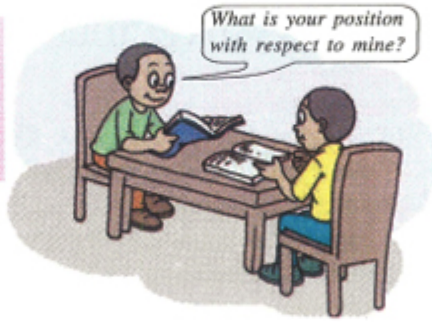
1 POSITION, SCALARS AND VECTORS



POSITION

OBJECTIVE

*A*t the end of the topic, students should be able to:

- use the Cartesian co-ordinate to locate position of objects on the x-y plane.

The position of a point in a plane can be located by choosing axes, which intersect at right angles to each other. The vertical reference axis is called the **y-axis** or **dependent axis** while the horizontal axis is called the **x-axis** or **independent axis.** The point where they intersect is called the **origin** which is labelled (0,0). The choice of the axes described above is called the **Cartesian** or **rectangular co-ordinate.** x is the distance of the point P from the origin along x-axis or horizontal while y is the distance of the point P from the origin along the y-axis or vertical.

How to locate the position of a point in a plane

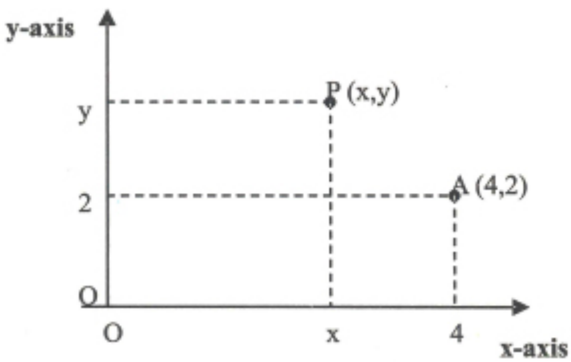


Figure 1.1a: Points in a cartesian plane

The position of a point P (x,y) in the x – y plane can be found by moving x-units along the x-axis and y-units along the y-axis. The point A (4,2) can be located by moving 4 units along the x-axis and 2 units along the y-axis.

If a particle moves on a line, its position is determined by measuring how far it is from origin of the line. All points to the right of the origin are assigned positive values while all distances to the left of the origin are negative. The point P is 3 units to the right of the origin O and is positive.

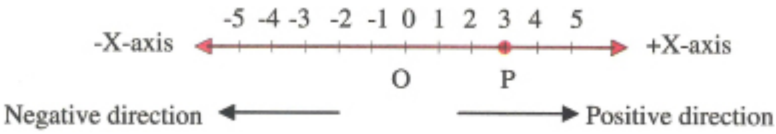


Figure 1.1b: Points on a line

SCALARS AND VECTORS

OBJECTIVE

At the end of the topic, students should be able to:

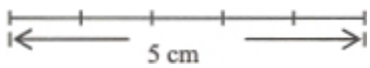
- distinguish between scalar and vector quantities;
- add two or more vectors;
- explain the meaning of the resultant of two or more vectors;
- resolve a vector into two perpendicular directions; and
- use the resolution of vectors to find the resultant of two or more vectors.

Concept of scalars

All quantities in physics are grouped into vectors and scalars. Scalars are quantities which are described by their magnitude or size only. They do not have any specified direction.

Scalars are quantities that have only magnitude or size. Scalars have no direction in space.

A number or the length of a line represents a scalar. Examples of scalars are *mass, distance, temperature, time, work, speed, energy* and *pressure.* These quantities are fully described by their **size** or **magnitude.** A line segment can represent the size of these quantities. The distance of 250 m can be represented by a line segment of length 5 cm using a scale of 50 m to 1 cm.



Concept of vectors

A vector is a quantity that has both magnitude and direction in space.

To describe a vector, we must state both its **size** and **direction.** Force is a vector; its magnitude, represented by a line, describes its strength and the arrow on the line represents the direction of the vector. A force of 50 N can be represented by a line of length 5 cm. The scale indicates that 1 cm represents 10 N. The arrow on the line gives the direction of the vector.

Force of 50N represents line PQ

Examples of vectors are *force, acceleration, velocity, electric field,* *displacement,* and *momentum.* These quantities are described fully by both **direction** and **magnitude.**

Vector notation or representation

One of the following notations can represent a vector:

(a) Graphical representation: A line can be drawn to represent both the magnitude and the direction of the vector. The length of the line gives the size of the vector while the arrowhead on the line gives the direction of the vector.

(b) Representation by letters with arrow or line above or under: Letters with arrow above or under them are used to represent vectors. Examples are:$\vec{A}$, $\underline{B}$ or $\underline{AB}$. The direction of **AB** is from A to B. A is the tail or beginning of the vector and B is the head or end of the vector.

(c) Representation using bold faced letters: In print, we represent vectors by boldly printed letters like **A, B, X, Y, a, b,** etc.

