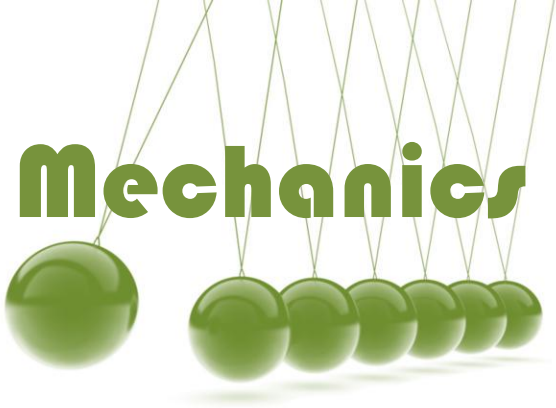


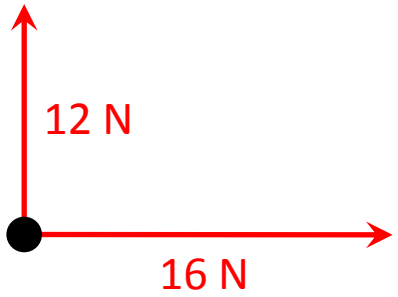
M1

Resultant Forces

Objective: To be able to find the single resultant force of a system of forces.

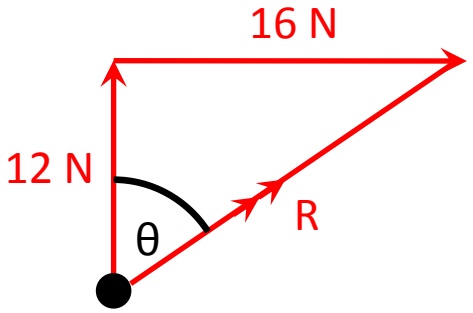
The resultant force is the single force that represents a system of forces. Earlier we looked at two or more forces acting in the same direction (or opposite). Forces can act in any direction, all affecting the acceleration of an object.

Eg. Two forces act on this particle in the same plane, but at 90° to each other.



This system of forces can also be looked at in an 'end-to-end' manner:

The resultant joins the beginning to the end in a straight line.



The size of the resultant force, R, is called the MAGNITUDE of R, and can be found using Pythagoras' Theorem.

$$R^2 = 12^2 + 16^2$$

$$R^2 = 400$$

$$R = 20N$$

The direction of R is given by θ, and is calculated using trigonometry.

$$\tan\theta = \frac{16}{12}$$

$$\theta = \tan^{-1}\left(\frac{16}{12}\right)$$

$$\theta = 53.13°(2dp)$$

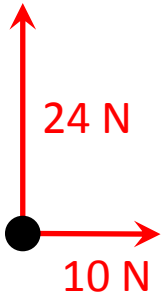
R is described as:

"a force with magnitude 20N, acting in a direction 53.13° from the vertical"

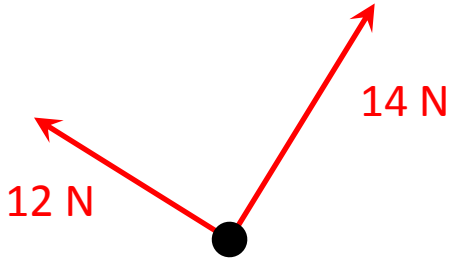
or:

R = 20N, 53.13° (from vertical)

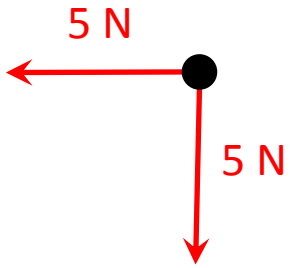
Eg. Find the resultant forces for each of these systems of forces:



R = 26N (22.62° from vertical)



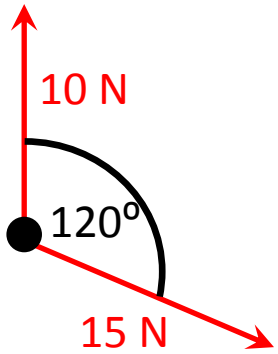
R = 18.44N (40.60° from 14N force)

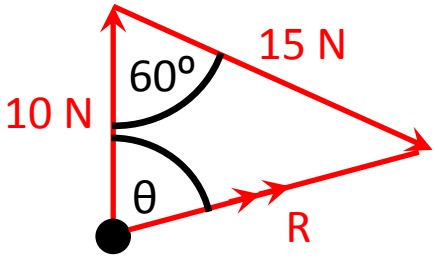


R = 7.07N (45°)

The forces may not all act at 90° to each other, but may act at other angles in the same plane.

Eg. Two forces below both act on a particle 120° apart from each other. Find the resultant force.





