Guided Ex. 2 Pg 351 Francis

Q1

A solid aluminium block of mass 1.5 kg is heated for 7.5 minutes by an electric immersion heater embedded in the block. The mean values of the current through the heater and p.d. across it are 2.5 A and 12.0 V respectively. Assuming that the heat losses and the heat capacity of the heater are negligible, calculate the temperature rise of the block. (Mean specific heat capacity of aluminium = 9.1×10^2 J kg^{-1} K^{-1})

Q2

A copper tube of mass 110 g is heated to a temperature of 100 °C and then rapidly transferred to a well insulated aluminium can of mass 80 g containing 200 g of water at 10 °C. If the final temperature of the cube and water (after stirring) is 14 °C, calculate the specific heat capacity of the copper. You may assume that the heat loss to the surroundings is negligible.
(Mean specific heat capacities for water and aluminium are 4.2×10^3 J kg^{-1} K^{-1} and 9.1×10^2 J kg^{-1} K^{-1} respectively)

Q3

A small electric immersion heater is used to heat up 200 g of milk in a baby's feeding bottle. The heater operates at a p.d. if 240 V and takes a current of 1.0 A. If the bottle is wrapped in a thick towel during heating so that heat loss to the surroundings may be taken as negligible, how long does it take for the temperature of the milk to rise from 18 °C to 38 °C ? The bottle has a heat capacity of 24 J K^{-1} and the specific heat capacity of the milk used is 3.9×10^3 J kg^{-1} K^{-1}.

Guided Ex. 3 Pg 354 Francis

Q1

Calculate the mass of ice which melts when 2.5 kg of cabbage at a temperature of 20 °C is mixed with ice and water at 0 °C in a well insulated container. You may assume that heat loss to the surroundings is negligible and that all the cabbage is cooled to 0 °C. (Specific heat capacity of cabbage = 2.0×10^3 J kg^{-1} K^{-1} ; specific latent heat of fusion of ice = 3.4×10^5 J kg^{-1})

Q2

Calculate the total amount of heat which is given out when 200 g of steam condenses to water at 40 °C. (Specific heat capacity of water = 4.2×10^3 J kg^{-1} K^{-1} and specific latent heat of steam = 2.26×10^6 J kg^{-1})

Q3

To ensure that there is no shortage of ice at a party, a girl pours 3×10^3 ml of water at 24 °C into a large plastic bag which she then ties securely and places in the freezer. If it can be assumed that the heat capacity of the bag is negligible and it takes 50 minutes for all the water to freeze, calculate the rate at which the freezer extracts heat from the water. (Density of water = 1.0×10^3 kg m^{-3} ; 1 m^3 = 10^6 ml; specific heat capacity of water = 4.2 x 10^3 J kg^{-1} K^{-1} ; specific latent heat of fusion of ice = 3.37×10^5 J kg^{-1})

Q4

In an experiment to find the specific latent heat of vaporisation (l_v) of ethanol a student collects 4.8 g of condensed ethanol in 60 s when electric heater current and p.d. were 3.0 A and 24 V respectively.

(a) Calculate the value of l_v for ethanol from these results.

(b) The student feels that the value obtained in (a) is too high and decides to obtain a more accurate value by repeating the experiment using new current and p.d. values of 2.5 A and 20.0 V. He then collects 3.25 g of condensed ethanol in 60 s. Use both sets of results to obtain a new value for l_v.

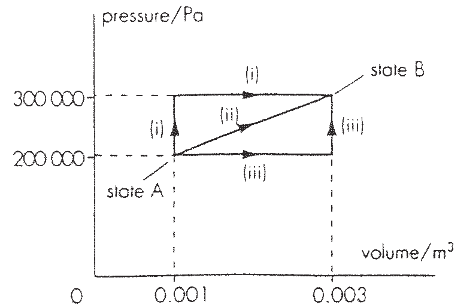
Q5

A fixed mass of an ideal gas has its state changed from state A to state B as shown in the table.

Change-of-state data

STATE	PRESSURE/Pa	VOLUME/m^3	TEMPERATURE/K	INTERNAL ENERGY/J
A	200 000	0.0010	100	300
B	300 000	0.0030	450	1350

Find how much heat has been supplied to the gas, and how much work has been done on it, if the change of state is carried out in the 3 different ways, (i) to (iii), as shown on the pressure-volume graph.



A diagram showing change in pressure with volume for three different ways of changing the state of a gas. This is called an 'indicator diagram'

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Q 5

5 Use the following physical data for ice, water and steam when necessary in answering this question.

	ice	*water*	*water*	*steam*
temperature	0 °C	0 °C	100 °C	100 °C
volume occupied by 1 kg at standard pressure / m^3	0.00109	0.00100	0.00104	1.67
kinetic energy of all the molecules in 1 kg / 10^5 J	1.89	1.89	2.58	2.58
potential energy of all the molecules in 1 kg (referred to ice at 0 °C) / 10^5 J	0	3.36	3.41	24.3
internal energy of 1 kg / 10^5 J	1.89	5.25	5.99	26.9

(a) In terms of the spacing of molecules, account qualitatively for the changes in volume which take place when 1 kg of ice is heated until it becomes 1 kg of steam. [4]

(b) Explain why there is no change in the kinetic energy of the molecules when ice at 0 °C changes to water at 0 °C. [2]

(c) What determines the internal energy of 1 kg of the substance? [2]

(d) Determine the specific latent heat of fusion of ice. [2]

(e) Calculate how much work has to be done by 1 kg of water in order to change to steam at 100 °C and at atmospheric pressure of 1.01×10^5 Pa. [3]

(f) Use the first law of thermodynamics to calculate the specific latent heat of vaporisation of water. [3]

(g) Outline an electrical method to determine the specific latent heat of vaporisation of water. [4]

so greater current is supplied.
(at fixed 25 kV supply)

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2 **(d)** Fig. 2.1 shows data for ethanol.

density	$0.79\ g\ cm^{-3}$
specific heat capacity of liquid ethanol	$2.4\ J\ g^{-1}\ K^{-1}$
specific latent heat of fusion	$110\ J\ g^{-1}$
specific latent heat of vaporisation	$840\ J\ g^{-1}$
melting point	$-120\ °C$
boiling point	$78\ °C$

Fig. 2.1

Use the data in Fig. 2.1 to calculate the thermal energy required to convert $1.0\ cm^3$ of ethanol at 20 °C into vapour at its normal boiling point. [6]

(e) (i) State the *first law of thermodynamics*.

(ii) Suggest why there is a considerable difference in magnitude between the specific latent heats of fusion and vaporisation.

[5]

For Examiner's Use

2 Some water in a saucepan is boiling.

(a) Explain why

(i) external work is done by the boiling water,

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....

....

(ii) there is a change in the internal energy as water changes to steam.

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....

[5]

(b) By reference to the first law of thermodynamics and your answers in (a), show that thermal energy must be supplied to the water during the boiling process.

....

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....[2]