Thermal Physics – 2021/20 GCE Physics A Component 01

1. Nov/2021/Paper_H556_01/No.4

The freezing point of ethanol is 159 K.

What is 159 K in °C?

A −432 °C

B −114 °C

C 114 °C

D 432 °C

Your answer ☐ **[1]**

2. Nov/2021/Paper_H556_01/No.9

A piston has a fixed amount of trapped ideal gas.

The gas exerts pressure p and has volume V. The thermodynamic (absolute) temperature of the gas is T. The mass of each atom is m. There are N atoms of the gas. The Boltzmann constant is k.

What quantities are required to determine the root mean square speed $\sqrt{\overline{c^2}}$ of the atoms?

A k and T

B p and V

C p, V and T

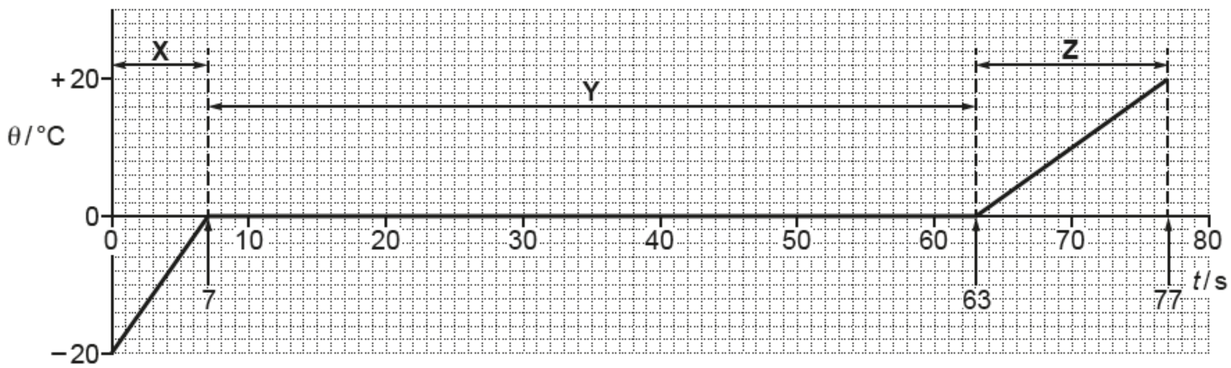
D p, V, N and m

Your answer ☐ **[1]**

3. Nov/2021/Paper_H556_01/No.18

A 150 W heater is used to heat 25 g of ice in a sealed and well-insulated container. The initial temperature of the ice is –20 °C.

The graph shows the variation of temperature θ with time t as the ice is heated.



There are three distinct regions of the graph, **X**, **Y** and **Z**.

(a) **(i)** Use the graph to determine the specific heat capacity c of the ice.

c = ... $\text{J kg}^{-1}\,\text{K}^{-1}$ **[3]**

(ii) Use the graph to determine the specific latent heat of fusion of ice L_f.

L_f = ... J kg^{-1} **[2]**

4. Nov/2020/Paper_H556_01/No.15

The kinetic theory of matter is a model used to describe the behaviour of particles (atoms or molecules) in an ideal gas. There are a number of assumptions made in the kinetic model for an ideal gas.

Which one of the following assumptions is **not** correct?

A The collisions of particles with each other and the container walls are perfectly inelastic.

B The electrostatic forces between particles are negligible except during collisions.

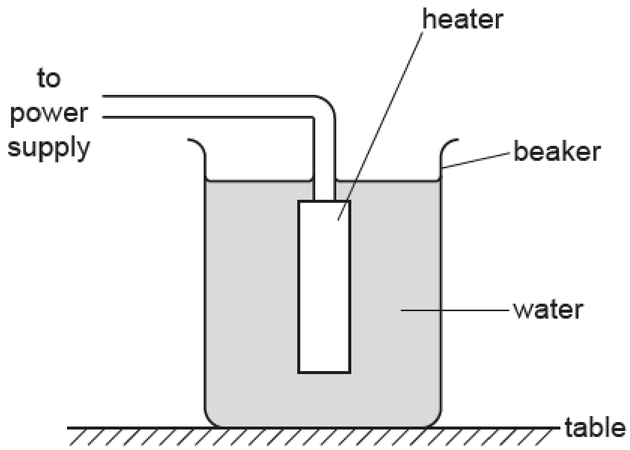
C The particles occupy negligible volume compared to the volume of the gas.

D There are a large number of particles in random motion.

Your answer ☐ **[1]**

5. Nov/2020/Paper_H556_01/No.17

(a) A heater is used to heat water in a beaker.



(i) Before switching on, the metal heater and the water are both at room temperature.

Describe the motion of the atoms of the metal heater and of the water molecules.

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.... **[3]**

(ii) The heater is now switched on.
The power of the heater is 200 W.
The mass of the water in the beaker is 500 g.
It takes 10.0 minutes to increase the temperature of the water in the beaker from 20 °C to 60 °C.

Calculate the energy transferred from the water to the **beaker and the surroundings**.

