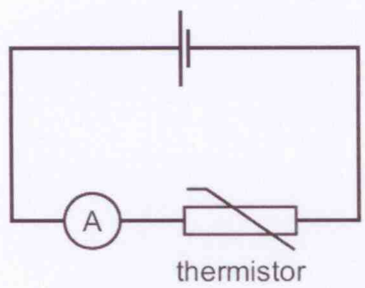
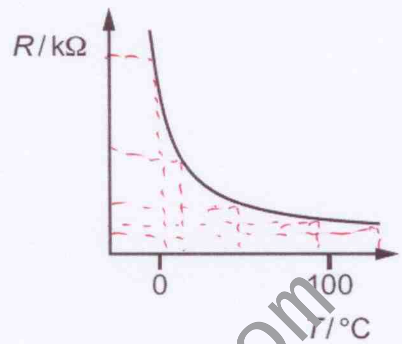
## Measurements techniques - 2018

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

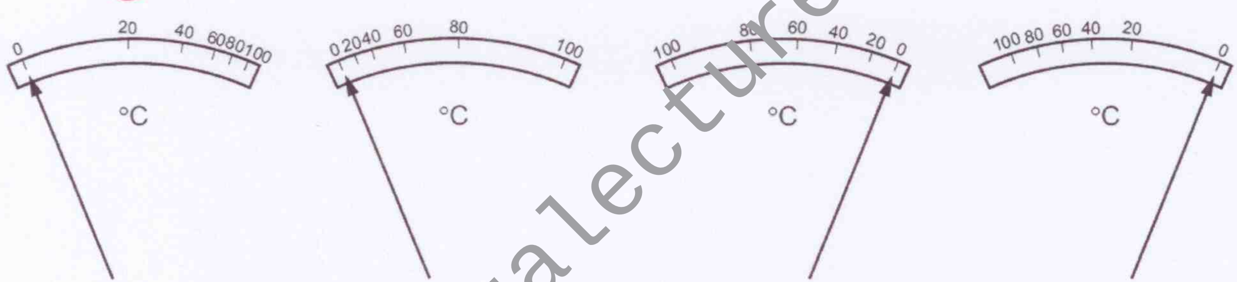
In the circuit shown, an analogue ammeter is to be recalibrated as a thermometer. The ammeter is connected in series with a thermistor. The thermistor is a component with a resistance that varies with temperature. The graph shows how the resistance $R$ of the thermistor changes with temperature $T$.




Which diagram could represent the temperature scale on the ammeter?

A B C D




**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 ± 0.1) 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%

$\frac{\Delta V}{V} = 3\frac{\Delta l}{l} = 3 \times \frac{0.1}{30} = 0.01$

$\% = 0.01 \times 100 = 1\%$

**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.

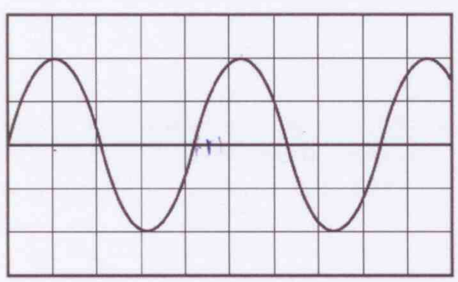
$$E = \frac{V^2 t}{R} = \frac{4.0^2 \times 50}{10.0} = 80\,\text{J}$$

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.



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. (g is a constant, so has no effect on the calculation of ΔE.)

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** $(1.61 \pm 0.09) \times 10^{10}\,\text{N m}^{-2}$

$$\frac{\Delta E}{E} = \frac{\Delta m}{m} + \frac{\Delta l}{l} + \frac{2\Delta d}{d} + \frac{\Delta e}{e}$$

$$= \frac{0.002}{2.3} + \frac{0.005}{2.864} + \frac{0.02}{0.82} + \frac{0.2}{7.6}$$

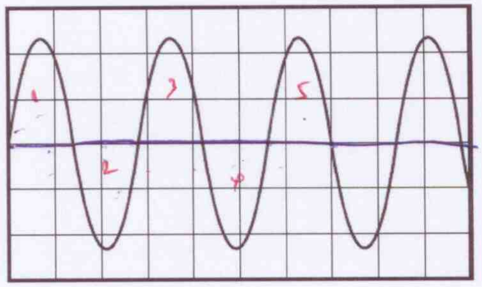
$$= 0.0533$$

$$\Delta E = 0.0533 \times E$$
$$= 0.0533 \times 1.61 \times 10^{10}$$
$$= 8.6 \times 10^{8}$$
$$= 0.086 \times 10^{10}$$
$$\approx 0.09 \times 10^{10}$$

**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.



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

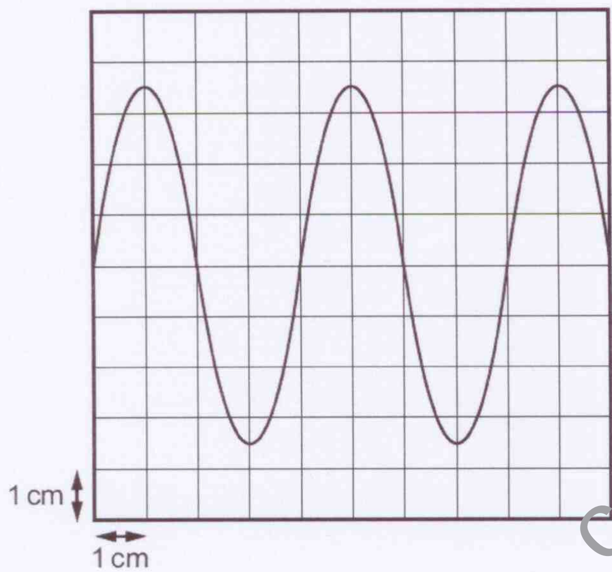
A person calculates the potential difference across a wire by using the measurements shown.

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

| | quantity | value | uncertainty |
|---|---|---|---|
| **A** | current / A | 5.0 | ±0.5 |
| **B** | diameter of wire / mm | 0.8 | ±0.1 |
| **C** | length of wire / m | 150 | ±5 |
| **D** | resistivity of metal in wire / Ωm | $1.6 \times 10^{-8}$ | $\pm 0.2 \times 10^{-8}$ |

**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.




A = 3.5 cm × 2 V/cm
= 7.0 V
T = 2 ms

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.

T = L x
= 4 cm × 0.5 ms/cm
= 2 ms

f = 1/T = 1/(2×10⁻³ s)
= 500 Hz
= 0.5 kHz

λ = v/f