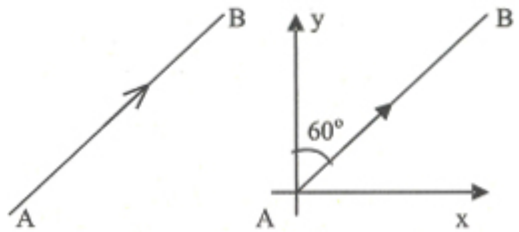


Figure 1.1: Graphical representation of vectors in ax-y plane

Magnitude of vectors

The magnitude or the size of a vector **B** is written as /**B**/. This is represented graphically by the length of the line representing **B.**

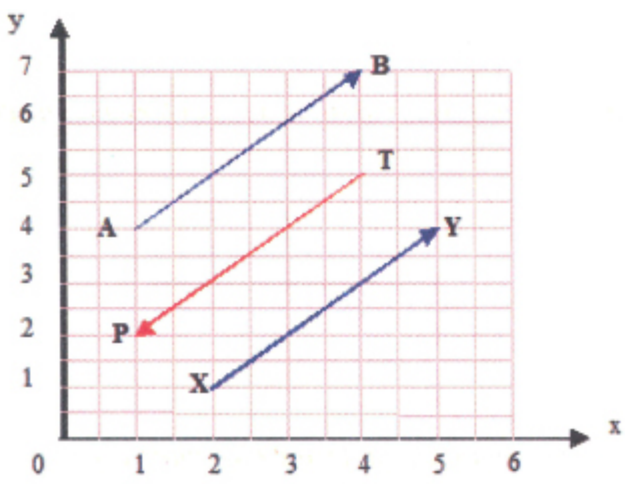


Figure 1.2: Equal and negative vectors

Negative and equal vectors

A vector has both magnitude and direction. **AB,** as a vector, has two directions; if **AB** defines the positive direction, then **BA** defines the negative or opposite direction. **A** vector, moving opposite to another vector, whose direction is given, is a negative vector. *Two vectors are equal if they have the same magnitude and move in the same direction.* In Figure 1.2, **TP** is the negative of **AB** while **XY** is equal to **AB.**

Addition of vectors

Two or more vectors acting at the same time at a common point can be added to produce a new vector, which has the same effect as the original vectors. The new vector, obtained by adding two vectors **A** and **B,** is **the resultant** vector of **A** and **B.**

Resultant vector is a single vector which replaces two or more vectors in magnitude and direction, and still produces the same effect as the original vectors acting together.

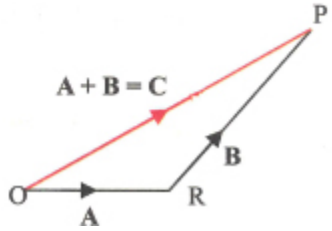


Figure 1.3 Resultant of two vectors

Figure 1.3 shows two vectors **A** and **B** added to obtain a third vector **C.** **C** is the resultant of **A** and **B,** it is obtained as follows:

(i) draw an arrow to represent A.

(ii) draw B such that the tail begins at the head of A.

(iii) the resultant of A and **B** is **C**. **C** is such that its tail concides with the tail of **A** and its head corrocides with the head of **B.**

$$\mathbf{A} + \mathbf{B} = \mathbf{C} \text{ or } \underline{OR} + \underline{RP} = \underline{OP}$$

Parallel vectors are two or more vectors moving in the same direction or in the opposite direction. Their lines of action (the direction through which the vectors act) do not meet. Such vectors are called **non-concurrent vectors.** Parallel vectors are of two types;

1. Like parallel vectors (forces): Forces which act in the same direction are called like parallel forces (vectors). The magnitude of the resultant resultant of like parallel forces is the algebraic addition of their magnitudes.

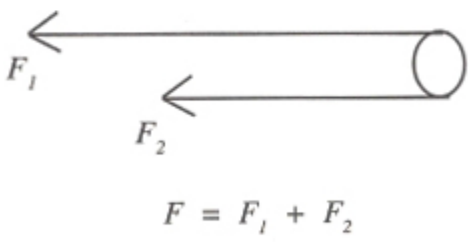


Figure 1.4 Like parallel vectors

2. Unlike parallel vectors (forces): Parallel forces, which act in the direction opposite to each, are called unlike parallel forces (vector). The resultant of unlike forces is the difference of their magnitudes.

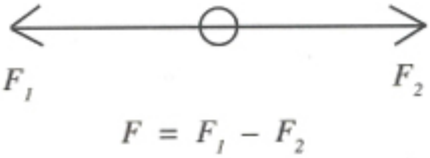


Figure 1.5 Unlike parallel vectors

Addition of coplanar forces

Coplanar forces are two more forces acting on the same plane. If they meet at a common point or their line of action meets at a common point, they are called **coplanar concurrent forces.** The addition of coplanar concurrent forces is not always equal to their algebraic addition of their magnitudes. The magnitude of the resultant of two forces (vectors), inclined at an angle (Î¸) increases as the angle between them decreases.

If two forces **a** and **b** are inclined at an angle Î¸ to each other as shown in Figure 1.6, the resultant **r** of **a** and **b** is given by the cosine rule;

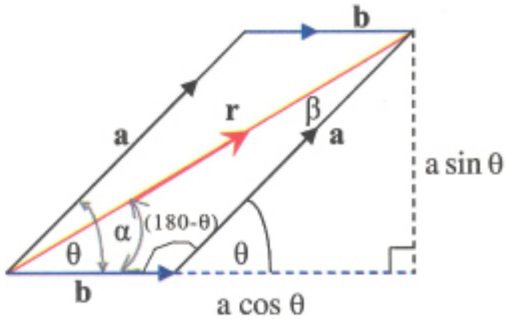


Figure 1.6 Addition of vectors

$$r^2 = a^2+b^2-2ab\cos\ (l80 -)$$

Parallelogram law of vector addition

The parallelogram law of vector addition states that if two vectors acting at a common point are represented in magnitude and direction by the adjacent sides of a parallelogram, their resultant is represented in magnitude and direction by the diagonal of the parallelogram drawn from their common point of intersection and directed away from that point.

