# Intermediate Physics Challenge Task 1

# ANSWER BOOKLET

## Part 1: Experimental Setup [8 marks]

**Explain** why the ammeter is connected in series whereas the voltmeter is connected in parallel.

**Suggest** a suitable value for the resistance of the ammeter.

**Suggest** a suitable value for the resistance of the voltmeter.

**State** the resolution of the ammeter.

**Determine** the reading on the ammeter and suggest a suitable uncertainty on the reading.

**State** the resolution of the voltmeter.

**State** the reading on the voltmeter and suggest a suitable uncertainty on the reading.

## Part 2: V–I for a light bulb [10 marks]

The results of the experiment are shown in table 1. The values of current were measured using an ammeter with a higher resolution than the ammeter shown in the question paper.

| Potential difference / V | Current / A | Resistance / Ω | Power / W | Temperature / K |
|---|---|---|---|---|
| 3.0 | 0.96 | | | |
| 4.0 | 1.10 | | | |
| 5.0 | 1.21 | | | |
| | | | | |
| 7.0 | 1.40 | | | |
| 8.0 | 1.48 | | | |
| 9.0 | 1.56 | | | |
| 10.0 | 1.63 | | | |

Table 1: Values of potential difference and current for a bulb.

**Add the readings** of potential difference and current to the table.

**Calculate** the resistance of the light bulb filament, $R$, for each pair of values given in table 1.

**Calculate** the power, $P$, of the light bulb for each pair of values given in table 1.

For the results shown in table 1, assume that the equation:

$$P \approx b \times T^4$$

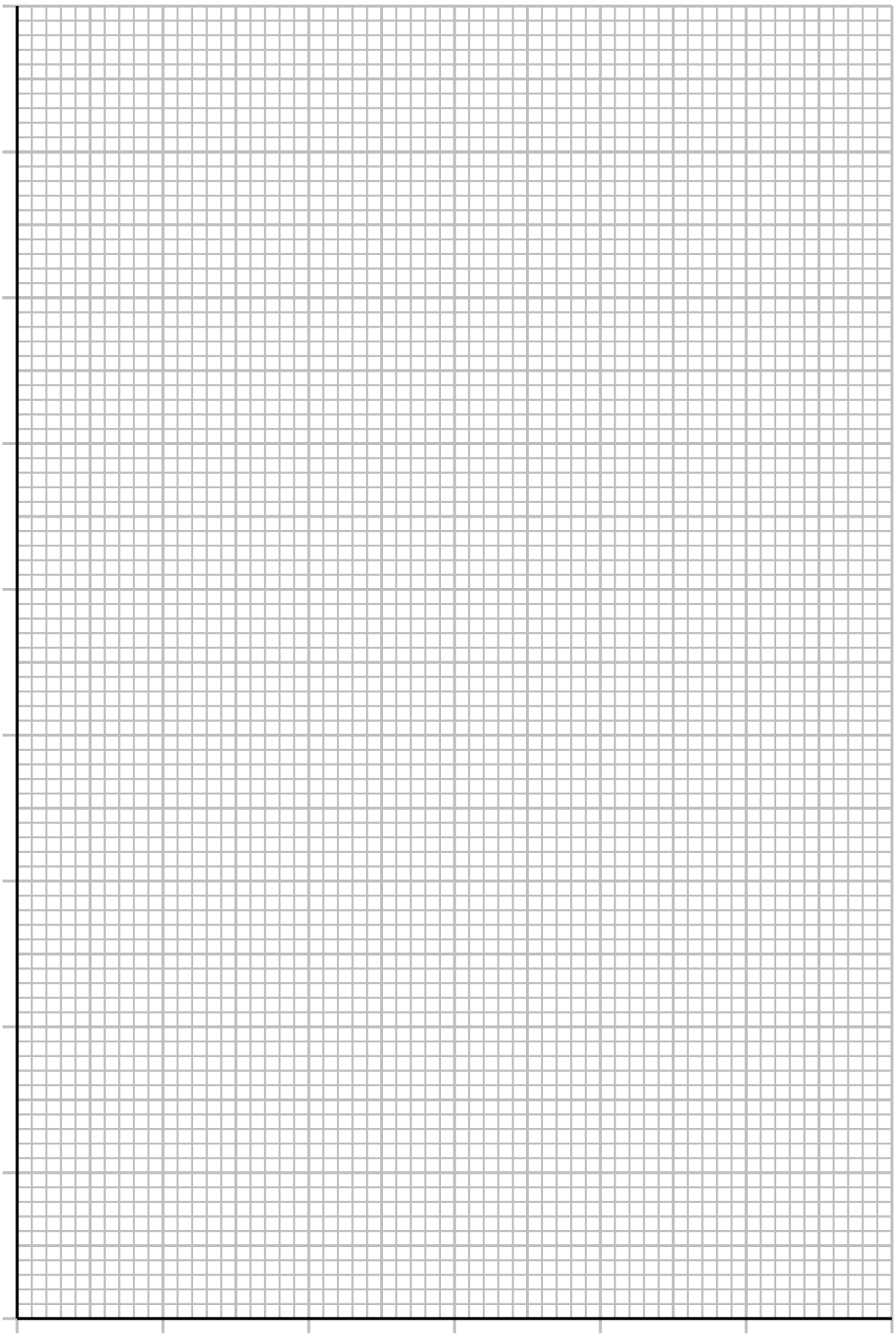
applies with a value of $b$ for the bulb used of:

