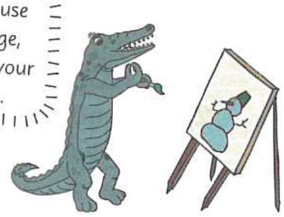
Forces and Vector Diagrams

Scale drawings are useful things — they can help you resolve forces or work out the resultant force.

Use Scale Drawings to Find Resultant Forces

1) Draw all the forces acting on an object, to scale, 'tip-to-tail'.
2) Then draw a straight line from the start of the first force to the end of the last force — this is the resultant (or net) force.
3) Measure the length of the resultant force on the diagram to find the magnitude of the force and the angle to find its direction.

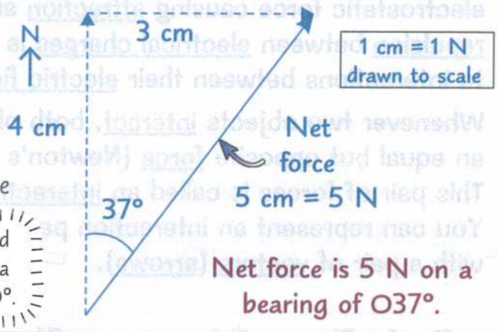
Make sure the scale you use is sensible. You want large, clear diagrams that make your calculations easier to do.



EXAMPLE: A man is on an electric bicycle that has a driving force of 4 N north. However, the wind produces a force of 3 N east. Find the net force acting on the man.

1) Start by drawing a scale drawing of the forces acting.
2) Make sure you choose a sensible scale (e.g. 1 cm = 1 N).
3) Draw the net force from the tail of the first arrow to the tip of the last arrow.
4) Measure the length of the net force with a ruler and use the scale to find the force in N.
5) Use a protractor to measure the direction as a bearing.

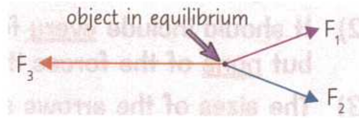
A bearing is an angle measured clockwise from north, given as a 3 digit number, e.g. 10° = 010°.



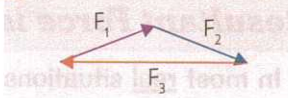
Net force is 5 N on a bearing of 037°.

An Object is in Equilibrium if the Forces on it are Balanced

1) If all of the forces acting on an object combine to give a resultant force of zero, the object is in equilibrium.
2) On a scale diagram, this means that the tip of the last force you draw should end where the tail of the first force you drew begins. E.g. for three forces, the scale diagram will form a triangle.
3) You might be given forces acting on an object and told to find a MISSING force, given that the object is in equilibrium.
4) To do this, draw out the forces you do know (to scale and tip-to-tail), then join the END of the LAST force to the START of the FIRST force. Make sure you draw this last force in the right direction — it's in the opposite direction to how you'd draw a resultant force.
5) This line is the missing force so you can measure its size and direction.



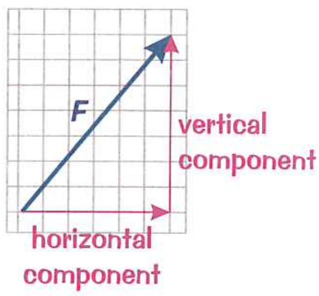
Tip-to-tail the forces join up...



...so the resultant force is zero.

You Can Split a Force into Components

1) Not all forces act horizontally or vertically — some act at awkward angles.
2) To make these easier to deal with, they can be split into two components at right angles to each other (usually horizontal and vertical).
3) Acting together, these components have the same effect as the single force.
4) You can resolve a force (split it into components) by drawing it on a scale grid. Draw the force to scale, and then add the horizontal and vertical components along the gridlines. Then you can just measure them.



Don't blow things out of proportion — it's only scale drawings...

