الأزهر الشريف
قطاع المعاهد الأزهريه
منطقة كفر الشيخ الأزهريه

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book

Mathematics

Applications

second secondary grade

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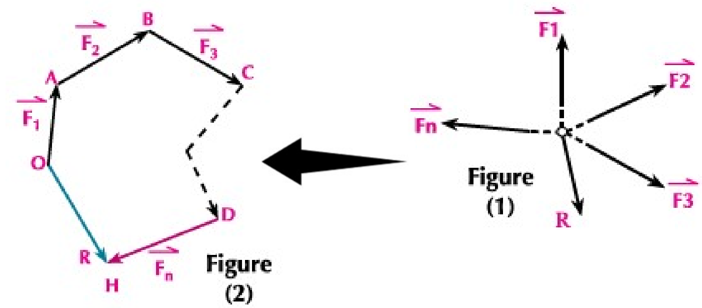
The resultant of coplanar forces meeting at a point

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

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

$$\overrightarrow{R} = \overrightarrow{F_1} + \overrightarrow{F_2} + \overrightarrow{F_3} + \dots + \overrightarrow{F_n}$$

and the polygon is called polygon of forces, it is easy to notice that forming a polygon of forces



$$\overrightarrow{R} = \overrightarrow{F_1} + \overrightarrow{F_2} + \overrightarrow{F_3} + \dots + \overrightarrow{F_n}$$

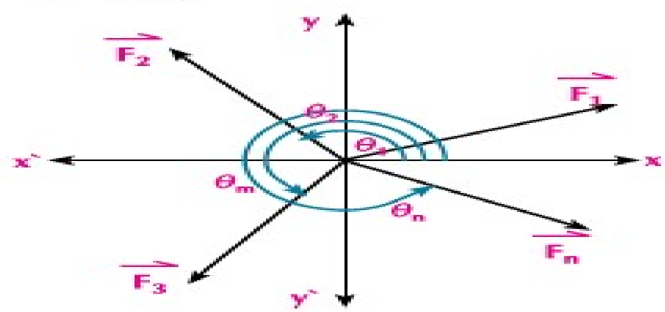
The resultant of coplanar forces meeting at apoint analytically

If the coplanar forces $\overrightarrow{F_1}$, $\overrightarrow{F_2}$, $\overrightarrow{F_3}$,..... , $\overrightarrow{F_n}$ act at a point in the coordinate plane system, to make the polar angles θ_1 , θ_2 , θ_3 , ... , θ_n respectively and $\overrightarrow{i}$, $\overrightarrow{j}$ are two fundamental unit vectors in directions $\overrightarrow{OX}$, $\overrightarrow{OY}$ then: $\overrightarrow{R} = \overrightarrow{F_1} + \overrightarrow{F_2} + \overrightarrow{F_3} + \dots + \overrightarrow{F_n}$
Resolving each force in the perpendicular directions $\overrightarrow{OX}$, $\overrightarrow{OY}$ then:

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

$$\overrightarrow{R} = (F_1 \cos\theta_1 + F_2 \cos {}_2\theta + \dots\dots + F_n \cos\theta_n) \overrightarrow{i}$$
$$+ (F_1 \sin\theta_1 + F_2 \sin {}_2\theta + \dots\dots + F_n \sin\theta_n) \overrightarrow{j}$$

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



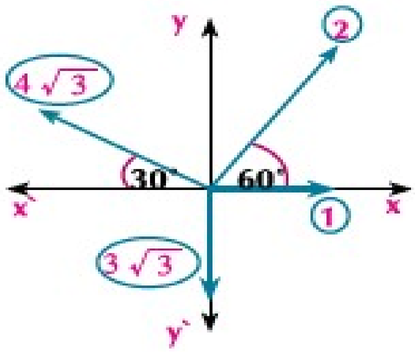
Complete the following:

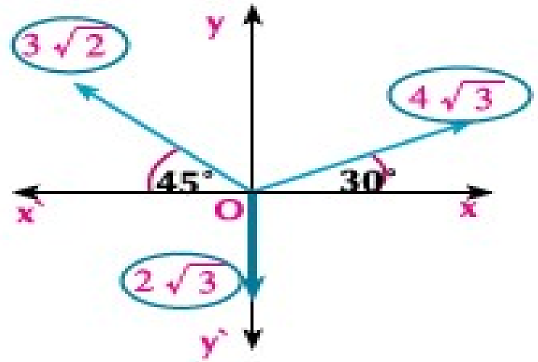
1. If the forces $\overrightarrow{F_1} = 2\overrightarrow{i}$, $\overrightarrow{F_2} = \overrightarrow{i} - 2\overrightarrow{j}$, $\overrightarrow{F_3} = 6\overrightarrow{j}$ then:
the magnitude of the resultant of the forces = ... and its direction = ...