$$b = 4 \times 10^{-13}\,\text{W/K}^4$$

**Calculate** the temperature, $T$, of the filament.

## Part 3: Graphical Analysis [14 marks]

**Plot a graph** of $R$ against $T$.



For the range of temperatures calculated in table 1, **discuss** the extent to which your graph supports the theory:

$$R \approx \alpha T + \beta$$

**Estimate** a value for $\alpha$

**Estimate** a value for $\beta$

Using data from your graph, **discuss** whether or not this theory is likely to be valid at lower temperatures.

## Part 4: Experimental Investigation [8 marks]

**Determine** the potential difference across the light bulb and the 22 Ω resistor.

**Calculate** the current through the light bulb and the resistance of the light bulb filament.

**Determine** the potential difference across the same light bulb that was used in the previous circuit and the 22 Ω resistor.

**Calculate** the current through the light bulbs and the resistance of the light bulb filament used in the previous circuit.

**Compare** the light bulbs used in Part 4 (your experiment) and the light bulb used in Part 2 (data in table 1). **State** one similarity and one difference between the two different light bulbs.

# Intermediate Physics Challenge Task 2

# ANSWER BOOKLET

## Part 1: Experimental Introduction [4 marks]

**State** the resolution of the tape measure (using the metric scale).

When using the tape measure provided, **suggest** a suitable uncertainty on the measurement of rebound height.

It is important to reduce measurement errors as much as possible. **Explain** why the measurement of rebound height should be repeated several times (for the same drop height).

The measurement of both drop height and rebound height can be affected by parallax error. **Explain** how to reduce the effect of parallax error.

## Part 2: Investigating a Bouncing Ball [11 marks]

**Suggest** a more reliable method for measuring the rebound height.

Record your experimental results in table 1. Use some or all of the rows.

| Drop height / m | Rebound height 1 / m | Rebound height 2 / m | Rebound height 3 / m | Average rebound height / m | Efficiency |
|---|---|---|---|---|---|
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Table 1: Experimental results.

