

Physics > Big idea PFM: Forces and motion > Topic PFM2: Moving by force

**Progression toolkit: Changing motion**

<b>Learning focus</b>	A resultant force on an object can cause it to speed up or slow down, depending on the direction of the force.				
<b>As students' conceptual understanding progresses they can:</b>					
<b>As students' conceptual understanding progresses they can:</b>	Calculate the size and direction of the resultant force of two forces acting along the same straight line.  <div style="background-color: #4a4a8a; color: white; padding: 2px; width: 15px; margin: 0 auto;">P</div>	Describe how quickly the speed of an object can be changed if acted on by resultant forces of different size.  <div style="background-color: #4a4a8a; color: white; padding: 2px; width: 15px; margin: 0 auto;">P</div>	Describe how the speed of an object changes throughout the time that a resultant force is acting on it.	Explain how friction and other resistive forces can act to continually reduce the speed an un-propelled object.	Explain why friction and other resistive forces make it necessary to exert a constant force to keep an object moving at a steady speed.  <div style="background-color: #4a4a8a; color: white; padding: 2px; width: 15px; margin: 0 auto;">B</div>
<b>Diagnostic questions</b>	How much is left over? <sup>(2)</sup>	Drag race	Skydiving <hr/> Rolling stone	Shopping trolley disaster!	Supermarket dash
<b>Response activities</b>	Calculating resultant force <sup>(2)</sup>	Steady force		Counter force	Trolley racing

Key:

