7 **(a)** A heating coil is connected to an alternating potential difference V, given by the expression

$$V = V_0 \sin(380t).$$

The potential difference V is measured in volts and the time t is measured in seconds.
The root-mean-square (r.m.s.) potential difference is 17V.

(i) Determine

1. the peak potential difference V_0,

V_0 = ... V [2]

2. the frequency f of the supply.

f = ... Hz [2]

(ii) The average current in the heating coil is zero.
Explain why there is a heating effect in the coil.

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.....[2]

(b) A student determines the specific heat capacity of water using the apparatus shown in Fig. 7.1.

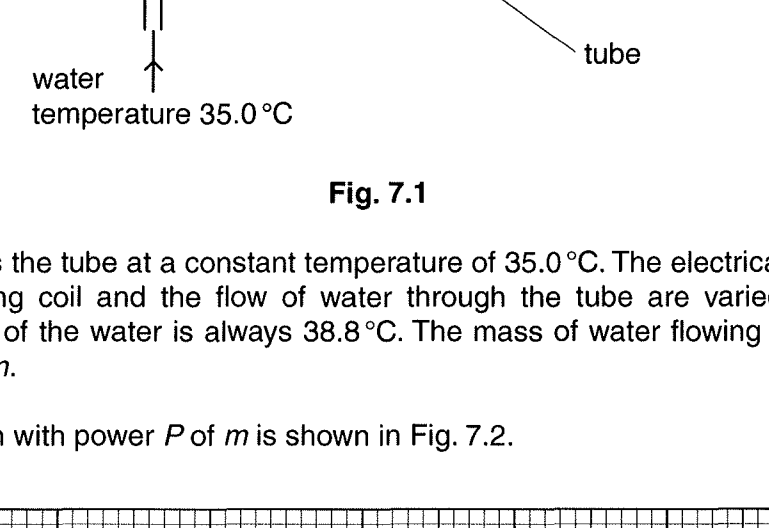

Fig. 7.1

Water enters the tube at a constant temperature of 35.0 °C. The electrical power P dissipated in the heating coil and the flow of water through the tube are varied so that the output temperature of the water is always 38.8 °C. The mass of water flowing through the tube per unit time is m.

The variation with power P of m is shown in Fig. 7.2.

Fig. 7.2

(i) Define *specific heat capacity.*

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.....[2]

(ii) Suggest why there is an intercept on the power axis of the graph of Fig. 7.2.

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.....[1]

(iii) Use Fig. 7.2 to determine a value for the specific heat capacity, in $J\,kg^{-1}\,K^{-1}$, of the water. Show your working.

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

(c) The experiment in **(b)** is repeated with water entering the tube at a temperature of 45.0 °C and leaving at 48.8 °C.

On the axes of Fig. 7.2, sketch a graph to show qualitatively the variation with power P of m. [2]

(d) The specific heat capacity of water is approximately constant.
The specific heat capacity of a gas depends on whether it is measured at constant volume or at constant pressure.

(i) State the first law of thermodynamics.

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.....[2]

(ii) Use the first law of thermodynamics to explain why the specific heat capacity of an ideal gas measured at constant volume is different to the specific heat capacity when measured at constant pressure.

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.....[3]