

1. Question part 1/2 | 9702 Feb-March 2016 P4 V2 Q3

3 (a) Define *specific heat capacity*.

.....

.....

.....[2]

(b) A student carries out an experiment to determine the specific heat capacity of a liquid using the apparatus illustrated in Fig. 3.1.

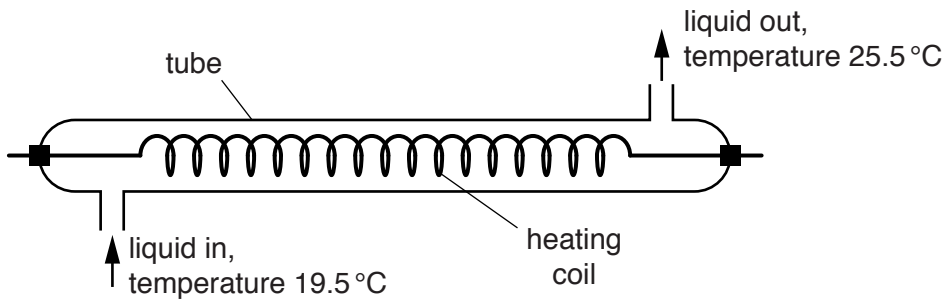


Fig. 3.1

Liquid enters the tube at a constant temperature of 19.5°C and leaves the tube at a temperature of 25.5°C. The mass of liquid flowing through the tube per unit time is m . Electrical power P is dissipated in the heating coil.

The student changes m and adjusts P until the final temperature of the liquid leaving the tube is 25.5°C.

The data shown in Fig. 3.2 are obtained.

$m/\text{g s}^{-1}$	P/W
1.11	33.3
1.58	44.9

Fig. 3.2

(i) Suggest why the student obtains data for two values of m , rather than for one value.

.....

.....[1]

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1. Question part 2/2 | 9702 Feb-March 2016 P4 V2 Q3

- (ii) Calculate the specific heat capacity of the liquid.

Show your working.

specific heat capacity = ... $\text{J kg}^{-1} \text{K}^{-1}$ [3]

- (c) When the heating coil in (b) dissipates 33.3W of power, the potential difference V across the coil is given by the expression

$$V = 27.0 \sin(395t).$$

The potential difference is measured in volts and the time t is measured in seconds.

Determine the resistance of the coil.

resistance = ... Ω [3]

[Total: 9]

- 3 (a)** Explain what is meant by the statement that two bodies are in *thermal equilibrium*.

.....
.....
..... [1]

- (b)** Suggest suitable types of thermometer, one in each case, to measure

- (i)** the temperature of the flame of a Bunsen burner,

..... [1]

- (ii)** the change in temperature of a small crystal when it is exposed to a pulse of ultrasound energy.

..... [1]

- (c)** Some water is heated so that its temperature changes from 26.5°C to a final temperature of 38.0°C .

State, to an appropriate number of decimal places,

- (i)** the change in temperature in kelvin,

change = ... K [1]

- (ii)** the final temperature in kelvin.

final temperature = ... K [1]

[Total: 5]

- 6 (a)** The slew rate of an ideal operational amplifier (op-amp) is said to be infinite.

Explain what is meant by *infinite slew rate*.

.....

 [2]

- (b)** The circuit of Fig. 6.1 is designed to indicate whether the temperature of the thermistor is above or below 24°C .

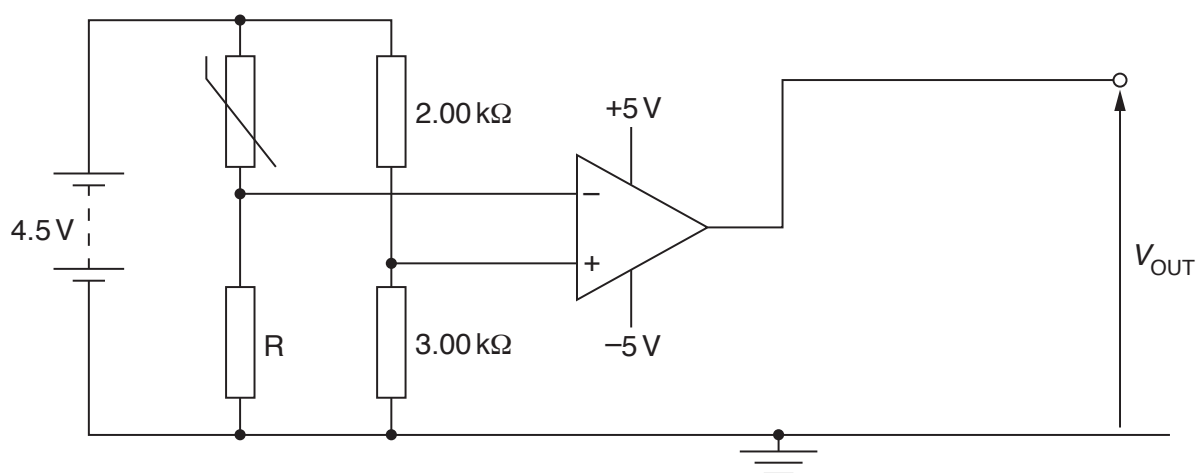


Fig. 6.1

The operational amplifier (op-amp) is assumed to be ideal.

At 24°C , the resistance of the thermistor is $1.50\text{ k}\Omega$.

- (i)** Determine the resistance of resistor R such that the output V_{OUT} of the op-amp changes at 24°C .

resistance = ... Ω [2]

(ii) On Fig. 6.1,

- 1. draw two light-emitting diodes (LEDs) connected so as to indicate whether the output V_{OUT} of the op-amp is either +5 V or –5 V, [2]
- 2. label with the letter G the LED that will be emitting light when the temperature is below 24 °C. Explain your working.

.....

.....

..... [3]

[Total: 9]

- 8 A student designs a circuit incorporating an operational amplifier (op-amp) as shown in Fig. 8.1.

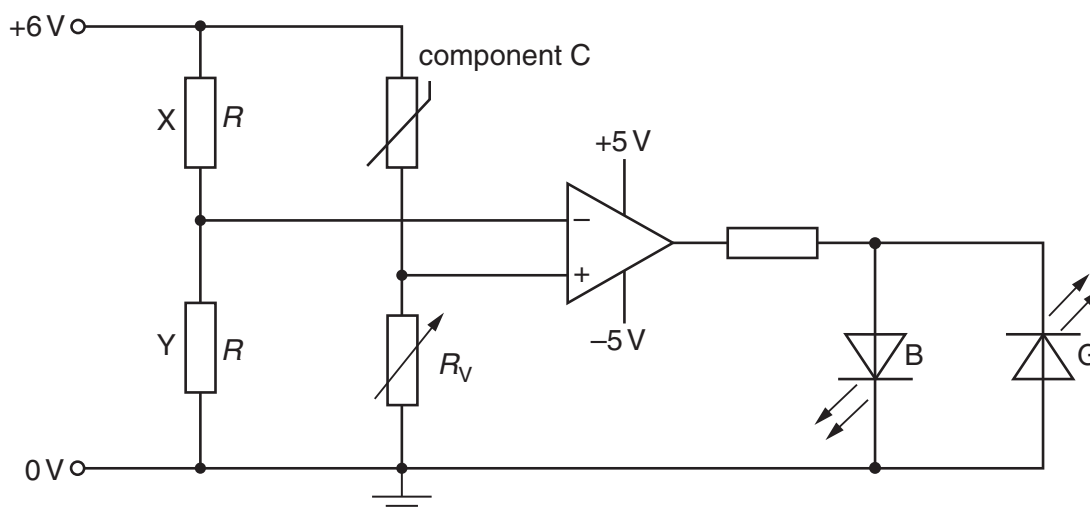


Fig. 8.1

- (a) (i) On Fig. 8.1, draw a circle around the output device. [1]

- (ii) State the purpose of this circuit.

.....

[2]

- (b) The resistors X and Y each have resistance R .
 When conducting, the LED labelled B emits blue light and the LED labelled G emits green light.

- (i) State whether blue light or green light is emitted when the resistance of component C is greater than the resistance R_V of the variable resistor. Explain your answer.

.....

[3]

(ii) State and explain what is observed as the resistance of component C is reduced.

.....

.....

.....

.....

.....[3]

(c) Suggest the function of the variable resistor.

.....

.....[1]

[Total: 10]

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5. Question part 1/2 | 9702 Oct-Nov 2017 P4 V1 Q1

1 (a) State

(i) what may be deduced from the difference in the temperatures of two objects,

.....
..... [1]

(ii) the basic principle by which temperature is measured.

.....
..... [1]

(b) By reference to your answer in (a)(ii), explain why two thermometers may not give the same temperature reading for an object.

.....
.....
..... [2]

(c) A block of aluminium of mass 670 g is heated at a constant rate of 95 W for 6.0 minutes.
The specific heat capacity of aluminium is $910 \text{ J kg}^{-1} \text{ K}^{-1}$.
The initial temperature of the block is 24°C .

(i) Assuming that no thermal energy is lost to the surroundings, show that the final temperature of the block is 80°C .

[3]

- (ii) In practice, there are energy losses to the surroundings.
The actual variation with time t of the temperature θ of the block is shown in Fig. 1.1.

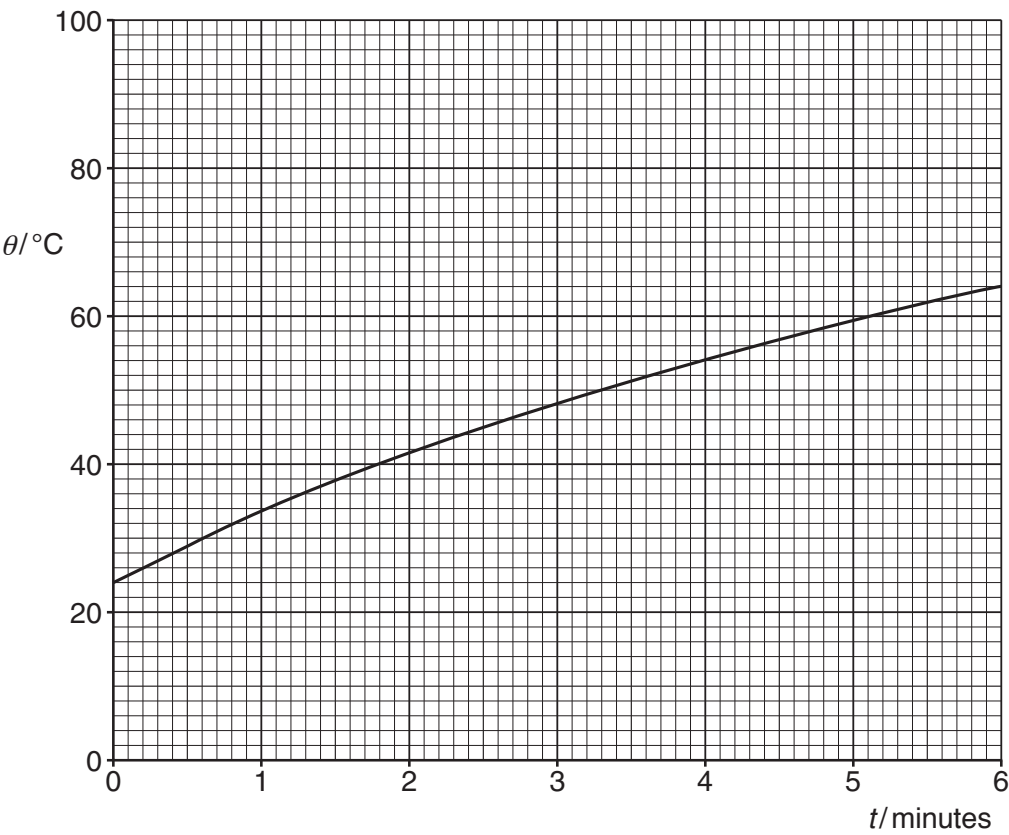


Fig. 1.1

1. Use the information in (i) to draw, on Fig. 1.1, a line to represent the temperature of the block, assuming no energy losses to the surroundings. [1]
2. Using Fig. 1.1, calculate the total energy loss to the surroundings during the heating process.

energy loss = ... J [2]

[Total: 10]

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6. Question part 1/2 | 9702 Oct-Nov 2017 P4 V3 Q1

1 (a) State

- (i)** what may be deduced from the difference in the temperatures of two objects,

.....
..... [1]

- (ii)** the basic principle by which temperature is measured.

.....
..... [1]

- (b)** By reference to your answer in **(a)(ii)**, explain why two thermometers may not give the same temperature reading for an object.

