


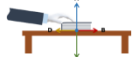
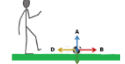

























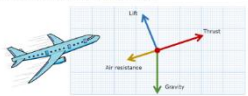

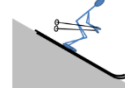

## Progression toolkit: Resultant forces in two dimensions

Learning focus	Scale diagrams of vectors, that represent forces, can be used to find the resultant force on an object and to predict its acceleration.				
As students' conceptual understanding progresses they can:	<div>CONCEPTUAL PROGRESSION</div>				
	Identify forces between interacting objects. <div>P</div>	Identify the free body (force) diagram representing the forces on an object.	Draw and interpret free body (force) diagrams to describe the resultant force on an object.	Use scale diagrams of force vectors in two dimensions to find the resultant force acting on an object.	Determine the change of motion caused by two dimensional forces acting on an object. <div>B</div>
Diagnostic questions	Where's the force?	Flying high	Rocket	Sledging fun	Take off!
	Rolling ball	Sledging disaster			Kite
Response activities	Skiing	Cycling		Scale drawing	

Key:

**P** Prior understanding from earlier stages of learning

**B** Bridge to later stages of learning


<p><b>Where's the force?</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Where's the force?</b></p> <p>A trolly is a push or a pull. Force is measured in Newton (N). Arrows can be used to represent the size and direction of force.</p>  <p>5. A book is being pushed across a table top. Which arrow or arrows show a force acting on the book?</p>  <p>2. A ball has been kicked and is moving forwards. Which arrow or arrows show a force acting on the ball?</p>  <p>Developed by the University of York Science Education Group, the Salters' Institute and the Institute of Physics. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a>. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<p><b>Rolling ball</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Rolling ball</b></p> <p>A ball is kicked and is moving forwards. An arrow from X to Y is shown below.</p>  <p>What is the forwards force on the ball at Y?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A The forwards force at Y is bigger than at X. <input type="checkbox"/></p> <p>B The forwards force at Y is the same as at X. <input type="checkbox"/></p> <p>C The forwards force at Y is smaller than at X. <input type="checkbox"/></p> <p>D There is no forwards force at Y. <input type="checkbox"/></p> <p>Developed by the University of York Science Education Group, the Salters' Institute and the Institute of Physics. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a>. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<p><b>Flying high</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Flying high</b></p> <p>An aeroplane is flying horizontally at a constant speed.</p>  <p>A free body diagram can be drawn to show all the forces acting on the plane. Arrows are used to represent the size and direction of each force.</p> <p>Which free body diagram best shows the forces on the aeroplane?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A  B  C </p> <p>D  E  F </p> <p>Developed by the University of York Science Education Group, the Salters' Institute and the Institute of Physics. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a>. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<p><b>Sledging disaster</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Sledging disaster</b></p> <p>A child has lost their sled on the snow. It's sliding down the slope.</p>  <p>A free body diagram can be drawn to show all the forces acting on the sled. Arrows are used to represent the size and direction of each force.</p> <p>Which free body diagram best shows the forces on the sled?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A  B  C </p> <p>D  E  F </p> <p>Developed by the University of York Science Education Group, the Salters' Institute and the Institute of Physics. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a>. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<p><b>Rocket</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Rocket</b></p> <p>A rocket is travelling through space. It's flying towards the right.</p>  <p>Two body diagram when the rockets are fired.</p> <p>What is the resultant force on the rocket?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A  B  C </p> <p>Developed by the University of York Science Education Group, the Salters' Institute and the Institute of Physics. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a>. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>
<p>Simple multiple choice</p>	<p>Simple multiple choice</p>	<p>Simple multiple choice</p>	<p>Simple multiple choice</p>	<p>Simple multiple choice</p>
