1.3 Vectors & Scalars

Lesson Objectives:

1. Distinguish between vector and scalar quantities, and give examples of each.
2. Determine the sum or difference of two vectors by a graphical method.
3. Resolve vectors into perpendicular components along chosen axes.

Scalar Quantities & Vector Quantities

Scalar Quantities

A quantity which has magnitude but no direction

E.g. mass, time, distance, speed, energy, density, etc

Vector Quantities

A quantity which has magnitude as well as direction

E.g. displacement, velocity, acceleration, force, momentum, angular velocity, force, electric field strength etc

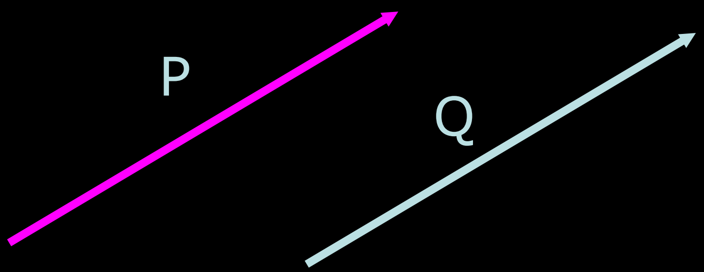
Scalar Quantities & Vector Quantities

Equal Vectors

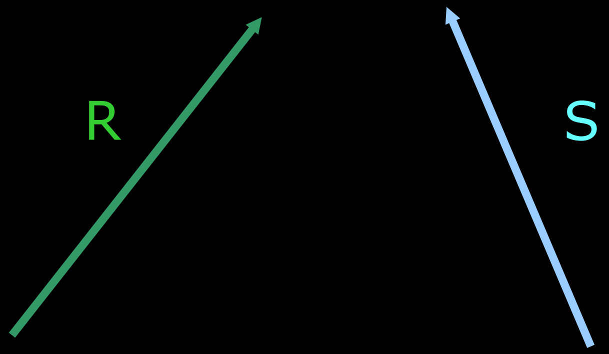
Two vectors P and Q are equal if

*   magnitude of P = magnitude of Q

*   direction of P = direction of Q



Equal Vectors

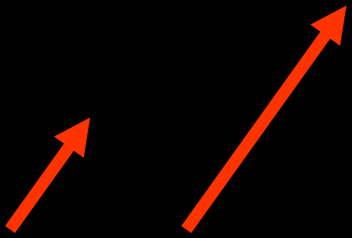


Unequal Vectors

Scalar Quantities & Vector Quantities

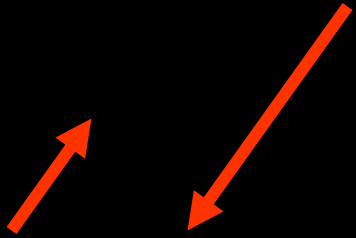
Multiplication and division of vectors by scalars

When multiplied by a scalar, the vector will have the same direction but different magnitude.



V **2V**

When multiplied by a negative scalar, the vector will have the opposite direction and different magnitude.