The direction of the resultant with respect to **b** is defined by the angle Î± as shown in Figure 1.6. The direction of the resultant r with respect to **b** is given by:

$$\tan \quad = \frac{a \sin \theta}{b + a\cos \theta} \quad \text{or}$$

$$\frac{\sin \alpha}{a} = \frac{\sin \beta}{b} = \frac{\sin (180 - \theta)}{r}$$

The resultant of two vectors (forces) is greatest when they are parallel and acting in the same direction. It decreases as the angle (*Î¸*) between the vectors (forces) increases. The minimum resultant occurs when they are parallel and acting in opposite directions. This is illustrated in Figure 1.7.

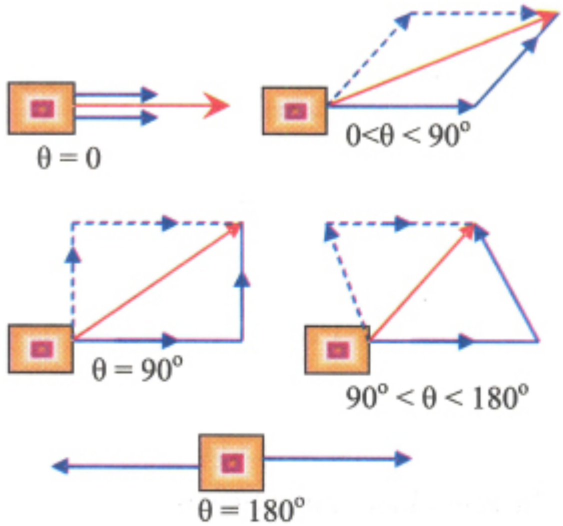


Figure 1.7 Magnitude of resultant force varies with the angle (Î¸) between the two forces

CLASS ACTIVITY

Determination of resultant of two forces using a force board

Apparatus: Drawing board, masses, two fixed pulleys, threads, sharp pencil and paper.

Method

(a) Set up the apparatus as shown in Figure 1.8. Pass the thread through the grooves of the pulleys with the weights P = 3 N (300g mass) and Q = 4 N (400g mass).

(b) Attach the third weight R = 5 N (500g mass) at the centre O of the thread. When the system is in equilibrium, use a pencil to mark the position O and three other dots along the length of the thread OA, OB, and OC.

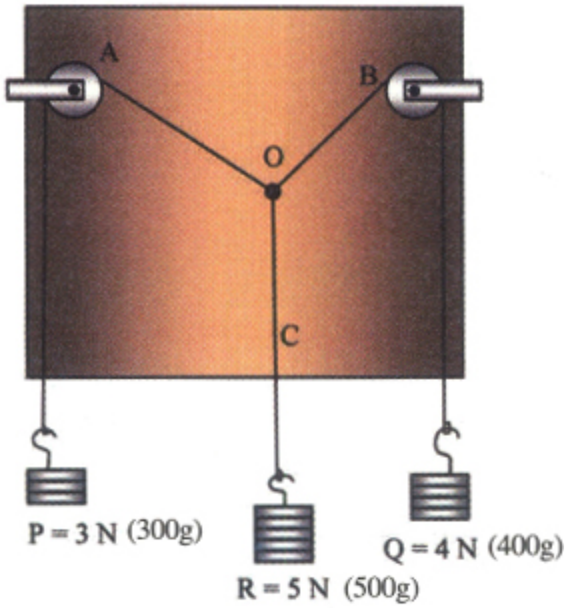


Figure 1.8 Determining the resultant of two forces using a force board

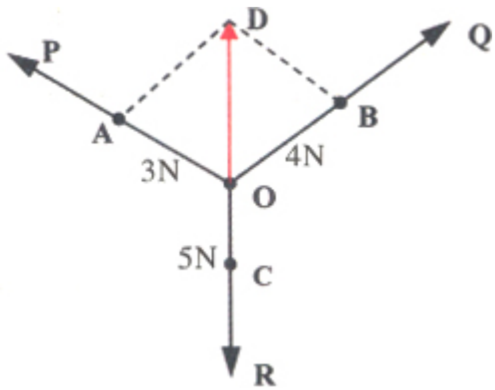


Figure 1.9 Diagrammatic representation of forces

(c) Remove the weights and join the dots A, B and C to O.

(d) Using a suitable scale (1 cm to represent 1 N), mark 3 cm along OA to represent 3 N force, 4 cm along OB to represent 4 N and 5 cm along OC to represent 5 N.

(e) Using the sides OA and OB as adjacent sides of a parallelogram, complete the parallelogram OADB.

(f) Measure the diagonal of OADB and compare it with the length OC.

(g) Repeat the experiment with different values of P and Q.

Conclusion: The diagonal of the parallelogram is the same as the resultant of P and Q.

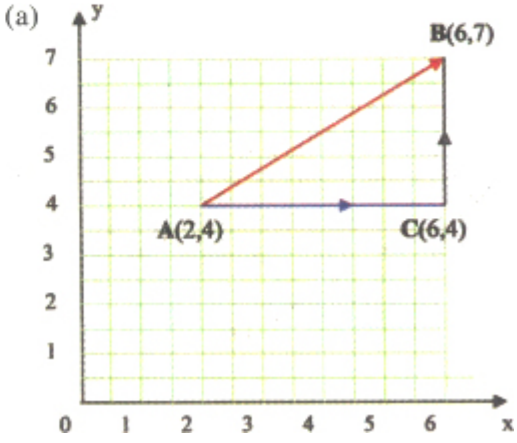
Worked examples

1. A termite crawls from a point A(2,4) to another point B(6,7) in 5 seconds. The coordinate of the points is in metres (m).
   (a) Draw a vector representing the displacement of the termite from A to B.
   (b) Find (i) the displacement in metres.