.....
.....
..... [2]

- (c)** A block of aluminium of mass 670 g is heated at a constant rate of 95 W for 6.0 minutes.
The specific heat capacity of aluminium is $910 \text{ J kg}^{-1} \text{ K}^{-1}$.
The initial temperature of the block is 24°C .

- (i)** Assuming that no thermal energy is lost to the surroundings, show that the final temperature of the block is 80°C .

[3]

- (ii) In practice, there are energy losses to the surroundings.
The actual variation with time t of the temperature θ of the block is shown in Fig. 1.1.

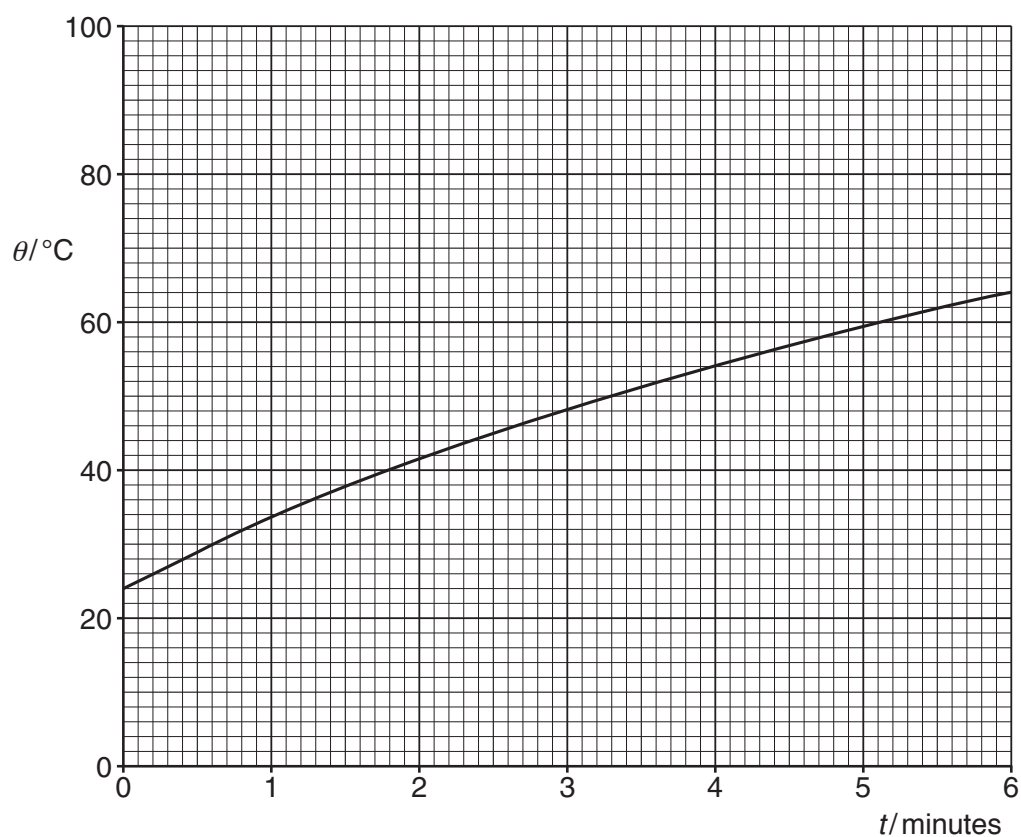


Fig. 1.1

- Use the information in (i) to draw, on Fig. 1.1, a line to represent the temperature of the block, assuming no energy losses to the surroundings. [1]
- Using Fig. 1.1, calculate the total energy loss to the surroundings during the heating process.

energy loss = ... J [2]

[Total: 10]

3 (a) Define *specific latent heat of fusion*.

.....

.....

.....[2]

(b) A student sets up the apparatus shown in Fig. 3.1 in order to investigate the melting of ice.

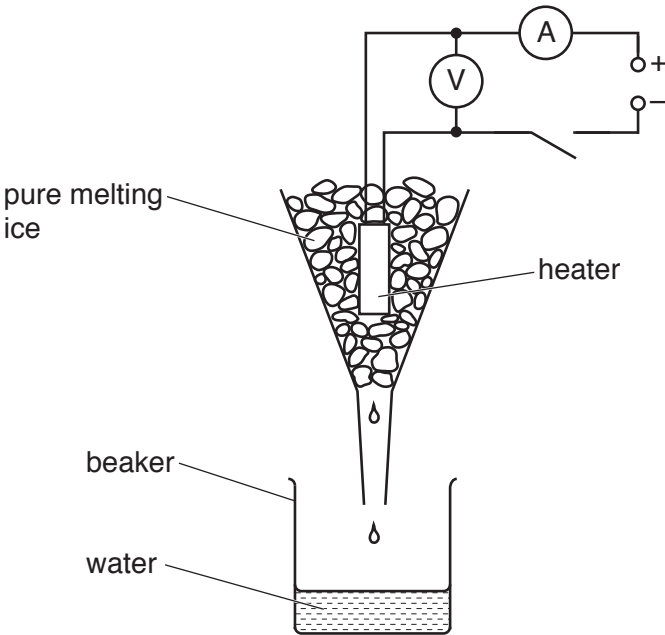


Fig. 3.1

The heater is switched on.
When the pure ice is melting at a constant rate, the data shown in Fig. 3.2 are collected.

voltmeter reading /V	ammeter reading /A	initial mass of beaker plus water /g	final mass of beaker plus water /g	time of collection /minutes
12.8	4.60	121.5	185.0	5.00

Fig. 3.2

The specific latent heat of fusion of ice is 332 J g^{-1} .

(i) State what is observed by the student that shows that the ice is melting at a constant rate.

.....

.....[1]

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7. Question part 2/2 | 9702 Oct-Nov 2018 P4 V2 Q3

(ii) Use the data in Fig. 3.2 to determine the rate at which

1. thermal energy is transferred to the melting ice,

rate = ... W

2. thermal energy is gained from the surroundings.

rate = ... W
[4]

[Total: 7]

- 7 (a) Use band theory to explain why the resistance of an intrinsic semiconductor decreases as its temperature rises.

.....

.....

.....

.....

.....

.....

.....

.....

.....[5]

- (b) The variation with temperature t of the resistance R of a thermistor is shown in Fig. 7.1.

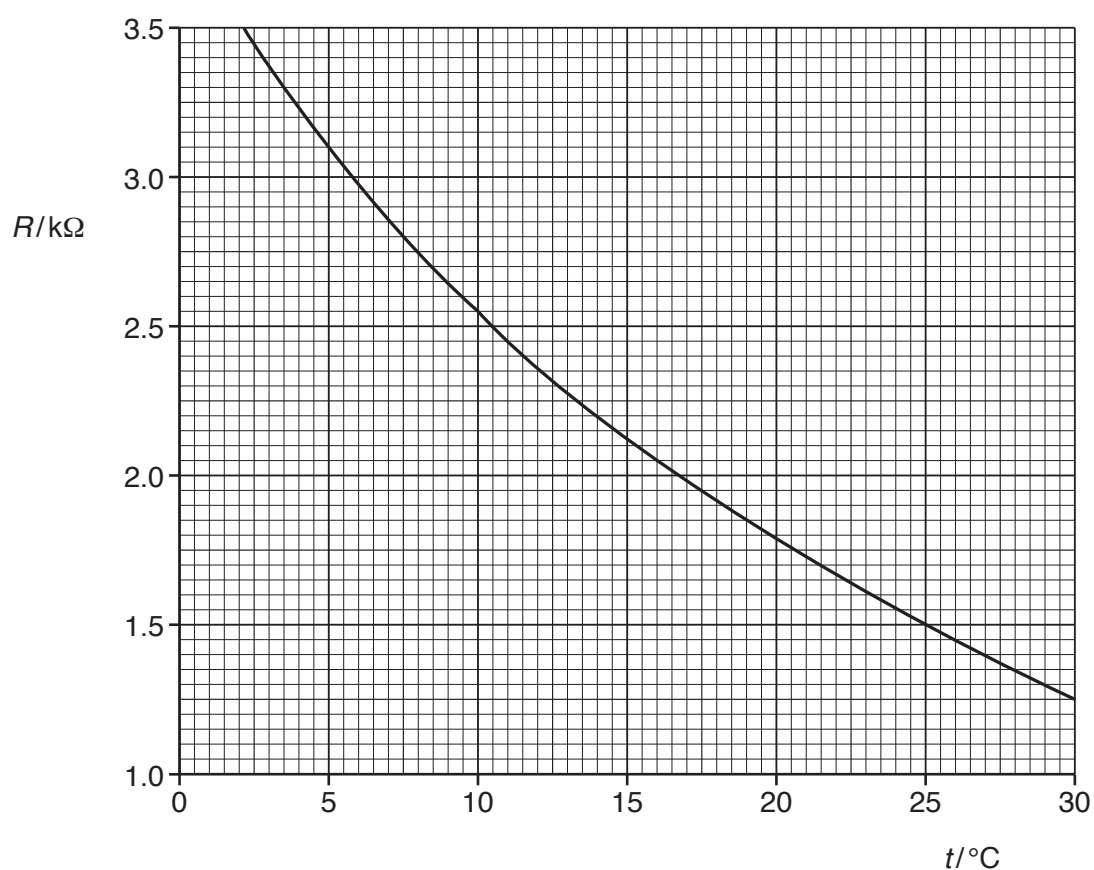


Fig. 7.1

The thermistor is connected into the circuit shown in Fig. 7.2.

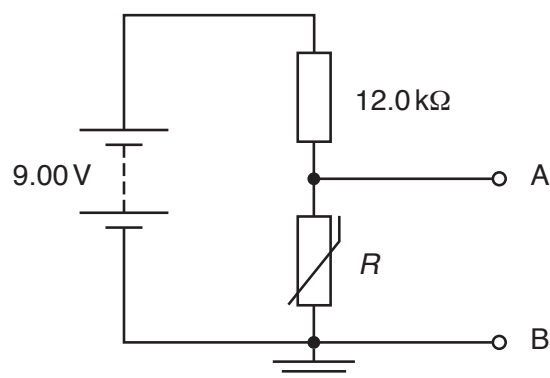


Fig. 7.2

The battery has electromotive force (e.m.f.) 9.00 V and negligible internal resistance.

When the temperature of the thermistor is 25 °C, the potential difference between the terminals A and B is 1.00 V.

The temperature of the thermistor changes from 25 °C to 10 °C.

Determine, to two significant figures, the change in potential difference between A and B.

change = ... V [3]

(c) The temperature of the thermistor in **(b)** changes from 25 °C to 10 °C at a constant rate.

State **two** reasons why the potential difference between A and B does **not** change at a constant rate.

1.

.....

2.

.....

[2]

[Total: 10]

- 3 (a) State what is meant by *specific latent heat*.

.....
.....
..... [2]

- (b) A student determines the specific latent heat of vaporisation of a liquid using the apparatus illustrated in Fig. 3.1.

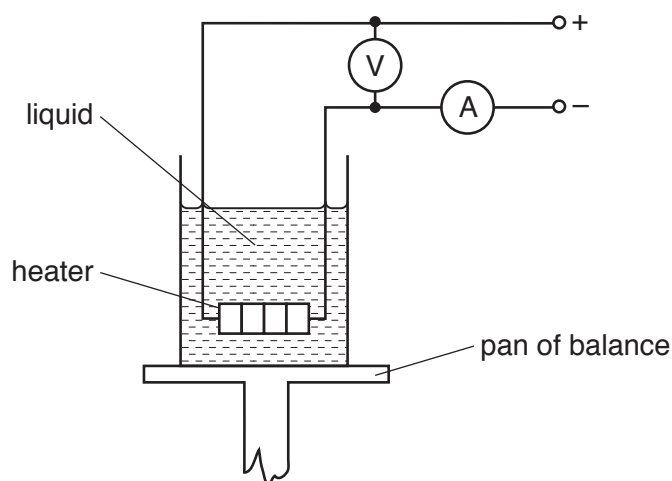


Fig. 3.1

The heater is switched on. When the liquid is boiling at a constant rate, the balance reading is noted at 2.0 minute intervals.

After 10 minutes, the current in the heater is reduced and the balance readings are taken for a further 12 minutes.

The readings of the ammeter and of the voltmeter are given in Fig. 3.2.

	ammeter reading /A	voltmeter reading /V
from time 0 to time 10 minutes	1.2	230
after time 10 minutes	1.0	190

Fig. 3.2

The variation with time of the balance reading is shown in Fig. 3.3.