V **-2V**

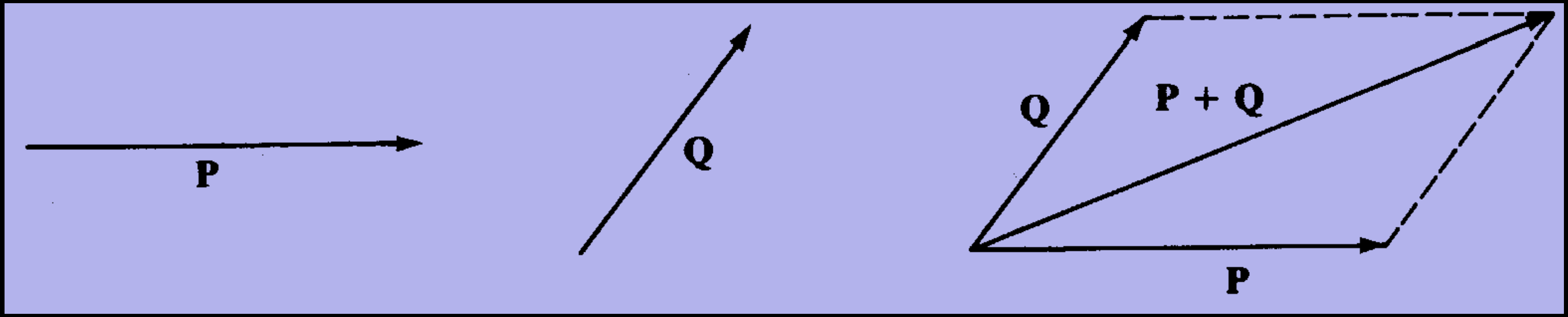
Scalar Quantities & Vector Quantities

Addition of Vectors

Method 1: Parallelogram of Vectors

Method 2: Triangle of Vector

Method 1: Parallelogram of Vectors



Resultant = (P+Q)

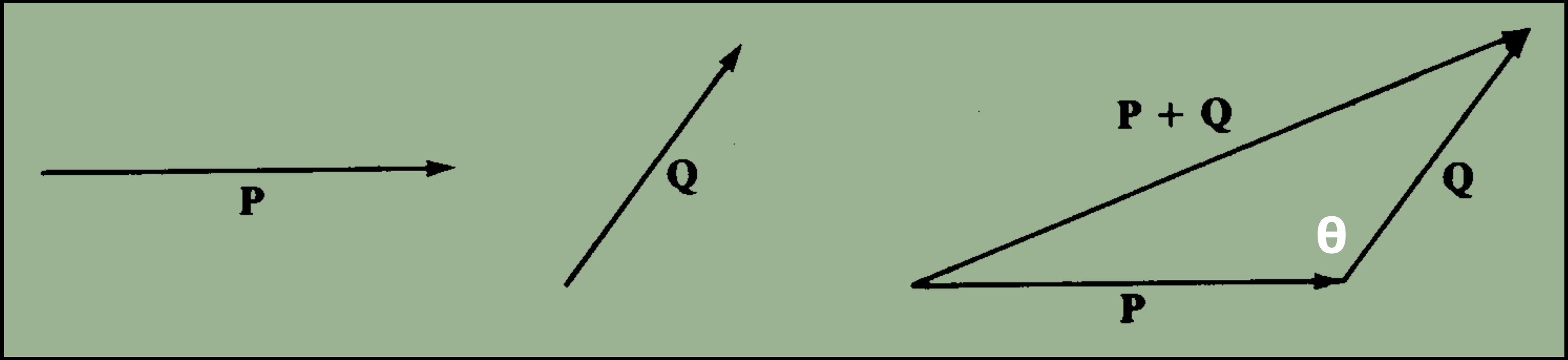
Scalar Quantities & Vector Quantities

Addition of Vectors

Method 1: Parallelogram of Vectors

Method 2: Triangle of Vector

Method 2: Triangle of Vectors



Resultant = (P+Q)

