SNS COLLEGE OF TECHNOLOGY

23MET101- ENGINEERING MECHANICS

UNIT I - BASICS & STATICS OF PARTICLES

Resolution and Composition of forces

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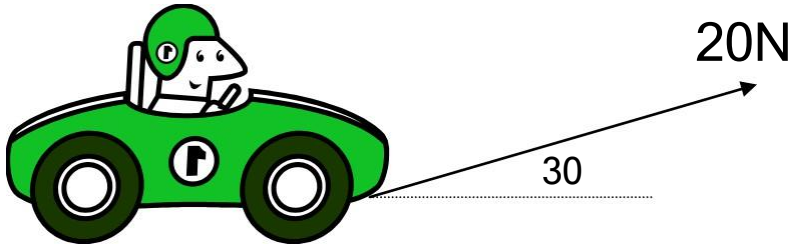
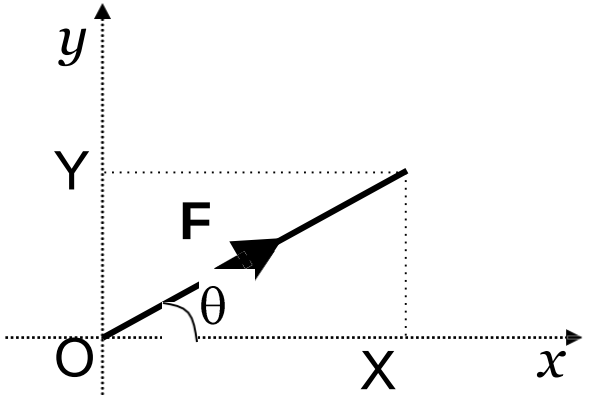
Resolution and Composition of Forces



Splitting of forces into their components

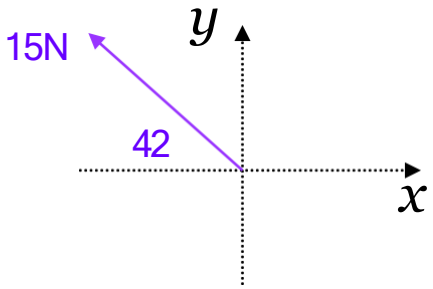
Resolution of force is a **reverse process** in which a single force is expressed in terms of its components. These components are sometimes referred to as the resolved parts of the force.



