1 Fig. 5.1 shows an X-ray tube.

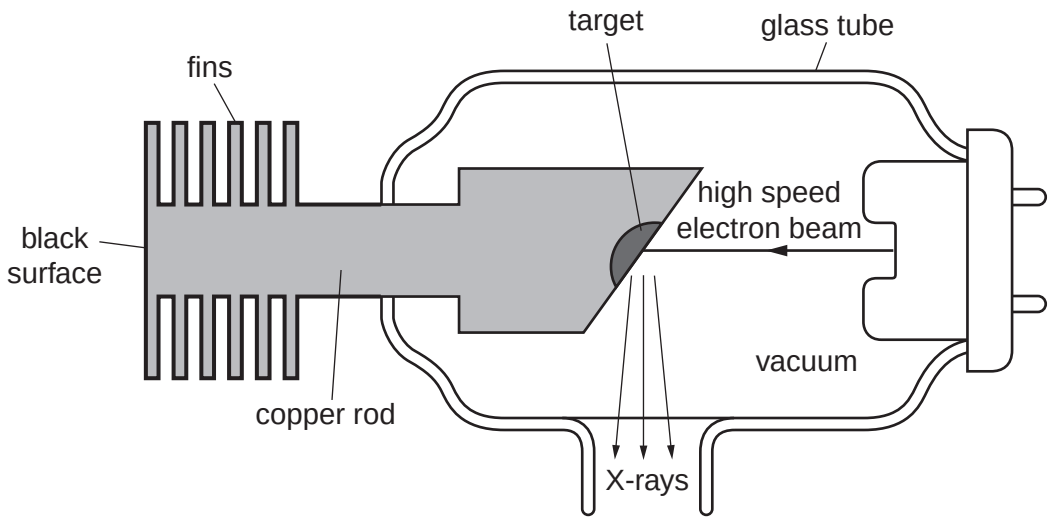

Fig. 5.1

In the production of X-rays, the target gets very hot. Thermal energy must be removed from the target. The tube has several design features to enable this to happen.

For each of the following types of energy transfer, describe how the design of the tube increases the rate of energy transfer. State where the thermal energy transfer mostly happens, the particular design feature that increases the rate of this transfer, and a brief explanation.

(a) conduction

where .....

design feature .....

explanation .....

..... [3]

(b) convection

where .....

design feature .....

explanation .....

..... [3]

(c) radiation

where .....

design feature .....

explanation .....

..... [3]

[Total: 9]

2 **(a)** **(i)** In the space below, draw a labelled diagram of the apparatus you would use to measure the specific heat capacity of a liquid. If you choose an electrical method, you must include the circuit.

[3]

(ii) List the quantities you would need to measure, or previously know, in order to calculate the specific heat capacity of the liquid.

.....

.....

.....

.....

.....[3]

(b) Some sea water has a specific heat capacity of 3900 J/(kg °C) and a boiling point of 100.6 °C.

(i) Calculate the energy required to raise the temperature of 0.800 kg of this sea water from 12.0 °C up to its boiling point. State the equation that you use.

(ii) The energy to raise the temperature in **(b)(i)** is supplied at the rate of 620 W.

Calculate the time taken to raise the sea water to its boiling point.

time = ...[2]

[Total: 12]

3 A certain substance is in the solid state at a temperature of –36 °C. It is heated at a constant rate for 32 minutes. The record of its temperature is given in Fig. 5.1.

time / min	0	1			10	14	18	22	24	26	28	30	32
temperature / °C	–36	–16	–9	–9	–9	–9	32	75	101	121	121	121	121

Fig. 5.1

(a) State what is meant by the term *latent heat*.

.....

..... [2]

(b) State a time at which the energy is being supplied as latent heat of fusion.

..... [1]

(c) Explain the energy changes undergone by the molecules of a substance during the period when latent heat of vaporisation is being supplied.

.....

.....

..... [2]

(d) **(i)** The rate of heating is 2.0 kW.

Calculate how much energy is supplied to the substance during the period 18 – 22 minutes.

energy supplied = ... [2]

(ii) The specific heat capacity of the substance is 1760 J/(kg °C).