Magnitude of resultant = $\sqrt{P^2 + Q^2 - 2PQ\cos\theta}$

Scalar Quantities & Vector Quantities

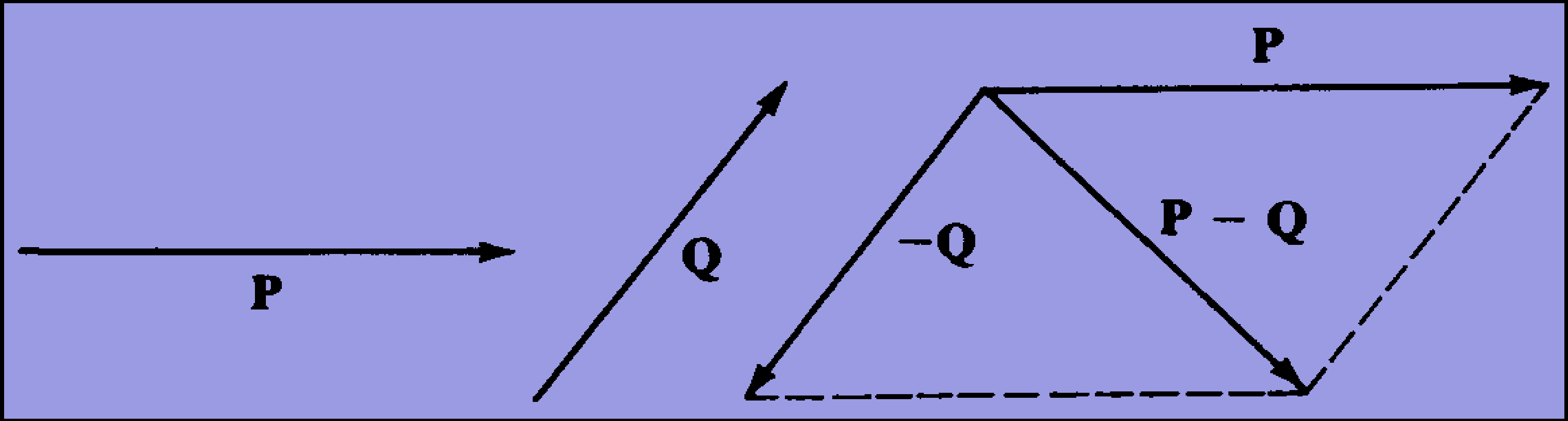
Subtraction of Vectors

$$(P - Q) = P + (-Q)$$

Method 1: Parallelogram of Vectors

Method 2: Triangle of Vector

Method 1: Parallelogram of Vectors



Resultant = (P-Q)

Scalar Quantities & Vector Quantities

Subtraction of Vectors

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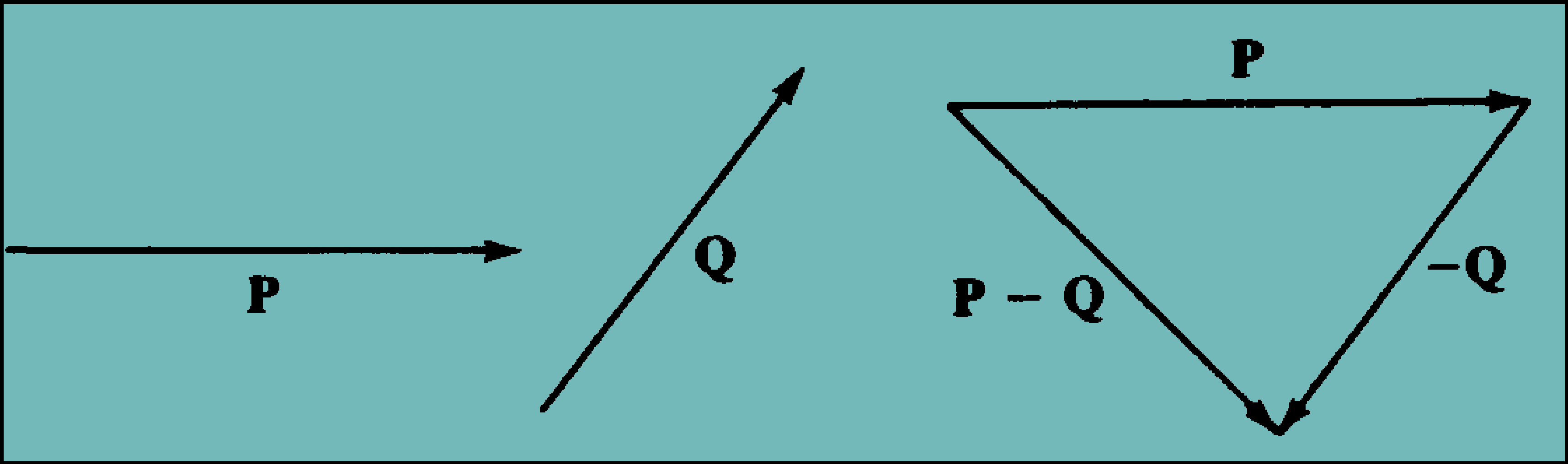
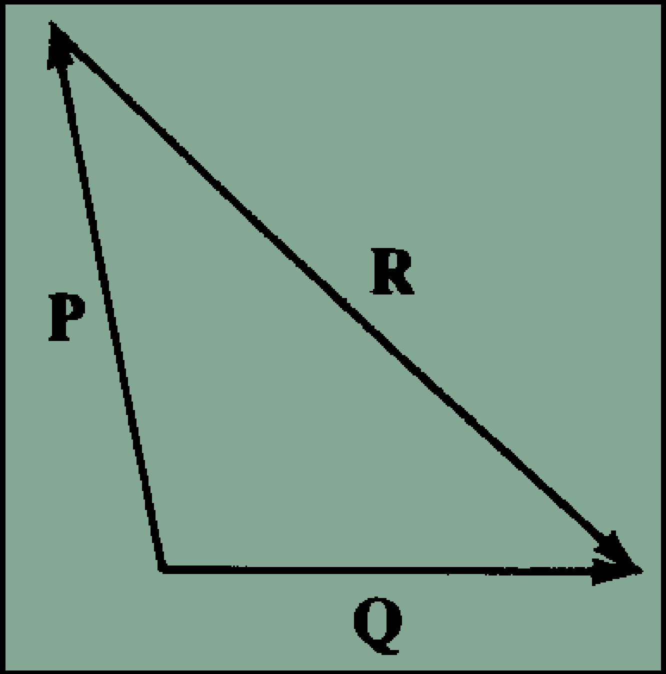


