

resultant of coplanar forces meeting at point

Tuesday, September 9, 2025 11:34 PM

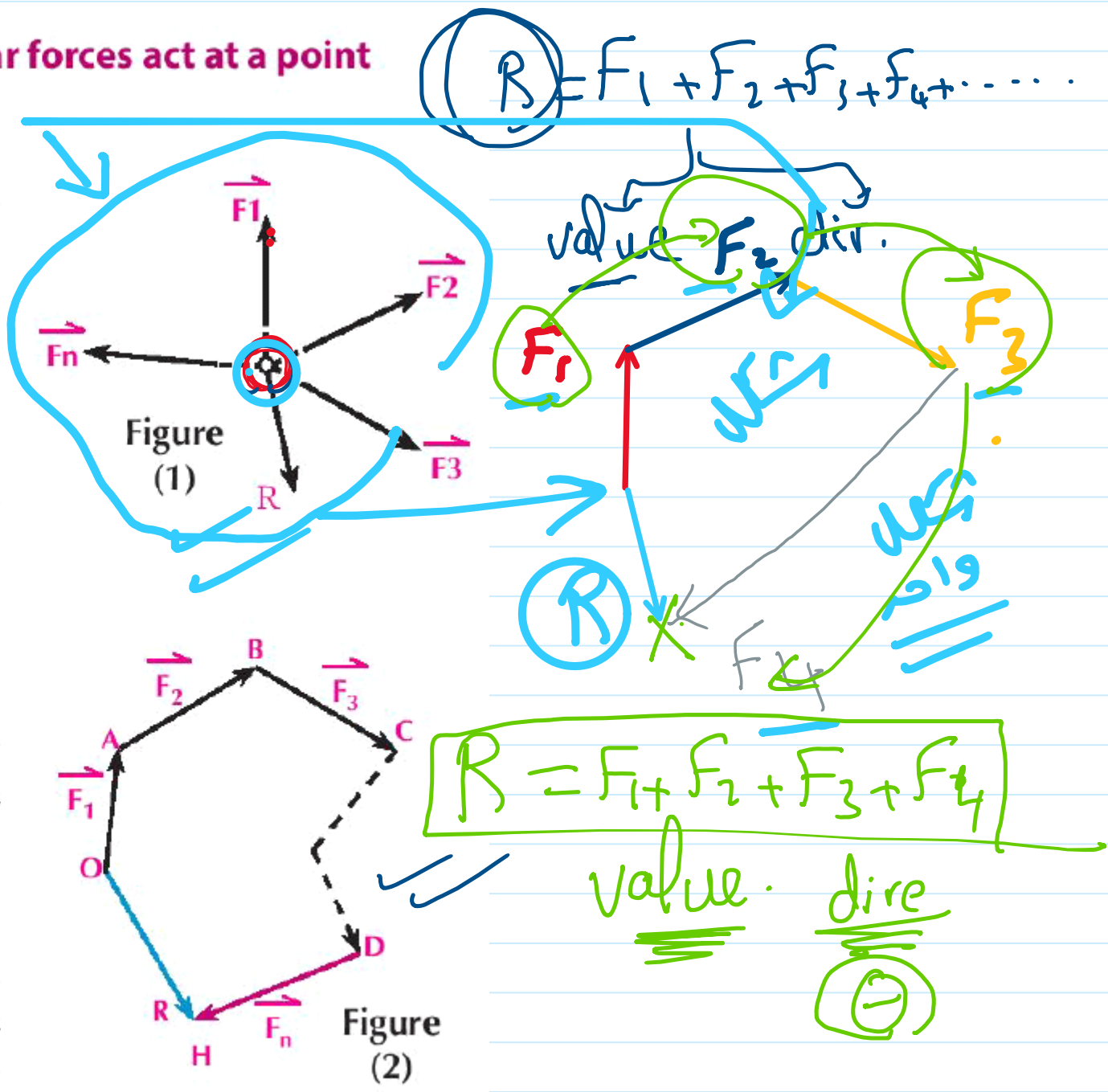
Resultant of a set of coplanar forces act at a point geometrically:

If set of forces $\vec{F}_1, \vec{F}_2, \vec{F}_3, \dots, \vec{F}_n$ act on a particle as shown in figure (1).

Using a suitable drawing scale, draw \vec{OA} represents \vec{F}_1 , \vec{AB} represents \vec{F}_2 , \vec{BC} represents \vec{F}_3 and so on, till \vec{F}_n is represented by \vec{DH} .

