INVESTIGATING FORCES   04 FEBRUARY 2014

Lesson Description

In this lesson we:

- Revise the concept of a vector including examples of vector quantities
- Show how to draw a free body diagram
- Use trigonometry to find the resultant of two perpendicular forces

Summary

What is a vector?

A **vector** is a mathematical tool we use in Physics when quantities have size (magnitude), direction and a specific S.I unit. Quantities that have size (magnitude) and a specific S.I unit but no direction, are called **scalar quantities**.

Examples of vector quantities

Displacement: The change in position of an object. **S.I Unit** metres m

Velocity: The rate of change in position of an object **S.I Unit** metres $m.s^{-1}$

Acceleration: The rate of change of velocity of an object. **S.I Unit** metres $m.s^{-2}$

Force: A push or pull exerted on an object. **S.I Unit** Newton N

Representing Vectors

We use an arrow to represent a vector quantity. We say the arrow has a head and a tail.

Tail

Head

The length of the arrow – from tail to head - indicates the size (magnitude)

The direction is shown by the direction in which the arrow head points

Direction

There are different ways we can indicate direction:

- In words E.g. up, down , to left, to the right
- Compass points E.g. North N, East E South W
- Bearing E.g On a bearing of 135^0
- Angles E.g at an angle of 45^0 to the horizontal

Adding Vectors together

The sum of two or more vectors is called the **resultant.** We find the resultant by placing vectors "head to tail"
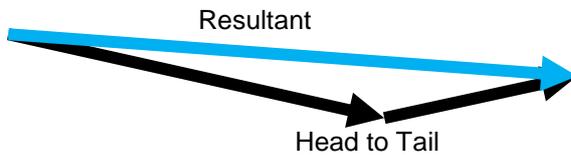
Free Body Diagrams

In a free-body diagram, the object is drawn as a dot and the forces acting on the object are drawn as vectors (arrows) with the tail of the vector on the body and the heading pointing away from the body. Free body diagrams are not usually drawn to scale but the relative magnitude of the forces must be shown.

Test Yourself

Question 1

Which of the following are vector quantities?

A   Energy

B   Mass

C   Time

D   Velocity

Question 2

Which of the following are scalar quantities?

A   Displacement

B   Distance

C   Acceleration

D   Force

Question 3

Which of the following are vectors?

A   50 kg

B   50 s

C 5 m.s^{-1}

D 5 m.s^{-1} East

Question 4

A boy walks 6 km East then turns around a runs 8 km in the opposite direction. What is his resultant displacement?

A   14 km

B   2km

C   - 2km

D   2 km West

Question 5

A 50kg box is placed on a table. A force of 50N upwards is exerted on the box. What would you observe happening to the box?

A   The box would remain stationary on the table

B   The box would lift off the table for a short time and then fall down again

C   The box would move upwards

D   The box would move downwards

Question 6

A ball of mass 5kg is at rest on a frictionless surface. Which statement best describes the forces acting on the ball?

A   There are no forces acting on the ball

B   The only force acting on the ball is its weight

C   The surface exerts an upward force on the ball that is equal in magnitude to the weight

D   There is a non-zero resultant force acting on the ball

Question 7

A metal ball is placed a fixed distance away from two strong magnets in turn. Magnet A exerts on force of 2,5 N to the left on the ball while magnet B exerts a force of 5 N to the left on the ball Next the magnets are arranged with magnet A on the left the ball in the middle and magnet B on the right. What is the resultant force acting on the ball? (Ignore the effects of friction)

A   2,5 N to the left

B   2,5 N to the right

C   5N to the right

D   7,5N to the left

Question 8

Give one word or phrase for the following:

a.)   The sum of all forces acting on an object

b.)   The size of a vector

c.)   The ratio of the adjacent and opposite sides of a right angled triangle

Improve your Skills

Question 1

Xoli exerts a force of 8N on a box placed on a horizontal frictionless surface. At the same time, Pretty exerts a horizontal force of 10N at an angle of 90^0 to the force Xoli applies. Calculate the magnitude and direction of the resultant of these two forces.

Question 2

A large metal sphere with a mass of 500kg is suspended by cables on a construction site as shown in the sketch below.

Cable A

150^0
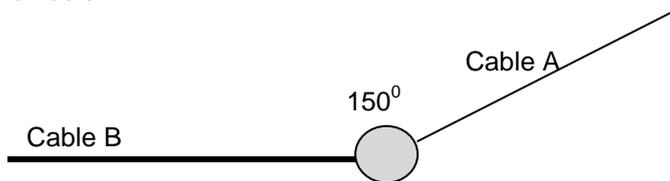
Cable B

a.)   Draw a free body diagram to show all the forces acting on the metal rod

b.)   Draw a sketch to show the resultant of the forces acting on the sphere:

    i.)   while the sphere is suspended

    ii.)   If Cable A breaks

c.)   The tension in Cable B is 2500N at the moment Cable A breaks. Calculate the magnitude of the resultant of the forces acting on the sphere.