OX= Fcosθ

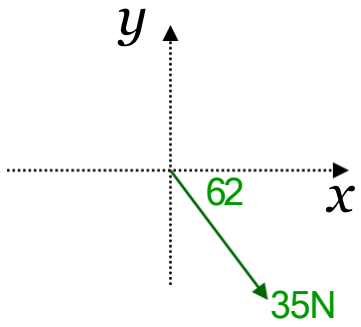
OY= Fsinθ

Examples



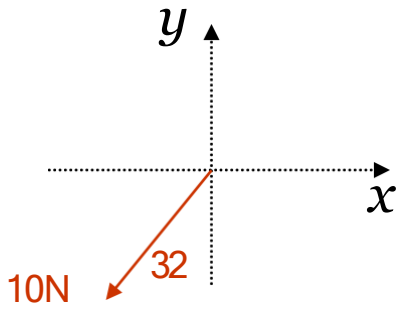
$X = -15 \times \cos 42 = -11.1\,N$

$Y = 15 \times \sin 42 = 10.0\,N$



$X = 35 \times \cos 62 = 16.4\,N$

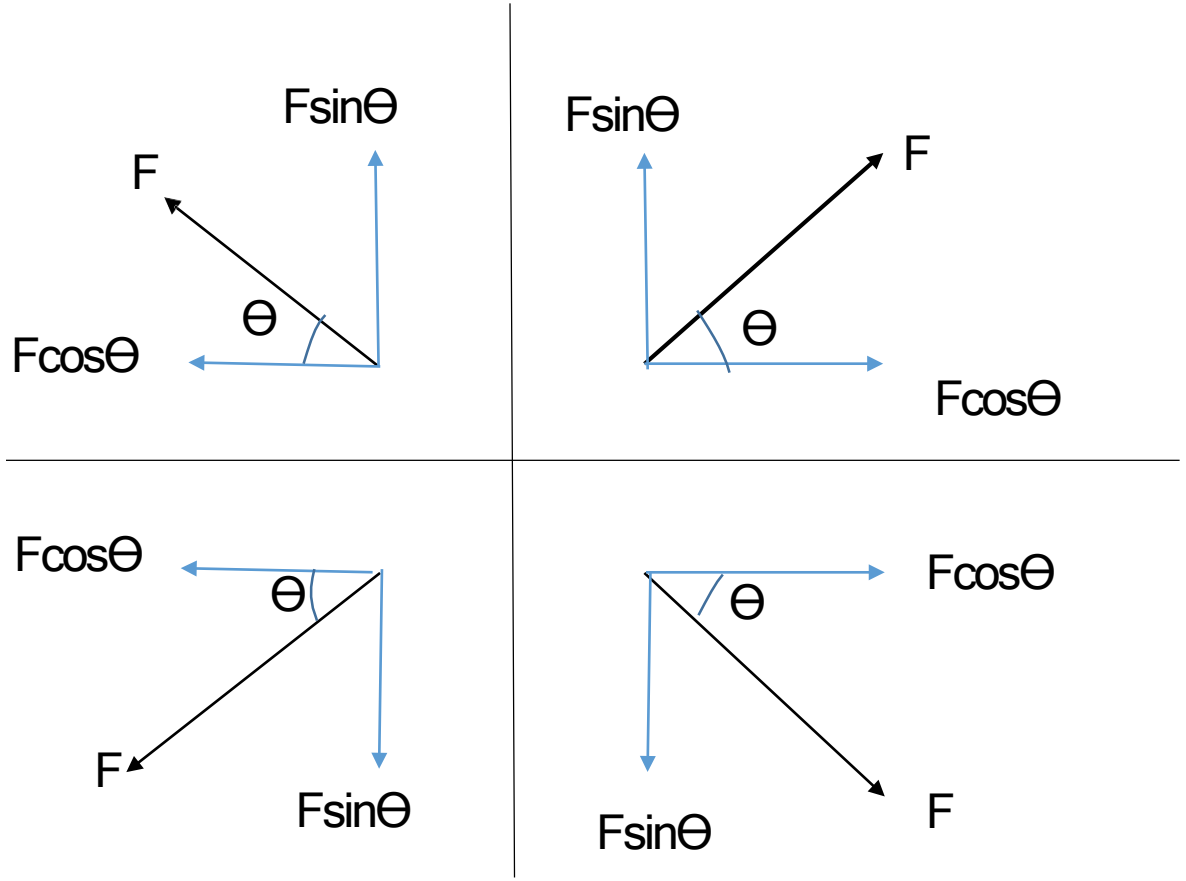
$Y = -35 \times \sin 62 = -30.9\,N$



$X = -10 \times \sin 32 = -5.30\,N$

$Y = -10 \times \cos 32 = -8.48\,N$

Resolution and Composition of Forces



1. It is convenient to have
   $F_x = F\cos\Theta$
   $F_y = F\sin\Theta$
   and Always measure angle from horizontal reference (acute angle).

