(a) State an expression, in terms of work done and heating, that is used to calculate the increase in internal energy of a system.

$\Delta U = +\Delta Q + \Delta W$, where ΔQ is heat added to system and ΔW is work done on the system.

[2]

(b) State and explain, in terms of your expression in **(a)**, the change, if any, in the internal energy

(i) of the water in an ice cube when the ice melts, at atmospheric pressure, to form a liquid without any change of temperature,

Vol decreases so work is done on the system and no change in Temp so energy is being used in breaking the bonds. thus ΔU will increases

[3]

(ii) of the gas in a tyre when the tyre bursts so that the gas suddenly increases in volume. Assume that the gas is ideal.

No time for heat exchange thus $\Delta Q = 0$
work is done against the atmosphere so
ΔW is -ve thus ΔU decreases

[3]

(a) Define *specific latent heat.*

Thermal energy required to change the state of a unit mass of a substance at a constant temp

[2]

(b) A beaker containing a liquid is placed on a balance, as shown in Fig. 3.1.

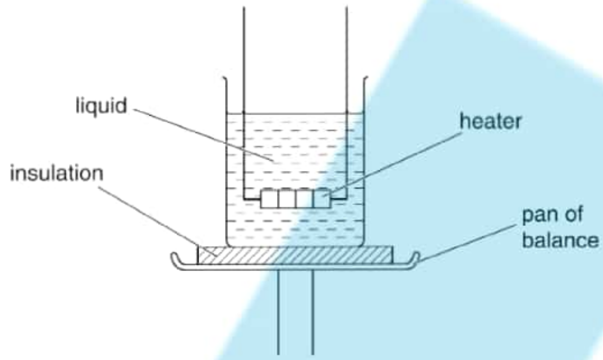

Fig. 3.1

A heater of power 110W is immersed in the liquid. The heater is switched on and, when the liquid is boiling, balance readings *m* are taken at corresponding times *t*.

A graph of the variation with time *t* of the balance reading *m* is shown in Fig. 3.2.

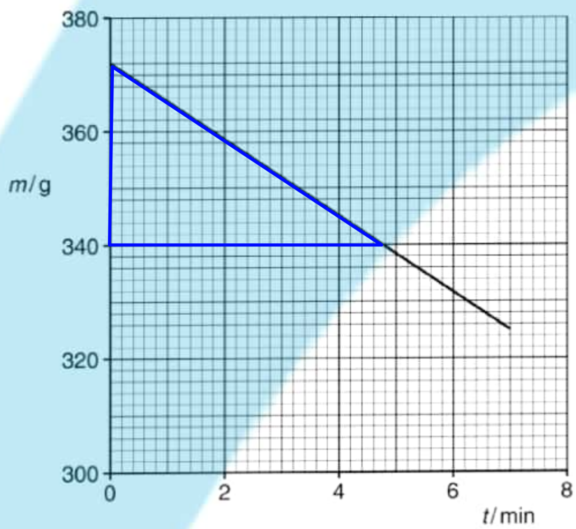

Fig. 3.2

(i) State the feature of Fig. 3.2 which suggests that the liquid is boiling at a steady rate.

straigh line

[1]

(ii) Use data from Fig. 3.2 to determine a value for the specific latent heat *L* of vaporisation of the liquid.

$$P \times t = \Delta m L$$

$$110 \times 4.8 \times 60 = \frac{372 - 340}{1000} \times L$$

$$\frac{31680}{0.032} = L \qquad L = 9.9 \times 10^5$$

L = 9.9×10^5 $J kg^{-1}$ [3]

(iii) State, with a reason, whether the value determined in **(ii)** is likely to be an overestimate or an underestimate of the normally accepted value for the specific latent heat of vaporisation of the liquid.

overestimate as heat is lost to sorrunding for that

[2]

(a) State what is meant by *specific latent heat.*

....

....

.... [2]

(b) A beaker of boiling water is placed on the pan of a balance, as illustrated in Fig. 2.1.

