Temperature

Question paper 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Temperature
Sub Topic	
Paper Type	Theory
Booklet	Question paper 1

Time Allowed: **65 minutes**

Score: **/54**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 The variation with temperature of the resistance R_T of a thermistor is shown in Fig. 6.1.

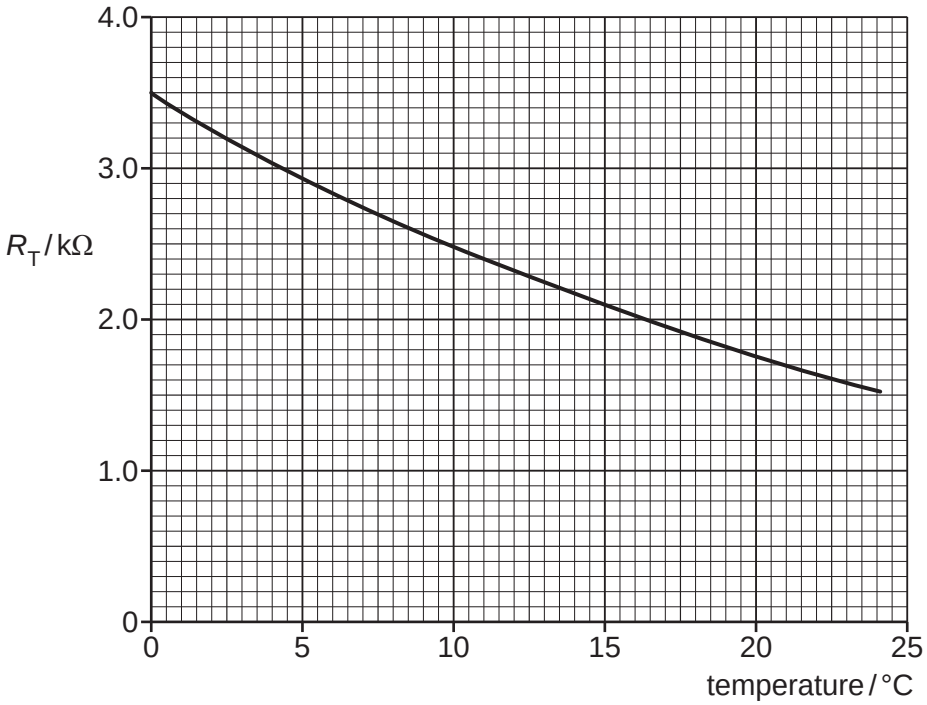

Fig. 6.1

The thermistor is connected into the circuit of Fig. 6.2.

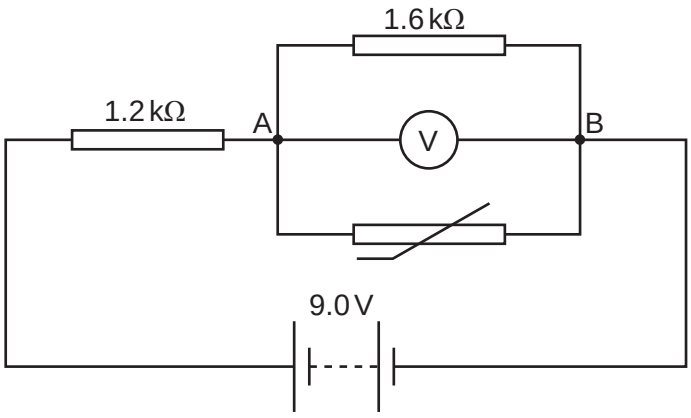

Fig. 6.2

The battery has e.m.f. 9.0V and negligible internal resistance. The voltmeter has infinite resistance.

(a) For the thermistor at 22.5 °C, calculate

(i) the total resistance between points A and B on Fig. 6.2,

resistance = ... Ω [2]

(ii) the reading on the voltmeter.

voltmeter reading = ...V [2]

(b) The temperature of the thermistor is changed. The voltmeter now reads 4.0V. Determine

(i) the total resistance between points A and B on Fig. 6.2,

resistance = ... Ω [2]

(ii) the temperature of the thermistor.

temperature = ... °C [2]

(c) A student suggests that the voltmeter, reading up to 10 V, could be calibrated to measure temperature.

Suggest two disadvantages of using the circuit of Fig. 6.2 with this voltmeter for the measurement of temperature in the range 0 °C to 25 °C.

1. .....

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2. .....

.....

[2]

2 An electronic sensor may be represented by the block diagram of Fig. 9.1.

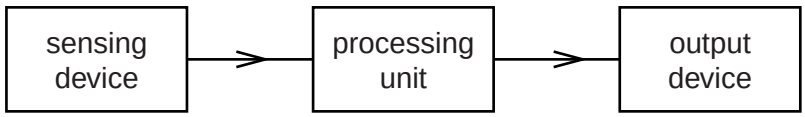

Fig. 9.1

(a) State the function of the processing unit.

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..... [2]

(b) A student designs a sensing unit for temperature change. A 4 V supply, a fixed resistor of resistance 2.5 kΩ and a thermistor are available. The thermistor has resistance 3.0 kΩ at 6 °C and resistance 1.8 kΩ at 20 °C.

Complete the circuit diagram of Fig. 9.2 to show how the resistor and the thermistor are connected to provide an output that is greater than 2 V at 6 °C and less than 2 V at 20 °C. Mark clearly the output V_{OUT}.

