3 A student investigates how the resistance of a thermistor varies with temperature.

(a) The student sets up the circuit shown in Figure 5 to measure current and voltage.

He finds that it does not work.

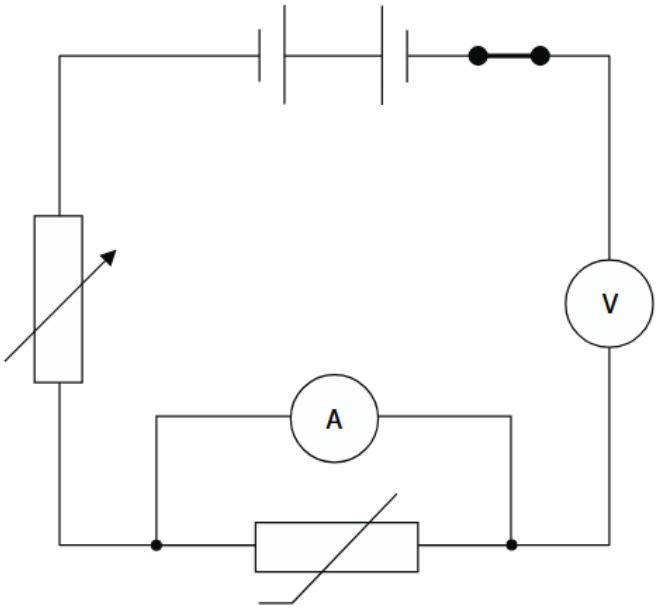


Figure 5

Give **three** modifications the student should make to the circuit so that the circuit works correctly.

(3)

1 .....

.....

2 .....

.....

3 .....

.....

(b) The student uses the equipment shown in Figure 6 to measure the temperature of the thermistor.

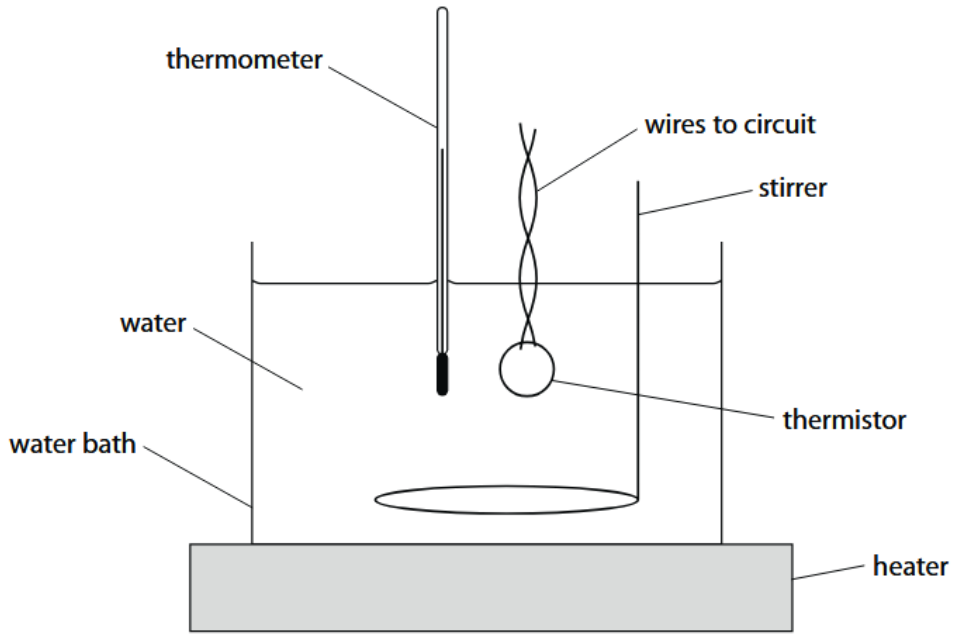


Figure 6

(i) Give **one** reason for using the water bath.

(1)

.....

.....

(ii) The equipment shown in Figure 6 is for investigations in the temperature range from 20 °C to 100 °C.

State **one** way the student could develop this experimental procedure to investigate temperatures outside this range.

(1)

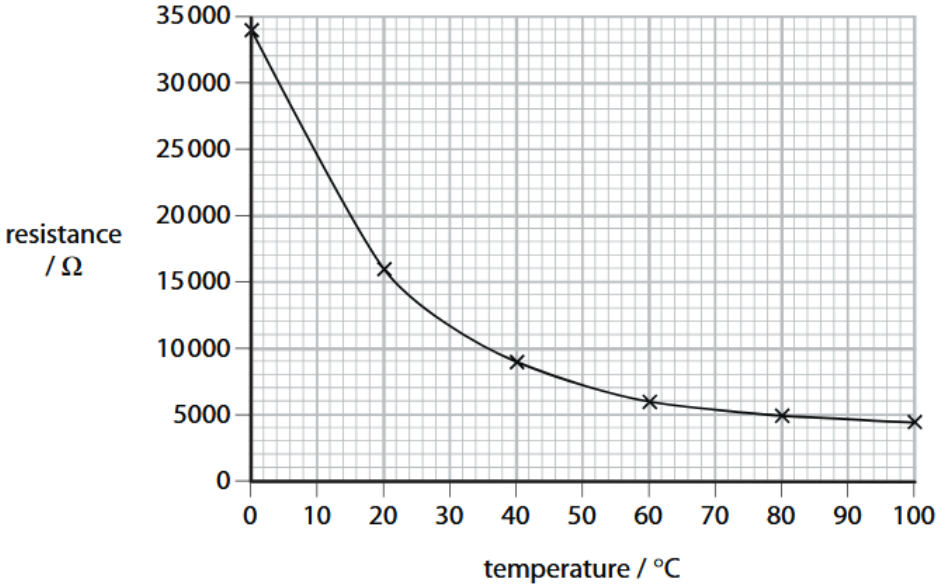
.....