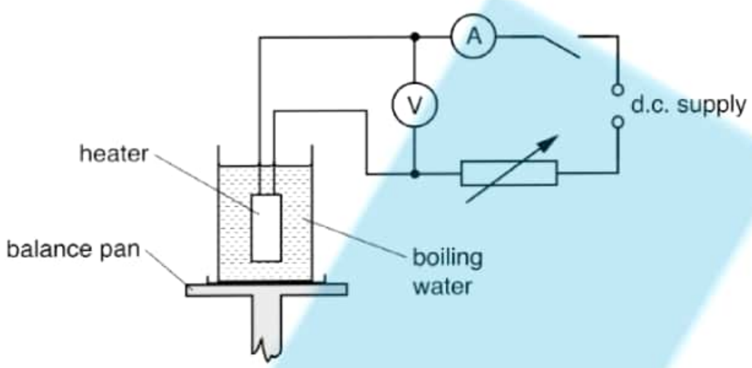

Fig. 2.1

The water is maintained at its boiling point by means of a heater.
The change *M* in the balance reading in 300 s is determined for two different input powers to the heater.
The results are shown in Fig. 2.2.

voltmeter reading / V	ammeter reading / A	*M* / g
11.5	5.2	5.0
14.2	6.4	9.1

Fig. 2.2

(i) Energy is supplied continuously by the heater.
State where, in this experiment,

1. external work is done,

on the atmosphere

....

2. internal energy increases. Explain your answer.

the potential energy of the molecule is increasing as they are changing into gas

[3]

(ii) Use data in Fig. 2.2 to determine the specific latent heat of vaporisation of water.

$11.5 \times 5.2 \times 300 = 5 \times L + H$

$1.794 \times 10^4 = 5L + H$

$2.7264 \times 10^4 = 9.1L + H$

$(2.7264 - 1.794) \times 10^4 = 4.1L$

$L = 2.3 \times 10^3$

$14.2 \times 6.4 \times 300 = 9.1 \times L + H$

specific latent heat = 2300 $J g^{-1}$ [3]

[Total: 8]

(a) State what is meant by the *internal energy* of a system.

....

....

....

.... [2]

(b) An ideal gas undergoes a cycle of changes as shown in Fig. 2.1.

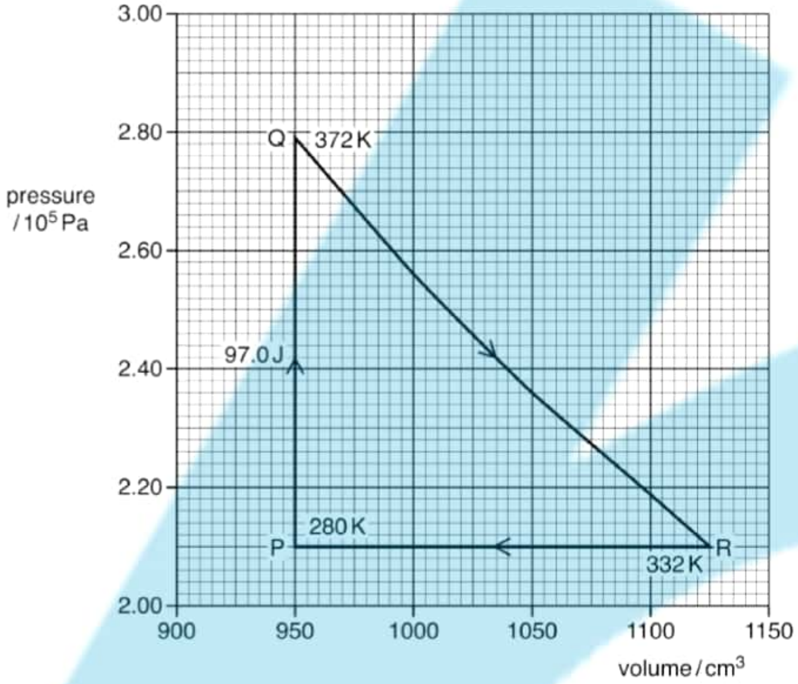

Fig. 2.1

At point P, the gas has volume 950 cm^3, pressure 2.10×10^5 Pa and temperature 280 K.

The gas is heated at constant volume and 97.0 J of thermal energy is transferred to the gas. Its pressure and temperature change so that the gas is at point Q on Fig. 2.1.

The gas then undergoes the change from point Q to point R and then from point R back to point P, as shown on Fig. 2.1.

Some energy changes that take place during the cycle PQRP are shown in Fig. 2.2.

$x + 37 = -$

	change P → Q	change Q → R	change R → P
thermal energy transferred to gas / J	+97.0	0	-91.5
work done on gas / J	0	−42.5	+37.0
increase in internal energy of gas / J	+97	-42.5	-54.5

Fig. 2.2

$97 + (-42.5) + x = 0$
$x = -54.5$

(i) State the total change in internal energy of the gas during the complete cycle PQRP. Explain your answer.