- specific heat capacity of water = 4200 $J\,kg^{-1}\,K^{-1}$

energy transferred = ... J **[3]**

(b)* A student is carrying out an experiment to determine the specific latent heat of fusion L_f of ice. The student has two sets of apparatus next to each other on the laboratory bench, as shown in **Fig. 17.1** and **Fig. 17.2**.

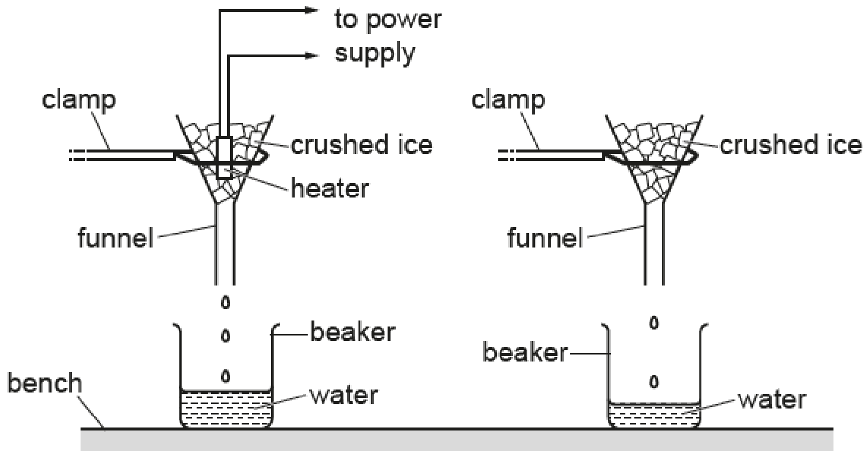

Fig. 17.1 **Fig. 17.2**

Both funnels are identical and have the same mass of crushed ice at 0 °C.

The current in the heater is 5.0 A and the potential difference across it is 12 V.

Fig. 17.3 shows the variation of mass of water m collected in each beaker with time t.

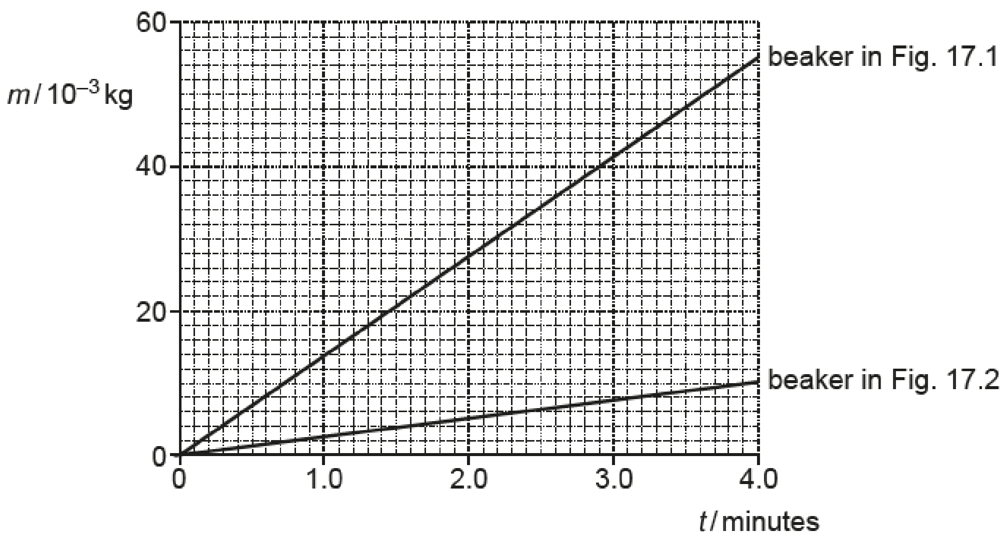

Fig. 17.3

Describe and explain the shape of the two graphs in **Fig. 17.3** and use them to determine the specific latent heat of fusion L_f of ice. **[6]**

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Additional answer space if required

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6. Nov/2021/Paper_H556_03/No.4(a)

This question is about an electric cooker, which consists of an oven and an electromagnetic induction hob.

***(a)** The oven is not sealed, so the air inside remains at atmospheric pressure of 1.0×10^5 Pa. The volume of the oven is $0.065\,m^3$. The air inside the oven behaves as an ideal gas.

The temperature of the oven increases from room temperature to 200 °C.

Show that the internal energy of the air in the oven is the same at **all** temperatures of the oven. Support your answer with an explanation of the motion of the air molecules in terms of kinetic theory. **[6]**

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7. Nov/2020/Paper_H556_03/No.4(c)

(c) Use the information in **(b)(ii)** and the data below to show that the root mean square (r.m.s.) speed of the air molecules inside the ISS is approximately 15 times smaller than the orbital speed of the ISS.

- molar mass of air = $2.9 \times 10^{-2}\,\text{kg}\,\text{mol}^{-1}$
- temperature of air inside the ISS = 20 °C

[3]