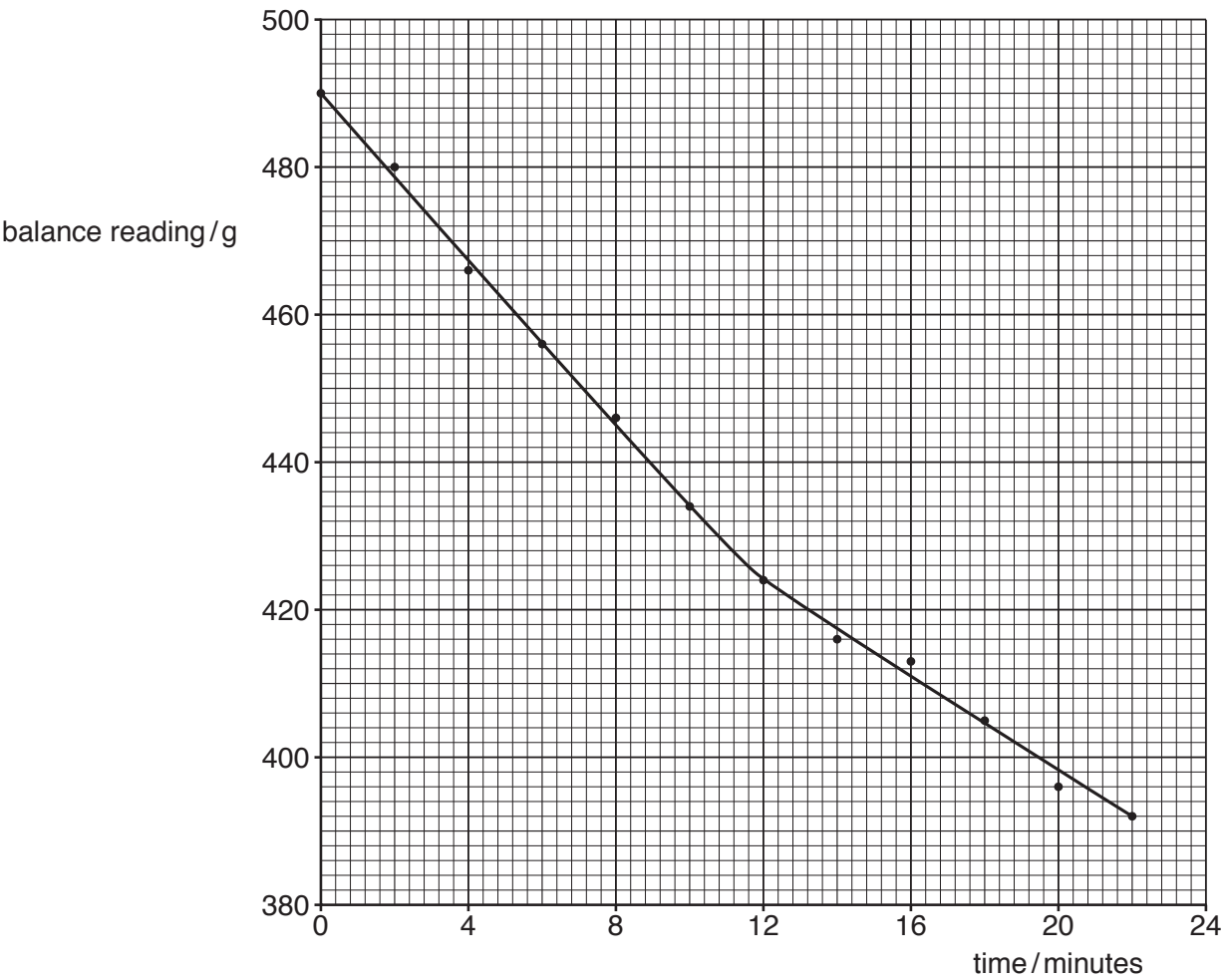


Fig. 3.3

9702 Physics Paper 4 - Temperature

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9. Question part 3/3 | 9702 Oct-Nov 2019 P4 V1 Q3

- (i) From time 0 to time 10.0 minutes, the mass of liquid evaporated is 56 g.

Use Fig. 3.3 to determine the mass of liquid evaporated from time 12.0 minutes to time 22.0 minutes.

mass = ... g [1]

- (ii) Explain why, although the power of the heater is changed, the rate of loss of thermal energy to the surroundings may be assumed to be constant.

.....

..... [1]

- (iii) Determine a value for the specific latent heat of vaporisation L of the liquid.

$L = \dots\dots\dots \text{Jg}^{-1}$ [4]

- (iv) Calculate the rate at which thermal energy is transferred to the surroundings.

rate = ... W [2]

[Total: 10]

- 3 (a) State what is meant by *specific latent heat*.

.....
.....
..... [2]

- (b) A student uses the apparatus illustrated in Fig. 3.1 to determine a value for the specific latent heat of fusion of ice.

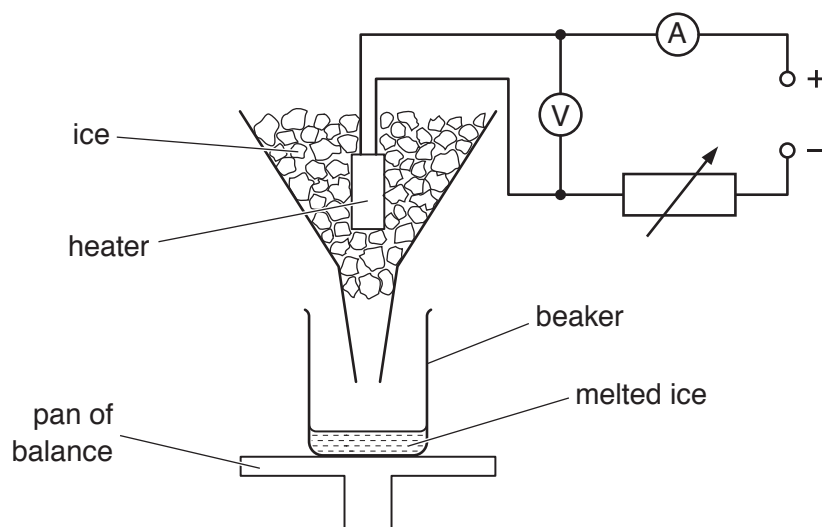


Fig. 3.1

The balance reading measures the mass of the beaker and the melted ice (water) in the beaker.

The heater is switched on and pieces of ice at 0°C are added continuously to the funnel so that the heater is always surrounded by ice.

When water drips out of the funnel at a constant rate, the balance reading is noted at 2.0 minute intervals. After 10 minutes, the current in the heater is increased and the balance readings are taken for a further 12 minutes.

The variation with time of the balance reading is shown in Fig. 3.2.

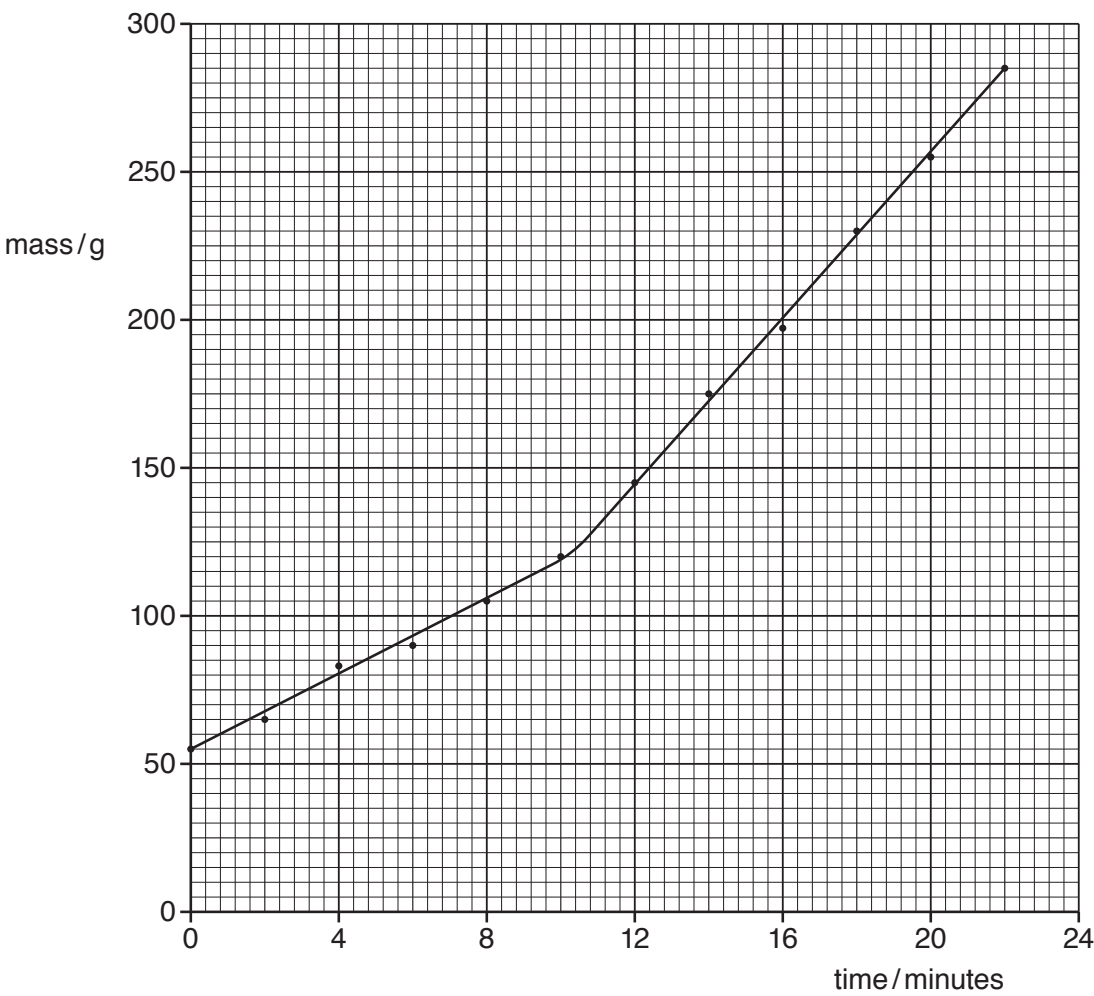


Fig. 3.2

The readings of the ammeter and of the voltmeter are shown in Fig. 3.3.

	ammeter reading /A	voltmeter reading /V
from time 0 to time 10 minutes	1.8	7.3
after time 10 minutes	3.6	15.1

Fig. 3.3

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10. Question part 3/3 | 9702 Oct-Nov 2019 P4 V2 Q3

- (i) From time 0 to time 10.0 minutes, 65 g of ice is melted.

Use Fig. 3.2 to determine the mass of ice melted from time 12.0 minutes to time 22.0 minutes.

mass = ... g [1]

- (ii) Explain why, although the power of the heater is changed, the rate at which thermal energy is transferred from the surroundings to the ice is constant.

.....

..... [1]

- (iii) Determine a value for the specific latent heat of fusion L of ice.

$L = \dots\dots\dots \text{Jg}^{-1}$ [4]

- (iv) Calculate the rate at which thermal energy is transferred from the surroundings to the ice.

rate = ... W [2]

[Total: 10]

11. Question part 1/2 | 9702 Feb-March 2020 P4 V2 Q7

- 7 (a) On Fig. 7.1, sketch the temperature characteristic of a negative temperature coefficient (n.t.c.) thermistor. Label the axes with quantity and unit.



Fig. 7.1

[2]

- (b) An n.t.c. thermistor and a resistor are connected as shown in Fig. 7.2.

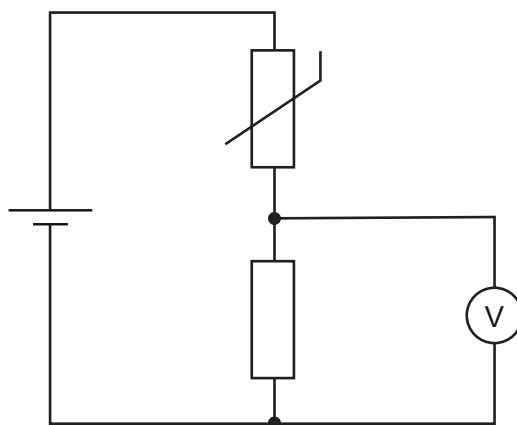


Fig. 7.2

The temperature of the thermistor is increased.

State and explain the change, if any, to the reading on the voltmeter.

.....

 [2]

- (c) The variation with the fractional change in length $\Delta x/x$ of the fractional change in resistance $\Delta R/R$ for a strain gauge is shown in Fig. 7.3.

