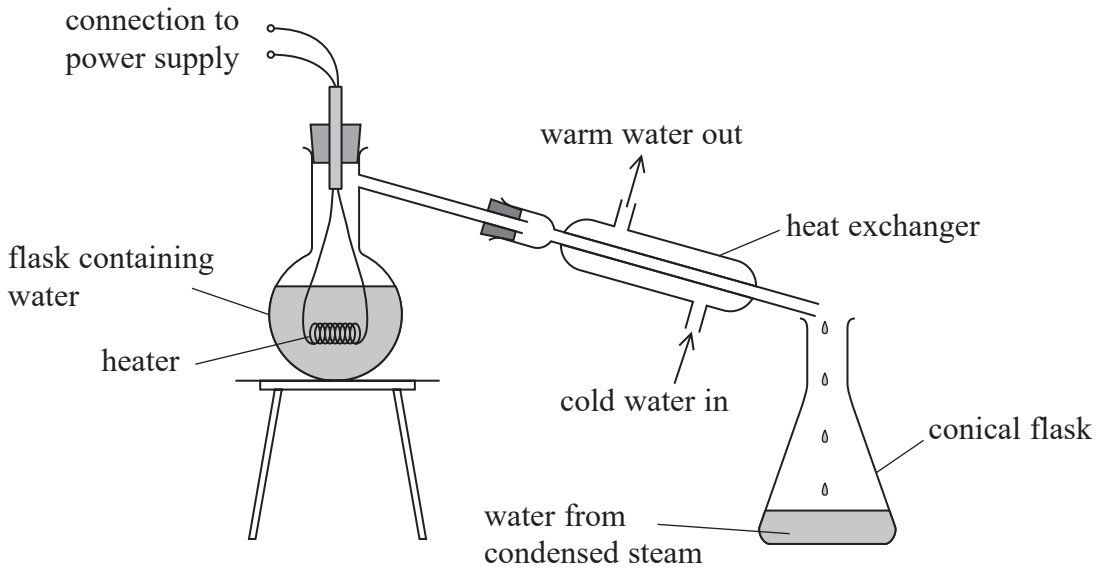
8 The apparatus shown can be used to determine a value for the specific latent heat of vaporisation of water.



(a) In one experiment the current in the heater was 8.20 A, and the potential difference across the heater was 230 V.

(i) Show that the power of the heater was about 2 kW.

(2)

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(ii) There was 0.655 kg of water in the flask at an initial temperature of 22.5 °C. The heater was switched on, and the water in the flask was heated to boiling point.

Calculate the minimum time taken for the water to be heated to 100.0 °C.

specific heat capacity of water = 4190 J kg^{-1} K^{-1}

(3)

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.....

Minimum time taken for water to be heated = ...

(b) The heater was left on and water continued to boil in the flask. The water was allowed to boil for a few minutes. The conical flask was then placed under the heat exchanger and water was collected in it.

(i) Give a reason why the water was left boiling for a few minutes before the conical flask was put in place.

(1)

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(ii) Water with a mass of 95.0 g was collected in a time of 125 s.

Calculate the rate of energy transfer in the heat exchanger.

specific latent heat of vaporisation of water = $2.26 \times 10^6\,J\,kg^{-1}$

(3)

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Rate of energy transfer in the heat exchanger = ...

(iii) Discuss your answers to (a)(i) and (b)(ii).

(3)

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(c) State how the apparatus could be modified to minimise the effect of a significant source of error.

(1)

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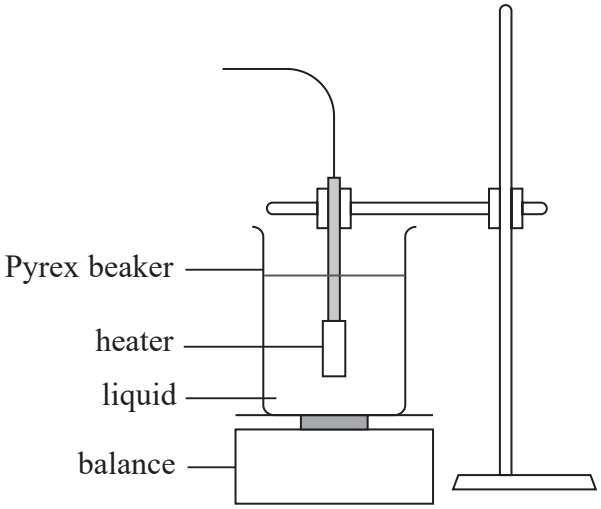
(Total for Question 8 = 13 marks)

6 A student determined the latent heat of vaporisation of a liquid using an electrical heater to boil the liquid in a Pyrex beaker.