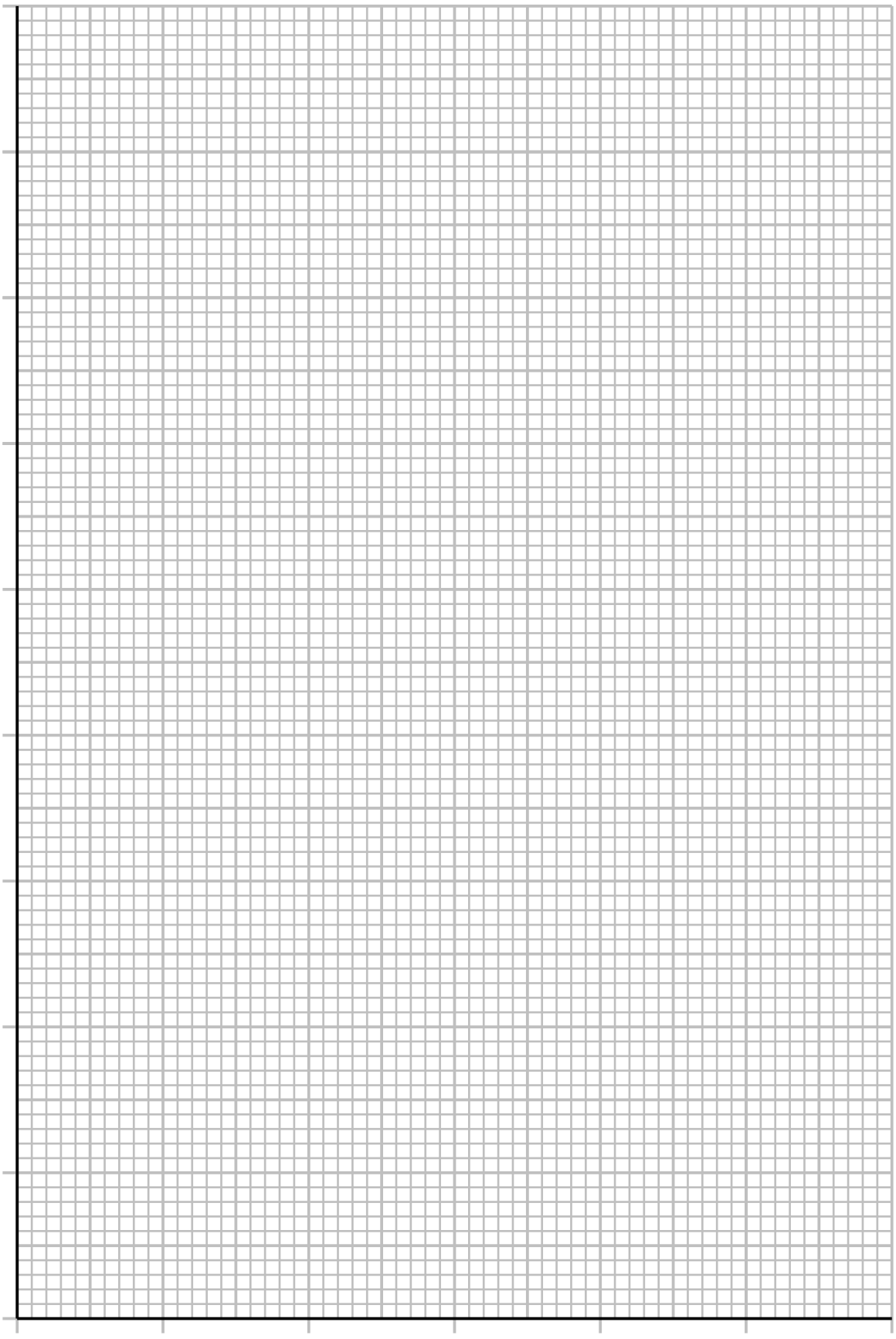
**Calculate** the average rebound height.

For each set of results, **calculate** the efficiency.

**Explain** why it is not necessary to know the mass of the bouncy ball.

## Part 3: Graphical Analysis [11 marks]

**Plot a graph** of efficiency against drop height.



**Describe** the relationship between the height the bouncy ball is dropped from and the efficiency of the bouncy ball.

**Explain** how the relationship between drop height and efficiency would change if the bouncy ball was dropped from a very high height.

## Part 4: Effect of Temperature [4 marks]

**Suggest** a suitable method to determine the effect of temperature on efficiency for a bouncy ball.

# Intermediate Physics Challenge Task 3

# ANSWER BOOKLET

## Part 1: Mass of a Beaker [7 marks]

**Determine** the position of the centre of mass of the 50 cm ruler.

**Record** all your results and calculations in the table in the answer booklet.
**Include the units** for each column.

| Volume of water used | Distance $x$ | Distance $y$ | Mass of water $M$ | Mass of empty beaker $m$ |
|---|---|---|---|---|
| | | | | |
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Table 1: Results for the mass of an empty beaker.

**Determine** the average mass of the empty beaker. **State** the units.

## Part 2: Investigating a Cantilever [10 marks]

**Determine** the width $a$, of the ruler.

**Determine** the thickness, $b$, of the ruler.

**Explain** how to accurately determine, using the apparatus provided, the deflection, $y$, of the ruler when a mass is suspended from the free end.

