Forces, motion and egg-xtreme impacts

In this experiment, we will be dropping masses from different heights onto an egg protected by a rubber crumple zone to see whether it will break.

Materials:

- There are 10 groups of two.
- There are 5 different lengths of rubber 'crumple zone' and two of each length. The lengths used include 2, 4, 6, 8, 10 cm.
- Each group is assigned a different mass as follows:

  2cm: 150g (Group 1) and 300g (Group 2)

  4cm: 200g (Group 3) and 350g (Group 4)

  6cm: 250g (Group 5) and 500g (Group 6)

  8cm: 300g (Group 7) and 600g (Group 8)

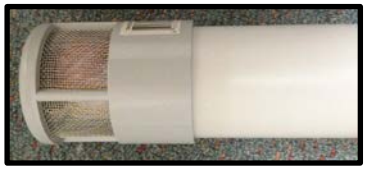
  10cm: 300g (Group 9) and 600g (Group 10)

- Make sure the groups draw faces on their eggs.

***Example:**

Q1. Write down the weight your group has been assigned, called m (in kg): ___0.250___

Q2. Measure the length of rubber crumple zone, called L (in m): ___0.03___



Step 1: Place the egg in a plastic bag, and then into the semi-transparent end cap. Make sure the egg is placed upright, with the larger end towards the bottom.

Step 2: Place the rubber crumple zone into the end of plastic pipe, and then attach the end-cap (with egg) to the same end.

Step 3: Place the weight into the open end of the pipe, holding it by the string. Lower the string all the way slowly until it gently touches the top of the crumple zone. Place a clip on the string to mark the top of the pipe.

Step 4: Using the clip for reference, raise the weight 0.1m (10cm). Drop the weight onto the egg+crumple zone. Undo the end-cap and check whether the egg has broken. Indicate whether the egg has broken (cross) or not (tick) for the 0.1m column in Table 1.

Step 5: Repeat steps 3 and 4, raising the weight to the increasing heights in Table 1. until the egg finally breaks.

Step 6: Select a new egg. Repeat the previous steps, beginning with the highest successful (unbroken egg) height first. Do your repeat trials agree?

Table 1. Does the egg break when the mass is dropped from different heights?

Height (m)	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**
First Egg	/	/	/	/	/	x		
Repeat Eggs					x			
				/	/	x		

*Example for 3cm rubber (L=3cm) and 250g mass (m=250)

Step 7: Choose the best egg trial. Look across the row in Table 1 and answer the following:

Q3. What is the height just before the egg breaks? _____ Write into Table 2 at (A)

Q4. What is height just above where the egg breaks? _____ Write into Table 2 at (B)

You will calculate the energy for two heights – one for just before the egg breaks (A) and one for just after (B). This will give you a range for which the crumple zone will stop protecting the egg. Use the values for m, (from Q1), and A and B (from Q3 and Q4). Record your results in Table 2.

0.250*10*0.5 = 1.175

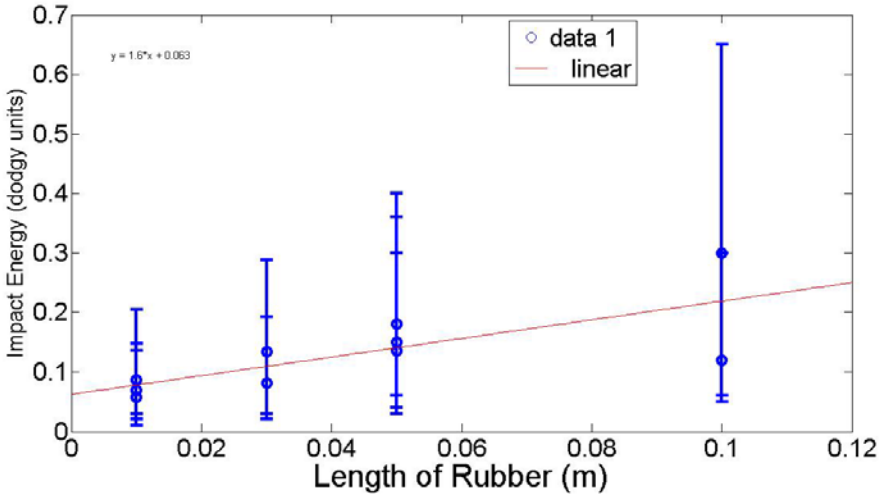
0.250*10*0.6 = 1.425

Table 2. Finding the kinetic energy for egg breakage

A (Lower Height)	**Impact Energy** mgA	**B** (Upper Height)	**Impact Energy** mgB
0.5	1.175	0.6	1.425

The demonstrator will now collate the data from the groups. The demonstrator will make a plot of Impact Energy vs Crumple Zone Length, using the information from A and B to make error bars. The exact impact energy required to break the egg will be somewhere between the error bars.

The demonstrator will fit a line of best fit through the data points.



Example plot with only a few results (not all the correct ones we use in the actual experiment) The red line is the line of best fit.

Make a prediction: What is the minimum length of rubber crumple zone needed to protect a mass of 50 grams, dropped from a height of 3 metres? Hint - first calculate the impact energy.

For 50g dropped from 3m it will require ~6-7cm of crumple zone.