$\Delta U = 0$ because there is no change in PE and KE

.... [2]

(ii) On Fig. 2.2, complete the energy changes for the gas during

1. the change P → Q,

2. the change Q → R,

3. the change R → P.

[5]

(a) A student states, quite wrongly, that temperature measures the amount of thermal energy (heat) in a body.

State and explain two observations that show why this statement is incorrect.

1. When the substance is changing state at constant temp, the thermal energy input is still there.

2. When 2 objects of different mass are at same temp and of same material they would have different heat losses.

[4]

(b) A thermometer and an electrical heater are inserted into holes in an aluminium block of mass 960 g, as shown in Fig. 3.1.

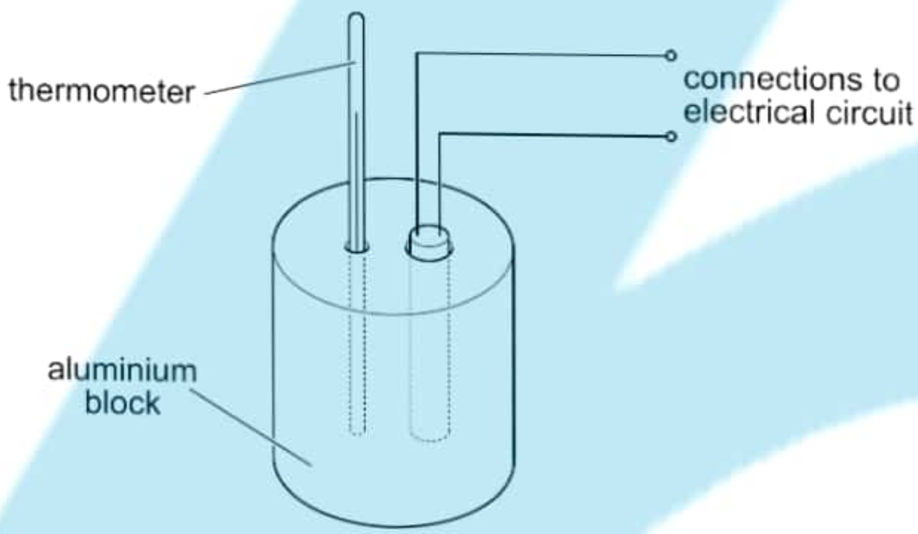

Fig. 3.1

The power rating of the heater is 54 W.

The heater is switched on and readings of the temperature of the block are taken at regular time intervals. When the block reaches a constant temperature, the heater is switched off and then further temperature readings are taken. The variation with time t of the temperature θ of the block is shown in Fig. 3.2.

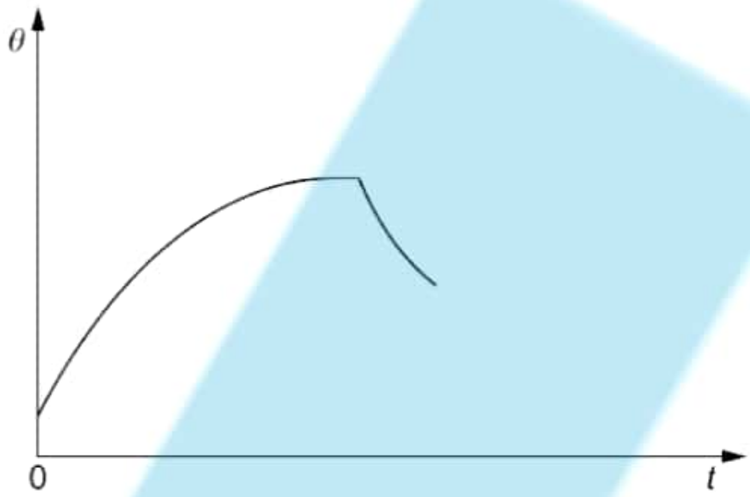

Fig. 3.2

(i) Suggest why the rate of rise of temperature of the block decreases to zero.

the energy lost to sorrundings is equal to the rate of increase in thermal energy

[2]

(ii) After the heater has been switched off, the maximum rate of fall of temperature is 3.7 K per minute.

Estimate the specific heat capacity of aluminium.

$54 \times 60 = mc\Delta t$

$54 \times 60 = 0.96 \times c \times 3.7$

912

910

$c = \frac{Q}{m\Delta t}$

specific heat capacity = 910 J kg^{-1} K^{-1} [3]