Then the vector \vec{OH} in the opposite cyclic order represents the resultant of the forces, where:

$\vec{R} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \dots + \vec{F}_n$
and the polygon is called polygon of forces, it is easy to notice that forming a polygon of forces is the result of applying the triangle of forces several consecutive times.



resultant of coplaner forces meeting at point_1

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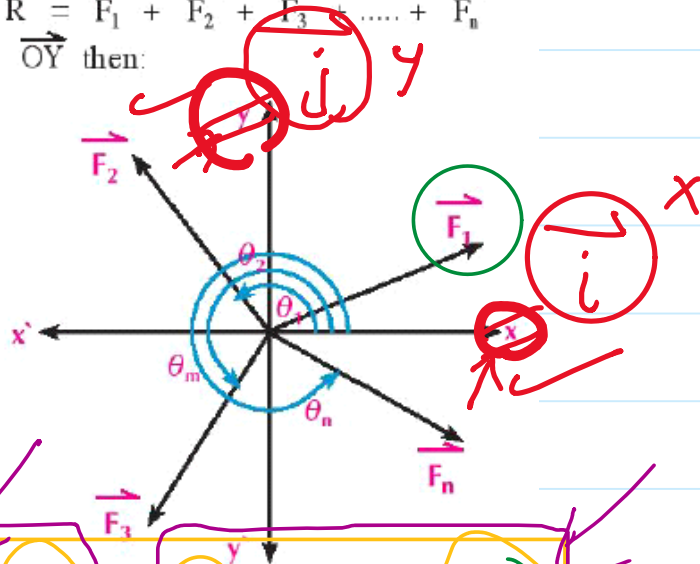
The resultant of coplaner forces meeting at a point analytically

If the coplaner forces $\vec{F}_1, \vec{F}_2, \vec{F}_3, \dots, \vec{F}_n$ act at a point in the coordinate plane system, to make the polar angles $\theta_1, \theta_2, \theta_3, \dots, \theta_n$ respectively and \vec{i}, \vec{j} are two fundamental unit vectors in directions \vec{OX}, \vec{OY} then: $\vec{R} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \dots + \vec{F}_n$
Resolving each force in the perpendicular directions \vec{OX}, \vec{OY} then:

$$\begin{aligned} \vec{R} &= (F_1 \cos \theta_1 \vec{i}, F_1 \sin \theta_1 \vec{j}) \\ &+ (F_2 \cos \theta_2 \vec{i}, F_2 \sin \theta_2 \vec{j}) \\ &+ \dots + (F_n \cos \theta_n \vec{i}, F_n \sin \theta_n \vec{j}) \end{aligned}$$

$$\vec{R} = (F_1 \cos \theta_1 + F_2 \cos \theta_2 + \dots + F_n \cos \theta_n) \vec{i} + (F_1 \sin \theta_1 + F_2 \sin \theta_2 + \dots + F_n \sin \theta_n) \vec{j}$$

$$\vec{R} = \left(\sum_{r=1}^n F_r \cos \theta_r \right) \vec{i} + \left(\sum_{r=1}^n F_r \sin \theta_r \right) \vec{j}$$



value
dir.

$$\vec{F}_1 = F_1 \cos \theta_1 \vec{i} + F_1 \sin \theta_1 \vec{j}$$

value direc x y

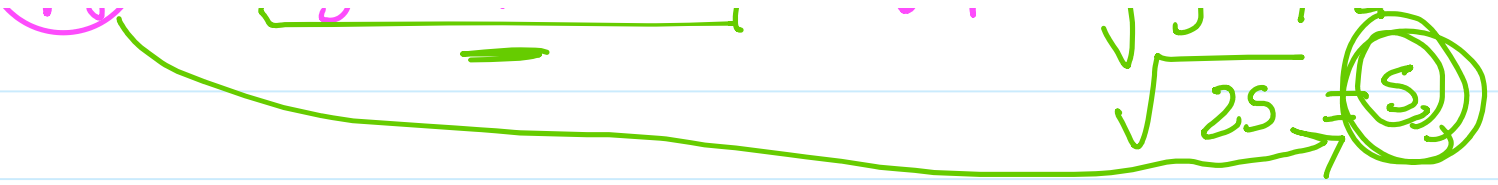
$$\vec{F}_2 = F_2 \cos \theta_2 \vec{i} + F_2 \sin \theta_2 \vec{j}$$