Use the information in the table for the period 18 – 22 minutes to calculate the mass of the substance being heated.

mass heated = ... [3]

[Total: 10]

4 A technician has been asked to design a liquid-in-glass thermometer, using alcohol as the liquid.

(a) (i) State what is meant by the *sensitivity* of the thermometer.

.....

..... [1]

(ii) State one design feature the technician could use in order to ensure a very sensitive thermometer.

.....

..... [1]

(b) (i) State what is meant by the *range* of the thermometer.

.....

..... [1]

(ii) State one design feature that would ensure that the thermometer measured the desired range of temperatures.

.....

..... [1]

(c) (i) State what is meant by *linearity*, as it applies to the thermometer.

.....

..... [1]

(ii) State one design feature that would ensure linearity in the technician's thermometer.

.....

..... [1]

[Total: 6]

5 A student in a laboratory uses the apparatus shown in Fig. 4.1 to determine the specific heat capacity of aluminium.

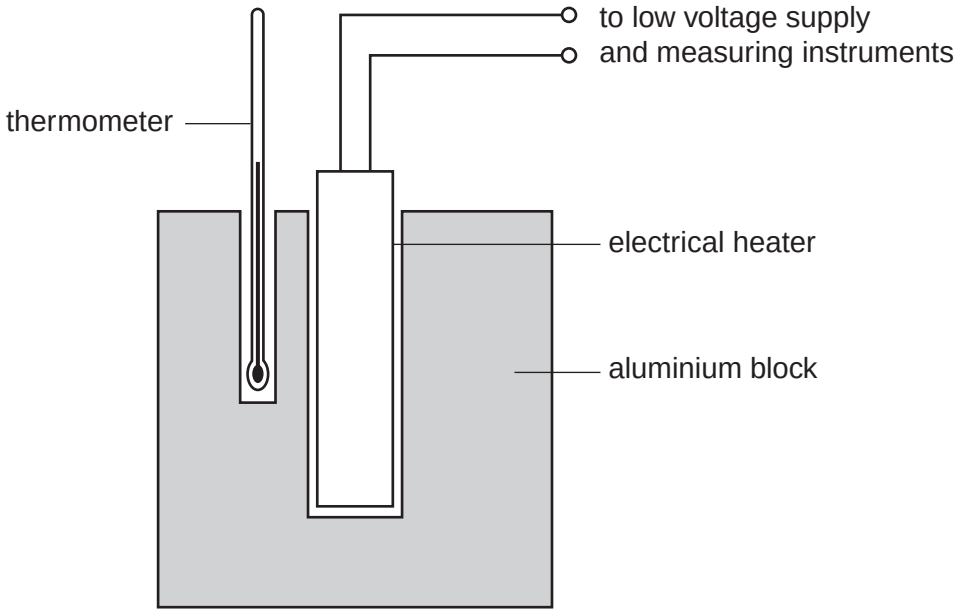

Fig. 4.1

The readings obtained in the experiment are given below.

mass of aluminium block = 0.930 kg

initial temperature of block = 13.1 °C

final temperature of block = 41.3 °C

electrical energy supplied = 23 800 J

(a) Define *specific heat capacity*.

.....

..... [2]

(b) Use the readings above to calculate the specific heat capacity of aluminium.

State the equation you use.

specific heat capacity = ... [3]

(c) Because the student knows it is good scientific practice to repeat readings, after a short time he carries out the experiment again, supplying the same quantity of electrical energy.

This time the temperature readings are:

initial temperature of block = 41.0 °C

final temperature of block = 62.1 °C

(i) Use these figures to calculate a second value for the specific heat capacity of aluminium.

specific heat capacity = ... [1]

(ii) The student did not make any mistakes when taking the readings.

Suggest why the second value for the specific heat capacity of the aluminium is greater than the first.

.....

..... [2]

(d) Suggest two ways of improving the experiment in order to give as accurate a result as possible.

1. .....

.....

2. .....

..... [2]

[Total: 10]