(ii) the velocity of the termite in ms^{-1}.

Solution

(a)



(b) $/AB/^2 = /AC/^2 + /CB/^2$

$/AB/^2 = (6 - 2)^2 + (7 - 4)^2$

$/AB/^2 = 25$

$/AB/ = 5$ m

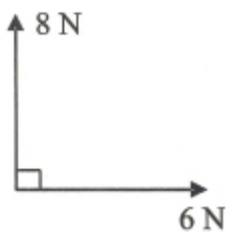
(ii) $\text{Velocity} = \dfrac{\text{Displacement}}{\text{Time}} = \dfrac{5}{5} = 1\ ms^{-1}$

2. The diagram below shows two forces acting at right angles to each other.

(a) Draw a vector diagram to represent the forces and their resultant.

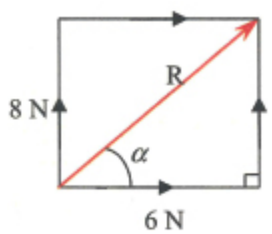
(b) Calculate the magnitude of the resultant force.

(c) What is the direction of the resultant with the 6 N force?



Solution

(a)



(b) From phythagora's theorem,

$R^2 = 8^2 + 6^2 = 100$

$R^2 = \sqrt{100} = 10\ N$

(c) $$\tan \alpha = \frac{8}{6} = 1.333$$

$$\alpha = \tan^{-1} 1.333 = 53.1^{0}$$

3. The resultant of two forces is 10 N. The magnitude of one of the forces is 5 N and it makes an angle of 60Â° with the resultant force. Calculate the magnitude of the second force.

Solution

Using cosine rule

$/\underline{MD}/^{2} = /\underline{OD}/^{2} + /\underline{OM}/^{2} - 2/\underline{OD}//\underline{OM}/\cos 60^{\circ}$

$P^2 = 10^2 + 5^2 - 2 \text{ x } 10 \text{ x } 5 \cos 60^{0} = 75$

$P = \sqrt{75} = 8.66N$

4. Two forces with magnitudes of 25 N and 18 N respectively are inclined at an angle of 120Â° to each other. Calculate the resultant force and the angle it makes with the 18 N force.

Solution

$$R^2 = A^2 + B^2 - 2AB\cos$$

$$R^2 = 25^2 + 18^2 - 2\times 25\times 18\cos(180-120)$$

$$R^2 = 625 + 324 - 900\cos 60^{o}$$

$$R^2 = 499$$

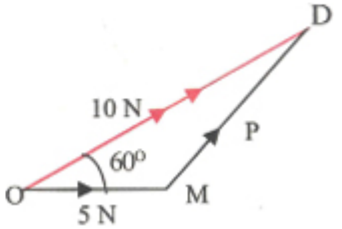
$$\therefore R = \sqrt{499} = 22.34\ N$$

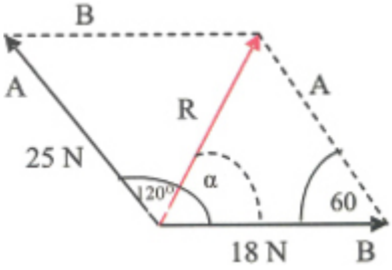
$$\frac{\sin \alpha}{A} = \frac{\sin 60}{R}$$

$$\frac{\sin}{25} = \frac{\sin 60}{22.34} \Rightarrow \sin \quad = \frac{25\sin 60}{22.34}$$

$$\sin \quad = 0.9691 \Rightarrow \quad = \sin^{-1}(0.9691)$$

$$\alpha = 75.73^{o}$$

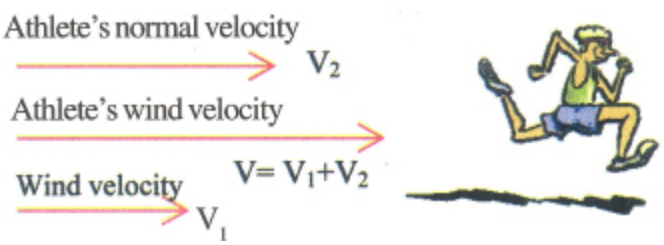




Velocity vector

Velocity is a vector. The length of the vector represents its magnitude while the direction is the same as the direction of the motion. The wind affects the velocity of a moving object.

Have you heard of wind-assisted race? The velocity of an athlete is affected by the direction of wind. An athlete runs a wind-assisted race if he moves in the same direction as the wind; he runs faster than his normal speed when he moves in the direction of the wind. The wind-assisted velocity of the athlete is the sum of his normal velocity and the velocity of the wind.



If he moves against the wind, his velocity is reduced. In the same manner, the velocity of the river affects the velocity of a speedboat.

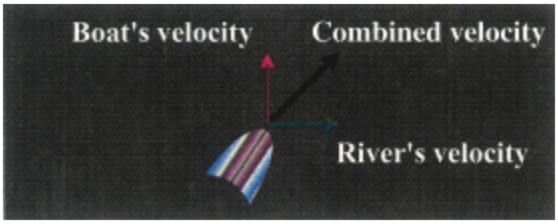


Figure 1.10

If the boat moves perpendicular to the flow of the river, its velocity is the vector sum of its velocity and the velocity of the river.