$$\vec{F}_3 = F_3 \cos \theta_3 \vec{i} + F_3 \sin \theta_3 \vec{j}$$

$$\vec{R} = (F_1 \cos \theta_1 + F_2 \cos \theta_2 + F_3 \cos \theta_3) \vec{i} + (F_1 \sin \theta_1 + F_2 \sin \theta_2 + F_3 \sin \theta_3) \vec{j}$$

$$\vec{R} = 9 \vec{i} + 4 \vec{j}$$

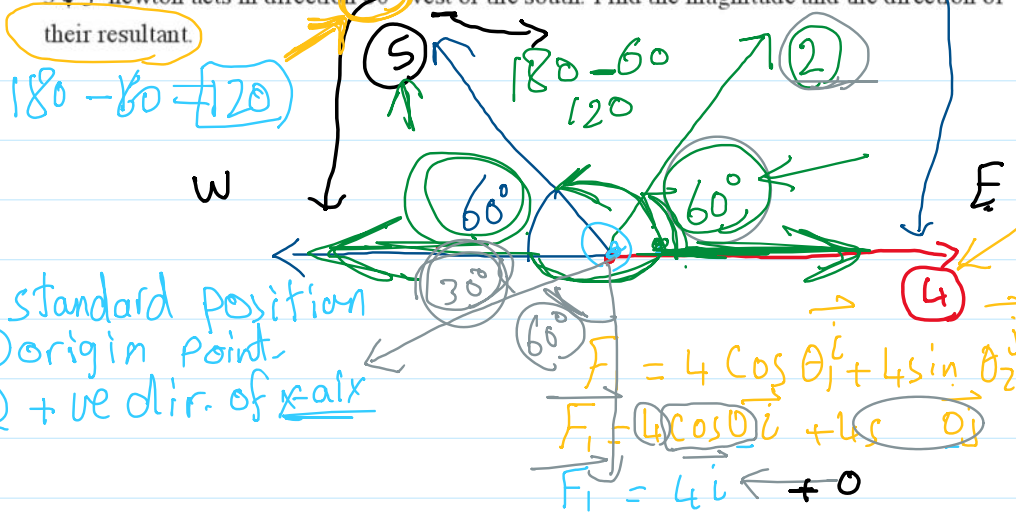
$$\text{value} = \sqrt{9^2 + 4^2} = \sqrt{25} = 5$$



resultant of coplaner forces meeting at point_3

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- 1 Four coplanar forces act on a particle, the first of magnitude 4 newton, acts in the East direction, The second of magnitude 2 newton, acts in direction 60° North of the East, the third of magnitude 5 newton, acts in direction 60° North of the West and the fourth of magnitude $3\sqrt{3}$ newton acts in direction 60° west of the south. Find the magnitude and the direction of their resultant.



$$\vec{F}_2 = 2 \cos 60 \hat{i} + 2 \sin 60 \hat{j} = \hat{i} + \sqrt{3} \hat{j}$$

$$\vec{F}_3 = 5 \cos 120 \hat{i} + 5 \sin 120 \hat{j} = -\frac{5}{2} \hat{i} + \frac{5\sqrt{3}}{2} \hat{j}$$

$$F_4 = 3\sqrt{3} \cos 210 \hat{i} + 3\sqrt{3} \sin 210 \hat{j} = -\frac{9}{2} \hat{i} - \frac{3\sqrt{3}}{2} \hat{j}$$

$$\vec{R} = (4 + 1 - \frac{5}{2} - \frac{9}{2}) \hat{i} + (\sqrt{3} + \frac{5}{2} \sqrt{3} - \frac{3\sqrt{3}}{2}) \hat{j}$$