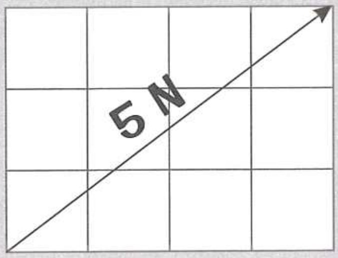
Keep those pencils sharp and those scale drawings accurate — or you'll end up with the wrong answer.

Q1 A remote-controlled boat crosses a stream. The motor provides a 12 N driving force to the west. The river's current causes a force of 5 N north to act on the boat. Find the size of the net force. [2 marks]

Forces and Vector Diagrams

Warm-Up

Find the sizes of the horizontal and vertical components of the force shown on the right. Each side of a square represents 1 N.



Horizontal component = ... N

Vertical component = ... N

1 **Figure 1** shows a girl on a swing. Her weight of 500 N acts vertically downwards and a tension force of 250 N acts on the ropes at an angle of 30° to the horizontal. Grade 6-7

Figure 1

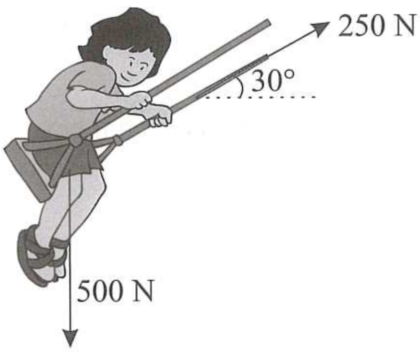
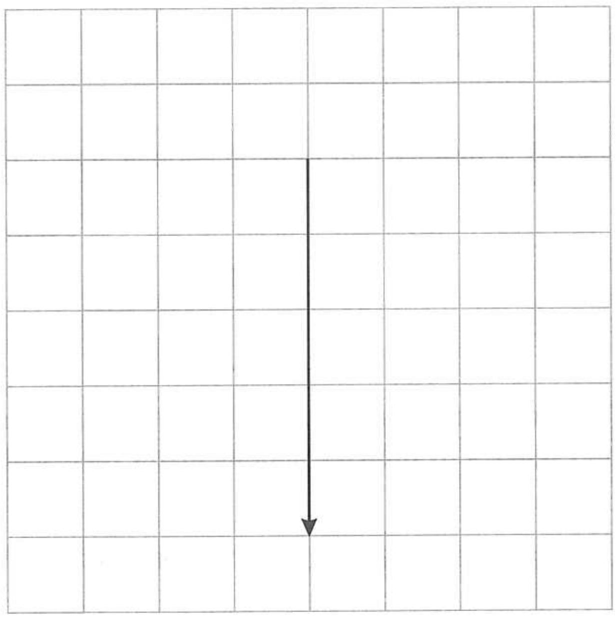


Figure 2



a) **Figure 2** shows an incomplete scale drawing for the forces acting on the girl. Only the girl's weight has been drawn so far. Calculate the scale used in the drawing.

.... cm = ... N
[1]

b) Complete the scale drawing in **Figure 2** to find the magnitude of the resultant force acting on the girl.

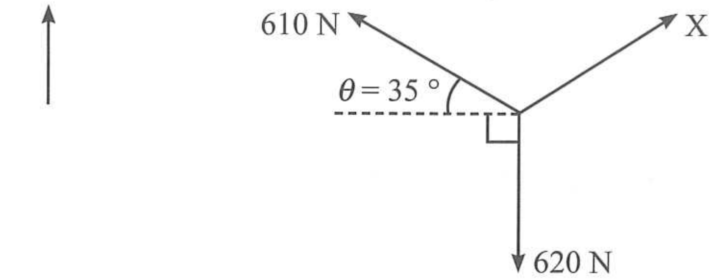
Magnitude = ... N
[2]

[Total 3 marks]

2 One of the events at a school sports day is a three-way tug of war. Three teams each pull on a rope, all three of which are attached to a metal ring. **Figure 3** shows the forces exerted on the ring. It is not drawn to scale.

