

## CHOCOLATE IMPACT TESTER

### OVERVIEW

**DURATION:** 15 minutes

**TARGET AUDIENCE:** Age 8+

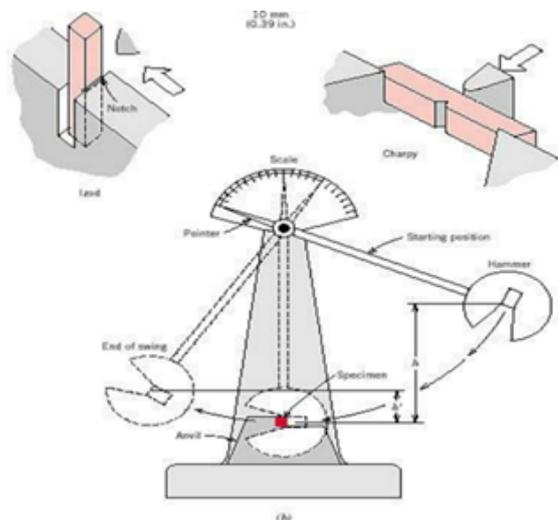
Materials have different properties and it is important for us to know and measure these, so we have different methods of testing them. This activity is designed to test the toughness of chocolate bars and to understand how their structure affects this and relates to real world applications.

### EQUIPMENT

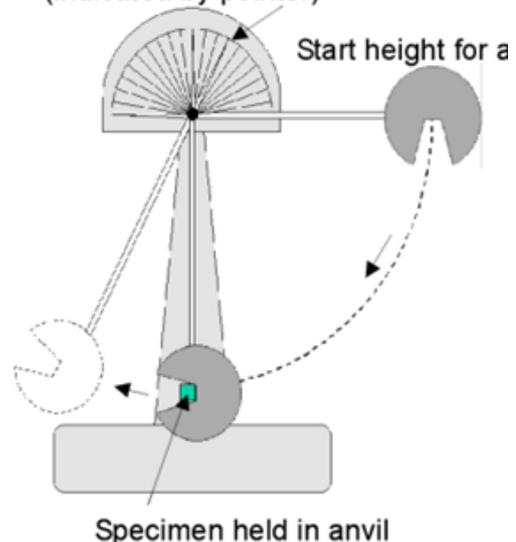
- 1 Charpy Impact Tester
- Variety of chocolate bars (Mars, Crunchie, Wispa)
- 1 Bowl
- Activity sheets
- Cleaning wipes

### METHODOLOGY

1. Build the Charpy tester using the instructions and pieces included.
2. While unloaded lift the pendulum anticlockwise to different heights and release, each time resetting the dial to 100%. Do this until you find the correct height for the pendulum to push the dial to 0%.
3. Place a chocolate bar in the plastic mount and reset the dial, lift the pendulum to the height previously found and let go, the pendulum will swing and break the chocolate bar and record how much energy the chocolate bar absorbed during the impact. This relates to how tough the chocolate is.
4. Record the percentage energy on the information sheet and observe the fracture surfaces. Reset the dial to 100%.
5. Place the next chocolate bar in the plastic mount in the same position and repeat the experiment until all the different chocolate has been tested.



Energy absorbed during fracture  
(indicated by pointer)



To access a full equipment kit for the Chocolate Impact Tester activity contact [info@royce.ac.uk](mailto:info@royce.ac.uk)

## BACKGROUND SCIENCE

A Charpy Tester is a method of impact testing designed to measure impact energy; the energy absorbed by a material when struck which gives us the relative toughness of the sample. Relative toughness is a measure of how difficult it is for a crack to go through the material, the higher the percentage absorbed the tougher the material.

Ductile means that a material can undergo plastic deformation without cracking. This is when the material stretches and changes structure when under stress before failing. Brittle means a material cracks with little to no plastic deformation. We often assume hard objects are also tough, but this is often not the case. A ductile material tends to be tougher as the energy is spread more evenly through the material, whereas with a brittle material the impact energy is focused at one point and is therefore much more likely to form a crack through the sample. This means that a brittle material can fail at lower impact energies than ductile ones. However, they do deform elastically which means a change in shape that is recoverable when the stress is removed, this is undesirable in many real-life situations.

For the test we use a Crunchie, a Whisper and a Mars bar. If you wish to use other chocolate bars or samples, ensure there is a variety of structures that will show a pattern. The Crunchie absorbs relatively little energy and often does not fit back together after as pieces fly off during testing and is brittle and not very tough. This is because it is similar to a kitchen plate, when it is dropped it breaks into lots of pieces.

We also test a Mars bar, and this absorbs all the energy of the swing and does not break so is very tough. However, it does usually have a crack in the chocolate. This is because the chocolate is slightly brittle still, but the caramel and nougat insides are soft and 'ductile' this shares the energy through the rest of the bar instead of being concentrated at one point. It is this ability that makes the Mars toughest.

Finally, we use a Wispa bar that absorbs energy but don't shatter as they are less brittle. This means they fit back together almost perfectly, depending on the temperature they can be tougher or less tough than the Crunchie.



## FOLLOW UP QUESTIONS

1. Which bar do you think will be hardest to break and why?
2. Which bar(s) would you build a house out of and why?
3. What does tough mean?
4. What percentage absorption would you predict for each?

## SAFETY

Ensure no audience members are allergic to any of the ingredients in the chocolate bars. Ensure the equipment is placed in a stable position on a table to avoid it slipping and falling. Check the equipment for splinters and integrity. To avoid damaging fingers make sure the chocolate bar is put into position when the arm is at rest, all demonstrators or members of the public should be warned not to put hands anywhere near the equipment while the pendulum is in motion.