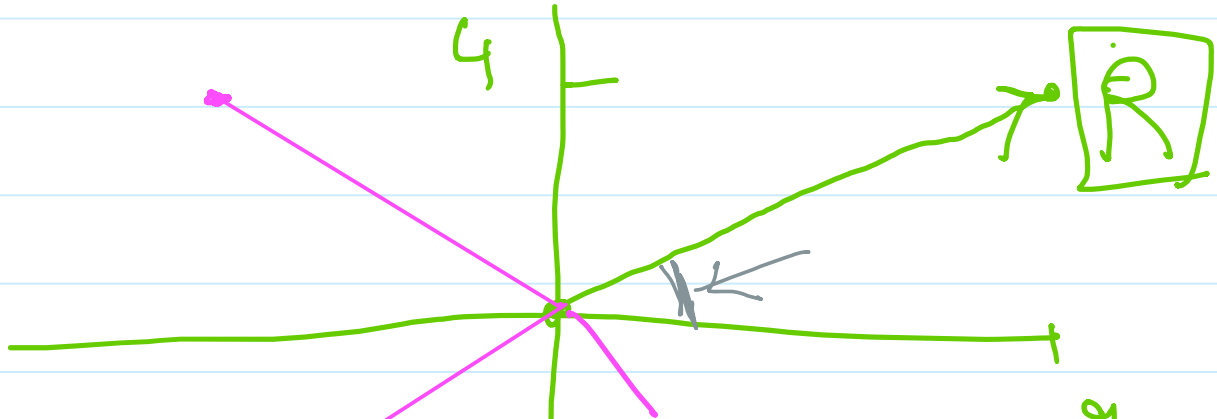
$$\vec{R} = -2 \hat{i} + 2\sqrt{3} \hat{j} \Rightarrow R = \sqrt{(-2)^2 + (2\sqrt{3})^2}$$

$$R = \sqrt{16} = 4 \text{ N}$$

$$\tan \theta = \frac{y}{x} = \frac{2\sqrt{3}}{-2} = -\sqrt{3} \Rightarrow \theta = -60^\circ \text{ or } 300^\circ$$

$\Rightarrow 120^\circ$

9, 4



$$\tan \theta = \frac{y}{x}$$

$$\frac{4}{9}$$

$$R = 9i + 4j$$

$$R = 9\vec{i} + 4\vec{j}$$

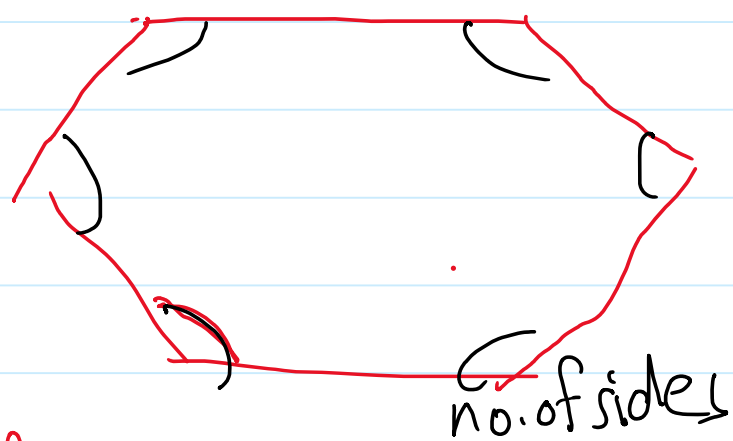
$$R = -9i - 4j$$

$$R = 9i - 4j$$

resultant of coplaner forces meeting at point_4

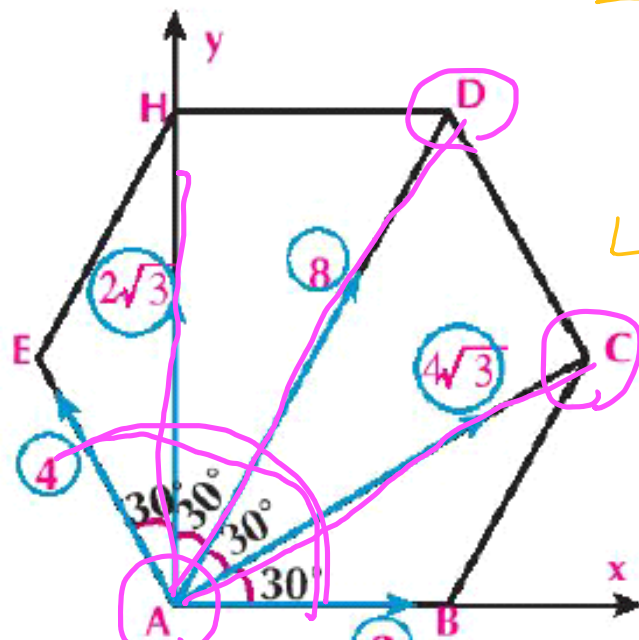
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2) A B C D H E is a regular hexagon. Forces of magnitudes 2 , $4\sqrt{3}$, 8 , $2\sqrt{3}$ and 4 kg.wt act at point A in directions \overrightarrow{AB} , \overrightarrow{AC} , \overrightarrow{AD} , \overrightarrow{AH} , \overrightarrow{AE} respectively. Find the magnitude and the direction of their resultant.



