N act along the sides AB, BC and CA respectively. Determine magnitude of the resultant of such a system of forces.

using Pythagoras theorem:

$$AC^2 = AB^2 + BC^2$$

$$AC^2 = (40)^2 + (30)^2$$

$$AC = 50 \text{ mm}$$



$$\therefore \sin\theta = \frac{30}{50} = 0.6$$

$$\cos\theta = \frac{40}{50} = 0.8$$

Resolving all the forces horizontally (i.e. along AB),

$$\Sigma f_x = 40 - 30\cos\theta$$

$$= 40 - (30 \times 0.8) = 16 \text{ N}$$

now resolving all the forces vertically (i.e, along BC)

$$\Sigma f_y = 50 - 30\sin\theta$$

$$= 50 - (30 \times 0.6) = 32 \text{ N}$$

now, $R = \sqrt{(\Sigma f_x)^2 + (\Sigma f_y)^2}$

$$= \sqrt{(16)^2 + (32)^2}$$

$$R = 35.8 \text{ N}$$ Ans

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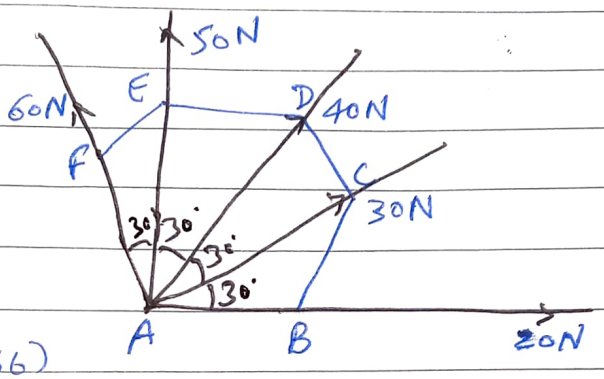
Q8. The forces 20N, 30N, 40N, 50N and 60N are acting at one of the angular points of a regular hexagon, towards the other five angular points, taken in order. Find the magnitude and direction of the resultant force.



$\Sigma f_x = 20\cos 0° + 30\cos 30° + 40\cos 60° + 50\cos 90° + 60\cos 120°$

$= (20 \times 1) + (30 \times 0.866) + (40 \times 0.5) + (50 \times 0) + 60(-0.5)$

$= 36.0\,N$ — (1)

$\Sigma f_y = 20\sin 0° + 30\sin 30° + 40\sin 60° + 50\sin 90° + 60\sin 120°$

$= (20 \times 0) + (30 \times 0.5) + (40 \times 0.866) + (50 \times 1) + (60 \times 0.866)$

$= 151.6\,N$ — (2)

$R = \sqrt{\Sigma f_x^2 + \Sigma f_y^2} = \sqrt{(36)^2 + (151.6)^2}$

$R = 155.8\,N$

also, $\tan\theta = \frac{\Sigma f_y}{\Sigma f_x} = \frac{151.6}{36.0}$

$\theta = \tan^{-1}(4.211)$

$\theta = 76.6°$

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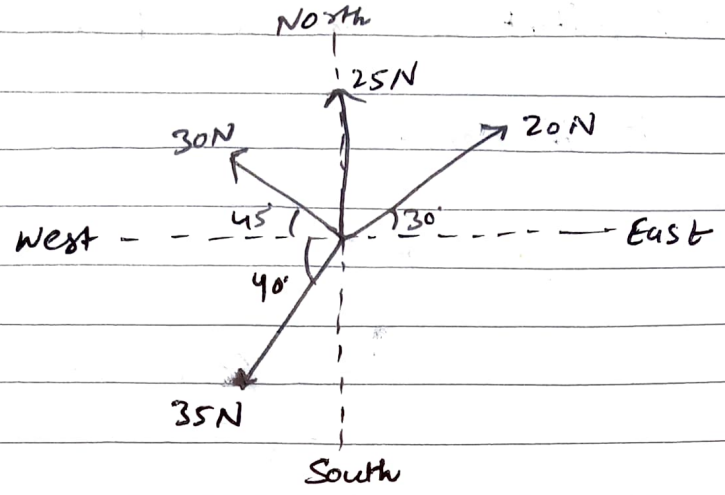
Q: find the magnitude and direction of the resultant force



$$\Sigma f_x = 20\cos 30^\circ + 25\cos 90^\circ + 30\cos 135^\circ + 35\cos 220^\circ$$
$$= (20 \times 0.866) + (25 \times 0) + 30(-0.707) + 35(-0.766)$$
$$= -30.7\ N$$

$$\Sigma f_y = 20\sin 30^\circ + 25\sin 90^\circ + 30\sin 135^\circ + 35\sin 220^\circ\ N$$
$$= (20 \times 0.5) + (25 \times 1.0) + (30 \times 0.707) + 35(-0.6428)$$
$$= 33.7\ N$$

$$R = \sqrt{\Sigma f_x^2 + \Sigma f_y^2} = \sqrt{(-30.7)^2 + (33.7)^2}$$

$$R = 45.6\ N$$

$$\tan\theta = \frac{\Sigma f_y}{\Sigma f_x} = \frac{33.7}{-30.7} = -1.098$$

$$\theta = \tan^{-1}(-1.098)$$
$$\theta = 47.7^\circ$$

but as Σf_x is negative & Σf_y is positive, ∴ Resultant lies in 2nd quadrant.

$$\theta = 180^\circ - 47^\circ = 132.3^\circ \text{ Ans}$$

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Q10. Find the angle between two equal forces P, when their resultant is equal to (i) P and (ii) P/2.

(i) if Resultant is equal to P.

$$R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$$

$$P = \sqrt{P^2 + P^2 + 2 \cdot P \cdot P\cos\theta}$$

$$= P\sqrt{2 + 2\cos\theta}$$

$\therefore 2\cos\theta = -1$ or $\cos\theta = -0.5$ or $\theta = 120^\circ$

(ii) when resultant is equal to P/2, then

$$0.5P = \sqrt{P^2 + P^2 + 2P \cdot P\cos\theta}$$

$$= P\sqrt{2 + 2\cos\theta}$$

$$2\cos\theta = -1.75 \text{ or } \cos\theta = -0.875$$

$\therefore \theta = 151^\circ$ Ans