Worked examples

1. A speedboat whose velocity in still water is 12 ms^{-1}, is crossing a river flowing due east, at a velocity of 5 ms^{-1}. If the boat is moving due north, calculate its velocity across the river and the direction the boat is moving.

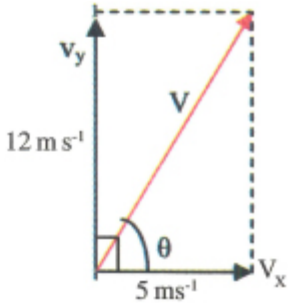
Solution

$V^2 = V_x^2 + V_y^2$

$V^2 = 5^2 + 12^2 = 25 + 144 = 169$

$V = 13\ ms^{-1}$

$$\tan = \frac{12}{5} = 2.4 \Rightarrow \tan^{-1} = 67.4^o$$



2. An athleteâ€™s velocity in still air is 10ms^{-1}. Find his velocity on the day a gentle wind blows at 2 ms^{-1};
   (a) in the direction of the athlete.
   (b) in the opposite direction to the athlete.

Solution

(a) $V = V_1 + V_2 = 10\ ms^{-1} + 2\ ms^{-1} = 12\ ms^{-1}$.

(b) $V = V_1 - V_2 = 10\ ms\ s^{-1} - 2\ ms^{-1} = 8\ ms^{-1}$.

Summary

â€¢ Scalars are quantities that have only magnitude or size. Examples of scalars are *mass, distance, temperature, time, work, speed, energy and pressure.*

â€¢ A vector has both magnitude and direction. Examples of vectors are *force, acceleration, electric field, velocity, displacement and momentum.*

â€¢ A resultant vector is a single vector which replaces two or more vectors in magnitude and direction and still produces the same effect as the original vectors acting together.

â€¢ The direction of the resultant vector will always oppose the directions of the vectors it is replacing.

â€¢ The parallelogram law of vector addition states that if two forces (vectors) acting at a common point are represented in magnitude and direction by the adjacent sides of a parallelogram, their resultant is represented in magnitude and direction by the diagonal of the parallelogram drawn from their common point of intersection and directed away from that point.

Practice questions 1a

1. (a) What is a vector? (b) Define the resultant of two or more vectors.
   (b) Two forces of magnitudes 1200 N and 1500 N act, such that

their lines of action intersect forming an angle (Î¸). Find their resultants N if Î¸ is (i) 0Â° (ii) 30Â° (iii) 90Â° (iv) 135Â° (v) 180.Â°

2. State the parallelogram law of vector addition. The resultant of 60 N and 80 N forces is 100N. What is the angle between (i) the forces; (ii) the 80 N force and the resultant?
3. (a) What do you understand by resultant of two forces?
   (b) What is the effect on the resultant of two forces, if the angle between them is decreased?
   (c) A force of 200 N is inclined at an angle of 120Â° to another force P. The angle between the 200 N force and the resultant force is 50Â°. Find the magnitude of the;
   (i) force P.
   (ii) resultant of the two forces.
4. A hawk is flying due east with a velocity of $8ms^{-1}$ when a wind blows with a velocity of $4ms^{-1}$ in the direction of north. Find the velocity and direction of the hawk through the wind.
5. On a day, the velocity of wind is 15 km h^{1} in the South – West direction, a cyclist is heading due North with a velocity of 22 km h^{-1}. Calculate the velocity and the direction of the cyclist as a result of the wind.

RESOLVING VECTORS INTO COMPONENTS

OBJECTIVES

At the end of the topic, students should be able to:

- resolve vectors into components; and
- find the resultant of two or more vectors using resolution of vectors.

We can resolve or split a single vector into two or more parts called **components.** The components, when added, produce the same effect as the original vector.

A vector can be resolved in many ways. The easiest and commonest method is to split the vector (force) into two mutually perpendicular components as shown in Figure 1.11.

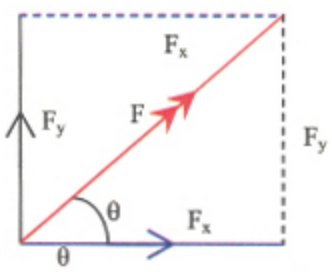


Figure 1.11: Resolution of vectors into components

The force F is resolved into two perpendicular components. The x–

component (F_x) is along the horizontal axis and y– component (F_y) is along the vertical axis.

Using trigonometric identities;

$$\frac{F_y}{F} = \sin \qquad \Rightarrow F_y = F \sin$$

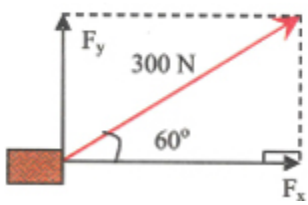
$$\frac{F_x}{F} = \cos \qquad \Rightarrow F_x = F \cos$$

A vector along the vertical direction or y – axis has no part along the horizontal direction or the x – axis. Also, a vector along the x – axis has no part in the vertical direction or y – axis.

Worked examples

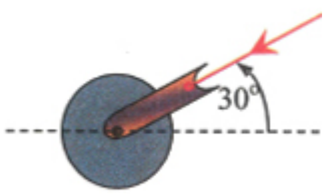
1. A boy pulls a box along a horizontal ground with a force of 300 N inclined at an angle of 60Â° to the horizontal.
   (a) Calculate the vertical and horizontal components of the force.
   (b) Which of these components does work and why?