2. Assume force pointing Right and Top as positive otherwise negative

Procedure to find ResultantForce

Procedureto find the magnitudeanddirection of the resultant force

1. Find ΣF_x
2. Find ΣF_y
3. Magnitude of the resultant force is given by

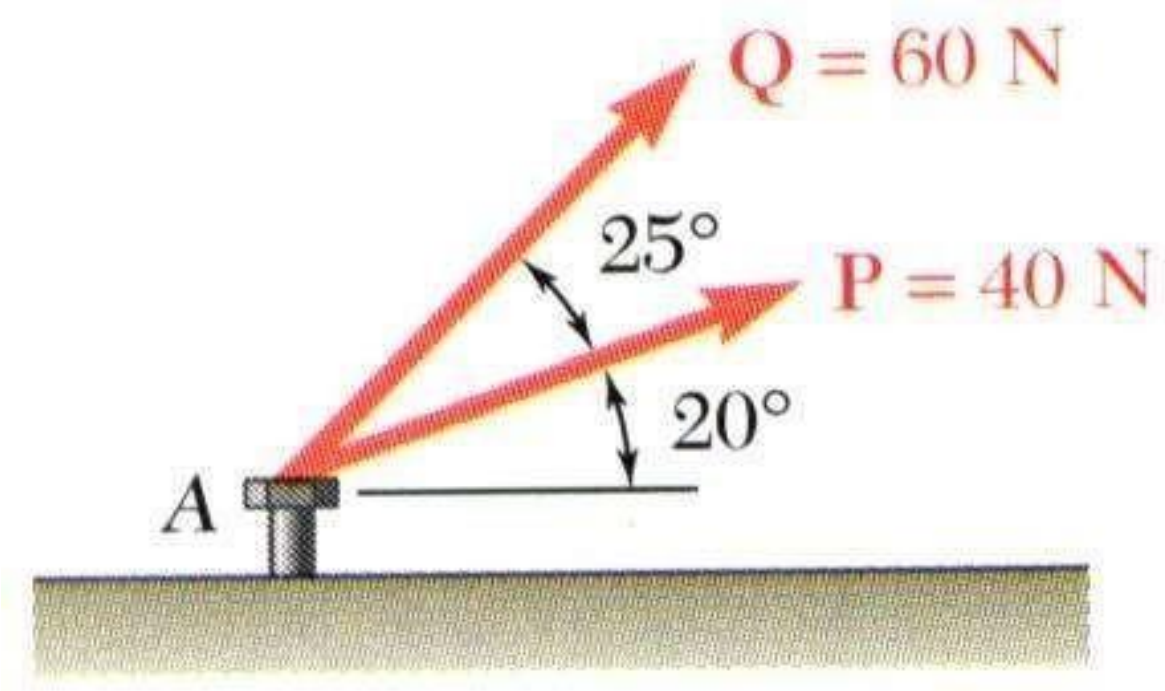
$$= \sqrt{(\Sigma \quad)^2+(\Sigma \quad)^2}$$

4. Plot ΣF_x and ΣF_y with its appropriate sign
5. Direction of the resultant force is given by

$$\tan\Theta = \frac{\Sigma}{\Sigma}$$

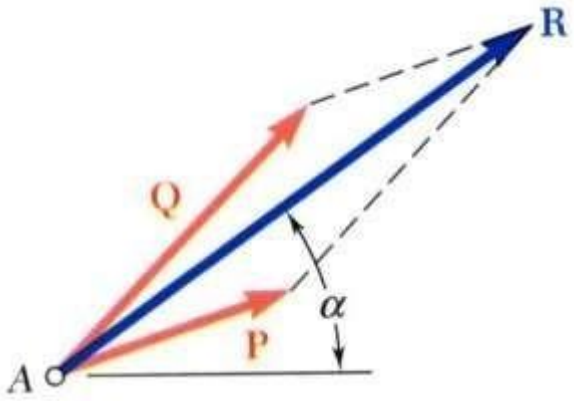
Problems

Problem No 1



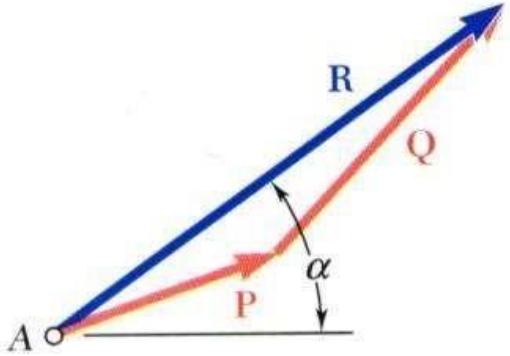
Two forces act on a bolt at *A*. Determine their resultant.

Problem No 1 (contd...)