Record your experimental value of $L$ and $y$ in table 2. Use some or all of the rows.

| Length of cantilever, $L$ / m | Deflection of cantilever, $y$ / m | $L^3$ / m$^3$ |
|---|---|---|
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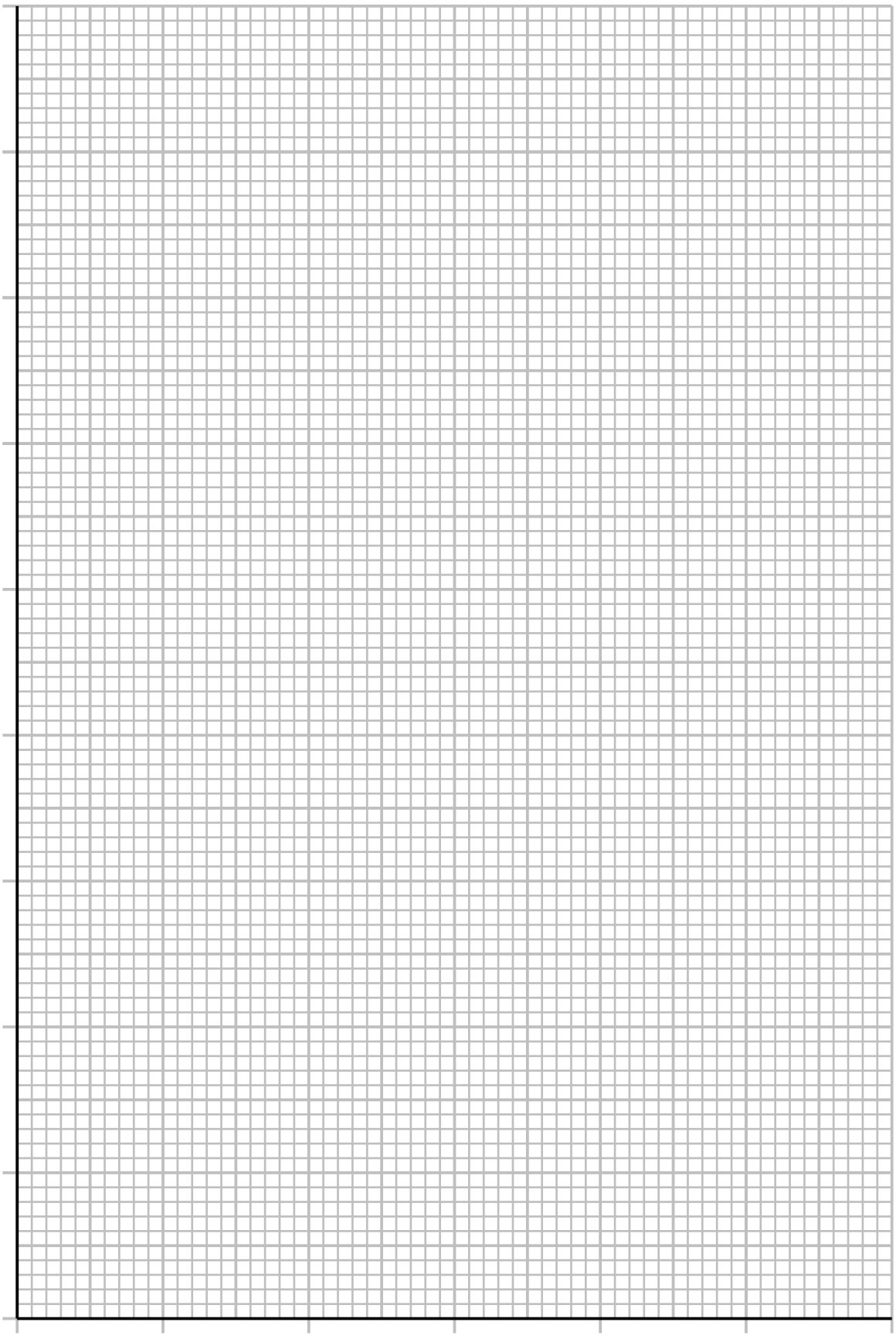
Table 2: Results for deflection of a cantilever.

**Determine** a value for $M$, the mass of the beaker and water, used in the investigation. Ignore the mass of the string.

## Part 3: Graphical Analysis [7 marks]

**Plot a graph** of $y$ on the y-axis against $L^3$ on the x-axis.



**Determine** the gradient of the line of best fit. **State** the units of the gradient.

## Part 4: Determination of Young's modulus [6 marks]

**Calculate** the value of the Young's modulus, $E$, for the ruler.

**State** and **explain** which of your measurements will result in the greatest uncertainty in the calculated value of Young's modulus.

**Suggest** a method to reduce the uncertainty in the measurement you have identified.