Question 1

(18 marks)

Pat often makes a hot cup of tea. She brings the water to the boil at 100 °C and adds it to the tea leaves. As the tea brews for a few minutes, it cools to 90.0 °C. This is still too hot to drink so Pat pours the tea into a cup and blows on the surface of the tea until it cools to 65.0 °C.

(a) Define the term 'internal energy'. (2 marks)

(b) Calculate the heat energy lost to the environment as 0.250 kg of tea in the cup cooled down from 90.0 °C to 65.0 °C. Assume that the specific heat capacity of tea is the same as that for water. (2 marks)

(c) Use the kinetic theory to explain why blowing on the surface of the tea helps the tea to cool down quickly. (5 marks)

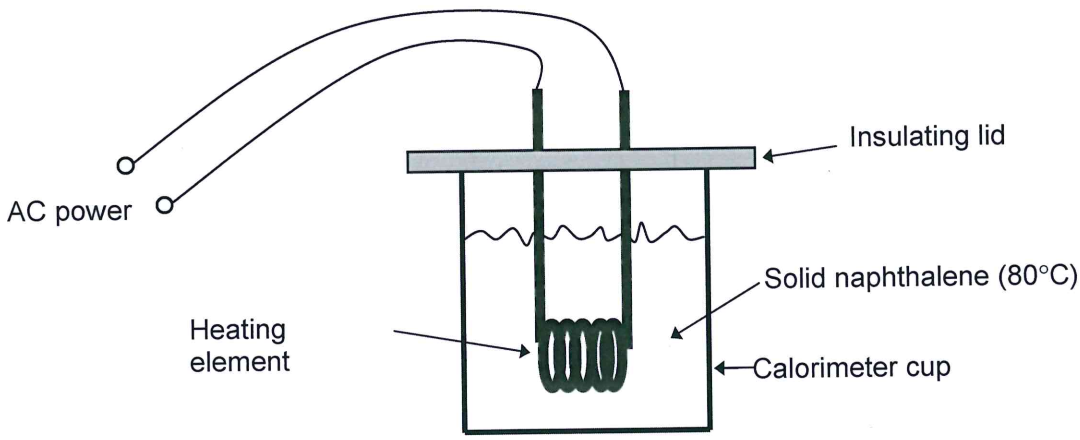
On hot days, Pat makes iced tea by adding ice cubes at 0.00 °C to the pot of freshly brewed tea, cooling it from 90.0 ° to 0.00 °C.

(d) If the amount of liquid in the teapot was 0.250 kg, calculate the difference in internal energy between tea at 90.0 °C and iced tea at 0.00 °C. (2 marks)

Question 2

(17 marks)

Hayley investigated the accuracy of the stated power rating on a heating element that was marked '100 W'. She placed solid naphthalene at its melting point of 80.0°C in a calorimeter cup at 80.0°C together with the heating element, and timed how long it took to melt varying amounts of naphthalene.



She collected the following results:

Mass of naphthalene (kg)	Time to melt (s)
0.150	288
0.250	480
0.350	670
0.450	865
0.550	1055

L_f (naphthalene) = 1.48×10^5 J kg^{-1}

She then used the following relationship to decide how to plot the data:

$$P = \frac{Q}{t} = \frac{mL_f}{t}$$

She used the gradient of the line from her plot to calculate the actual power output of the heating element.

(a) Draw a clearly-labelled graph on the graph paper provided on page 19. Plot time on the x-axis and mass on the y-axis. (5 marks)

(b) From the graph, obtain the gradient of the line you have plotted. Show all workings and include the units in your answer. (5 marks)

(c) Use the gradient of the graph and the equation to calculate the power output of the heating element. (3 marks)

(d) From the graph, determine the time taken to melt 0.300 kg of naphthalene. (2 marks)

(e) Would you expect the calculated power rating to be higher or lower than the true power rating (not the rating printed on the heating element)? Explain your answer. (2 marks)

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Question 3

(4 marks)

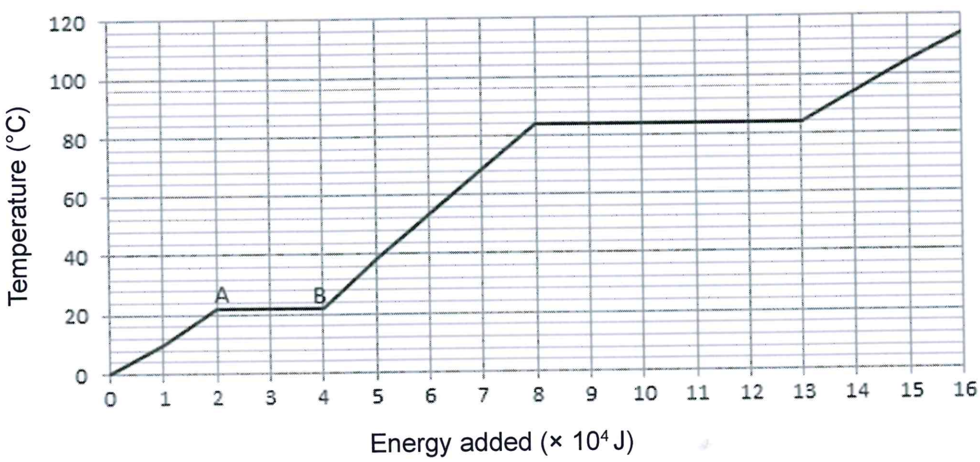
A plastic iceblock tray containing 250 mL of water, initially at 18°C, is placed in the freezer compartment of a refrigerator. How much heat must be lost from this water when it has all become ice at 0°C?

Question 4

(16 marks)

A 0.680 kg solid sample of an unknown substance is heated slowly while inside an insulated container. The graph below illustrates the heating curve of this substance.

Heating curve for 0.680 kg of an unknown substance



(a) State the temperature at which

(i) the substance boils. (1 mark)

Answer: ________________

(ii) the substance melts. (1 mark)

Answer: ________________

(b) Explain why the temperature remains constant between Points A and B on the graph even though energy has been added. Your answer should demonstrate your understanding of phase change and temperature at a particle level. (6 marks)

(c) Calculate the latent heat of vaporisation of this substance, and give the correct units. (4 marks)

(d) Calculate the specific heat capacity of this substance in the liquid phase. (4 marks)

Question 5

(4 marks)

One of the original theories of heat involved the concept of heat being contained in an object and, when the object was cut, the heat contained in the object being released. Drilling holes in cannons challenged this theory. As the drill bit becomes duller, the cannon and drill bit get hotter and it takes longer to drill a hole to the right depth.

(a) Explain why the cannon gets hotter when the drill becomes less sharp. (2 marks)

(b) Water is used when drilling holes through rock during mining operations to keep the drill bit from overheating. If 0.150 litres of the cooling water (initially at 100°C) was evaporated, how much energy was removed from the drill? (2 marks)

Question 6

(4 marks)

A 25.0 gram cube of ice, initially at 0.00°C, fell on a bench and melted.

(a) Calculate the energy required to change the ice cube from a solid to a liquid. (2 marks)

(b) Describe briefly what happened to the particles of the bench that were in contact with the ice cube as it melted. (2 marks)