1. **9702/11/M/J/18/No.4**

   In the circuit shown, an analogue ammeter is to be recalibrated as a thermometer. The ammeter is connected in series with a thermistor. The thermistor is a component with a resistance that varies with temperature. The graph shows how the resistance $R$ of the thermistor changes with temperature $T$.

   ![Circuit Diagram](image1)

   ![Graph](image2)

   Which diagram could represent the temperature scale on the ammeter?

   ![Temperature Scales](image3)

2. **9702/11/M/J/18/No.5**

   The sides of a cube are measured with calipers. The measured length of each side is $(30.0 \pm 0.1)\text{mm}$. The measurements are used to calculate the volume of the cube. What is the percentage uncertainty in the calculated value of the volume?

   A 0.01%  
   B 0.3%  
   C 1%  
   D 3%
3. **9702/12/M/J/18/No.3**

A student measures the current through a resistor and the potential difference (p.d.) across it. There is a 4% uncertainty in the current reading and a 1% uncertainty in the p.d. reading. The student calculates the resistance of the resistor.

What is the percentage uncertainty in the calculated resistance?

- **A** 0.25%
- **B** 3%
- **C** 4%
- **D** 5%

4. **9702/12/M/J/18/No.4**

A student applies a potential difference $V$ of $(4.0 \pm 0.1)V$ across a resistor of resistance $R$ of $(10.0 \pm 0.3)\Omega$ for a time $t$ of $(50 \pm 1)s$.

The student calculates the energy $E$ dissipated using the equation below.

$$E = \frac{V^2 t}{R} = \frac{4.0^2 \times 50}{10.0} = 80 \text{ J}$$

What is the absolute uncertainty in the calculated energy value?

- **A** 1.5 J
- **B** 3 J
- **C** 6 J
- **D** 8 J

5. **9702/12/M/J/18/No.23**

The diagram shows the screen of a cathode-ray oscilloscope (c.r.o.) displaying a wave.

![Wave Diagram](attachment:image.png)

The time-base of the c.r.o. is set at 10 ms/division.

What is the frequency of the wave?

- **A** 0.24 Hz
- **B** 4.2 Hz
- **C** 12 Hz
- **D** 24 Hz
6.  9702/13/M/J/18/No.4
What will reduce the systematic errors when taking a measurement?

A. adjusting the needle on a voltmeter so that it reads zero when there is no potential difference across it
B. measuring the diameter of a wire at different points and taking the average
C. reducing the parallax effects by using a marker and a mirror when measuring the amplitude of oscillation of a pendulum
D. timing 20 oscillations, rather than a single oscillation, when finding the period of a pendulum

7.  9702/13/M/J/18/No.5
In an experiment to determine the Young modulus $E$ of the material of a wire, the measurements taken are shown.

- mass hung on end of wire $m = 2.300 \pm 0.002 \text{kg}$
- original length of wire $l = 2.864 \pm 0.005 \text{m}$
- diameter of wire $d = 0.82 \pm 0.01 \text{mm}$
- extension of wire $e = 7.6 \pm 0.2 \text{mm}$

The Young modulus is calculated using

$$E = \frac{4mgl}{\pi d^2 e}$$

where $g$ is the acceleration of free fall.

The calculated value of $E$ is $1.61 \times 10^{10} \text{N m}^{-2}$.

How should the calculated value of $E$ and its uncertainty be expressed?

A. $(1.61 \pm 0.04) \times 10^{10} \text{N m}^{-2}$
B. $(1.61 \pm 0.05) \times 10^{10} \text{N m}^{-2}$
C. $(1.61 \pm 0.07) \times 10^{10} \text{N m}^{-2}$
D. $(1.61 \pm 0.09) \times 10^{10} \text{N m}^{-2}$
8. 9702/13/M/J/18/No.22
A cathode-ray oscilloscope (c.r.o.) is used to determine the frequency of a sound wave.

The diagram shows the waveform on the screen.

![Waveform Diagram]

The time-base setting is 5.0 ms/div.

What is the frequency of the sound wave?

A  57 Hz  
B  71 Hz  
C  114 Hz  
D  143 Hz

9. 9702/12/F/M/18/No.5
A person calculates the potential difference across a wire by using the measurements shown.

Which measured quantity has the greatest contribution to the percentage uncertainty in the calculated potential difference?

<table>
<thead>
<tr>
<th>quantity</th>
<th>value</th>
<th>uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>A current/A</td>
<td>5.0</td>
<td>±0.5</td>
</tr>
<tr>
<td>B diameter of wire/mm</td>
<td>0.8</td>
<td>±0.1</td>
</tr>
<tr>
<td>C length of wire/m</td>
<td>150</td>
<td>±5</td>
</tr>
<tr>
<td>D resistivity of metal in wire/Ωm</td>
<td>1.6 × 10⁻⁸</td>
<td>±0.2 × 10⁻⁸</td>
</tr>
</tbody>
</table>
10. 9702/12/F/M/18/No.6

A cathode-ray oscilloscope (c.r.o.) is connected to an alternating voltage. The following trace is produced on the screen.

![Oscilloscope Trace](image)

The oscilloscope time-base setting is 0.5 ms cm\(^{-1}\) and the Y-plate sensitivity is 2 V cm\(^{-1}\).

Which statement about the alternating voltage is correct?

A. The amplitude is 3.5 cm.
B. The frequency is 0.5 kHz.
C. The period is 1 ms.
D. The wavelength is 4 cm.