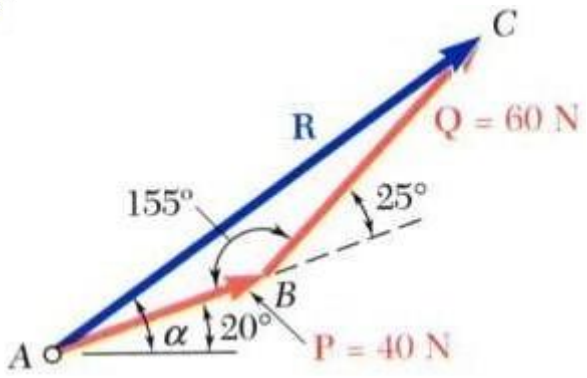
- Graphical solution - A parallelogram withsides equal to **P** and **Q** is drawn to scale. The magnitude and direction of the resultant or of the diagonal to the parallelogram are measured,

R = 98 N α = 35°



- Graphical solution - A triangle is drawn with **P** and **Q** head-to-tail and to scale. The magnitude and direction of the resultant or of the third side of the triangle are measured,

R = 98 N α = 35°



- Trigonometric solution - Apply the triangle

From the Law of Cosines,

$$R^2 = P^2 + Q^2 - 2PQ\cos B$$
$$= (40\text{N})^2 + (60\text{N})^2 - 2(40\text{N})(60\text{N})\cos 155°$$

$$\boxed{R = 97.73\text{N}}$$

From the Law of Sines,

$$\frac{\sin A}{Q} = \frac{\sin B}{R}$$

$$\sin A = \sin B \frac{Q}{R}$$
$$= \sin 155° \frac{60\text{N}}{97.73\text{N}}$$
$$A = 15.04°$$
$$\alpha = 20° + A$$
$$\boxed{\alpha = 35.04°}$$