<p><b>Sledging fun</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Sledging fun</b></p> <p>A child is whizzing downhill on a sledge.</p>  <p>Which of diagram show how to add the vectors correctly? Choose all that are correct.</p> <p>A  B  C </p> <p>Free body diagram</p> <p>Is answer is the sledge speeding up or slowing down?</p> <p>A  B  C </p> <p>Developed by the University of York Science Education Group, the Salters' Institute and the Institute of Physics. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a>. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<p><b>Take off</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Take-off</b></p> <p>An aeroplane has just taken off. The free body diagram shows the forces acting on it as an aeroplane.</p>  <p>a. What is the best description of how the plane is moving?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A It is speeding up as it climbs. <input type="checkbox"/></p> <p>B It is slowing down as it climbs. <input type="checkbox"/></p> <p>C It is moving at a constant speed as it climbs. <input type="checkbox"/></p> <p>b. What is the best reason for your answer to part a?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A Resultant force is upwards as the plane is climbing. <input type="checkbox"/></p> <p>B Resultant force is downwards as gravity is bigger than lift. <input type="checkbox"/></p> <p>C Resultant force is in the direction the plane is travelling. <input type="checkbox"/></p> <p>D Resultant force is zero. <input type="checkbox"/></p> <p>Developed by the University of York Science Education Group, the Salters' Institute and the Institute of Physics. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a>. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<p><b>Kite</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Kites</b></p> <p>A child is flying a kite. The free body diagram shows the forces on the kite.</p>  <p>Which statement best describes how the kite is moving?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A The kite is not moving. <input type="checkbox"/></p> <p>B The kite is slowing. <input type="checkbox"/></p> <p>C The kite is falling. <input type="checkbox"/></p> <p>D Any of the above statements could be true. <input type="checkbox"/></p> <p>Developed by the University of York Science Education Group, the Salters' Institute and the Institute of Physics. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a>. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<p><b>Skiing</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Skiing</b></p> <p>A skier is sliding downhill. The free body diagram shows the size and direction of forces acting on the skier.</p>  <p>Free body diagram</p> <p>Te label each force in two ways.</p> <p>A The force of _____ on _____. This is called the _____ force.</p> <p>B The force of _____ on _____. This is called _____.</p> <p>C The force of _____ on _____. This is called the _____ force.</p> <p>Developed by the University of York Science Education Group, the Salters' Institute and the Institute of Physics. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a>. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<p><b>Cycling</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Cycling</b></p> <p>A cyclist is freewheeling along a level road. They are not pedalling.</p>  <p>Some students are discussing the forces acting on the cyclist.</p> <p><b>Isabel:</b> There's a force in the forwards direction. The force gets smaller as the cyclist slows down.</p> <p><b>Nikita:</b> Gravity doesn't act on objects that are already on the ground.</p> <p><b>Rehan:</b> There is a force in the forwards direction and frictional forces acting in the backwards direction.</p> <p><b>Thomas:</b> There is an upwards force from the ground acting on the cyclist, but the gravitational force is bigger.</p> <p>To answer</p> <p>1. Who do you think is correct about the forces on the bike?</p> <p>2. Who do you think is wrong about the forces on the bike? What would you say to help them understand?</p> <p>3. Draw a free body diagram for the cyclist. Label each force. The force of _____ on _____.</p> <p>4. Draw a free body diagram for the cyclist freewheeling downhill.</p> <p>Developed by the University of York Science Education Group, the Salters' Institute and the Institute of Physics. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a>. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>
<p>Simple multiple choice</p>	<p>Two-tier multiple choice</p>	<p>Simple multiple choice</p>	<p>Application and practice</p>	<p>Talking heads</p>

## Scale drawing


**BEST**  
STUDENT WORKSHEET

### Scale drawing

A motorboat is crossing a wide river.



The free-body diagram shows the forces acting on the boat, looking from above.



**Table**

Draw a scale diagram in order to find the resultant force on the boat.

Use a sheet of graph paper.

1. Choose a suitable scale for the forces vectors (force arrows).
2. Draw the one force vector to scale, in the right direction.
3. Add the other force vectors to turn, with the start of each new vector touching the tip of previous one.
4. Draw an arrow from the start of the first force vector to the tip of the last one. This is the resultant force.
5. Measure the size and the direction of the resultant force.

**Thinker**

What will the resultant force do to the movement of the boat?

Developed by the University of York Science Education Group, the Salters' Institute and the Institute of Physics.  
This document is a revision of the original. Download the original from [www.BestEvidenceScienceTeaching.org](http://www.BestEvidenceScienceTeaching.org).  
© University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.

## Application and practice