Forces

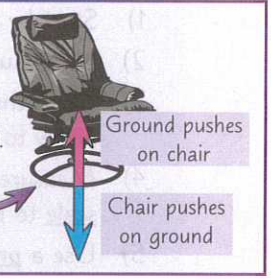
Force is a vector — it has both a size and a direction (unlike scalar quantities which only have a size — p.145). This means you can use arrows to represent the forces acting on an object or a system.

Interactions Between Objects Cause Forces

1) A force is a push or a pull on an object that is caused by it interacting with something.
2) Sometimes, objects need to be touching for a force to act. E.g. the normal contact force that acts between all touching objects, or friction between a car's tyre and the road. These are contact forces.
3) Other forces can act between objects that aren't touching (non-contact forces). They're usually caused by interacting fields. E.g. the gravitational attraction between objects (like the Earth and the Sun) is caused by their gravitational fields interacting.
4) Interacting magnetic fields (p.195) cause attraction or repulsion between magnetic objects, and the electrostatic force causing attraction and repulsion between electrical charges is due to interactions between their electric fields.
5) Whenever two objects interact, both objects feel an equal but opposite force (Newton's 3rd Law). This pair of forces is called an interaction pair. You can represent an interaction pair with a pair of vectors (arrows).

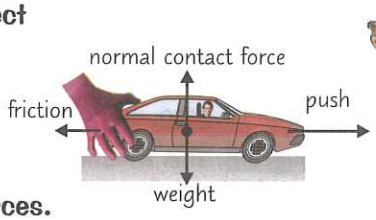
A chair exerts a force on the ground, whilst the ground pushes back at the chair with the same force (the normal contact force). Equal but opposite forces are felt by both the chair and the ground.

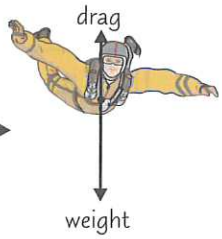
This is NOT a free body force diagram (below) — the forces are acting on different objects.



Free Body Force Diagrams Show All the Forces Acting on Objects

1) A free body force diagram shows an isolated body (an object or system on its own), and all the forces acting on it.
2) It should include every force acting on the body, but none of the forces it exerts on the rest of the world.
3) The sizes of the arrows show the relative magnitudes of the forces and the directions show the directions of the forces.

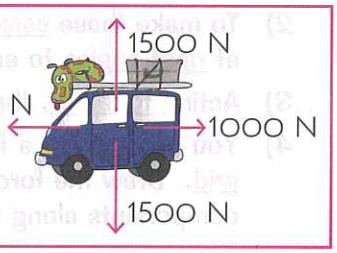




A Resultant Force is the Overall Force on a Point or Object

1) In most real situations there are at least two forces acting on an object along any direction.
2) If you have a number of forces acting at a single point, you can replace them with a single force (so long as the single force has the same effect as all the original forces together).
3) This single force is called the resultant force (or sometimes the net force on an object).
4) If the forces all act along the same line (they're all parallel), the overall effect is found by adding those going in the same direction and subtracting any going in the opposite direction.
5) Objects in equilibrium have a resultant force of zero — see the next page. Objects in equilibrium are either stationary, or moving at a steady speed (this is Newton's 1st Law — p.149).

- The normal contact force felt by the van is equal to its weight. These forces act in opposite directions, so there is no resultant force in the vertical direction (1500 N – 1500 N = 0 N).
- The frictional force acting on the van is smaller than the driving force pushing it forward, so there is a resultant force in the horizontal direction.
- 1200 N – 1000 N = 200 N. So the resultant force is 200 N (to the left).



Consolidate all your forces into one easy-to-manage force...

Free body force diagrams make most force questions easier, so if you can, always sketch one. Then get to work.