Sl.No.	ΣF_x	ΣF_y
1.	+40cos20	+40sin20
2.	+60cos45	+60cos45
	80.01	56.10

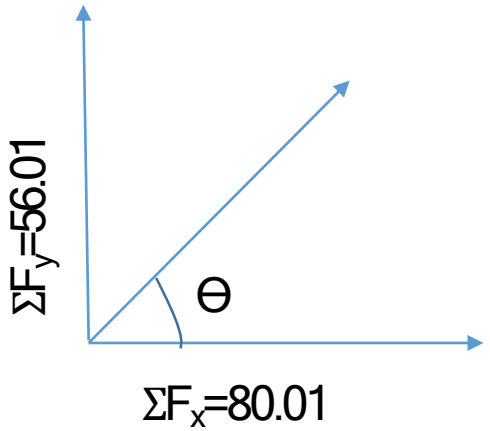
Magnitude of the resultant force

$$= \sqrt{(\Sigma \quad)^2+(\Sigma \quad)^2}$$

$$= \sqrt{(80.01)^2+(56.10)^2}$$

R=97.72N

Direction of resultant force

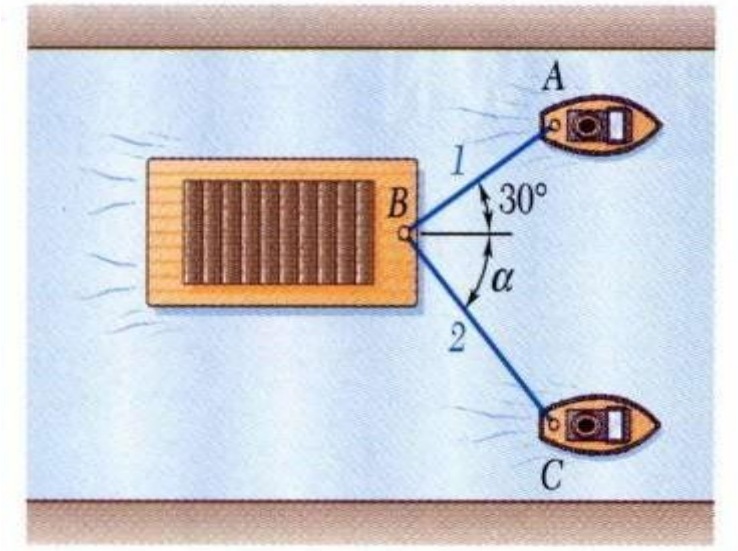


$$\tan\Theta = \frac{\Sigma}{\Sigma}$$

$$\tan\Theta = \left(\frac{56.1}{80.01}\right)$$

$$\Theta = 35^{o}$$

Problem 2

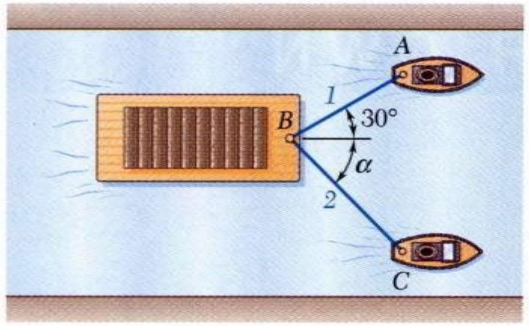


A barge is pulled by two tugboats. If the resultant of the forces exerted by the tugboats is a 25 kN directed along the axis of the barge, determine

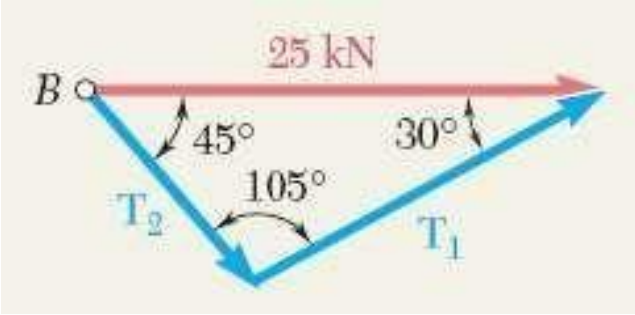
a) the tension in each of the ropes for $\alpha = 45^{o}$,

b) the value of α for which the tension in rope 2 is minimum.

Problem 2



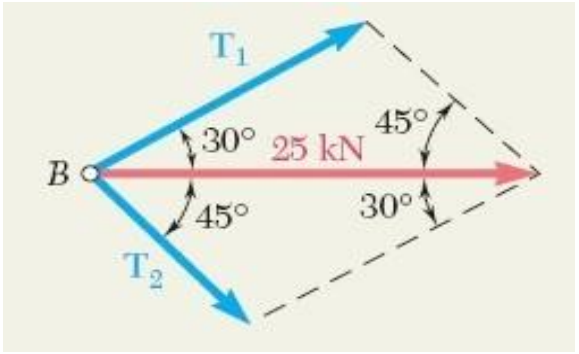
- Trigonometric solution - Triangle Rule with Law of Sines



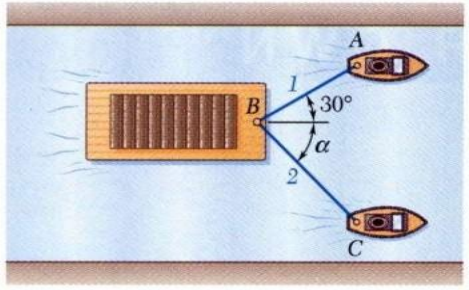
$$\frac{T_1}{\sin 45°} = \frac{T_2}{\sin 30°} = \frac{25\,\text{kN}}{\sin 105°}$$

$T_1 = 18.3\ \text{kN} \quad T_2 = 12.94\ \text{kN}$

- Graphical solution - Parallelogram Rule with known resultant direction and magnitude, known directions for sides.

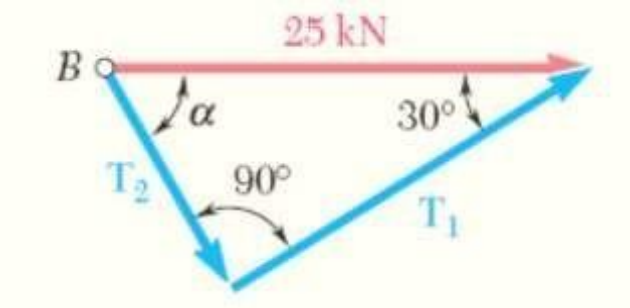


$T_1 = 18.5\ \text{kN} \quad T_2 = 12.8\text{kN}$



- The angle for minimum tension in rope 2 is determined by applying the Triangle Rule and observing the effect of variations in α.

