





Components

	NAME	DESCRIPTION	AUDIENCE
	<i>Investigating forces</i> teachers guide	This guide suggests teaching strategies and practical activities for students to explore situations involving balanced and unbalanced forces.	teachers
	<i>Force investigation</i> procedure sheet	This procedure sheet provides examples of investigations, using carts and pulleys, exploring motion due to unbalanced forces.	teachers

Purpose

To **Explore** effects of balanced and unbalanced forces on the motion of objects.

Outcomes

Students:

- understand forces are balanced when they are equal in magnitude but opposite in direction;
- discover that when forces acting on an object are unbalanced, they change its motion;
- discover that when forces acting on an object are balanced, they have no effect on its motion;
- understand gravity is a force that makes objects accelerate towards the centre of the Earth; and
- construct, interpret and analyse graphs from authentic data.

Activity summary

ACTIVITY	POSSIBLE STRATEGY
<p>Prior to commencing the procedure sheet, <i>Force investigation</i>, ask students to discuss what they learned about forces, in previous lessons. Responses may include:</p> <ul style="list-style-type: none"> • forces can act by contact or at a distance; • gravity acts on all objects on Earth; • forces have strength and direction; • forces can balance each other; and • unbalanced forces change the motion of objects. 	whole class or group discussion
<p>Using the procedure sheet, <i>Force investigation</i>, or another investigation of your choice, discuss with students the procedures outlined and the way they are presented.</p>	whole class discussion
<p>Present the two lists of activities below. Ask students to choose one activity from each list to help them explore balanced and unbalanced forces, and falling objects.</p> <p>Students plan, submit to teacher for approval and conduct their investigations. They may also plan and conduct a second investigation.</p>	individual investigation or working in pairs
<ul style="list-style-type: none"> • Students write up their investigations and summarise their discoveries about balanced forces, unbalanced forces and gravity. • Students share their findings with other groups in the class. • Strategies for sharing may include whiteboard summary, jigsaw or group report to whole class. 	working individually, then whole class presentation

Teacher notes

The procedure sheet, *Force investigation*, is designed to assist teachers and students when planning and conducting investigations about effects of balanced and unbalanced forces on the motion of objects. You may prefer to conduct procedures of your own choice.

The activities help to develop the following concepts:

- forces are balanced when they are equal in magnitude but opposite in direction;
- balanced forces don't change the motion of objects;
- unbalanced forces change (accelerate or decelerate) the motion of objects; and
- gravity is a force that makes unsupported objects accelerate towards the centre of the Earth.

If time permits, students may repeat the first investigation using their suggestions for increasing accuracy of measurements, in their responses to Question 4.

The following activities are additional examples of practical investigations through which students, using carts, pulleys, spring balances, string and weights, may explore effects of balanced and unbalanced forces on objects.

Set 1: Balanced and unbalanced forces

Possible activities include investigating:

- how extension of an elastic band may be used to measure magnitude of a force;
- motion of objects suspended by string over a single pulley;
- motion of a cart connected to weights suspended over the side/s of a desk; and
- force needed to prevent a cart moving when it's connected to weights suspended over the side of a desk.

Set 2: Falling objects

Possible activities include investigating:

- motion of falling objects;
- effects of parachutes on the motion of falling objects; and
- motion of toy cars down slopes.

Suggested answers to questions in *Force investigation*

Investigation 1

1. Answers will vary.
2. The more mass that is added to the cart, the faster the cart moves over the 0.50 m distance.
3. Same answer as question 2.
4. There are many ways to increase accuracy, such as using repeat trials and increasing the distance travelled.
5. The greater the unbalanced force, the faster the cart moves. This matches answers to questions 2 and 3.
6. The cart's average speed increases as masses are added. More masses increase the unbalanced force, which reduces the time required to travel the 0.5 m distance.
7. Increasing the mass of the cart causes it to move slower.

Investigation 2

1. The cart will remain at rest.
2. William is probably correct. When friction is taken into account, the cart is likely to remain stationary if only a small weight is added.
3. The cart will move towards end B as forces are now unbalanced.
4. As more masses are removed from end A the speed of the cart towards end B will increase. The difference between the forces is greater so the unbalanced force is greater.
5. A stationary cart has balanced forces acting on it. The motion of the cart isn't changing.
6. Katie is correct. According to Newton's second law the cart will continue to move at a constant speed, in the same direction, unless another unbalanced force acts to change its motion. Friction, an unbalanced force, will eventually stop the cart. William is incorrect in believing that balanced force means no motion — balanced force means no *change* in motion.

Technical requirements

The teachers guide and procedure sheet require Adobe Reader (version 5 or later), which is a free download from www.adobe.com. The procedure sheet is also available in Microsoft Word format.

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Associated SPICE resources

Forces 2: Investigating forces may be used in conjunction with related SPICE resources to address the broader topic of forces and motion.

DESCRIPTION	LEARNING PURPOSE
<i>Forces (overview)</i> This learning pathway shows how a number of SPICE resources can be used to teach concepts of balanced forces, unbalanced forces and motion.	
<i>Forces 1: Introduction to force</i> A video stimulates students' interest in learning about forces and motion, and elicits prior knowledge and misconceptions.	Engage
<i>Forces 2: Investigating forces</i> Practical activities provide opportunities for students to explore effects of forces on the motion of objects, including those falling in Earth's gravity.	Explore
<i>Forces 3: Balanced and unbalanced forces</i> An interactive learning object enables students to explain and predict effects of balanced and unbalanced forces on objects.	Explain
<i>Forces 4: Forces in the human body</i> Students apply their understanding of forces and motion to new contexts, such as: forces in the human body or designing and testing the effectiveness of a safety capsule to protect passengers in motor vehicle collisions.	Elaborate