

Energy stores, Sankey diagrams and efficiency

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab

Name: _____ Date: _____ Class: _____

How well does a ball return its energy after it hits the ground? In this lab a tennis ball is dropped onto four surfaces and the rebound height is measured. The ratio of heights gives the efficiency of the bounce, and the rest of the energy is shown to be wasted. It uses simple equipment at school or at home.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE P1, HS-PS3-4

Aim

To compare how efficiently a ball returns energy when it bounces on different surfaces.

Equipment

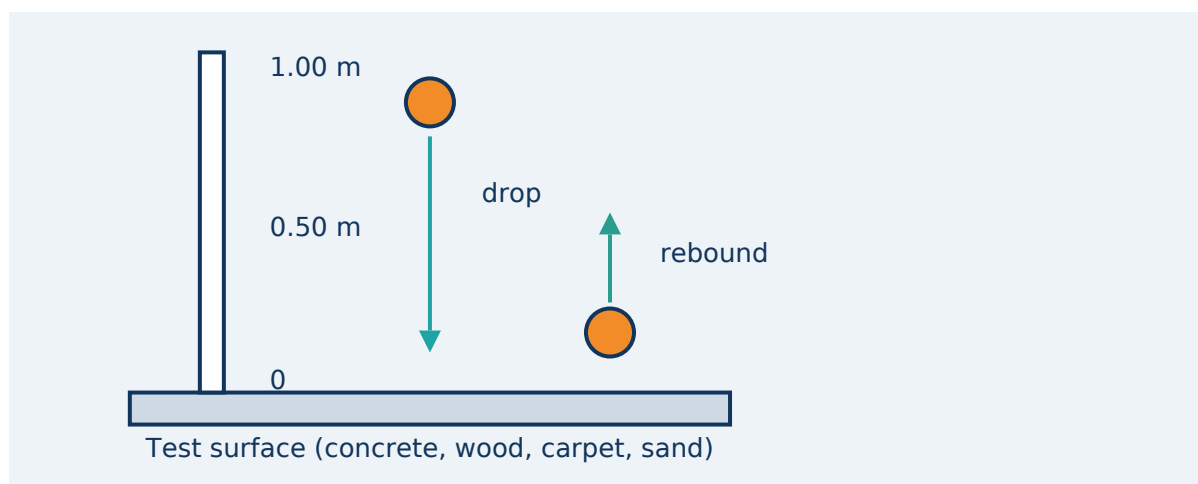
- Tennis ball of mass 0.058 kg
- Metre rule fixed upright, a phone for slow-motion video
- Four test surfaces: concrete slab, wooden board, carpet square, tray of sand
- Balance

Safety

Safety

Drop the ball only over the test surface and keep the area clear. Do not stand on chairs: fix the ruler to a wall or stand. Wipe up sand and keep it out of the eyes.

Method



A ball is dropped from 1.00 m and the rebound height is measured on a vertical rule.

1. Fix the metre rule upright beside the first test surface. Place the phone level with the rule to film the drop.
2. Release the ball from rest with its bottom at the 1.00 m mark. Do not throw it down.
3. Watch the slow-motion video and read the highest point reached after the first bounce. Repeat three times and take the mean rebound height h .
4. Repeat for the other three surfaces, using the same ball and the same release height.
5. Calculate the energy at release, the energy at rebound, and the efficiency = rebound height $\div$ release height $\times 100\%$.

Results

Sample results for a drop height of 1.00 m and $g = 9.8 \text{ N/kg}$. The release energy is $m g H = 0.058 \times 9.8 \times 1.00 = 0.568 \text{ J}$.

Surface	Mean rebound height (m)	Efficiency (%)	Energy returned (J)
Concrete	0.58	58	0.330
Wooden floor	0.52	52	0.296
Carpet	0.38	38	0.216
Sand tray	0.12	12	0.068

Analysis questions

Question 1 Energy at release

Calculate the gravitational potential energy of the ball at the 1.00 m mark.

Question 2 Concrete result

Use the concrete row to calculate the energy returned and the energy wasted in the first bounce.

Question 3 Where does the energy go?

Name two forms in which the wasted energy is transferred when the ball hits the surface.

Question 4 Rank the surfaces

Rank the four surfaces by efficiency and explain the order.

Question 5 Predict a second bounce

Assume that each bounce on concrete has the same efficiency. Predict the rebound height after the second bounce.

Question 6 Reading uncertainty

The rebound height is read to ± 0.02 m. Calculate the percentage uncertainty for the concrete and the sand results, and state which is less reliable.

Question 7 Improve the lab

Suggest two improvements to make the investigation more reliable.