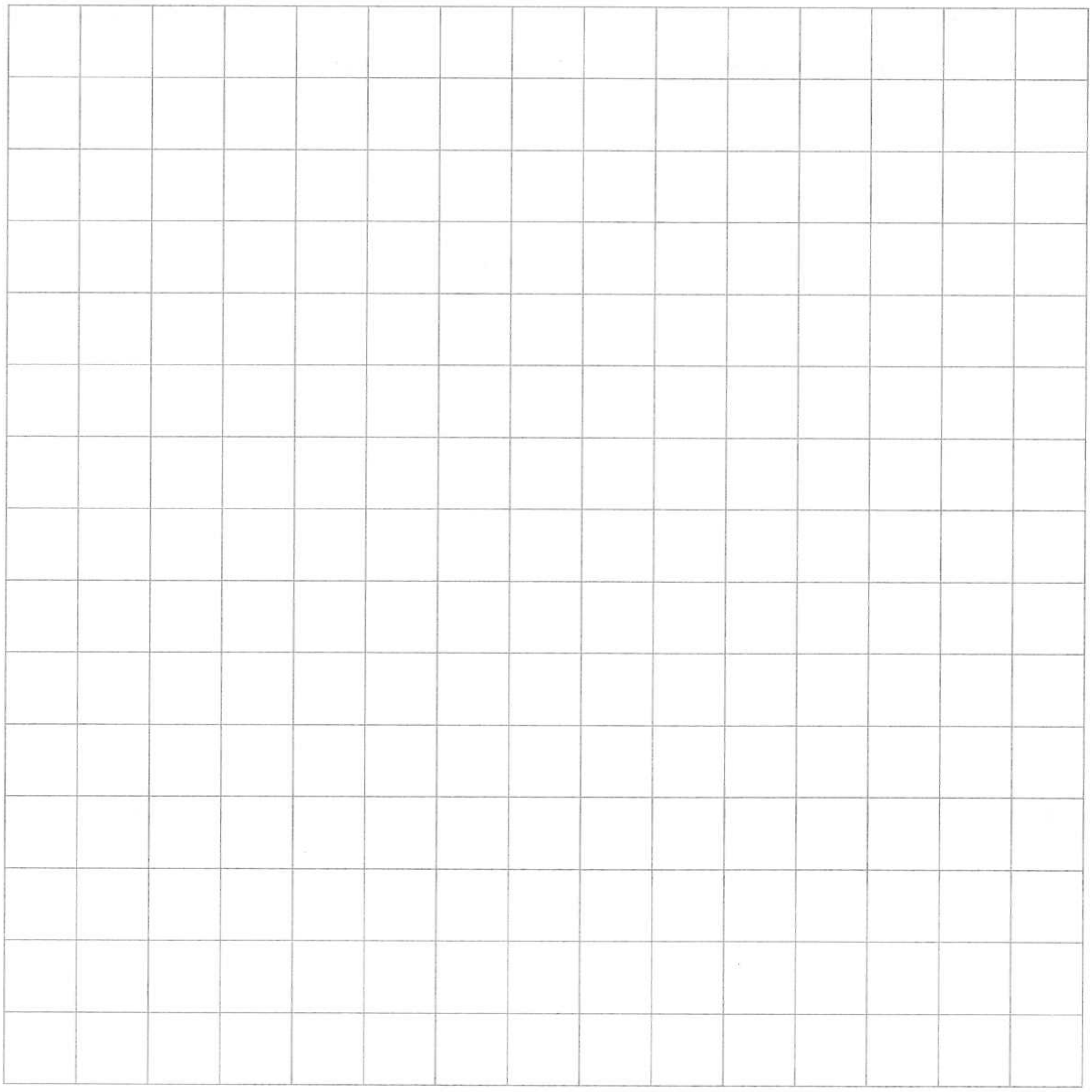
Grade 7-9

Figure 3



The ring is in equilibrium and does not move. Use the grid in **Figure 4** to create a scale drawing to determine the magnitude and direction as a bearing of force X.

Figure 4



Magnitude of force X = ... N

Direction = ... °

[Total 5 marks]