Thermal Properties - 2021 A2

1. Nov/2021/Paper_41/No.3

(a) Define *specific heat capacity*.

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.....

..... [2]

(b) A sealed container of fixed volume V contains N molecules, each of mass m, of an ideal gas at pressure p.

(i) State an expression, in terms of V, N, p and the Boltzmann constant k, for the thermodynamic temperature T of the gas.

..... [1]

(ii) Show that the mean translational kinetic energy E_K of a molecule of the gas is given by

$$E_K = \frac{3}{2}kT.$$

[2]

(iii) Explain why the internal energy of the gas is equal to the total kinetic energy of the molecules.

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..... [2]

(c) The gas in **(b)** is supplied with thermal energy Q.

(i) Explain, with reference to the first law of thermodynamics, why the increase in internal energy of the gas is Q.

.....

.....

..... [2]

(ii) Use the expression in **(b)(ii)** and the information in **(c)(i)** to show that the specific heat capacity c of the gas is given by

$$c = \frac{3k}{2m}.$$

[2]

(d) The container in **(b)** is now replaced with one that does not have a fixed volume. Instead, the gas is able to expand, so that the pressure of the gas remains constant as thermal energy is supplied.

Suggest, with a reason, how the specific heat capacity of the gas would now compare with the value in **(c)(ii)**.

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..... [2]

[Total: 13]

2. March/2021/Paper_42/No.3

(a) Using a simple kinetic model of matter, describe the structure of a solid.

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..... [2]

(b) The specific latent heat of vaporisation is much greater than the specific latent heat of fusion for the same substance.
Explain this, in terms of the spacing of molecules.

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..... [1]

(c) A heater supplies energy at a constant rate to 0.045 kg of a substance. The variation with time of the temperature of the substance is shown in Fig. 3.1. The substance is perfectly insulated from its surroundings.

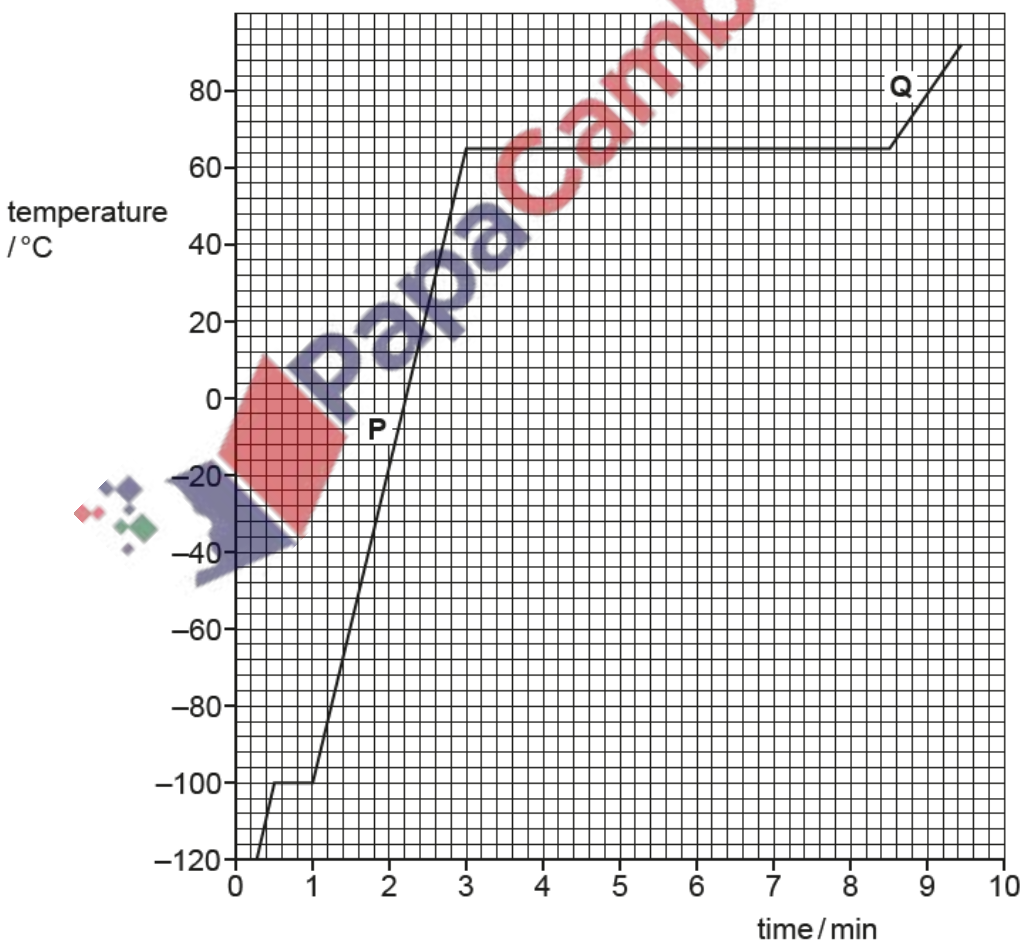

Fig. 3.1

(i) Determine the temperature at which the substance melts.

temperature = ... °C [1]

(ii) The power of the heater is 150 W.
Use data from Fig. 3.1 to calculate, in $kJ\,kg^{-1}$, the specific latent heat of vaporisation L of the substance.

L = ... $kJ\,kg^{-1}$ [3]

(iii) Suggest what can be deduced from the fact that section **Q** on the graph is less steep than section **P**.

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..... [1]

[Total: 8]