Solution



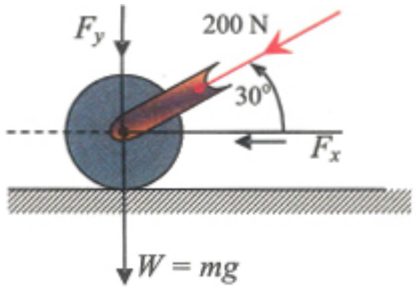
(a) F_y= Fsin Î¸= 300 sin 60 =259.8 N.
(b) F_x = Fcos Î¸=300 cos 60= 150 N.
(c) The horizontal component F_x does work because it acts in the direction of distance moved by the box. The vertical component F_y is not doing any work since its direction is perpendicular to the distance moved by the box.

2. The roller below is being pushed with a force of 200N at an angle of 30Â° to the ground. If the mass of the roller is 40 kg, calculate:



(a) the vertical and horizontal components of the force.
(b) the total downward force on the ground. {g 10 ms^{-2}}

Solution



(a) The vertical component F_y= FsinÎ¸
   F_y= 200 sin 30 = 100 N
   F_x = 200 cos 30 = 173.3 N

(b) Weight of the roller W = mass Ã— gravity
   Weight of the roller W = 40 Ã— 10 = 400 N
   Total downward force = W + F_y
   = 400 N+100 N
   = 500 N.

Resultant of two or more vectors by resolution of forces

The resultant of two or more vectors can be found by taking the following simple steps:

(a) resolving each vector into vertical and horizontal components.

(b) summing all the components along the vertical axis to obtain a vertical resultant.

(c) summing all the components along the horizontal axis to obtain a horizontal resultant.

(d) the final resultant of the vectors is the vector sum of the vertical and horizontal resultants.

$$F=\sum F_x+\sum F_y$$

Let us consider two forces A and B inclined at angles Î± and Î² to the horizontal respectively as shown in Figure 1.12(a) The resolved components are shown in Figure 1.12(b) and the horizontal and vertical components are shown in the table below.

Forces	Horizontal components	Vertical components
A	A_x = -Acos Î±	A_y = Asin Î±
B	B_x = -Bcos Î²	B_y = Bsin Î²

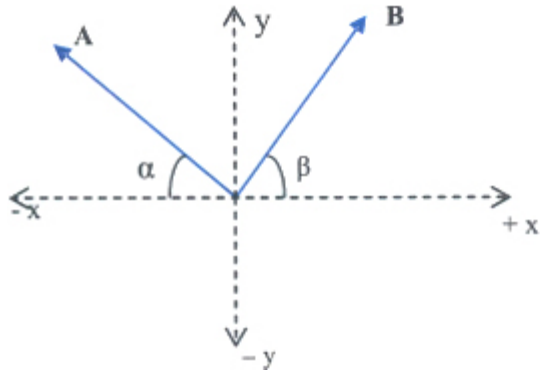


Figure 1.12 (a) Resolving inclined forces

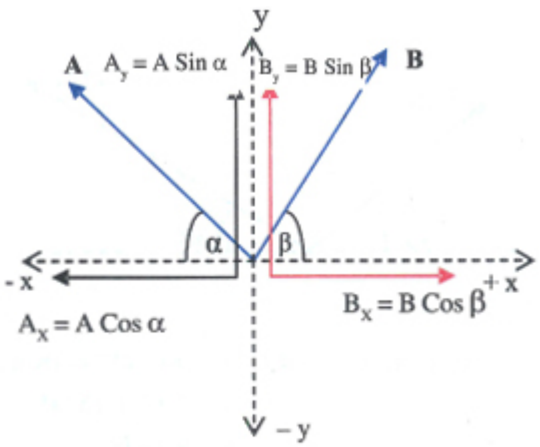


Figure 1.12 (b) Resolving inclined forces

The vertical resultant:

R_y = Asin Î±+ Bsin Î²

The horizontal resultant:

R_x = - Acos Î± +Bcos Î²

The vertical and horizontal resultants form two perpendicular components of the final resultant (R). This is illustrated in Figure 1.13.

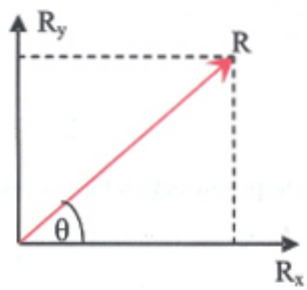


Figure 1.13 Resolving forces R into its components

The final resultant of A and B is obtained by the formula

$$R^2 = R_x^2 + R_y^2$$

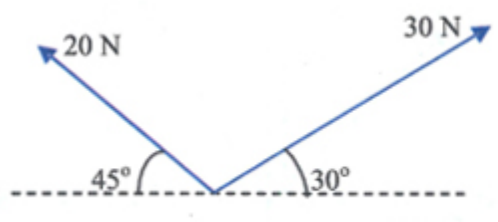
The direction of the resultant with the horizontal (*Î¸*) is given by:

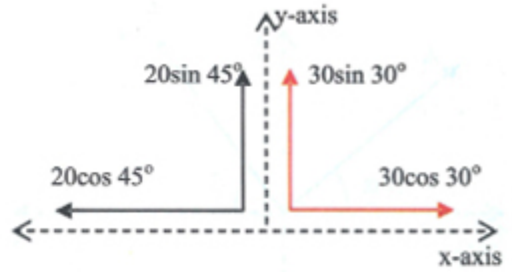
$$\tan = \frac{R_y}{R_x}$$

Worked example

1. Two forces 20 N and 30 N are inclined at angles 45Â° and 30Â° respectively as shown below. Calculate the resultant of the two forces and the angle it makes with the x-axis.