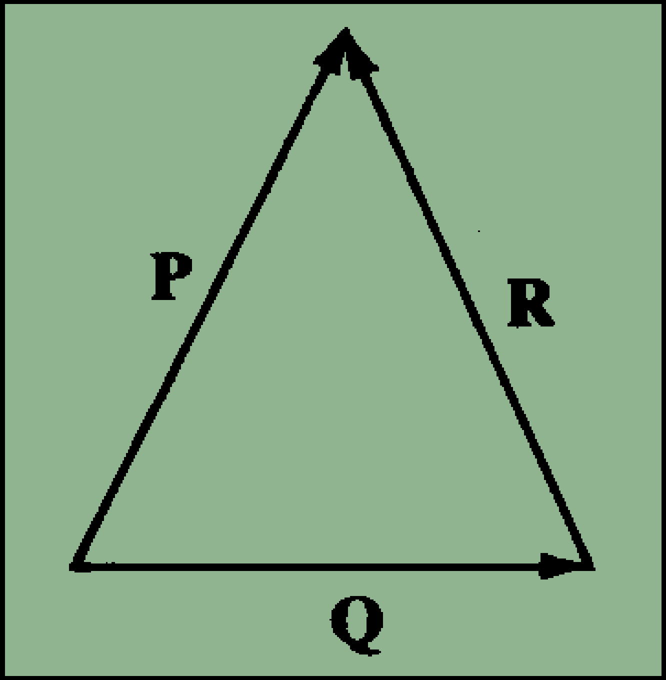
Resultant = (P-Q)

