Have a go at these questions from past Physics Olympiads

### Question 14

The centre part of the lid is depressed (pulled in to the jar) when it is sealed and pops back out when the jar is first opened

Glass food jars have a ‘safety seal’ to guarantee that the jar has not been opened since manufacture. The metal lid has a depression which “pops” or “clicks” when the jar is opened.

The safety seal works by having a lower pressure inside the jar. The greater atmospheric pressure keeps the metal lid depressed. When the jar is opened the pressure inside the jar increases and the lid snaps back into its original shape making the characteristic popping sound.

Assume atmospheric pressure is 101 kPa

1. The force required to “pop” or depress a jam jar lid with a centre part diameter of 4 . 0 cm is found to be 13 N.

**Show that** the pressure required to depress the lid is about 10 kPa

[2 marks]

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1. An empty jam jar is gently heated in an oven to a temperature of 80 °C. The lid is put on tightly to make an air tight seal and the jam jar allowed to cool from 80 °C. The safety seal “pops” down and is fully depressed when the jam jar reaches a temperature of 38 °C.

Using the result from part (a), **calculate** the pressure inside the jam jar at 38 °C.

[2 marks]

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1. The pressure of a gas becomes zero when the temperature falls to absolute zero. Use the results of the experiment with the jam jar to **estimate** a value for the absolute zero of temperature.

[4 marks]

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1. State one assumption necessary to be able use the results of the experiment to calculate the value of absolute zero.

[1 mark]

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1. The experiment is repeated but this time the jam jar is half full of jam. **Explain** whether or not this change affects the temperature at which the safety seal pops down.

[3 mark]

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1. The accepted value for absolute zero is -273 °C. Therefore, one or more of the values determined experimentally must have been incorrect.

By thinking about how the measurements might have been made, **suggest** which of the measurements in the experiment is most likely to have caused the difference between the value calculated in part (c) and the accepted value. **Explain** whether the measurement suggested was too low or too high.

[3 marks]

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Question 6. (4 marks)

* + 1. A cyclist wants to carry a heavy bag of books on her bicycle, using a shopping bag hanging from the handlebars. When she attaches the bag, it swings from side to side with a period of 1.2 s. When she rides the bicycle, her body swings from side to side each time she turns the pedals. If the bag swings with the same period, it makes the bike wobble dangerously from side to side.

The diameter of the back wheel is 650 mm. There are 15 teeth on the rear cog and 48 teeth on the chain ring. What speed on the road should the cyclist try to avoid?