Q1 A car has a driving force of 2000 N and a weight of 1600 N. There is a total resistive force of 1200 N acting against the driving force. Draw the free body force diagram for the car. [2 marks]

Forces

1 Forces are caused by interactions between objects. Grade 4-6

a) Forces can be split into contact and non-contact forces.

i) Describe what is meant by a 'contact force'.

.....

.....

[1]

ii) Give **two** examples of a contact force.

1. .....

2. .....

[2]

b) Give **one** example of a non-contact force.

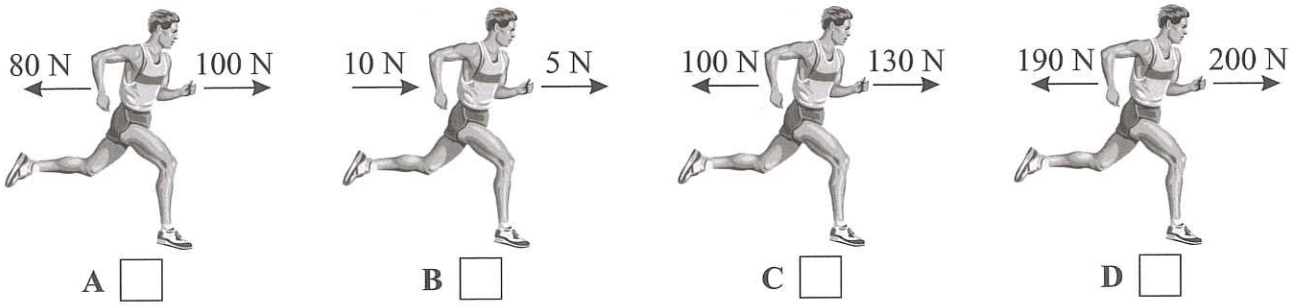
.....

[1]

[Total 4 marks]

2 **Figure 1** shows four runners who are running in windy weather. Which runner is experiencing the largest horizontal resultant force? Grade 4-6

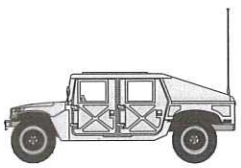
Figure 1



[Total 1 mark]

3 **Figure 2** shows a toy car. The weight of the car is 20 N. As it accelerates, it experiences a driving force of 30 N. There is a 5 N resistive force acting against the motion of the car. Add arrows to **Figure 2** to create a free body force diagram for the car. Grade 6-7

Figure 2

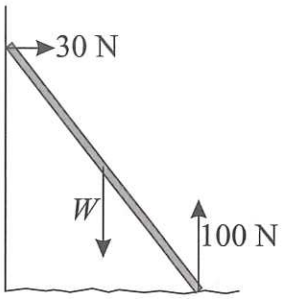


[Total 2 marks]

4 **Figure 3** shows an incomplete diagram of the forces acting on a ladder leaning against a wall. There is no friction between the ladder and the wall but there is friction between the ladder and the ground.

Grade 6-7

Figure 3



a) Complete **Figure 3** by drawing the missing frictional force.

[2]

b) Using **Figure 3**, determine the weight of the ladder, *W*.

Weight = ... N

[1]

[Total 3 marks]

5 **Figure 4** shows a pair of identical magnets. There is a force of repulsion between them.

Grade 6-7

Figure 4

a) The arrow in **Figure 4** shows the force exerted on magnet B by magnet A. Complete the diagram in **Figure 4** by drawing another arrow representing the force that magnet B exerts on magnet A.

[2]

b) Explain what is causing the force between the two magnets.

.....

.....

[1]

c) Magnet B is replaced by a much stronger magnet.
The strength of magnet A and the orientation of the magnets remains the same.
Describe how you would redraw the arrows on the diagram to show this new force interaction.

.....

.....

[2]

[Total 5 marks]

Exam Practice Tip

Make sure you get your head around the difference between an interaction pair and a free body force diagram. Free body force diagrams show the forces acting on a single object, whereas interaction pairs act on different objects.