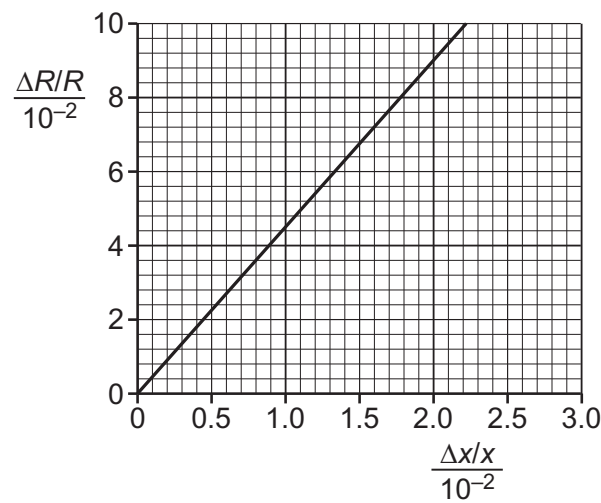


Fig. 7.3

The unstrained resistance of the gauge is $120\,\Omega$. Calculate the new resistance of the gauge when it is extended to a strain of 0.020.

resistance = ... Ω [3]

[Total: 7]

- 7 An ideal operational amplifier (op-amp) is to be used in a comparator circuit. Part of the comparator circuit is shown in Fig. 7.1.

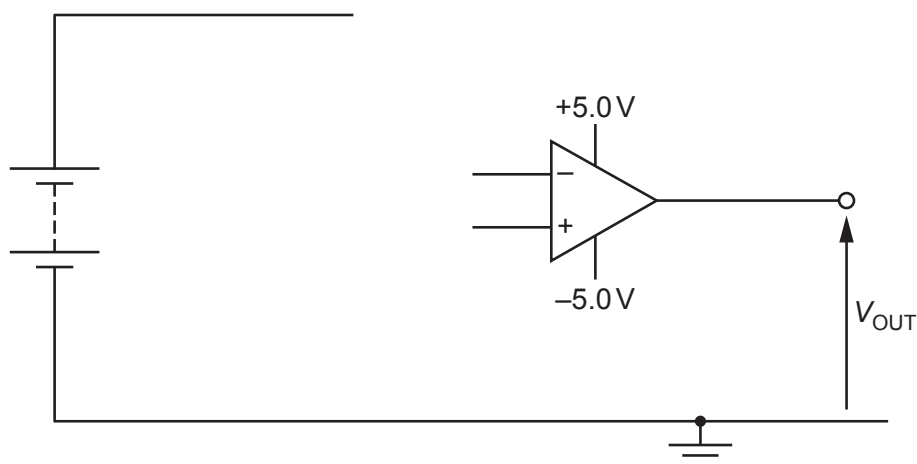


Fig. 7.1

Three resistors, each of resistance 1000Ω , and a negative temperature coefficient thermistor are available to complete the circuit.

The circuit is to be designed so that, at low temperatures, the output V_{OUT} is -5.0V and at higher temperatures, the output V_{OUT} is to be $+5.0\text{V}$.

(a) On Fig. 7.1, draw the input circuit to the inverting and non-inverting inputs of the op-amp. [4]

(b) State a suitable value for the thermistor resistance when the thermistor is at:

- (i) low temperature where V_{OUT} is -5.0V

..... [1]

- (ii) a higher temperature where V_{OUT} is $+5.0\text{V}$.

..... [1]

[Total: 6]

- 3 (a) Using a simple kinetic model of matter, describe the structure of a solid.

.....
.....
..... [2]

- (b) The specific latent heat of vaporisation is much greater than the specific latent heat of fusion for the same substance.
Explain this, in terms of the spacing of molecules.

.....
.....
..... [1]

- (c) A heater supplies energy at a constant rate to 0.045 kg of a substance. The variation with time of the temperature of the substance is shown in Fig. 3.1. The substance is perfectly insulated from its surroundings.

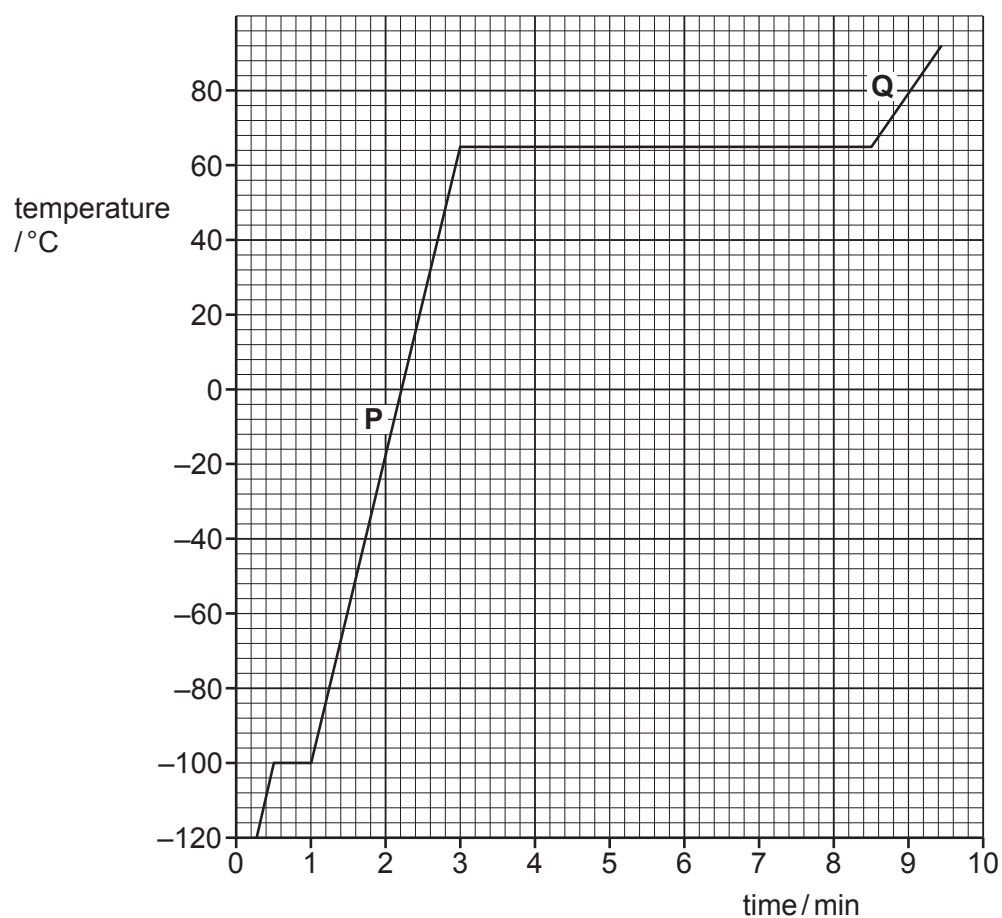


Fig. 3.1

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13. Question part 2/2 | 9702 Feb-March 2021 P4 V2 Q3

- (i) Determine the temperature at which the substance melts.

temperature = ... °C [1]

- (ii) The power of the heater is 150 W.
Use data from Fig. 3.1 to calculate, in kJ kg^{-1} , the specific latent heat of vaporisation L of the substance.

$L = \dots\dots\dots \text{kJ kg}^{-1}$ [3]

- (iii) Suggest what can be deduced from the fact that section **Q** on the graph is less steep than section **P**.

.....
..... [1]

[Total: 8]

- 8 The variation with temperature of the resistance of a thermistor is shown in Fig. 8.1.

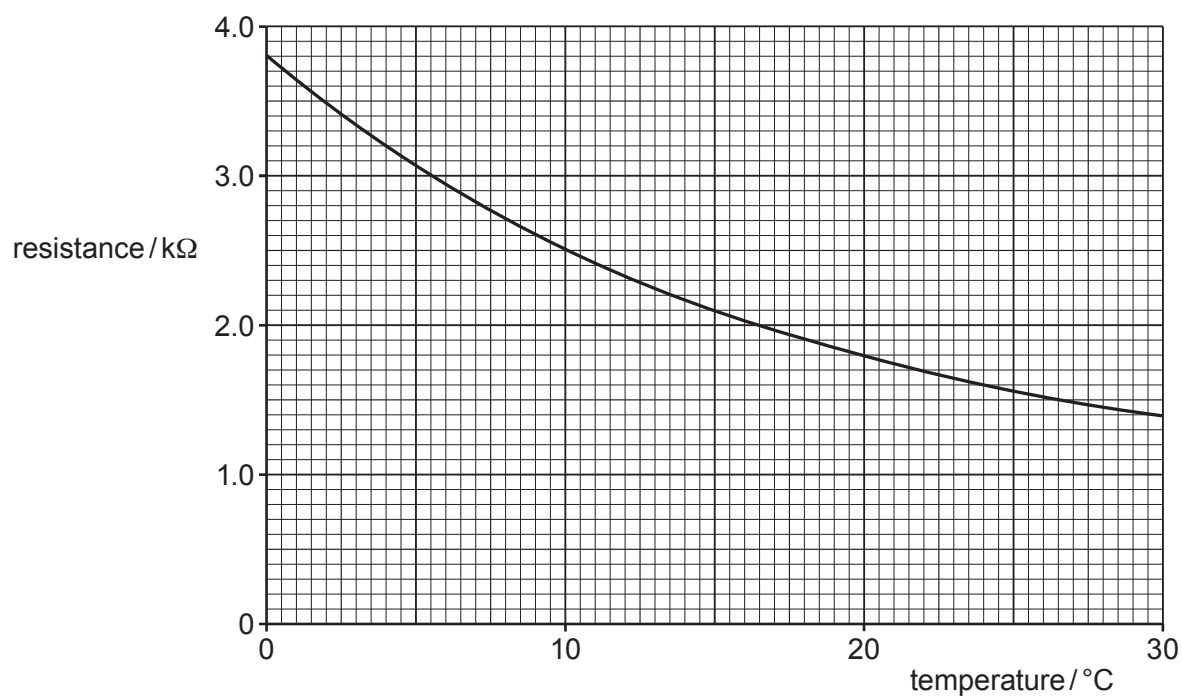


Fig. 8.1

A student includes the thermistor and an ideal operational amplifier (op-amp) in the circuit of Fig. 8.2.

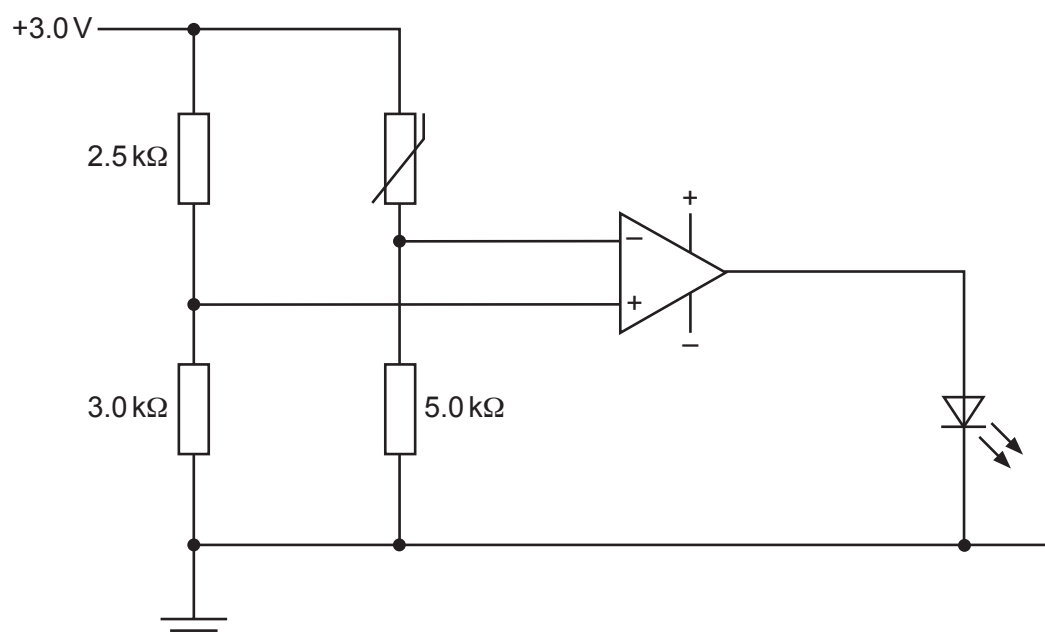


Fig. 8.2

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14. Question part 2/2 | 9702 May-June 2021 P4 V1 Q8

- (a) Calculate the potential V^+ at the non-inverting input of the op-amp.