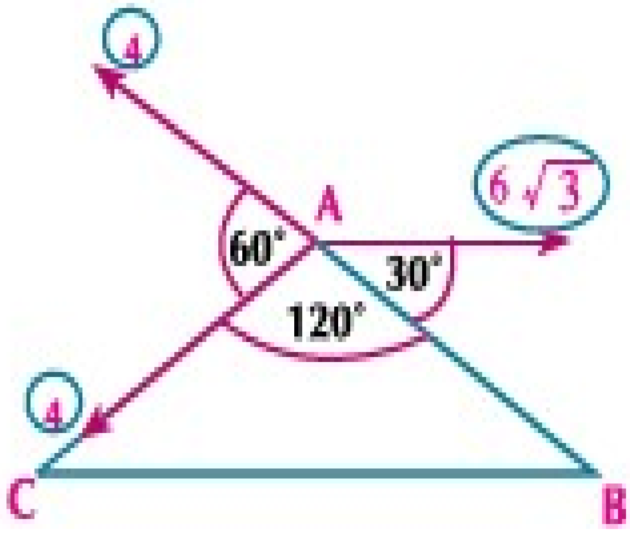
2. If the forces $\overrightarrow{F_1} = 2\overrightarrow{i} - 2\overrightarrow{j}$, $\overrightarrow{F_2} = 4\overrightarrow{i} - 8\overrightarrow{j}$, $\overrightarrow{R} = 2a\overrightarrow{i} - 3b\overrightarrow{j}$
then: a = ... , b = ...

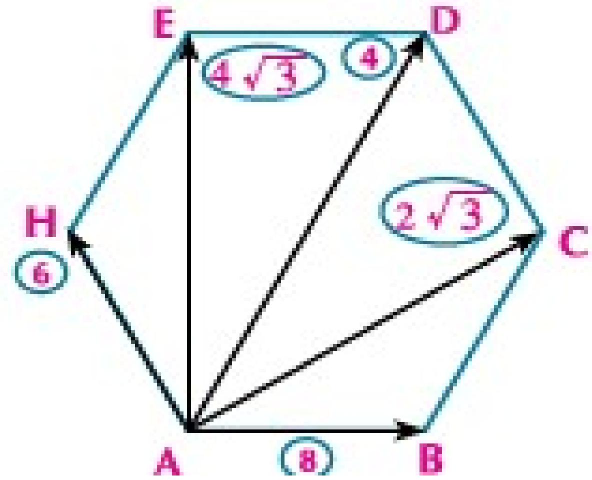
3. If $\overrightarrow{F_1} = 3\overrightarrow{i} - 2\overrightarrow{j}$, $\overrightarrow{F_2} = a\overrightarrow{i} - \overrightarrow{j}$, $\overrightarrow{F_3} = 4\overrightarrow{i} - b\overrightarrow{j}$, $\overrightarrow{R} = 6\overrightarrow{i} - 4\overrightarrow{j}$
then: a = ... , b = ...

Find the magnitude and the direction of resultant of the forces shown in each of the following figures:






4
6 √3
A
60°
30°
120°
4
C
B


E
D
4 √3
4
2 √3
H
C
6
A
8
B

- ABCD is a square of side length 12cm , $H \in \overline{BC}$ so BH = 5cm. Forces of magnitudes 2 , 13 , $4\sqrt{2}$ and 9 gm.wt act in directions of $\overrightarrow{AB}$, $\overrightarrow{AH}$, $\overrightarrow{CA}$, $\overrightarrow{AD}$ respectively. Find the magnitude of the resultant of these forces.

Creative thinking:

(14) **The opposite figure :** shows four coplanar forces act at the point (O) in the directions shown in the figure, where $\sin\theta = \frac{4}{5}$ and the resultant of these forces equals $8\sqrt{2}$ newton and makes an angle of measure 135° with $\overrightarrow{OX}$, then find the values of F , K.