

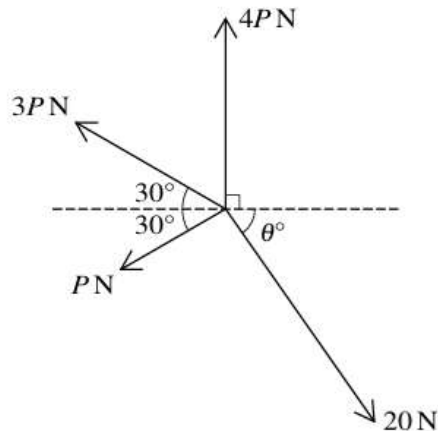
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Mathematics 9709/42

Paper 4 Mechanics May/June 2020

Question No(2)



Coplanar forces of magnitudes 20 N , PN , $3PN$ and $4PN$ act at a point in the directions shown in the diagram. The system is in equilibrium.

Find P and θ .

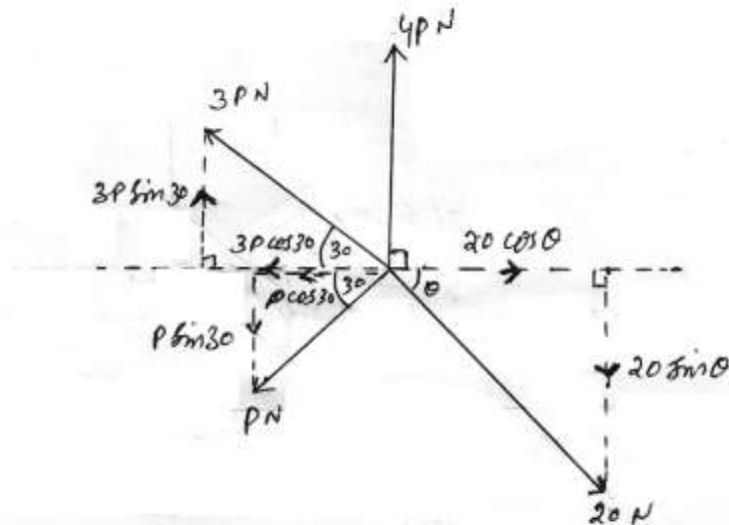
Solution:

Knowledge sharing

$F_x \cos \theta$ and $F_y \sin \theta$ are called rectangular components of a force F . These two components together have the same effect as the original force.

Rectangular components make an angle of 90° with each other.

Resolve the forces $P\text{N}$, $3P\text{N}$ and 20N into its rectangular components.



Resolving the forces horizontally,
Left hand forces = Right hand forces.

$$3P \cos 30 + P \cos 30 = 20 \cos \theta$$

$$4P \cos 30 = 20 \cos \theta$$

$$\Rightarrow 20 \cos \theta = 4P \cos 30 \rightarrow (1)$$

Resolving forces vertically

upward forces = downward forces

$$4P + 3P \sin 30 = P \sin 30 + 20 \sin \theta$$

$$4P + 3P \sin 30 - P \sin 30 = 20 \sin \theta$$

$$4P + 2P \sin 30 = 20 \sin \theta$$

$$4P + 2P\left(\frac{1}{2}\right) = 20 \sin \theta$$

$$\therefore \sin 30 = \frac{1}{2}$$

$$4P + P = 20 \sin \theta$$

$$5P = 20 \sin \theta$$

$$20 \sin \theta = 5P \rightarrow (2)$$

Divide equation (2) by Equation (1)

$$\frac{20 \sin \theta}{20 \cos \theta} = \frac{5P}{4P \cos 30}$$

$$\tan \theta = \frac{5P}{4P(0.8660)}$$

$$= \frac{5}{4(0.8660)}$$

$$= \frac{5}{3.464}$$

$$\tan \theta = 1.443$$

$$\theta = \tan^{-1}(1.443)$$

$$\theta = 55.3^\circ$$

substitute $\theta = 55.3^\circ$ in equation (2)

$$20 \sin 55.3^\circ = 5P$$

$$P = \frac{20 \sin 55.3^\circ}{5}$$

$$P = 3.29 \text{ N}$$