We need to use trigonometry to find R and θ. In this case, the cosine rule.

$$R^2 = 15^2 + 10^2 - 2\times 15\times 10\times \cos 60°$$

$$R^2 = 225 + 100 - 150$$

$$R^2 = 175$$

$$R = 13.23N (2dp)$$

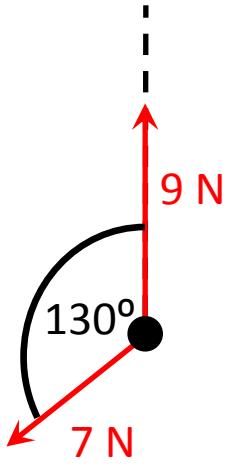
$$\cos\theta = \frac{10^2 + R^2 - 15^2}{2\times 10\times R}$$

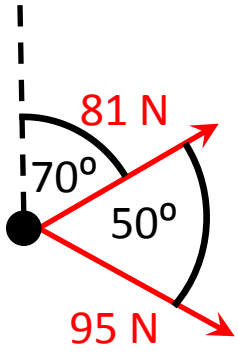
$$\cos\theta = 0.18898$$

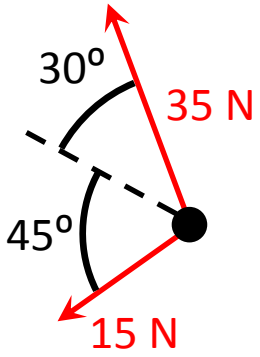
$$\theta = 79.11°$$

R = 13.23N, 79.11° (from vertical)

Eg. Find the resultant forces for each of these systems of forces, giving the angle from the dashed line:





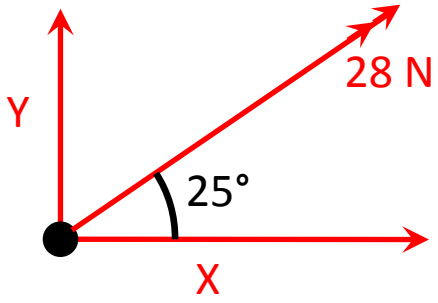


R = 7.00N (50.00°)

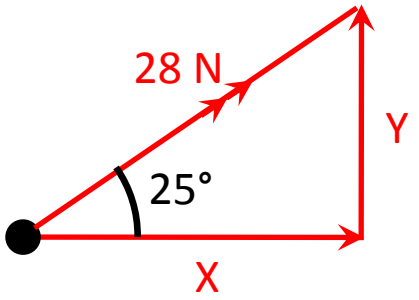
R = 159.62N (97.12°)

R = 41.49N (9.56°)

Find the two forces that act together to make the given resultant force:



We can make a right-angled triangle in this case.



Using trigonometry,

$$\cos 25 = \frac{X}{28} \qquad \sin 25 = \frac{Y}{28}$$

$$X = 28 \times \cos 25 \qquad Y = 28 \times \sin 25$$

$$X = 25.38N \qquad Y = 11.83N$$

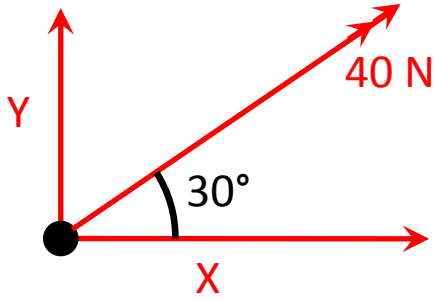
Where X and Y are at right angles to each other it is possible to determine their magnitude.

These two forces are the **components** of the resultant force, in the X and Y directions.

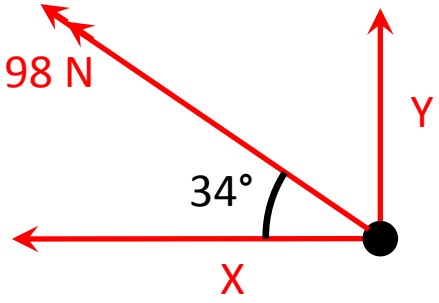
We call this procedure **Resolving Forces**.

In general: $X = R\cos\theta$ $Y = R\sin\theta$

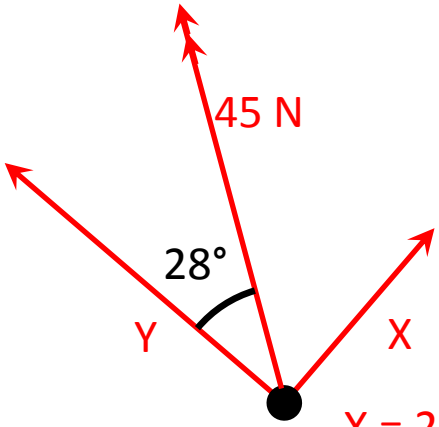
Find the components of the resultant force in the X and Y directions.