- The minimum tension in rope 2 occurs when $\mathbf{T_1}$ and $\mathbf{T_2}$ areperpendicular.

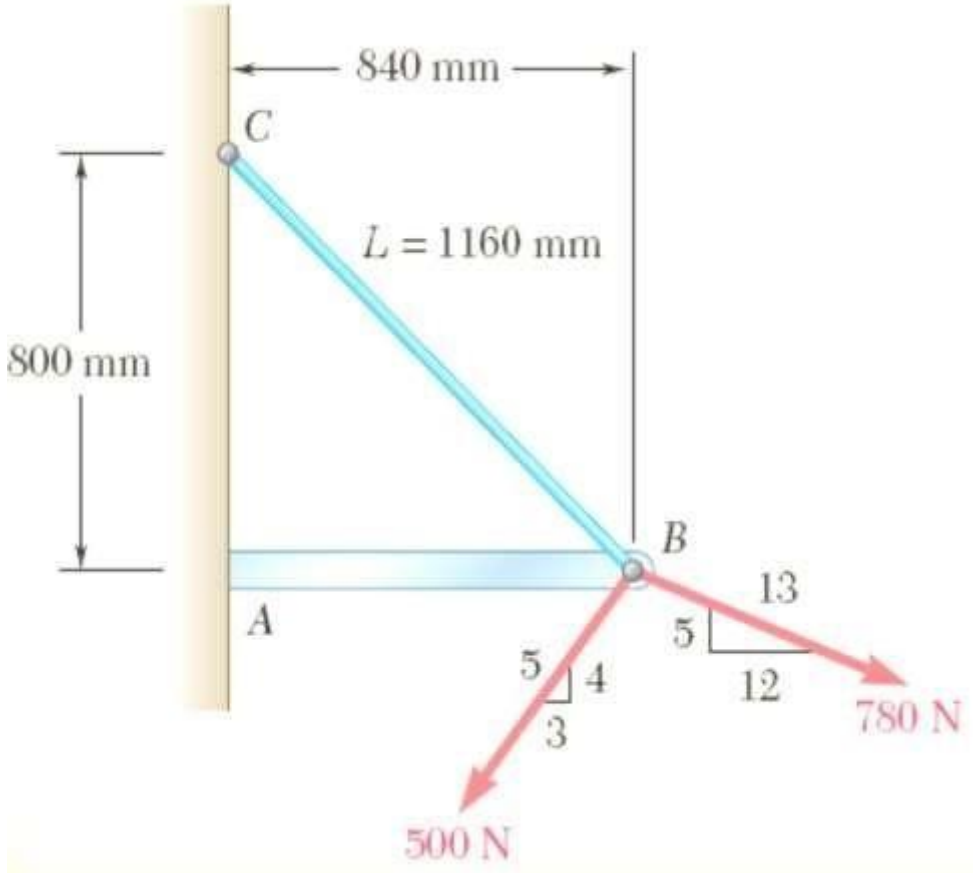


$$T_2 = (25\,\text{kN})\sin 30^\circ \qquad T_2 = 12.5\ \text{kN}$$

$$T_1 = (25\,\text{kN})\cos 30^\circ \qquad T_1 = 21.7\,\text{kN}$$

$$\alpha = 90^\circ - 30^\circ \qquad \alpha = 60^\circ$$

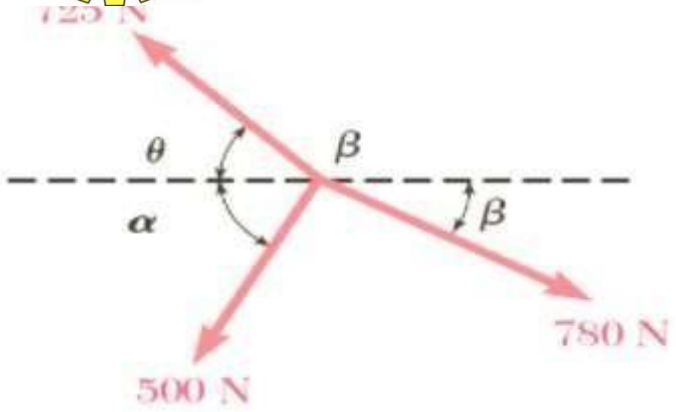
Problem 3



Knowing that the tension in cable *BC* is 725-N, determine the resultant of the three forces exerted at point *B* of beam *AB*.

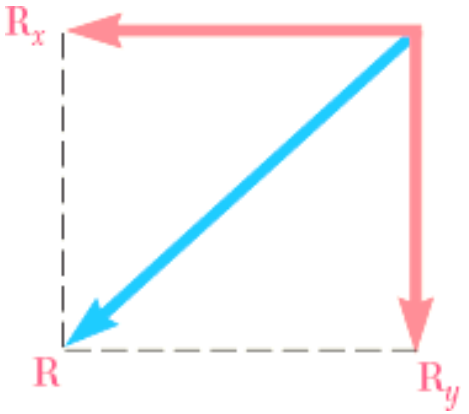
SOLUTION:

- Resolve each force into rectangular components.



Magnitude, N	x Component, N	y Component, N
725	−525	500
500	−300	− 400
780	720	− 300