$V^+ = \dots\dots\dots$ V [2]

- (b) At 10°C , the resistance of the thermistor is $2.5\text{ k}\Omega$.

State and explain whether the light-emitting diode (LED) is emitting light.

.....
.....
..... [2]

- (c) Explain why the student's circuit will not indicate any change in temperature above 0°C .

.....
.....
..... [2]

- (d) The resistor of resistance $5.0\text{ k}\Omega$ is changed to a resistor of resistance R so that the LED switches on or off at a temperature of 20°C .

Determine R in $\text{k}\Omega$.

$R = \dots\dots\dots$ $\text{k}\Omega$ [3]

[Total: 9]

15. Question part 1/2 | 9702 May-June 2021 P4 V2 Q7

- 7 (a) Two properties of an ideal operational amplifier (op-amp) are infinite input impedance and infinite bandwidth.

State what is meant by:

- (i) *infinite input impedance*

.....
 [1]

- (ii) *infinite bandwidth.*

.....
 [1]

- (b) A student uses a negative temperature coefficient thermistor in the circuit of Fig. 7.1 to indicate changes in temperature.

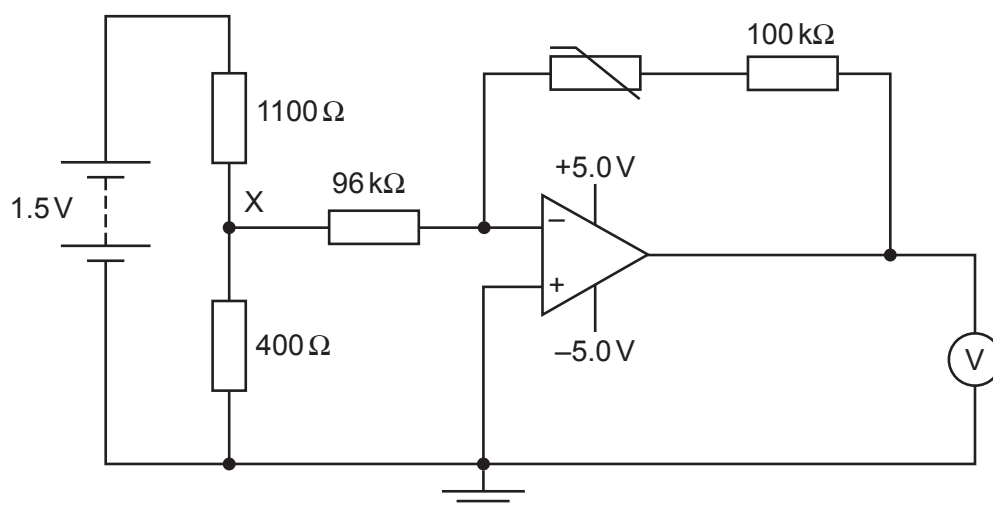


Fig. 7.1

- (i) Show that the potential at point X is 0.40 V.

[1]

(ii) The thermistor has a resistance of $360\text{ k}\Omega$ at a particular temperature.

For this temperature of the thermistor, calculate the magnitude of the reading on the voltmeter.

voltmeter reading = ... V [3]

(iii) The temperature of the thermistor increases.

State and explain the effect of this change on the magnitude of the reading on the voltmeter.

.....
.....
..... [2]

(iv) Explain why the amplifier circuit will no longer indicate temperature changes when the magnitude of the gain of the circuit is greater than 12.5.

.....
..... [1]

[Total: 9]

- 8 The variation with temperature of the resistance of a thermistor is shown in Fig. 8.1.

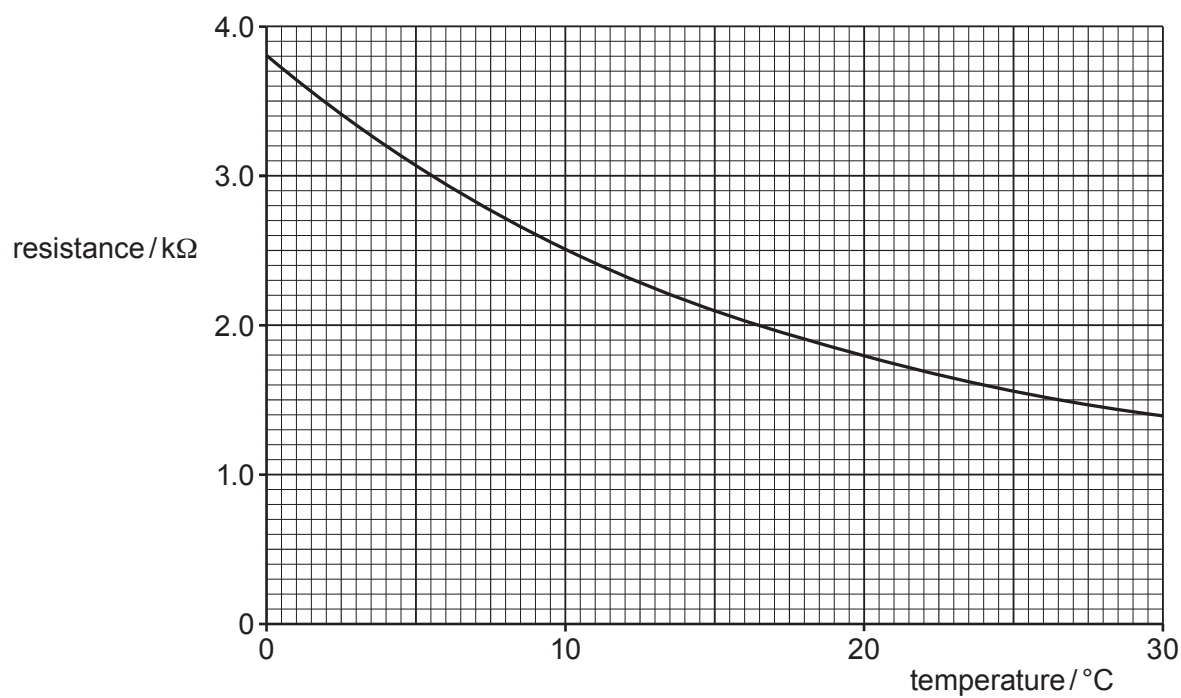


Fig. 8.1

A student includes the thermistor and an ideal operational amplifier (op-amp) in the circuit of Fig. 8.2.

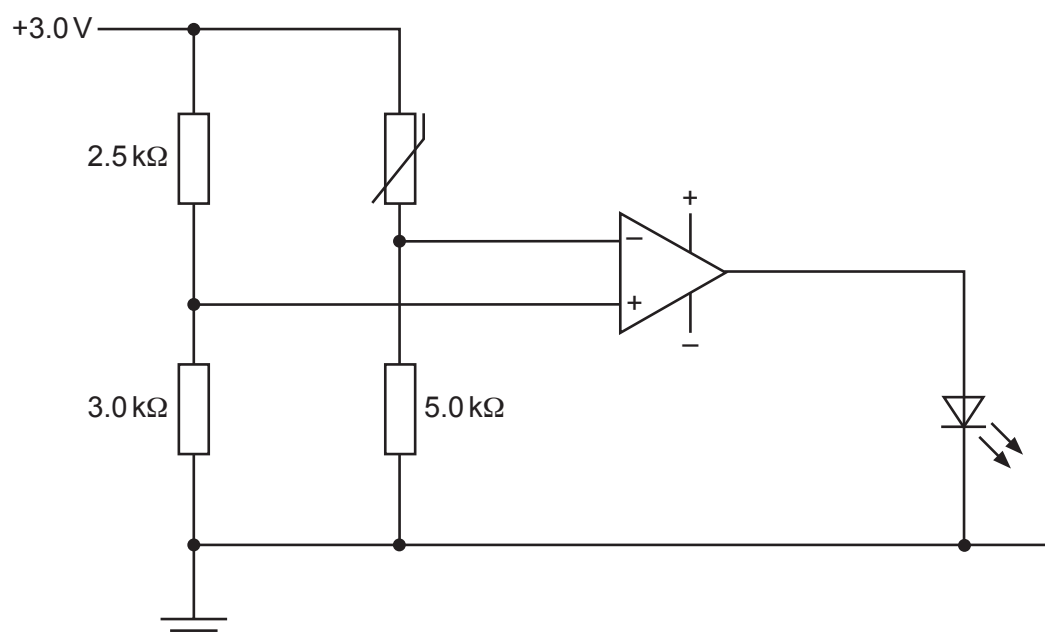


Fig. 8.2

(a) Calculate the potential V^+ at the non-inverting input of the op-amp.

$V^+ = \dots\dots\dots \text{ V [2]}$

(b) At 10°C , the resistance of the thermistor is $2.5\text{ k}\Omega$.

State and explain whether the light-emitting diode (LED) is emitting light.

.....
.....
..... [2]

(c) Explain why the student’s circuit will not indicate any change in temperature above 0°C .

.....
.....
..... [2]

(d) The resistor of resistance $5.0\text{ k}\Omega$ is changed to a resistor of resistance R so that the LED switches on or off at a temperature of 20°C .

Determine R in $\text{k}\Omega$.

$R = \dots\dots\dots \text{ k}\Omega [3]$

[Total: 9]

7 (a) State **two** properties of an ideal operational amplifier (op-amp).

1.
-
2.
-

[2]

(b) Fig. 7.1 shows a circuit that includes an ideal op-amp and two identical resistors R .

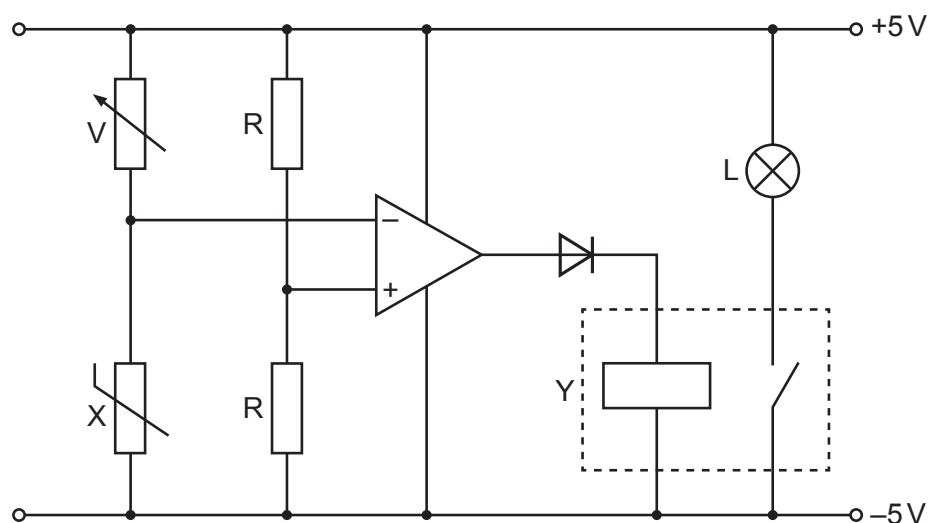


Fig. 7.1

State the names of components X and Y.

X: Y: [1]

(c) (i) Explain why the op-amp in Fig. 7.1 has only two possible output states.

-
-
-
- [2]

(ii) State the name of the type of op-amp circuit in which the op-amp behaves as in (c)(i).

..... [1]

(iii) Describe the environmental condition under which the lamp L in Fig. 7.1 will light.

.....

.....

..... [2]

(iv) Suggest the purpose of the variable resistor V in the circuit.

.....

..... [1]

[Total: 9]

7 (a) State **two** properties of an ideal operational amplifier (op-amp).

1.
-
2.
-

[2]

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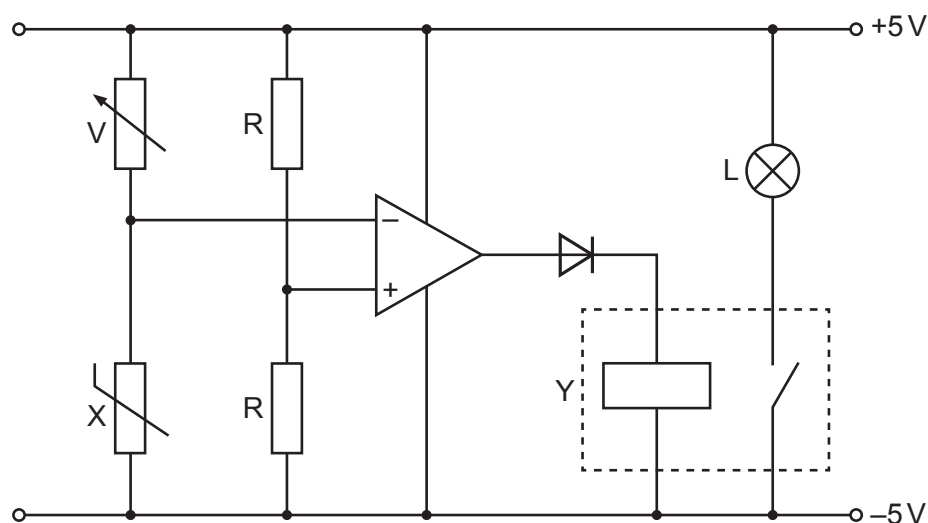


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-
-
-
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..... [1]

(iii) Describe the environmental condition under which the lamp L in Fig. 7.1 will light.