The apparatus used is shown below.

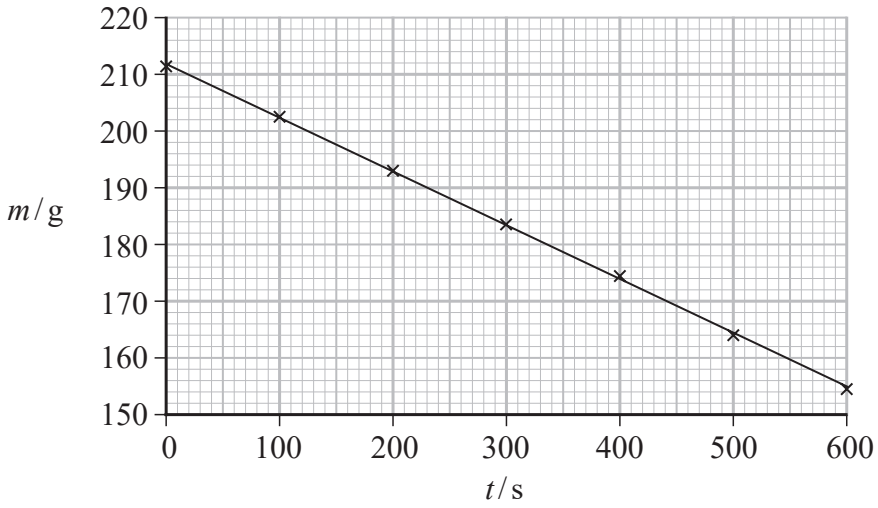


(a) She connected the heater into a circuit and took measurements of the potential difference V and the current I for the heater.

Complete the circuit diagram to show a suitable circuit.

(2)

(b) The student monitored the mass of the beaker and the liquid m over the time t for which the liquid was boiling. Her results are plotted on the graph.



The student used her graph to determine a value for the latent heat of the liquid in the beaker. She concluded that the liquid was pure water.

Liquid	Latent heat of vaporisation / MJ kg^{-1}
Pure water	2.26
Weak salt water solution	2.10
Strong salt water solution	2.00

Comment on the validity of the student's conclusion.

$V = 20.5\,\text{V}$

$I = 10.5\,\text{A}$

(7)

(c) Explain how this method might be modified to improve the accuracy of the student's conclusion.

(2)

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(Total for Question 6 = 11 marks)

8 A student investigated the rate at which a hot liquid transfers thermal energy to the surroundings. He placed hot water in a Pyrex beaker and measured the temperature of the water using a liquid-in-glass thermometer.

He obtained the following data for the temperature θ of the water at times t. He measured t using a stopwatch.

t / s	θ / °C		
0	95		
120	87		
240	81		
360	76		
480	71		

temperature of surroundings = 23 °C

Theory suggests that a liquid transfers internal energy to the surroundings at a rate proportional to the temperature difference $\Delta\theta$ between the liquid and the surroundings.

This leads to the expression

$$\Delta\theta = \Delta\theta_0 e^{-bt}$$

where b is a constant and $\Delta\theta_0$ is the initial temperature difference.

(a) Explain why a graph of ln $\Delta\theta$ against t should be a straight line.

(2)

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(b) (i) Plot a graph of ln $\Delta\theta$ against t on the grid opposite.
Use the columns provided in the table to show any processed data.

(5)

(ii) Determine the value of b.

(3)

$b =$ .....

(c) The student suggested that the experiment would have been more accurate if a temperature sensor and data logger had been used to collect the data.

Assess the validity of the student's suggestion.

(4)

(Total for Question 8 = 14 marks)

3 It was suggested on an online forum that it would be possible to cook a chicken by repeatedly slapping the chicken with one hand.

It was claimed that the energy transferred to a chicken in 8000 slaps would be sufficient to raise the temperature of the chicken from 23 °C to 165 °C.

In an investigation to test the claim, the effective mass of the hand was taken as 1.75 kg and the speed of the hand just before impact with the chicken as 6.25 m s^{-1}.

(a) Deduce whether the data confirms that 8000 slaps would be sufficient.
Assume that no energy is transferred from the chicken to the surroundings.

mass of chicken = 0.875 kg
specific heat capacity of chicken = 1770 J kg^{-1} K^{-1}
efficiency of energy transfer from the hand = 65%

(5)

(b) Explain whether the assumption made in (a) is realistic.

(2)

(Total for Question 3 = 7 marks)