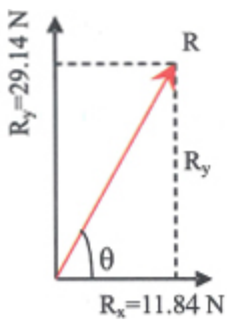
Solution





Vertical resultant R_y = 20sin 45Â° +30sin 30Â°
= 14.14+15.00
= 29.14 N

Horizontal resultant R_x = 30 cos 30Â°–20cos 45Â°
= 25.98- 14.14
= 11.84 N



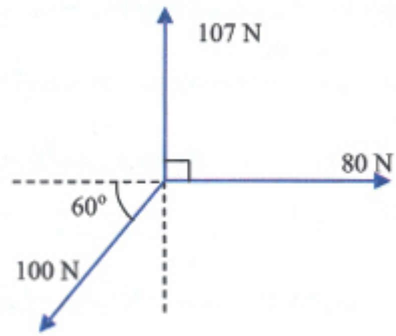
$$R = \sqrt{R_x^2 + R_y^2}$$
$$R = \sqrt{11.84^2 + 29.14^2}$$
$$R = \sqrt{989.37}$$
$$R = 31.5\ N$$

The direction of the resultant force with respect to the x-axis is Î¸.

$$\tan\theta = \frac{R_y}{R_x} = \frac{29.14}{11.84} = 2.459$$

$$\therefore \quad \theta = \tan^{-1} 2.459 = 67.9^{\circ}$$

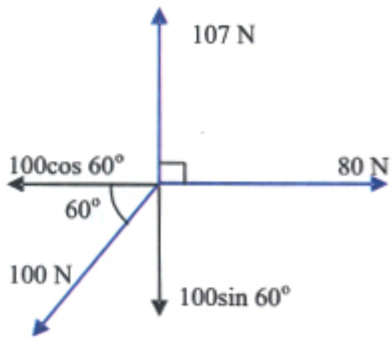
2. Three coplanar forces act simultaneously at a point as shown below:



Find the resultant of the forces and its direction with respect to the x – axis.
[sin 60Â° = 0.87, cos 60Â° = 0.50]

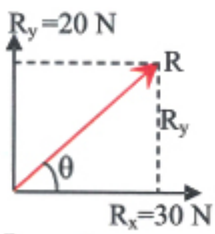
Solution

107 N force has no component along the x-axis. 80 N force has no component along the y-axis.



Vertical resultant $R_y = 107 - 100\sin 60^\circ$
$= 107 - 100 \times 0.87$
$= 20$ N.

Horizontal resultant $= 80 - 100\cos 60^\circ$
$= 80 - 100 \times 0.5$
$= 30$ N



$$R = \sqrt{R_x^2 + R_y^2}$$
$$R = \sqrt{30^2 + 20^2}$$
$$R = \sqrt{1300}$$
$$R = 36.1 \ N$$

$$\tan = \frac{R_y}{R_x} = \frac{20}{30} = 0.6667$$

$$\therefore \ \theta = \tan^{-1} 0.6667 = 33.7^\circ$$

Summary

â€¢ Resolution of vector is the splitting of a vector into two parts which are perpendicular to each other. The parts are called components.

â€¢ A vector along the y – axis has no part along the x – axis and a vector along the x – axis has no part along the y – axis.

â€¢ Resultant of more than two vectors is found by resolving each vector into two perpendicular parts.

Practice questions lb

1. Find the vertical and horizontal components of 500 N force when it is inclined at (i) 60Â° (ii) 90Â° (iii) 150Â° to the level ground.
2. A boy pulls a lawn mower by exerting a force of 700N to the handle. Calculate:
   (a) the vertical and horizontal components of his force on the mower if it is inclined at an angle of 55Â° to the horizontal.
   (b) the reaction of the ground on the mower if its weight is 1000 N.
3. A bus of total weight 15,000 N is parked on a hill inclined at an angle of 30Â° to the horizontal.
   (a) Calculate the components of the bus weight
   (i) along the plane of the hill.
   (ii) perpendicular to the plane of the hill.
   (b) If the bus is allowed to roll down the plane, state with reason the component moving the bus down the hill.
4. Two equal forces each of magnitude 34 N acts on a body. Calculate the magnitude and direction of the resultant if the angle between them is 120Â°.
5. Calculate the magnitude and direction of the resultant of the system of force shown in figure 15.14.