Scalar Quantities & Vector Quantities

Example

Express the vector R in terms of vectors P and Q





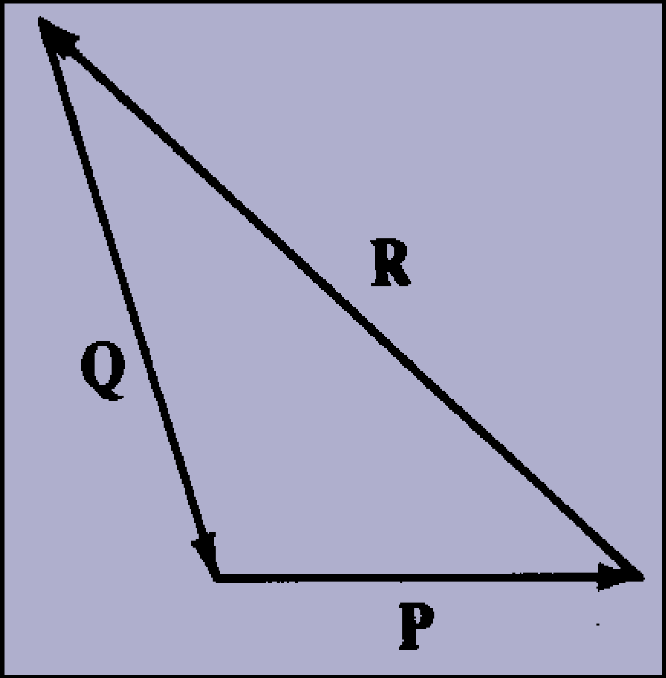
R = Q - P

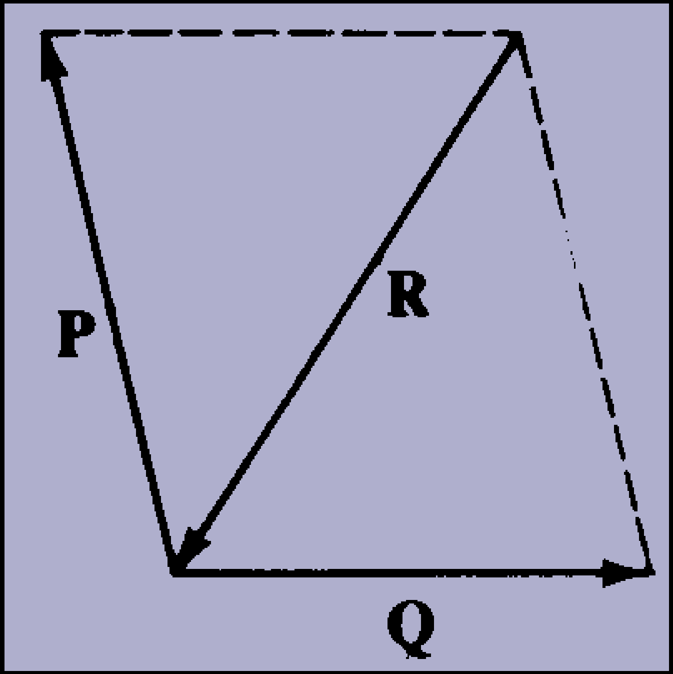
R = P - Q

Scalar Quantities & Vector Quantities

Example

Express the vector R in terms of vectors P and Q





R = - P - Q

R = - Q - P

Scalar Quantities & Vector Quantities

Components of a Vector

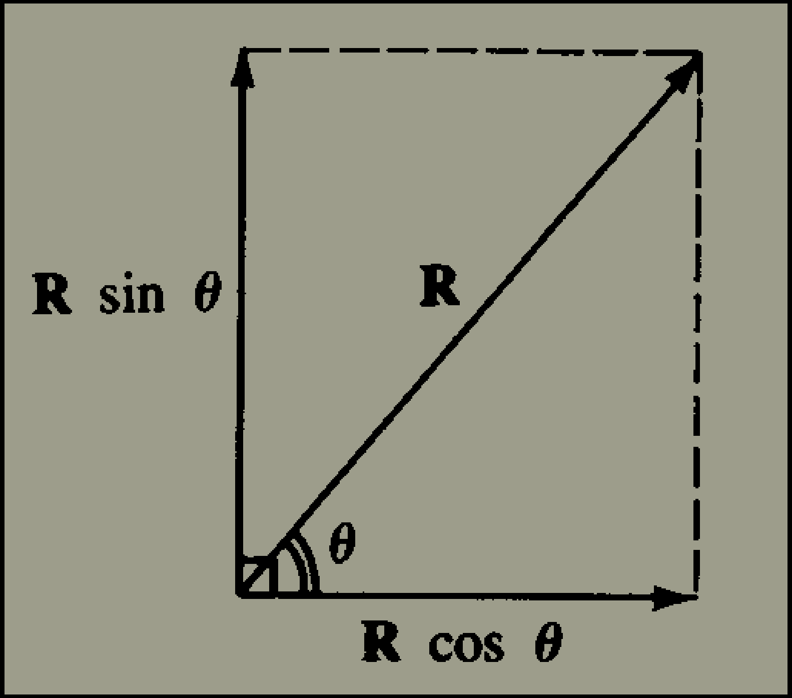
A vector **R** can be considered to be the resultant of two vectors known as the components of the vector **R**