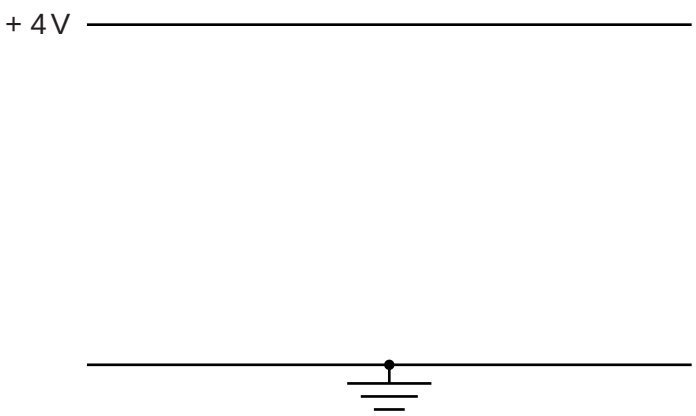

Fig. 9.2

[3]

(c) Suggest two uses of a relay as part of an output device.

1. .....

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2. .....

.....

[2]

3 **(a)** Two metal spheres are in thermal equilibrium.
State and explain what is meant by *thermal equilibrium*.

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..... [2]

(b) An electric water heater contains a tube through which water flows at a constant rate.
The water in the tube passes over a heating coil, as shown in Fig. 3.1.

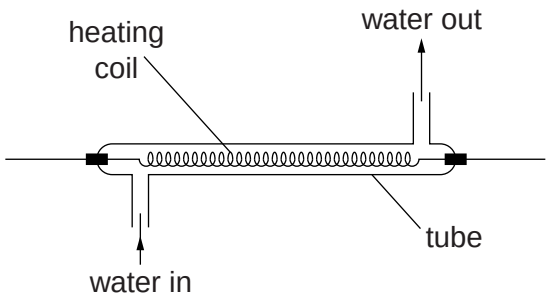

Fig. 3.1

The water flows into the tube at a temperature of 18 °C. When the power of the heater is 3.8 kW, the temperature of the water at the outlet is 42 °C.
The specific heat capacity of water is 4.2 J g^{-1} K^{-1}.

(i) Use the data to calculate the flow rate, in g s^{-1}, of water through the tube.

flow rate = ... g s^{-1} [3]

(ii) State and explain whether your answer in **(i)** is likely to be an overestimate or an underestimate of the flow rate.

.....

.....

..... [2]

4 **(a)** A resistance thermometer and a thermocouple thermometer are both used at the same time to measure the temperature of a water bath.

Explain why, although both thermometers have been calibrated correctly and are at equilibrium, they may record different temperatures.

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..... [2]

(b) State

(i) in what way the absolute scale of temperature differs from other temperature scales,

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..... [1]

(ii) what is meant by the absolute zero of temperature.

.....

..... [1]

(c) The temperature of a water bath increases from 50.00 °C to 80.00 °C.
Determine, in kelvin and to an appropriate number of significant figures,

(i) the temperature 50.00 °C,

temperature = ... K [1]

(ii) the change in temperature of the water bath.

temperature change = ... K [1]

5 **(a)** Some gas, initially at a temperature of 27.2 °C, is heated so that its temperature rises to 38.8 °C.
Calculate, in kelvin, to an appropriate number of decimal places,

(i) the initial temperature of the gas,

initial temperature = ... K [2]

(ii) the rise in temperature.

rise in temperature = ... K [1]

(b) The pressure p of an ideal gas is given by the expression

$$p = \frac{1}{3}\rho\langle c^2\rangle$$

where ρ is the density of the gas.

(i) State the meaning of the symbol $\langle c^2\rangle$.

.....

.....[1]

(ii) Use the expression to show that the mean kinetic energy $\langle E_K\rangle$ of the atoms of an ideal gas is given by the expression

$$\langle E_K\rangle = \frac{3}{2}kT.$$

Explain any symbols that you use.

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.....

..... [4]

(c) Helium-4 may be assumed to behave as an ideal gas.
A cylinder has a constant volume of $7.8 \times 10^3\,\text{cm}^3$ and contains helium-4 gas at a pressure of $2.1 \times 10^7\,\text{Pa}$ and at a temperature of 290 K.

Calculate, for the helium gas,

(i) the amount of gas,

amount = ... mol [2]

(ii) the mean kinetic energy of the atoms,

mean kinetic energy = ... J [2]

(iii) the total internal energy.

internal energy = ... J [3]

6 **(a)** The resistance of a thermistor at 0 °C is 3840 Ω. At 100 °C the resistance is 190 Ω. When the thermistor is placed in water at a particular constant temperature, its resistance is 2300 Ω.

(i) Assuming that the resistance of the thermistor varies linearly with temperature, calculate the temperature of the water.

temperature = ... °C [2]

(ii) The temperature of the water, as measured on the thermodynamic scale of temperature, is 286 K.

By reference to what is meant by the thermodynamic scale of temperature, comment on your answer in **(i)**.

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..... [3]

(b) A polystyrene cup contains a mass of 95 g of water at 28 °C.

A cube of ice of mass 12 g is put into the water. Initially, the ice is at 0 °C. The water, of specific heat capacity 4.2×10^3 J kg^{-1} K^{-1}, is stirred until all the ice melts.

Assuming that the cup has negligible mass and that there is no heat exchange with the atmosphere, calculate the final temperature of the water.

The specific latent heat of fusion of ice is 3.3×10^5 J kg^{-1}.

temperature = ... °C [4]