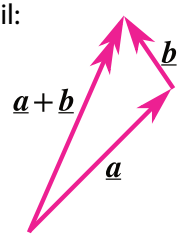
4 Vectors and Scalars

Scalar quantities have a magnitude (size) only, whereas vector quantities have a magnitude and a direction.

Vectors can be represented graphically as arrows. The length of the arrow indicates the magnitude of the vector. The direction of the arrow indicates the direction of the vector.

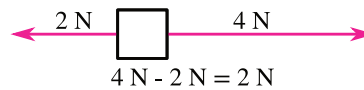
Quantity	Vector or Scalar?
Distance	Scalar
Time	Scalar
Displacement	Vector
Velocity	Vector
Acceleration	Vector
Speed	Scalar
Force	Vector
Gravitational potential energy	Scalar
Kinetic energy	Scalar
Momentum	Vector

When two vector quantities are added, the two arrows that represent the quantities are joined tip-to-tail:



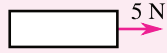
Subtracting a vector is the same as adding a vector pointing in the opposite direction.

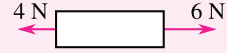
If two vectors are in opposite directions, they add to give a vector with magnitude equal to the difference of the original vectors' magnitudes.

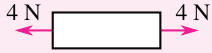


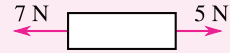
If two vectors are at right angles, the sum of their magnitudes can be calculated using Pythagoras' theorem.

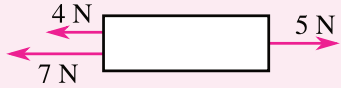
4.1 In each example, state the size and direction of the unbalanced force acting on the object. (Forces to the right or upward are assigned to be positive, whilst forces to the left or downward are assigned to be negative.)

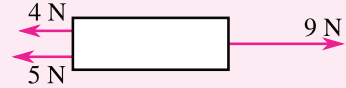
(a) 

(b) 

(c) 

(d) 

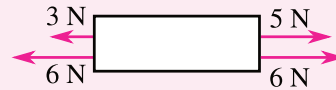
(e) 

(f) 

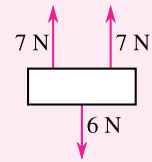
(g) 

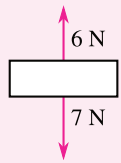
(h) 

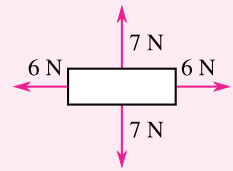
(i) 

(j) 

(k) 

(l) 

(m) 

(n) 

4.2 What is the resultant force on a racing car with 24.5 kN of driving force and 15.2 kN of opposing frictional forces (i.e. drag)?

4.3 What is the resultant magnitude of the displacement if a person walks north 5.00 km and east 4.00 km? i.e. How far away are they from the starting point?

4.4 Why is gravitational field strength a vector quantity?

4.5 Weight is a force. Force is a vector and so it has a direction. In what direction does your own weight point in these situations?

(a) not moving

(b) walking sideways

(c) walking in a circle

4.6 A stunt man drives a car out of the back of a moving lorry. For the stunt to work, the car must be moving at a velocity of -5.00 m/s the instant it has left the lorry. The lorry is travelling at a velocity of 25.0 m/s. What speed must the speedometer on the car reach before the car leaves the lorry?

4.7 Using a scale diagram, calculate the resultant force acting on a sailing boat when an easterly wind provides 2.50 kN of force, the tide provides 1.20 kN of force from the direction 30.0° more northerly than the wind.

4.8 A hiker walks 10.0 km east, 5.00 km south and 2.00 km west. Using a scale diagram, calculate his bearing from his start point. *[Note: bearings are given as angles where due north is* 0° *and the angle increases clockwise such that due east is* 90.0°*.]*

4.9 A kite is in equilibrium, so the total sum of the forces is equal to zero. On a vector diagram, the arrows representing the forces would form a closed loop. Three forces act on the kite; the force from the wind, the weight of the kite and the tension in the string. The wind produces a horizontal force of 70.0 N and an upward force of 50.0 N and the kite weighs 25.0 N. Use a scale diagram to find:

(a) the tension in the string;

(b) the acute angle the string makes to the horizontal.