Scalar Quantities & Vector Quantities

Resolving a Vector

It is useful to find the components of a vector R in two mutually perpendicular directions

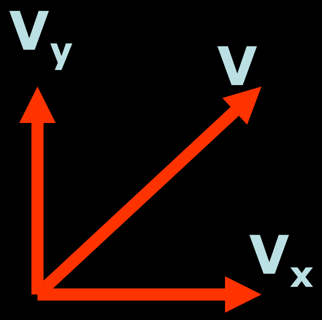
Process is known as resolving a vector into components

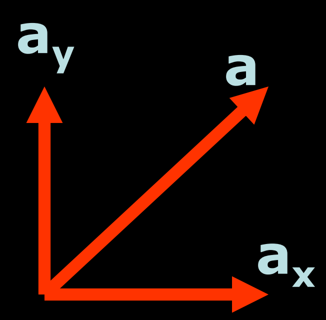


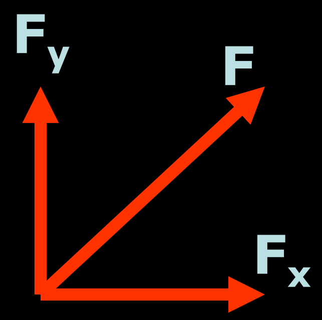
Scalar Quantities & Vector Quantities

Resolving a Vector

Subscripts are often used to denote vertical and horizontal components.







Scalar Quantities & Vector Quantities

Resolving a Vector

A stone thrown at an angle of 30^o to the horizontal with a velocity of 20 m s^{-1}. Calculate the horizontal and vertical velocity of the stone.

Answer

Horizontal component $= 20 \cos 30^o$

$= 17$ m s^{-1}

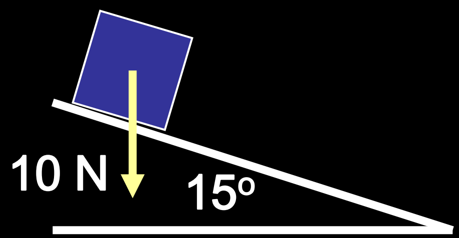
Vertical component $= 20 \sin 30^o$

$= 10$ m s^{-1}

Scalar Quantities & Vector Quantities

Resolving a Vector

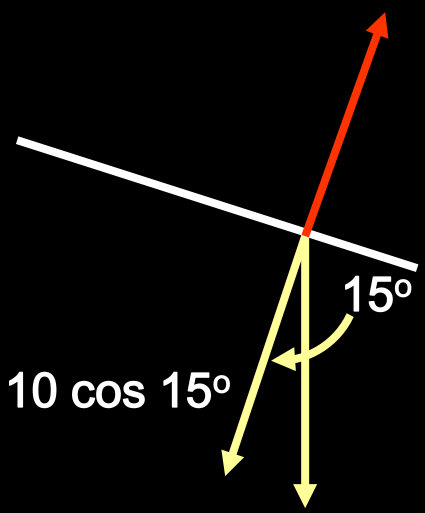
A box of weight 10 N rests on a plane inclined at 15°. Calculate the reaction force on the box and the frictional force holding the box in place.



Answer

Normal reaction force = 10 cos 15°

= 9.7 N



Scalar Quantities & Vector Quantities

Resolving a Vector

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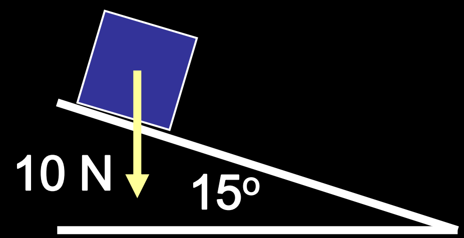
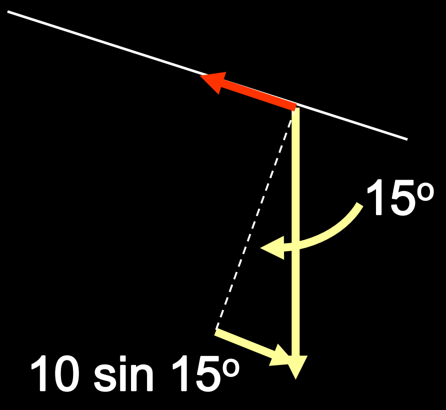