.....

(c) The student takes measurements for two other components, **A** and **B**.

The results for both these components are shown in Figure 7.

Component A



Component B

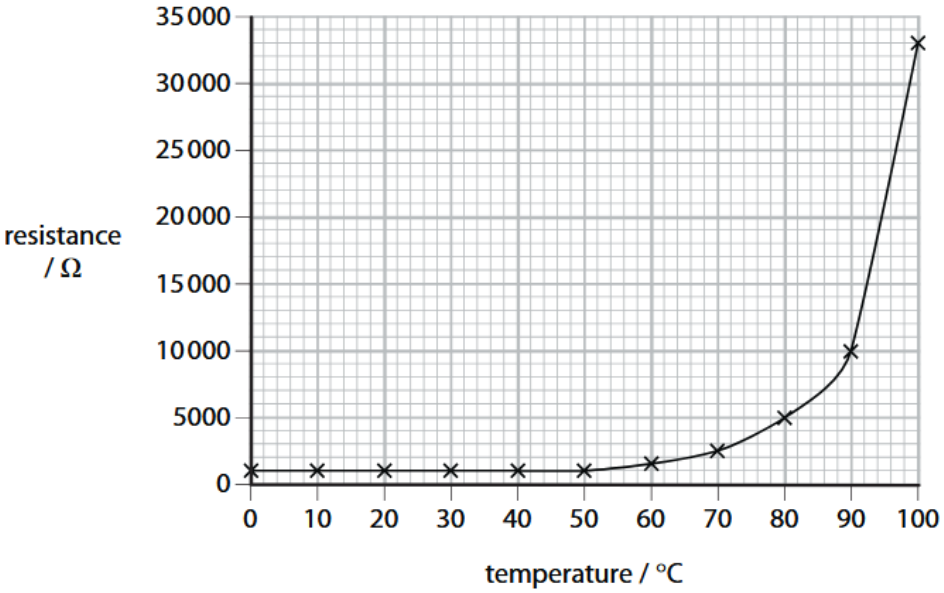


Figure 7

(i) Compare and contrast how the resistances of component **A** and component **B** vary with temperature.

(3)

(ii) Component **A** is connected to a 12V supply.

Which of these is the current in component **A** when the temperature is 80 °C?

(1)

☐ **A** $I = 12 \times 5000$

☐ **B** $I = \frac{12}{5000}$

☐ **C** $I = \frac{12^2}{5000}$

☐ **D** $I = \sqrt{\left(\frac{12}{5000}\right)}$

(Total for Question 3 = 9 marks)

Question number	Answer	Additional guidance	Mark
3(a)	• connect ammeter in series (with thermistor) (1) • connect voltmeter in parallel (with thermistor) (1) • reverse (connections for) one of the cells (1)	allow idea that meters should be swapped for two marks (equivalent to first two points)	**(3)**

Question number	Answer	Additional guidance	Mark
3(b)(i)	Any one of the following reasons: • the thermistor and the water are at the same temperature (1) • large volume of water gives a steady temperature rise (1)	accept idea that only small part of thermometer would be in contact with a thermistor in air accept difficult to control change in temperature of thermistor when heated in air	**(1)**

Question number	Answer	Additional guidance	Mark
3(b)(ii)	Any one of the following developments to the procedure: • add ice to increase lower limit of temperature range (1) • use liquid with higher boiling point to increase upper limit of temperature range (1)	accept named liquid with higher boiling point, e.g. oil	**(1)**

Question number	Answer	Additional guidance	Mark
3(c)(i)	A comparison and contrast that must include at least **one** similarity and **one** difference from the following points to a maximum of three marks: Similarities • resistance of both changes with temperature (1) • both graphs show a non-linear relationship (1) • data comparison, e.g. both have the same resistance at 80°C (1)		**(3)**

	Differences • resistance of **A** decreases with temperature but resistance of **B** increases with temperature (1) • for **A**, (largest slope/rate of change) is at lower temperature but for **B**, (largest slope/rate of change) is at higher temperature(s) (1) • for **B**, resistance is constant below 50°C but for **A** resistance is roughly constant above 60°C (1)	accept (smallest slope/rate of change) for A is at higher temperature but (smallest slope/rate of change) for B is at lower temperature	

Question number	**Answer**	**Mark**
3(c)(ii)	B	**(1)**