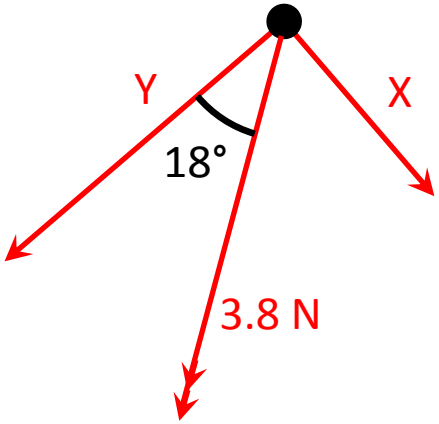
X = 34.6N
Y = 20 N



X = 81.2N
Y = 54.8N

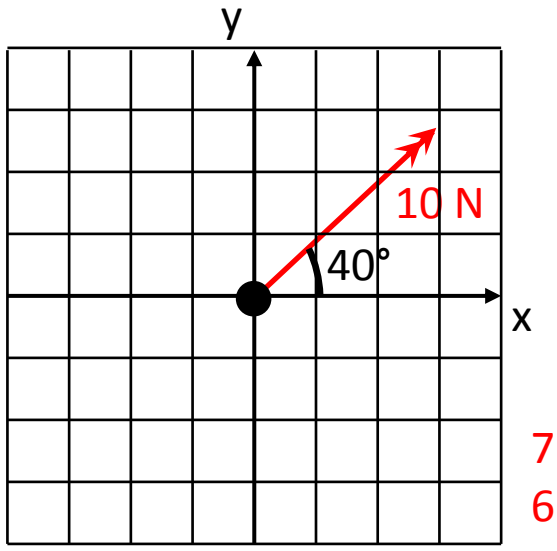


X = 21.1N
Y = 39.7N

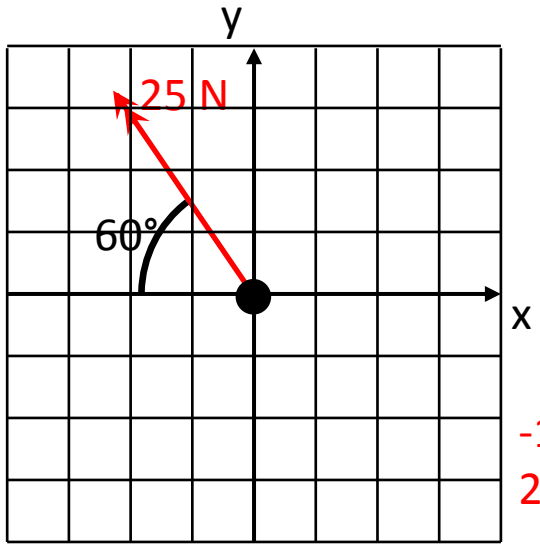


X = 1.2N
Y = 3.6N

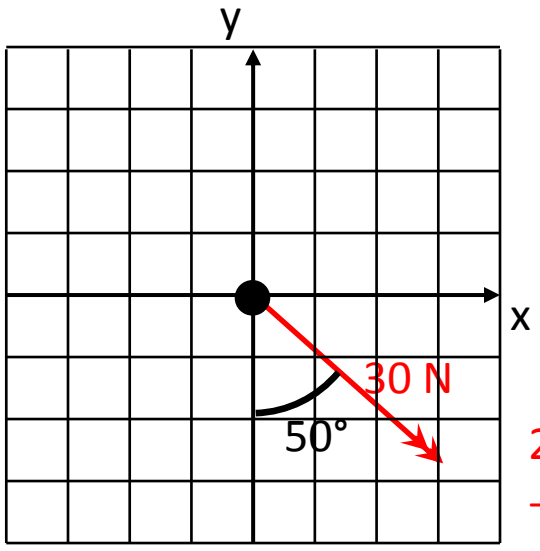
Find the components of the resultant force parallel to X and Y.



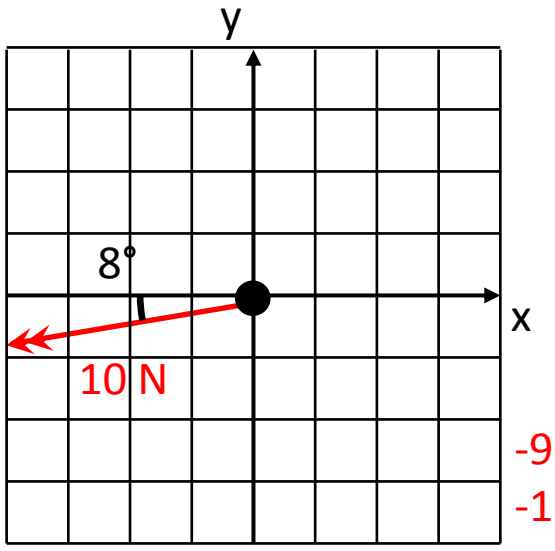
7.7N (parallel to x)
6.4N (parallel to y)



-12.5N (parallel to x)
21.7N (parallel to y)



23.0N (parallel to x)
-19.3N (parallel to y)



-9.9N (parallel to x)
-1.4N (parallel to y)

Important notes from this session:

A **resultant force** is the single force that has the same effect as the existing system of forces.

Component forces are perpendicular forces that have the same effect as the resultant force.

Components of a force are found by **resolving**.

In general: $X = R\cos\theta$ $Y = R\sin\theta$

Where θ is the angle between X and R.

All forces are fully described by a **magnitude** and **direction**.