Answer

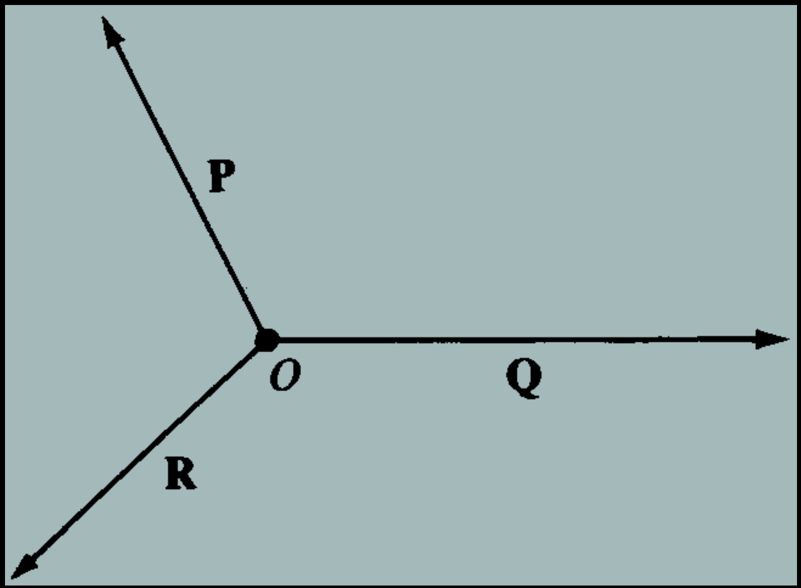
Friction $= 10 \sin 15^{o}$

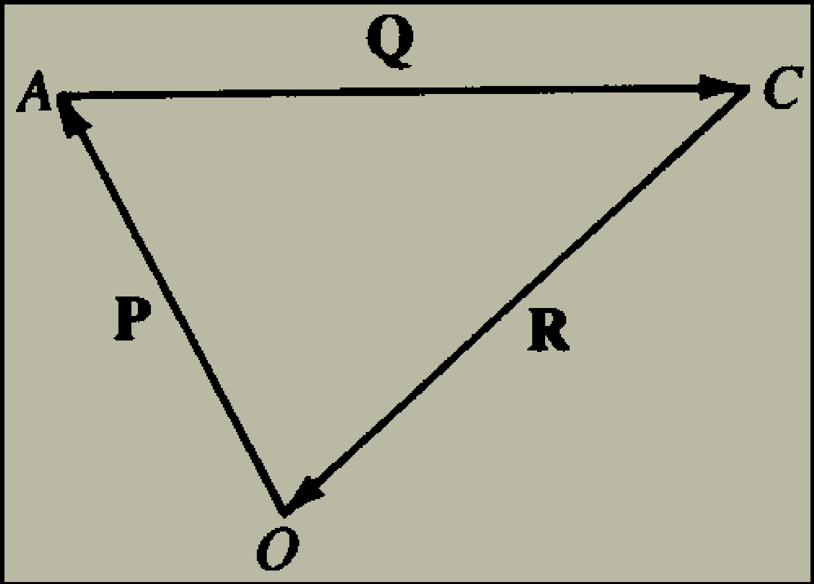
$= 2.6$ N

Scalar Quantities & Vector Quantities

Triangle of Forces

If three forces acting on a point can be represented in magnitude and direction by the three sides of a triangle taken <u>in order</u>, then the three forces are in <u>equilibrium</u>.





Scalar Quantities & Vector Quantities

Triangle of Forces

OR

If three forces acting on a point are in equilibrium, then they can be represented in magnitude and direction by the sides of a triangle taken in order.