.....

.....

..... [2]

(iv) Suggest the purpose of the variable resistor V in the circuit.

.....

..... [1]

[Total: 9]

- 2 Fig. 2.1 shows a laboratory thermometer that is calibrated to measure temperature in degrees Celsius.

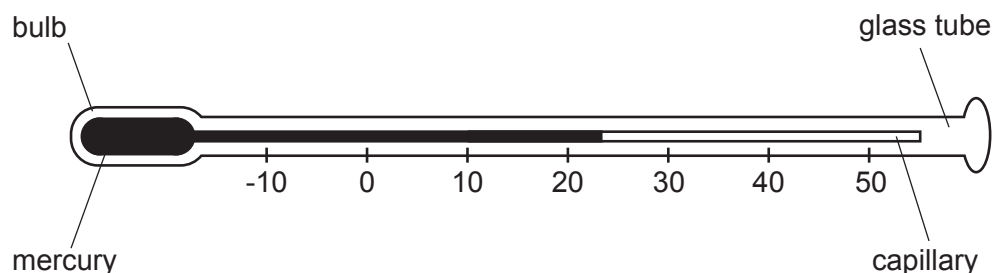


Fig. 2.1

The thermometer makes use of the fact that the density of mercury varies with temperature.

- (a) State **two** other physical properties of materials, apart from the density of a liquid, that can be used for measuring temperature.

1

2

[2]

- (b) The thermometer is initially at 23.0°C , as shown in Fig. 2.1. It is used to measure the temperature of an insulated beaker of water that is at 37.4°C . The bulb of the thermometer is inserted into the water, and the water is stirred until the reading on the thermometer becomes steady.

The mass of water in the beaker is 18.7 g.

The mass of mercury in the thermometer is 6.94 g.

The specific heat capacity of water is $4.18 \text{ J g}^{-1} \text{ K}^{-1}$.

The specific heat capacity of mercury is $0.140 \text{ J g}^{-1} \text{ K}^{-1}$.

The glass of the thermometer and the beaker containing the water can be considered to have negligible heat capacity.

- (i) Calculate, to three significant figures, the final steady temperature indicated by the thermometer in the water.

temperature = ... $^{\circ}\text{C}$ [4]

(ii) Suggest **one** change that could be made to the design of the thermometer that would enable it to give a more accurate measurement of temperature.

.....
..... [1]

(c) (i) Explain why the thermometer in Fig. 2.1 does **not** provide a direct measurement of thermodynamic temperature.

.....
.....
..... [2]

(ii) Thermodynamic temperature T may be determined by the behaviour of a type of substance for which T is proportional to the product of pressure and volume.

State the name of this type of substance.

..... [1]

[Total: 10]

- 2 Fig. 2.1 shows a laboratory thermometer that is calibrated to measure temperature in degrees Celsius.

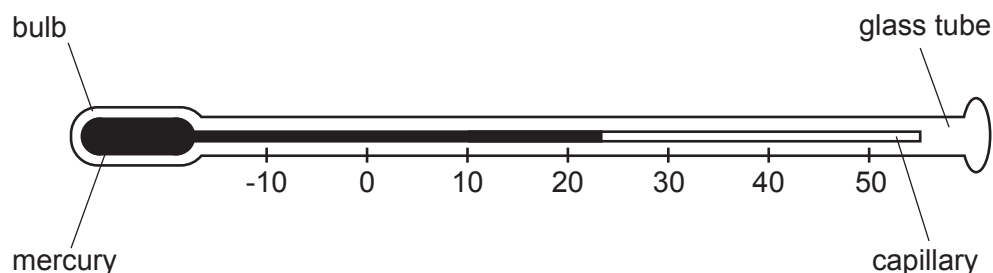


Fig. 2.1

The thermometer makes use of the fact that the density of mercury varies with temperature.

- (a) State **two** other physical properties of materials, apart from the density of a liquid, that can be used for measuring temperature.

1

2

[2]

- (b) The thermometer is initially at 23.0°C , as shown in Fig. 2.1. It is used to measure the temperature of an insulated beaker of water that is at 37.4°C . The bulb of the thermometer is inserted into the water, and the water is stirred until the reading on the thermometer becomes steady.

The mass of water in the beaker is 18.7 g.

The mass of mercury in the thermometer is 6.94 g.

The specific heat capacity of water is $4.18\text{ J g}^{-1}\text{ K}^{-1}$.

The specific heat capacity of mercury is $0.140\text{ J g}^{-1}\text{ K}^{-1}$.

The glass of the thermometer and the beaker containing the water can be considered to have negligible heat capacity.

- (i) Calculate, to three significant figures, the final steady temperature indicated by the thermometer in the water.

temperature = ... $^{\circ}\text{C}$ [4]

(ii) Suggest **one** change that could be made to the design of the thermometer that would enable it to give a more accurate measurement of temperature.

.....
..... [1]

(c) (i) Explain why the thermometer in Fig. 2.1 does **not** provide a direct measurement of thermodynamic temperature.

.....
.....
..... [2]

(ii) Thermodynamic temperature T may be determined by the behaviour of a type of substance for which T is proportional to the product of pressure and volume.

State the name of this type of substance.

..... [1]

[Total: 10]

21. Question part 1/2 | 9702 May-June 2023 P4 V1 Q3

3 (a) State the reason why two objects that are at the same temperature are described as being in thermal equilibrium.

.....
..... [1]

(b) Fig. 3.1 shows the variations with temperature of the densities of mercury and of water between 0 °C and 100 °C.

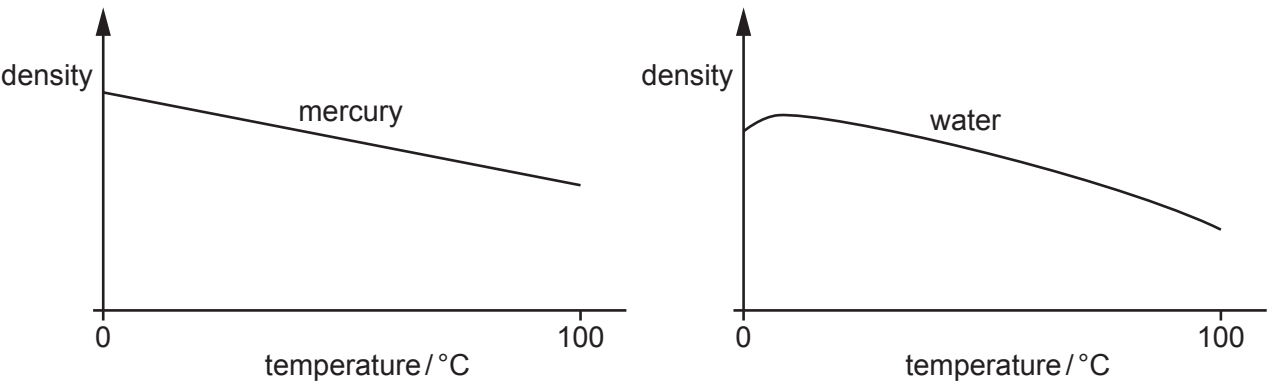


Fig. 3.1

Temperature may be measured using the variation with temperature of the density of a liquid.

Suggest why, for measuring temperature over this temperature range:

(i) mercury is a suitable liquid

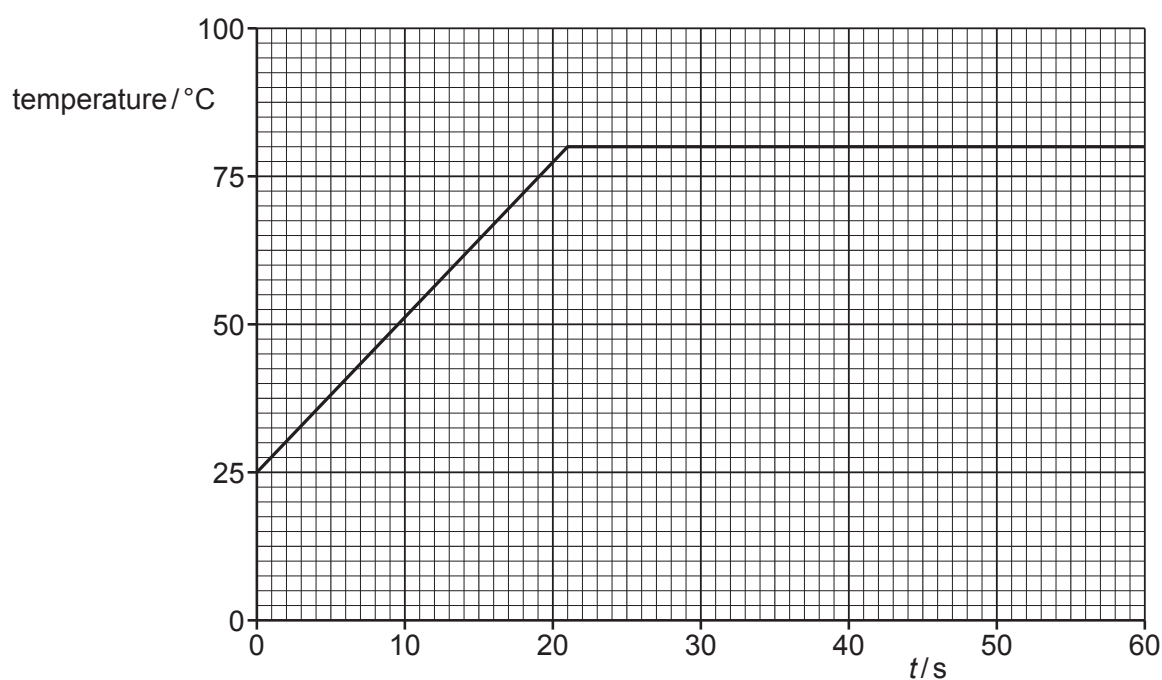
.....
..... [1]

(ii) water is not a suitable liquid.

.....
.....
..... [2]

(c) A beaker contains a liquid of mass 120 g. The liquid is supplied with thermal energy at a rate of 810 W. The beaker has a mass of 42 g and a specific heat capacity of 0.84 J g⁻¹ K⁻¹. The beaker and the liquid are in thermal equilibrium with each other at all times and are insulated from the surroundings.

Fig. 3.2 shows the variation with time *t* of the temperature of the liquid.

**Fig. 3.2**

- (i) State the boiling temperature, in °C, of the liquid.

temperature = ... °C [1]

- (ii) Determine the specific heat capacity, in $\text{J g}^{-1} \text{K}^{-1}$, of the liquid.

specific heat capacity = ... $\text{J g}^{-1} \text{K}^{-1}$ [4]

- (d) The experiment in (c) is repeated using water instead of the liquid in (c). The mass of liquid used, the power supplied, and the initial temperature are all unchanged. The specific heat capacity of water is approximately twice that of the liquid in (c). The boiling temperature of water is 100 °C.

On Fig. 3.2, sketch the variation with time t of the temperature of the water between $t = 0$ and $t = 60$ s. Numerical calculations are not required. [2]

[Total: 11]

3 (a) State the reason why two objects that are at the same temperature are described as being in thermal equilibrium.

.....
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(b) Fig. 3.1 shows the variations with temperature of the densities of mercury and of water between 0 °C and 100 °C.

