Forces at work: Bounce

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Educator notes

Learning objectives

- Reinforcing learning about the forces that act on an object as it moves through air and water
- Explaining the effects of some forces on an object as it bounces
- Making predictions using scientific knowledge and understanding
- Recording and evaluating observations and measurements
- Evaluating the reliability of the method used and suggesting improvements

Curriculum links

- Science (Physics)
  - Motion and forces
  - Working scientifically

Resources required

- Forces at work: Bounce slides
- Measuring bounce student sheet

Time needed: 30 minutes

This lesson builds on the learning from two other modules on forces; **Friction and grip** and **Drag and lift**. If you haven't delivered those modules yet, and your students haven't had any other lessons on those forces this activity may be quite challenging, though definitions of all these forces are included.

Equipment needed

- Electric fans (one per group)
- Scales (one per group)
- A few different types of ball (e.g. tennis, volleyball, table tennis)*
- Metre rulers or measuring tape
- Retort stands with clamp
- Spirit levels
- Pen/pencil and paper

* Students will only **drop** the balls, not forcefully bounce them. However, consider if using balls with a high degree of bounce is practical for your group and environment.

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Slide 1
Bounce

- Explain to students that they're going to think more about the forces all around us, and how they sometimes act at the same time
- They're also going to practise working scientifically, especially thinking about ways to improve an experiment

Slide 2
Bounce

- Tell the class that when tennis balls are tested for bounciness, they're dropped from a very specific height: 254cm. This is because the test was devised when imperial measurements were used more widely and 254cm = 100 inches
- The desired rebound of a standard tennis ball is surprisingly specific though; it's 135-147cm (53-58 inches). This rule was originally set in 1925 and has not changed since
- Let the class know that bounciness is determined by a variety of forces including friction, drag and lift, along with another important force they already know about: gravity

Slide 3 and 4
Forces recap: Friction

- Recap prior learning about forces by asking students to first define friction
- Show **Slide 4** to explain that it is a force that acts when objects or surfaces try to move against each other

Slide 5-8
Forces recap: Drag and lift

- Ask students to define drag and lift
- Show **Slide 6** to explain that they are both forces caused when objects move through the air
- Show **Slide 7** to explain that drag acts in the direction of the air flow, while lift acts at right angles to the air flow
- Remind students about downforce, or negative lift, using **Slide 8**

Slide 9
Lab activity: Measuring bounciness

- Drop one of the balls you brought straight down to the ground
- Ask students to think about when any of the forces you've just discussed might be acting on the ball
- Further discuss whether bouncing the ball at an angle might change how the forces act on it (lift on the way up)
- Split the class into groups of three. Explain that one of them will drop the balls, one will judge how high they bounce and one will record results. They can switch roles during the experiment
- If you have access to different surfaces for bouncing on, students can switch surface instead of switching ball
- Reinforce that students should only drop the balls, not forcefully bounce them
- Direct students in the activity using the instructions below, which are also in the student sheet

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Activity 1
Measuring bounciness

20 mins

1. Students should draw a results table such as the below with column headings as follows. For a younger or low ability, draw this table on the board for them to copy. The headers appear in the student sheet
2. Clamp the metre ruler vertically using the stand (on the ground). The ruler should rest on the ground. Use a spirit level to make sure the ruler is straight
3. Measure the diameter of the ball
4. One group member should carefully drop the ball from a height of 100cm (from the bottom of the ball) and observe how high it bounces. Do this a few times so that the judge can get an idea of how high it will go and get their eyes level with the top of the bounce
5. Then drop the ball three times and record how high it bounces (measure from the top of the ball)
6. Next, students can calculate the mean height of bounce
7. They should subtract the diameter of the ball to get the exact distance the bottom of the ball has travelled
8. If time permits, switch balls and repeat steps 2-6

Ball type	Diameter (cm)	Surface (if using)	Bounce height (cm)			Average bounce height (cm)	Bounce minus diameter (cm)
			1	2	3		

Evaluate your results

- Students should use their results to draw a bar chart. Using a different colour for each ball, they should show the mean bounce height of each ball
- Let the class know they're going to think more about their experiment, their results and if they can think of ways to improve it
- Give them time to consider the questions on their student sheets before answering (this could be done either individually or in groups)
- Bring the group back together to discuss the answers, featured below, along with the questions for your reference
- Use example answers to help direct the class, and discuss how results may vary depending on the setting and location

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Quiz

Q: Which ball had the biggest bounce?

The answer to this will depend on what balls you provided, but for example, a tennis ball will likely bounce higher than a golf ball.

Q: What would the effect of bouncing the ball on a different surface be? For example, grass or tarmac?

Encourage students to think about this in terms of friction between the ball and surface.

Q: Can you explain why some of the balls bounce better than others?

The material of the ball creates less friction with the ground, heavier balls bounce less than lighter ones because gravity pulls harder on heavier objects, balls with a more textured surface experience more drag as they move through the air.

Q: Discuss how consistent the results of each test were

This will vary based on your setting and the factors affecting the experiment.

Q: What is the biggest source of error in the experiment?

The answers to this may depend on your setting, but perhaps there's a draft in the room, or students found it hard to judge the height of the bounce with the naked eye.

Q: Could there be a more accurate way to measure the bounce of the ball?

Students should be encouraged to be creative here, but suggestions could include filming the bounce so you can use the video to judge its height.

Discussion

- Remind students that several forces act on any object as it moves, either through air, water or along a surface
- Explain that an experiment can almost always be improved to get more accurate results and its important think about ways to reduce the likelihood of error

Try next: You could follow up this lesson with a more in depth look at deformation and Hooke's Law, so students learn more about other forces that work on a bouncing ball