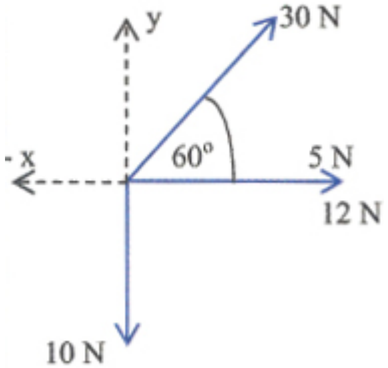


Figure 1.14 (a)

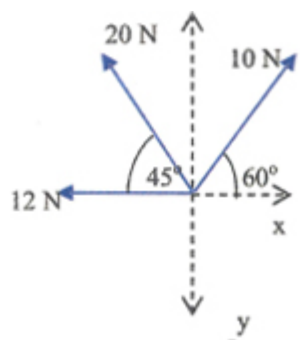


Figure 1.14 (b)

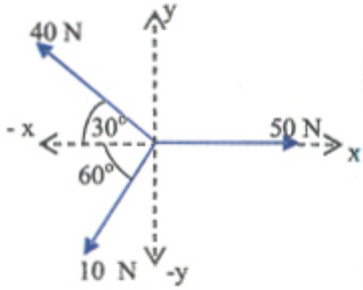
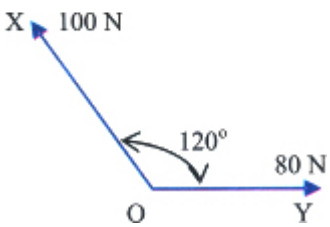


Figure 1.14 (c)

Past questions

1. Two forces of magnitudes 14.0N and 6.0N act at right angle to each other. Calculate the magnitude of the resultant.
   A. 84.00 N
   B. 15.23 N
   C. 12.65 N
   D. 8.00 N
2. A boy travels 8 km eastward to a point B and then 6 km northward to another point C. Determine the difference between the magnitudes of the displacement of the boy and the distance travelled by him.
   A. 2.0 km
   B. 4.0 km
   C. 10.0 km
   D. 14.0 km

   WASSCE
3. What is the resultant of the forces along OY in the diagram below?

   A. 20 N
   B. 30 N
   C. 60 N
   D. 90 N
   E. 180 N

   NECO
4. An athlete runs from West at a speed of 10 ms^{-1} against a strong wind travelling at a speed of 5 ms^{-1} from East to West. Which of the following statements is correct? The resultant velocity is
   A. 5 ms^{-1} East
   B. 5 ms^{-1} West
   C. 15 ms^{-1} East

   WASSCE

D. 15 ms^{-1} West

5. The resultant of two forces acting on an object is maximum when the angle between them is

A. 180Â°

B. 90Â°

C. 45Â°

D. 0Â° **WASSCE**

6. A boat travels from West to East at 40 km h^{-1}at right angle to the bank of a river flowing North to South at 30 km h^{-1}. Calculate the resultant velocity of the boat.

A. 70 km h^{-1}

B. 50 km h^{-1}

C. 40 km h^{-1}

D. 10 km h^{-1} **WASSCE**

7. A motor cyclist passing a road junction moves due west for 8 s at a uniform speed of 5 ms^{-1}. He then moves due north for another 6 s with the same speed. At the end of 6 s his displacement from the road junction is 50m in the direction

A. N53Â°E

B. N37Â°E

C. N53Â°W

D. N37Â°W **WASSCE**

8. Which of the following sets consists entirely of scalar quantities?

A. Impulse, mass and magnetic flux.

B. Speed, momentum and distance.

C. Displacement, electric field and energy.

D. Pressure, work and electric potential. **WASSCE**

9. Two forces whose resultant is 100 N are perpendicular to each other. If one of them makes an angle of 60Â° with the resultant, calculate its magnitude. [sin 60Â° = 0.8660, cos 60Â° = 0.5000]

A. 300.0 N

B. 173.2 N

C. 115.5 N

D. 86.6 N

E. 50.0 N **JAMB**

10. A lorry travels 10 km northwards, 4 km eastwards, 6 km southwards and 4 km westwards to arrive at a point T. What is the total displacement?

A. 6 km East

B. 4 km north

C. 6 km north

D. 4 km east **JAMB**

11. A body of weight W Newton rests on a smooth plane inclined at an angle Î¸ to the horizontal. What is the resolved part of the weight in Newton along the plane?

A. Wsin Î¸

B. Wcos *Î¸*

C. Wsec *Î¸*

D. Wtan *Î¸*

JAMB

12. Two forces of magnitude 7 N and 3 N act at right angle to each other. The angle between the resultant and the 7 N force is given by

A cos $= \frac{3}{7}$

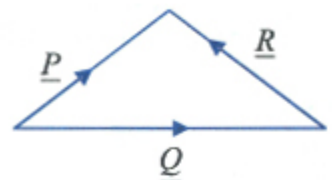
B. sin $= \frac{3}{7}$

C. tan $= \frac{3}{7}$

D. cot $= \frac{3}{7}$

JAMB

13. In the diagram below $\underline{P}$, $\underline{Q}$ and $\underline{R}$ are vectors. Which of the following options gives the correct relationship between the vectors?



A. $\underline{P} = \underline{Q} + \underline{R}$

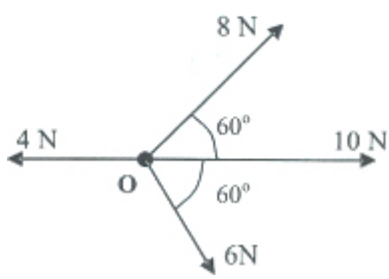
B. $\underline{P} = \underline{Q} - \underline{R}$

C. $\underline{P} = \underline{R} - \underline{Q}$

D. $\underline{P} + \underline{Q} + \underline{R} = 0$

JAMB 1993

14.



The diagram above shows forces 4 N, 6 N, 10 N and 8 N, which act at the point O in the directions, indicated. The net horizontal force is

A. $\sqrt{3}\ N$
B. 7
C. 13 N
D. 17 N

JAMB