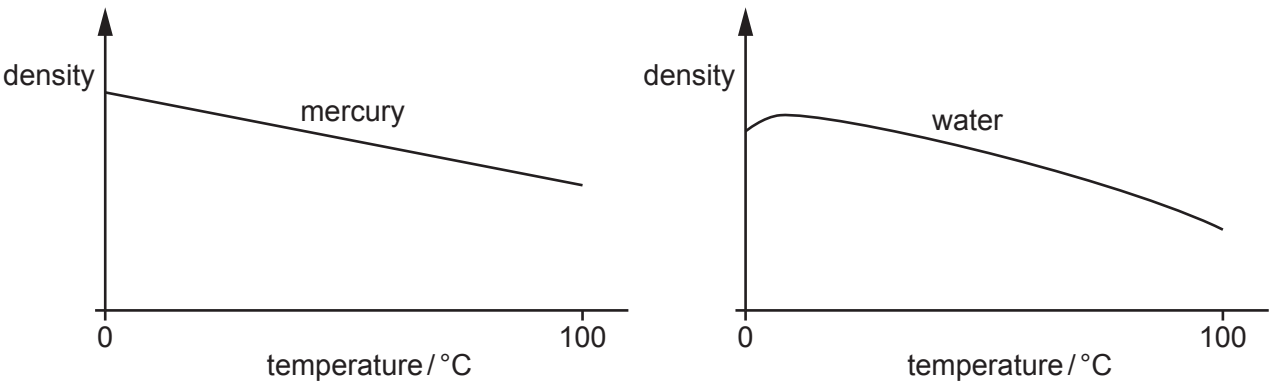


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Suggest why, for measuring temperature over this temperature range:

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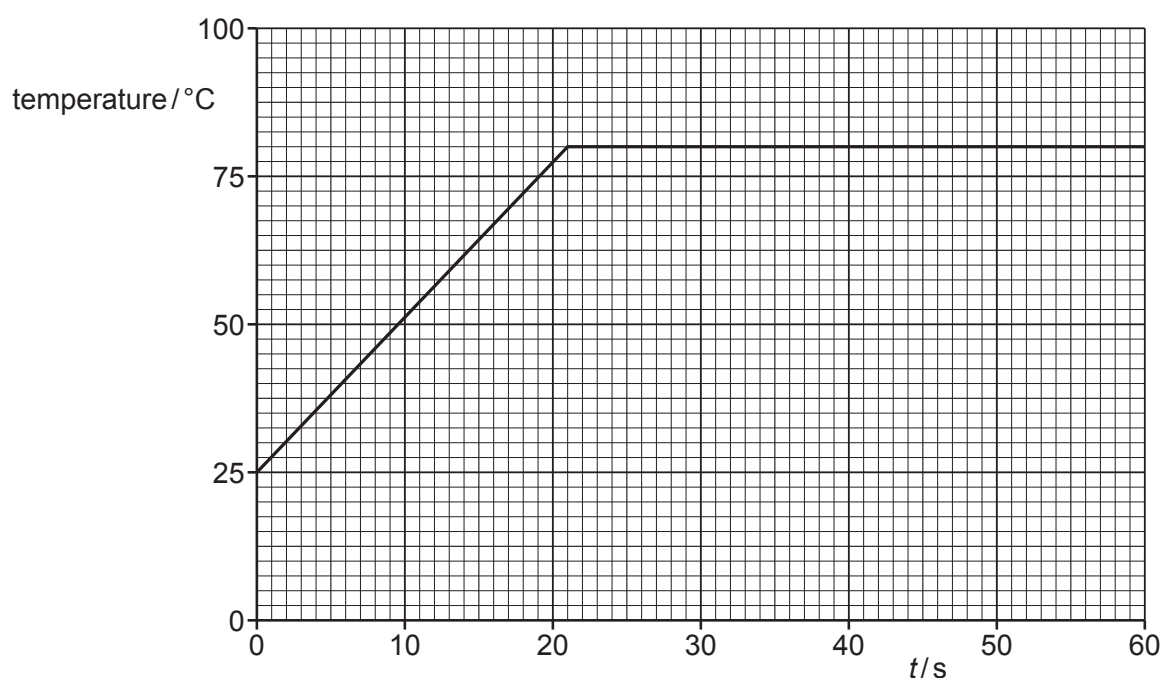
.....
..... [1]

(ii) water is not a suitable liquid.

.....
.....
..... [2]

(c) A beaker contains a liquid of mass 120 g. The liquid is supplied with thermal energy at a rate of 810 W. The beaker has a mass of 42 g and a specific heat capacity of 0.84 J g⁻¹ K⁻¹. The beaker and the liquid are in thermal equilibrium with each other at all times and are insulated from the surroundings.

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**Fig. 3.2**

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[Total: 11]

- 2 (a) (i) State the magnitude and unit of absolute zero on the thermodynamic temperature scale.
- [1]
- (ii) Explain why temperature measured using a laboratory liquid-in-glass thermometer does **not** give a measurement of thermodynamic temperature.
-
- [1]
- (b) Fig. 2.1 shows a simplified diagram of a type of thermometer called a platinum resistance thermometer.

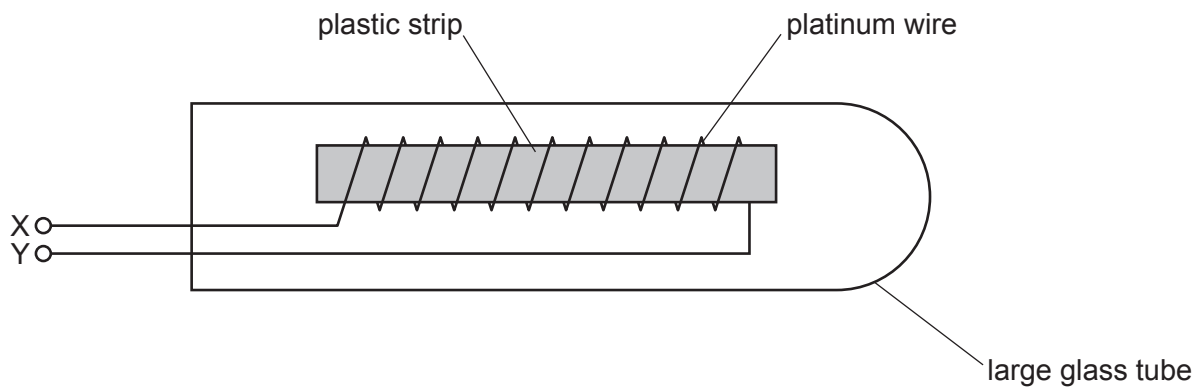


Fig. 2.1

The glass tube is immersed in the environment for which the temperature is to be determined. The resistance between the terminals X and Y is measured.

Fig. 2.2 shows the variation of the resistivity ρ of platinum with thermodynamic temperature T .

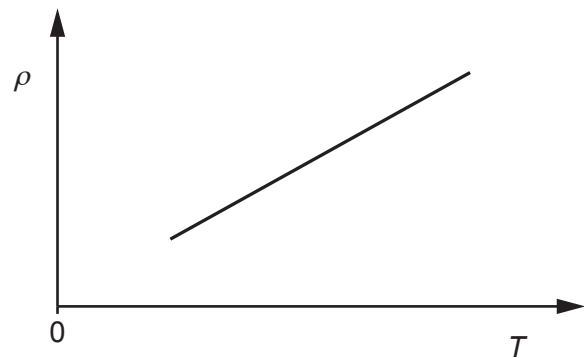


Fig. 2.2

(i) Explain how Fig. 2.2 shows that platinum is a suitable metal for use in a resistance thermometer.

.....

.....

..... [2]

(ii) Suggest a reason why a platinum resistance thermometer is **not** suitable for measuring a rapidly changing temperature.

.....

.....

..... [1]

(iii) Suggest a type of thermometer that is suitable for measuring a rapidly changing temperature.

..... [1]

(c) A negative temperature coefficient thermistor may be used as a type of resistance thermometer.

State **one** way in which the variation with temperature of the resistance of a thermistor differs from that of a platinum wire.

.....

..... [1]

[Total: 7]

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..... [1]

(ii) Explain why temperature measured using a laboratory liquid-in-glass thermometer does **not** give a measurement of thermodynamic temperature.

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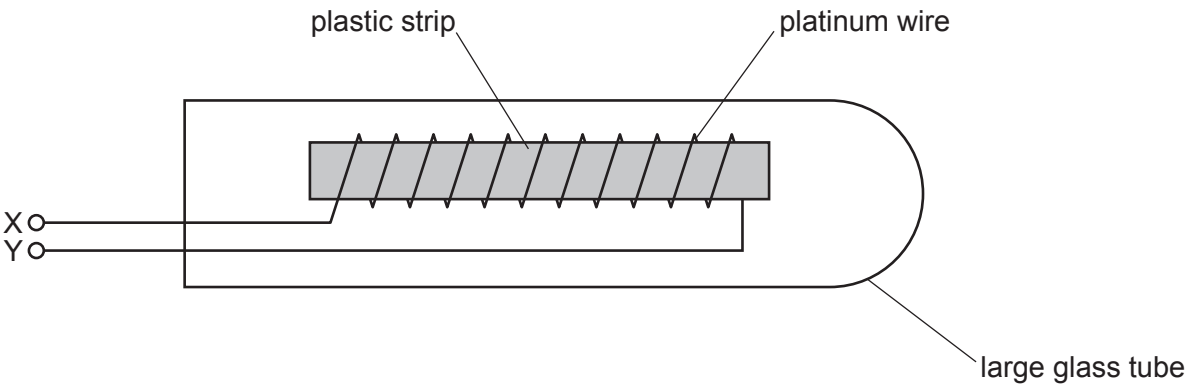


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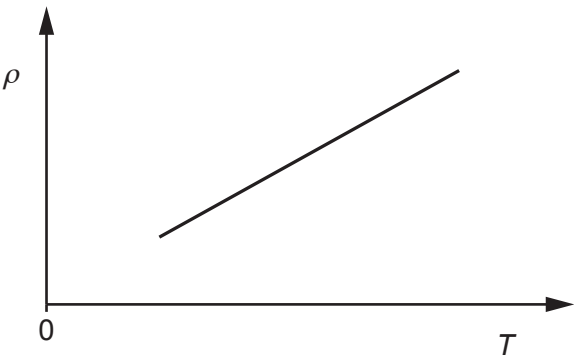


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..... [2]

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.....

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State **one** way in which the variation with temperature of the resistance of a thermistor differs from that of a platinum wire.

.....

..... [1]

[Total: 7]

2 (a) Define specific heat capacity.

.....

.....

..... [2]

(b) Two solid blocks X and Y are made from different metals. The blocks have different initial temperatures. Block Y is initially at room temperature.

The blocks are placed in direct thermal contact with each other at time $t = 0$. Fig. 2.1 shows the variation with t of the temperatures of the two blocks.

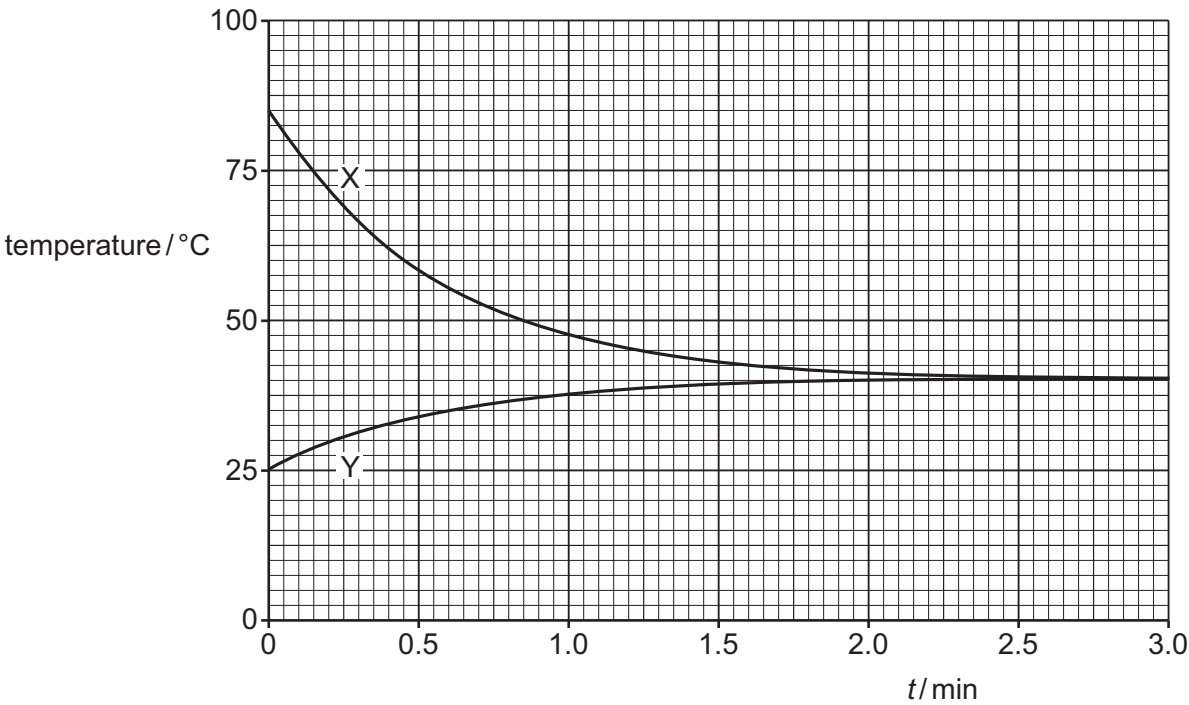


Fig. 2.1



(i) State **three** conclusions that may be drawn from Fig. 2.1. The conclusions may be qualitative or quantitative.

