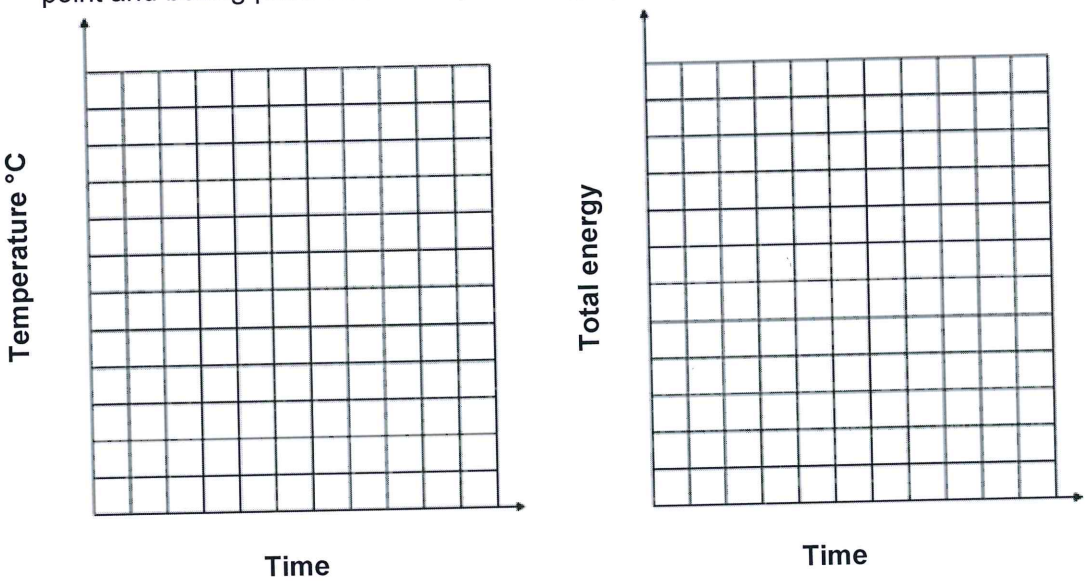
Answer 1

(5 marks)

An experiment is conducted in which 500 mL of ice at 0.00°C is placed into a beaker. An electric heater with a constant power output is used to heat the beaker.

(a) Sketch graphs on the axes below showing the temperature change over time, and the energy input over time, as the ice is melted and then brought to a boil. Label melting point and boiling point on the temperature graph. (3 marks)



(b) The experiment was repeated with a small fan placed on the top of the beaker. Explain how this would affect the melting and boiling results. (2 marks)

Description	Marks
(a) Temperature graph – flat, positive linear, flat	1
Any 2 points (minimum) included, e.g. melting, heating, boiling	1
Total energy input, should be positive linear	1
(b) fan would increase melting rate as warm air flow increases	1
Though boiling would take longer as fan cools water	1
	Total 5

Answer 2

(13 marks)

A modified Joule's heat apparatus, shown in the figure below, can be used to determine the specific heat capacity of an unknown liquid. A 40.0 watt 12.0 volt DC motor provides the necessary energy input to the oil through the motion of the cable and paddle. A student wants to use this apparatus to distinguish whether a liquid is olive oil or generic vegetable oil. 0.500 kg of oil is used in the experiment.

(a) Draw a free body diagram showing the forces acting on the frictionless pulley. (2 marks)

Description	Marks
Horizontal and Vertical Tensions	1
Force from 45° beam	1
	Total 2

(b) During one trial, the DC motor winds up the cable at a constant velocity for 50 seconds. Calculate the work done by the motor. (2 marks)

Description	Marks
$W_{DC\ motor} = Pt = 40 \times 50$	1
$= 2000$ J	1
	Total 2

(c) Using previous experimental results, the device was determined to have an 80% energy conversion efficiency from the electric motor to the oil.

(i) Explain what 'efficiency' means in this context. (2 marks)

(ii) Using information from parts (b) and (c), calculate the energy input into the oil. (1 mark)

(iii) What is one possible source of energy loss in the system? (1 mark)

Description	Marks
(i) That some of the energy is lost to the environment	1
Only 80% of the energy makes it from the motor to the oil	1
(ii) $2000 \times 0.8 = 1600$ J	1
(iii) any reasonable answer (Friction at the spindle; some heat lost to the environment.)	
	Total 4

(d) After several more trials, the results of this experiment are averaged and can be summarised as

'the temperature of this oil is raised 1.7°C from an energy input to the oil of 1.8×10^3 J'.

(i) Calculate the specific heat capacity of the liquid using these values. (3 marks)

(ii) A search on the internet finds the specific heat capacities for olive oil and generic vegetable oil listed as 1.97×10^3 and 1.67×10^3 J kg^{-1} K^{-1}, respectively. Explain which oil you think is in the apparatus. (2 marks)

Description	Marks
(i) $Q = mc\Delta T \Rightarrow c = Q / m\Delta T$	1
$= 1800$ J/0.5 kg $\times$ 1.7°C	1
$= 2.12$ (kJ/kg K)	1
(ii) Olive oil. It is closer to theoretical value.	1-2
	Total 5