	$R_x = -105$	$R_y = -200$

$$\mathbf{R} = R_x\mathbf{i} + R_y\mathbf{j} \qquad \mathbf{R} = (-105\ \text{N})\mathbf{i} + (-200\ \text{N})\mathbf{j}$$



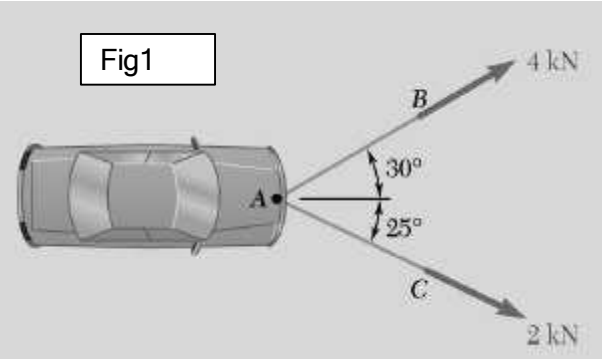
- Calculate the magnitude and direction.

$$\tan\alpha = \frac{-R_y}{-R_x} = \frac{200\,\text{N}}{105\,\text{N}} \qquad \alpha = 62.3^\circ$$

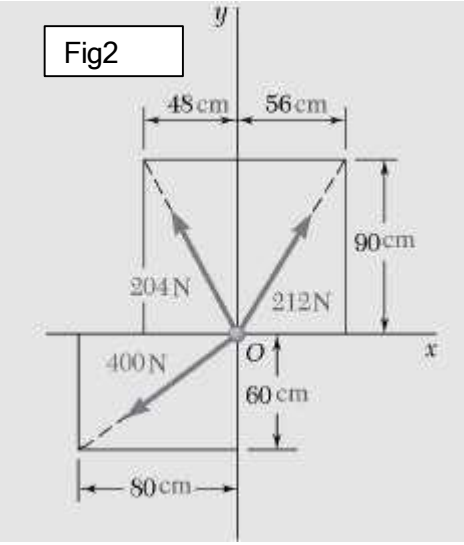
$$R = \sqrt{R_x^2 + R_y^2} = 225.9\,\text{N}$$

62.3°

Problems for Practice



A disabled automobile is pulled by means of two ropes shown in fig 1. Determine the Magnitude and direction of Resultant by(a) parallelogram law,(b)Trianglelaw(c)analytical method



Determine the magnitude anddirection of resultant force shown in fig 2.