- 1
-
- 2
-
- 3
-

[3]

(ii) The ratio $\frac{\text{mass of block Y}}{\text{mass of block X}}$ is equal to 1.3.

The metal in block Y has a specific heat capacity of $901 \text{ J kg}^{-1} \text{ K}^{-1}$.

Determine the specific heat capacity of the metal in block X.

specific heat capacity = ... $\text{J kg}^{-1} \text{ K}^{-1}$ [3]

[Total: 8]

2 (a) Define specific heat capacity.

.....

.....

..... [2]

(b) Two solid blocks X and Y are made from different metals. The blocks have different initial temperatures. Block Y is initially at room temperature.

The blocks are placed in direct thermal contact with each other at time $t = 0$. Fig. 2.1 shows the variation with t of the temperatures of the two blocks.

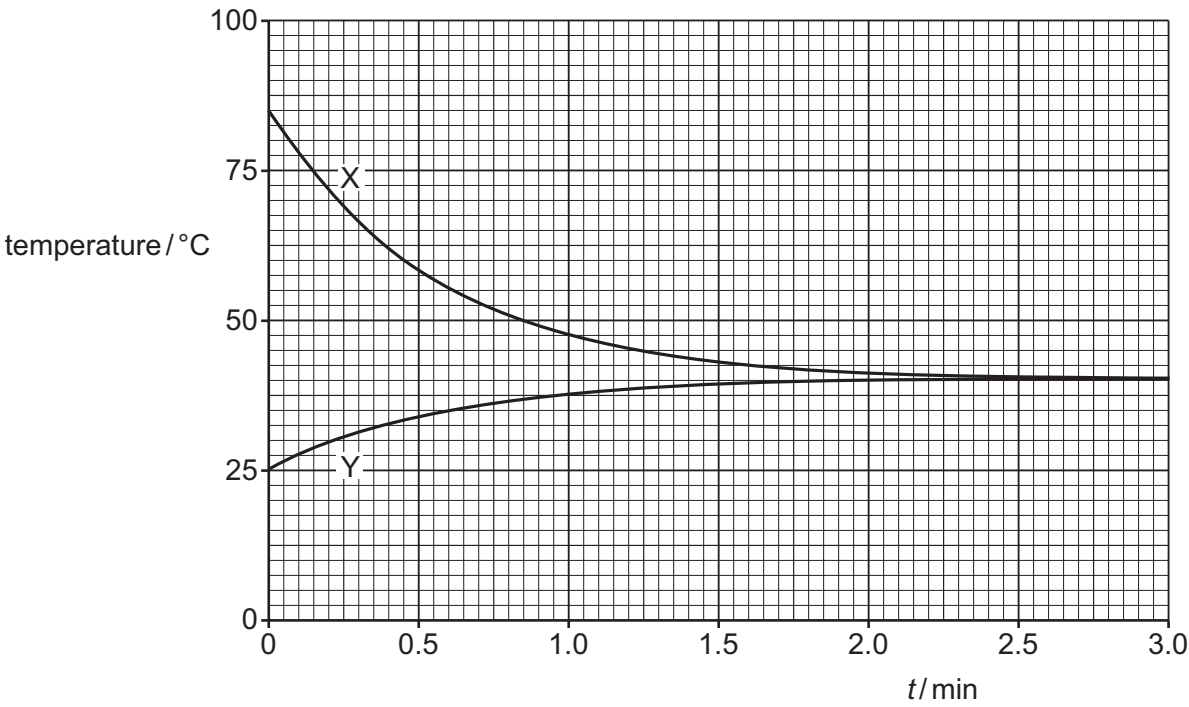


Fig. 2.1



(i) State **three** conclusions that may be drawn from Fig. 2.1. The conclusions may be qualitative or quantitative.

- 1
-
- 2
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-

[3]

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Determine the specific heat capacity of the metal in block X.

specific heat capacity = ... $\text{J kg}^{-1} \text{ K}^{-1}$ [3]

[Total: 8]

27. Question | 9702 May-June 2025 P4 V1 Q3

3 (a) Define specific latent heat.

.....

.....

..... [2]

(b) Explain why, for a substance, the specific latent heat of vaporisation is usually greater than the specific latent heat of fusion.

.....

.....

.....

.....

..... [3]

(c) An ice cube of mass 37.0g at temperature 0.0°C is placed in a beaker containing water of mass 208g at temperature 26.4°C.

When all the ice has melted, and all the water in the beaker has reached thermal equilibrium, the final temperature of all the water is 10.3°C.

The specific heat capacity of water is 4.18 Jg⁻¹ °C⁻¹.

The beaker has negligible specific heat capacity and is perfectly insulated from the surroundings.

Determine a value, to three significant figures, for the specific latent heat of fusion of water.

specific latent heat of fusion = ... Jg⁻¹ [4]

[Total: 9]

28. Question | 9702 May-June 2025 P4 V3 Q3

3 (a) Define specific latent heat.

.....

.....

..... [2]

(b) Explain why, for a substance, the specific latent heat of vaporisation is usually greater than the specific latent heat of fusion.

.....

.....

.....

.....

..... [3]

(c) An ice cube of mass 37.0g at temperature 0.0°C is placed in a beaker containing water of mass 208g at temperature 26.4°C.

When all the ice has melted, and all the water in the beaker has reached thermal equilibrium, the final temperature of all the water is 10.3°C.

The specific heat capacity of water is 4.18 Jg⁻¹ °C⁻¹.

The beaker has negligible specific heat capacity and is perfectly insulated from the surroundings.

Determine a value, to three significant figures, for the specific latent heat of fusion of water.

specific latent heat of fusion = ... Jg⁻¹ [4]

[Total: 9]

29. Question | 9702 May-June 2025 P4 V4 Q2

2 (a) State what is meant by two objects being in thermal equilibrium.

.....

.....

..... [2]

(b) A mass X of ice at 0°C is placed in a beaker containing a mass M of water at Celsius temperature t . The beaker is perfectly insulated and has negligible heat capacity. After some time, the ice that was added reaches thermal equilibrium with the original water in the beaker.

The specific latent heat of fusion of water is L . The specific heat capacity of water is c .
The final Celsius temperature of the system is θ .

Give expressions, in terms of some or all of X , M , t , θ , L and c , for the thermal energy:

(i) E_1 , gained by the ice as it melts to become water at 0°C

$E_1 =$ [1]

(ii) E_2 , lost by the water as its Celsius temperature decreases from t to θ

$E_2 =$ [1]

(iii) E_3 , gained by the melted ice as its Celsius temperature increases from 0°C to θ .

$E_3 =$ [1]

(c) Use your answers in (b) to show that the final Celsius temperature θ of the system is given by

$$\theta = \frac{Mct - XL}{c(M + X)}.$$

[2]

[Total: 7]

30. Question part 1/2 | 9702 Oct-Nov 2025 P4 V2 Q3

- 3 (a) State what is meant by two objects being in thermal equilibrium.

.....

.....

..... [2]

- (b) Fig. 3.1 shows a type of thermometer called a constant volume gas thermometer.

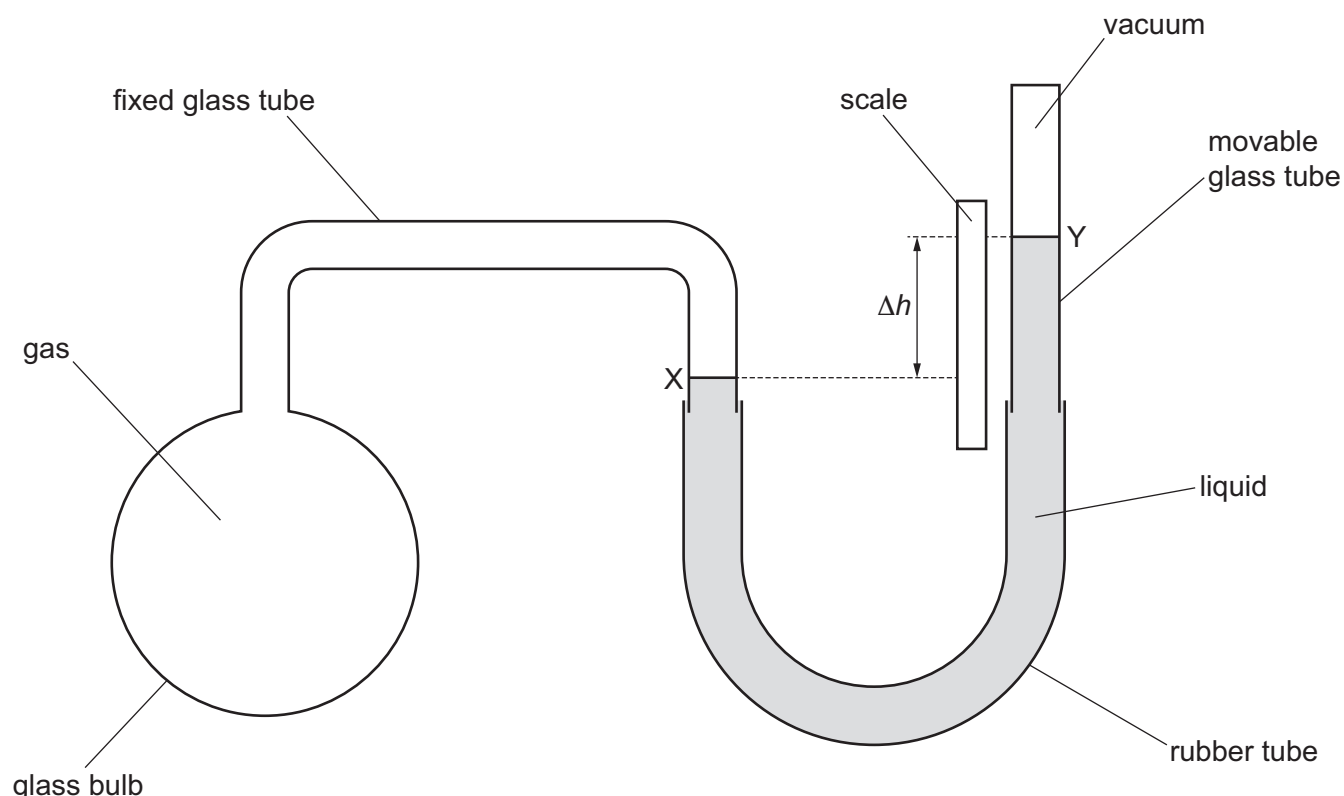


Fig. 3.1 (not to scale)

The thermometer is used to determine the thermodynamic temperature T of the gas in the glass bulb.

The glass bulb is immersed in the environment for which the temperature is to be measured. The height of the movable glass tube is then adjusted so that the level of the liquid on the left-hand side aligns with the reference line X marked on the fixed glass tube. The reference line Y is marked on the side of the movable glass tube. The level of the liquid at Y is higher than at X as a result of the pressure of the gas in the glass bulb.

The difference in height Δh between the liquid levels at X and Y is then measured using the scale. The thermodynamic temperature T of the gas is directly proportional to the pressure of the gas. This pressure is directly proportional to Δh .

30. Question part 2/2 | 9702 Oct-Nov 2025 P4 V2 Q3



- (i) The value of Δh can be used to calculate the pressure of the gas. In order to do this, the gravitational field strength is used, along with a property of the liquid.

State the property of the liquid that is used to calculate the pressure.

..... [1]

- (ii) Before the measurement of Δh can be made, the glass bulb needs to reach thermal equilibrium with the environment for which the temperature is to be measured.

State **two** disadvantages of using a constant volume gas thermometer to measure temperature.

1

.....

2

..... [2]

- (iii) Suggest **one** situation in which a constant volume gas thermometer would be an appropriate type of thermometer to choose for measuring temperature.

.....

.....

..... [1]

- (iv) Level X aligns with 2.31 cm on the scale. At 0 °C, level Y aligns with 8.69 cm.

At temperature θ , level Y aligns with 7.83 cm on the scale.

Determine a value for θ in °C.

$\theta =$ °C [3]

[Total: 9]