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

**B** Bridge to later stages of learning

<h3>How much is left over? (2)</h3> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>How much is left over? (2)</b></p> <p>The resultant force is the difference between the two forces.</p> <p>Put two forces in the same direction add together.</p> <p>Work out the resultant force on each toy car. Link each car to the size and direction of the resultant force on it.</p> <table border="1"> <thead> <tr> <th>Forces on the car</th> <th>Size of force</th> <th>Direction of force</th> </tr> </thead> <tbody> <tr> <td>15N → 30N →</td> <td>• 15N •</td> <td>• • •</td> </tr> <tr> <td>30N → 15N →</td> <td>• 30N •</td> <td>• forwards •</td> </tr> <tr> <td>45N → 15N →</td> <td>• 60N •</td> <td>• forwards •</td> </tr> <tr> <td>45N → 30N →</td> <td>• 15N •</td> <td>• backwards •</td> </tr> </tbody> </table> <p>Linking ideas</p>	Forces on the car	Size of force	Direction of force	15N → 30N →	• 15N •	• • •	30N → 15N →	• 30N •	• forwards •	45N → 15N →	• 60N •	• forwards •	45N → 30N →	• 15N •	• backwards •	<h3>Drag race</h3> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Drag race</b></p> <p>Two cars are racing from a starting point. The green car is pushed with a bigger force.</p> <p>After three seconds the green car is going faster than the red one.</p> <p>What is the best reason to explain why the green car is faster? Put a tick (✓) in the box next to the best answer.</p> <p>A A bigger force pushes it a bigger speed <input type="checkbox"/></p> <p>B A bigger force increases speed more each second <input type="checkbox"/></p> <p>C A bigger force is made by a faster car <input type="checkbox"/></p> <p>D A bigger force increases speed to a bigger top speed <input type="checkbox"/></p> <p>Simple multiple choice</p>	<h3>Skydiving</h3> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Skydiving</b></p> <p>Eve jumps out of a plane!!! She is wearing a parachute.</p> <p>Eve falls 5m in the first second.</p> <p>How far does she fall in the following second?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A Less than 5m <input type="checkbox"/></p> <p>B About 5m <input type="checkbox"/></p> <p>C A little more than 5m <input type="checkbox"/></p> <p>D A lot more than 5m <input type="checkbox"/></p> <p>Two-tier multiple choice</p>	<h3>Rolling stone</h3> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Rolling stone</b></p> <p>A large round stone is rolled down a steep slope. There is a marker flag every 10m.</p> <p>These statements are about the speed of the ball.</p> <p>For each statement, tick (✓) one column to show what you think.</p> <table border="1"> <thead> <tr> <th>Statements about the speed of the ball</th> <th>I am not sure if it's right</th> <th>I think it's right</th> <th>I think it's wrong</th> <th>I am sure it's wrong</th> </tr> </thead> <tbody> <tr> <td>A Speed at X is faster than speed at Y</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>B Speed at Y is faster than speed at X</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>C Speed at Z is faster than speed at Y</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>D Speed at Z is faster than speed at X</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> </tbody> </table> <p>Confidence grid</p>	Statements about the speed of the ball	I am not sure if it's right	I think it's right	I think it's wrong	I am sure it's wrong	A Speed at X is faster than speed at Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	B Speed at Y is faster than speed at X	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C Speed at Z is faster than speed at Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D Speed at Z is faster than speed at X	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<h3>Shopping trolley disaster!</h3> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Shopping trolley disaster!</b></p> <p>Tim is running through a car park with a full shopping trolley. She pushes it at a constant speed.</p> <p>She stops and leaves go of the shopping trolley!</p> <p>What happens to the trolley now? Put a tick (✓) in the box next to the best answer.</p> <p>A It immediately comes to a stop <input type="checkbox"/></p> <p>B It moves at a steady speed for a while and then stops <input type="checkbox"/></p> <p>C It immediately starts slowing down to a stop <input type="checkbox"/></p> <p>D It continues at a constant speed <input type="checkbox"/></p> <p>E Its speed increases for a while and then starts slowing to a stop <input type="checkbox"/></p> <p>What is the best reason to explain what happens? Put a tick (✓) in the box next to the best answer.</p> <p>A The forwards force is used up <input type="checkbox"/></p> <p>B There is no forwards force <input type="checkbox"/></p> <p>C There is a backwards force <input type="checkbox"/></p> <p>Two-tier multiple choice</p>
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<h3>Supermarket dash</h3> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Supermarket dash</b></p> <p>Timmy is running through a car park with a full shopping trolley. She pushes the trolley horizontally at a constant speed.</p> <p>1. How big is the force of Sophie on the trolley? Put a tick (✓) in the box next to the best answer.</p> <p>A Equal to the weight of the trolley <input type="checkbox"/></p> <p>B Greater than the weight of the trolley <input type="checkbox"/></p> <p>C Exactly equal to the friction on the trolley <input type="checkbox"/></p> <p>D A tiny bit bigger than the friction on the trolley <input type="checkbox"/></p> <p>E A bit bigger than the friction on the trolley <input type="checkbox"/></p> <p>2. Sophie doubles her force on the trolley. How does the trolley move now? Put a tick (✓) in the box next to the best answer.</p> <p>A With a constant speed, twice as fast as before <input type="checkbox"/></p> <p>B With a constant speed, faster than before but not twice as fast <input type="checkbox"/></p> <p>C With a continuously increasing speed <input type="checkbox"/></p> <p>D With an increasing speed at first, then at a factor constant speed <input type="checkbox"/></p> <p>Simple multiple choice</p>	<h3>Calculating resultant force (2)</h3> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Calculating resultant force (2)</b></p> <p>More than one force can push or pull an object. The forces add together, but their direction is important.</p> <p>Examples</p> <p>1. What is the resultant force on the bicycle?</p> <p>The forces are pushing against each other. The biggest force pushes forwards. The difference in the forces = 450 - 150 = 300. The resultant force = 300. It forwards.</p> <p>2. What is the resultant force on the trolley?</p> <p>The forces are both pushing forwards. They add together. The resultant force = 210 + 90 = 300. The resultant force is 300. It forwards.</p> <p>Application and practice - calculations</p>	<h3>Steady force</h3> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Steady force</b></p> <p>A trolley is pushed with a steady force. It is pushed by a weight hanging over a pulley.</p> <p>Predict</p> <p>What do you think a distance-time graph of the trolley's movement will look like?</p> <p>Explain</p> <p>Why do you think the graph will look like this?</p> <p>Watch the demonstration</p> <p>Observe</p> <p>Sketch a distance-time graph of how the trolley moves.</p> <p>Explain</p> <p>Where your prediction and explanation correct? Try to improve your first explanation to explain what happens more clearly.</p> <p>Predict, explain, observe, explain - practical/demonstration</p>	<h3>Counter force</h3> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Counter force</b></p> <p>A trolley is pushed up a slope. It is pushed by a weight hanging over a pulley.</p> <p>Predict</p> <p>When the trolley rolls along the level track, what do you think a distance-time graph of the movement will look like?</p> <p>Explain</p> <p>Why do you think the graph will look like this?</p> <p>Watch the demonstration</p> <p>Observe</p> <p>Sketch a distance-time graph of how the trolley moves along the level track.</p> <p>Explain</p> <p>Where your prediction and explanation correct? Try to improve your first explanation to explain what happens more clearly.</p> <p>Predict, explain, observe, explain - practical/demonstration</p>	<h3>Trolley racing</h3> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Trolley racing</b></p> <p>Timmy and Rebecca decide to have a race with their shopping trolleys. Pushing the wheels on the trolley to reduce friction.</p> <p>Some friends are talking about how using their wheels will help Sophie in the race.</p> <p>Paula: At top speed she won't need to push as hard.</p> <p>Rebecca: She will have a higher top speed.</p> <p>Timmy: At the start there will be a bigger resultant force on the trolley.</p> <p>Scarlett: She will be able to push with more force.</p> <p>TO ANSWER</p> <p>1. Why do you think it is right about why using her wheels will help Sophie? (2000) (10 marks)</p> <p>2. What happens do you think the other trolley? What would you say to them to help them to understand?</p> <p>Talking heads</p>																																								