standard

basic



sum of angle = $180(n-2)$

no. of sides

one angle = $\frac{180(n-2)}{n} = \frac{180(6-2)}{6} = \boxed{120^\circ}$

$X = 2 \cos 0^\circ + 4\sqrt{3} \cos 30^\circ + 8 \cos 60^\circ + 2\sqrt{3} \cos 90^\circ + 4 \cos 120^\circ$

$X = \boxed{} \vec{i}$

$Y = 2 \sin 0^\circ + 4\sqrt{3} \sin 30^\circ + 8 \sin 60^\circ + 2\sqrt{3} \sin 90^\circ + 4 \sin 120^\circ$

$Y = \boxed{} \vec{j}$

$R = \boxed{} \vec{i} + \boxed{} \vec{j}$

$\tan \theta = \frac{Y}{X}$

$\theta = \checkmark$

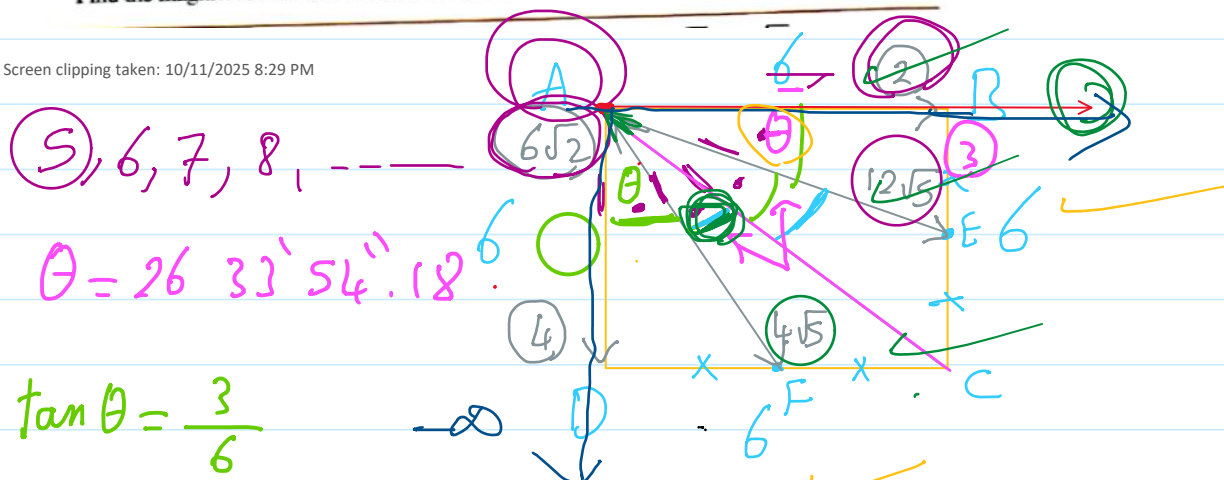
$R = \sqrt{X^2 + Y^2} = \checkmark$

resultant of coplaner forces meeting at point_5

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21 ABCD is a square of side length 6 cm. The point E is the midpoint of \overline{BC} and F is the midpoint of \overline{DC} , the five forces of magnitudes 2, $12\sqrt{5}$, $6\sqrt{2}$, $4\sqrt{5}$ and 4 kg.wt. act at the point A in the directions of \overline{AB} , \overline{AE} , \overline{CA} , \overline{AF} and \overline{AD} respectively. Find the magnitude and the direction of the resultant of these forces. « 30 kg.wt., $36^\circ 52' 12''$ »

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(5), 6, 7, 8, ---

$$\theta = 26^\circ 33' 54.18''$$

$$\tan \theta = \frac{3}{6}$$

$$\theta = \tan^{-1} \frac{3}{6} = 26^\circ 33' 54.18''$$

$$45^\circ - 26^\circ 33' 54.18'' = 18^\circ 26' 5.84''$$

$$X = 2 \cos 0^\circ + 12\sqrt{5} \cos 26^\circ 33' 54.18'' + 6\sqrt{2} \cos 45^\circ + 4\sqrt{5} \cos 63^\circ 26' 5.84'' + 4 \cos 90^\circ$$

$$Y = -2 \sin 0^\circ + 12\sqrt{5} \sin 26^\circ 33' 54.18'' + 6\sqrt{2} \cos 45^\circ - 4\sqrt{5} \cos 63^\circ 26' 5.84'' - 4 \cos 90^\circ$$