Test on Kinetic Theory and Thermal Energy

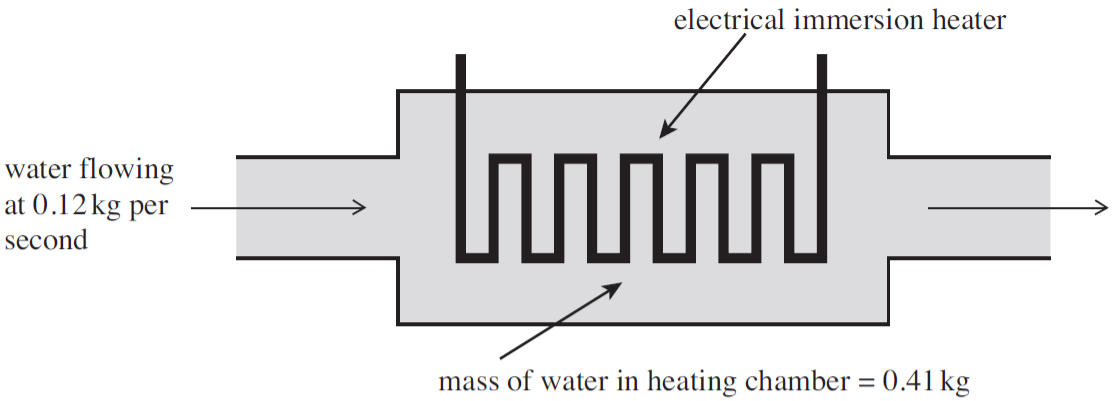
Instructions to students

- *You must write in **black** pen or ballpoint.*
- *This assignment consists of past questions from examination papers. You need to answer the questions fully in the spaces.*
- *You are expected to use a calculator.*
- *You are reminded of the need for good English and clear presentation.*

1 Jun 2012 PHYA5 Q 1

An electrical immersion heater supplies 8.5 kJ of energy every second. Water flows through the heater at a rate of 0.12 kg s^{-1} as shown in **Figure 1**.

Figure 1



(a) Assuming all the energy is transferred to the water, calculate the rise in temperature of the water as it flows through the heater.

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

answer = ... K

(2 marks)

(b) The water suddenly stops flowing at the instant when its average temperature is 26 °C. The mass of water trapped in the heater is 0.41 kg.

Calculate the time taken for the water to reach 100 °C if the immersion heater continues supplying energy at the same rate.

answer = ... s

(2 marks)

2 Jun 2012 PHYA5 Q4

The pressure inside a bicycle tyre of volume $1.90 \times 10^{-3}\ m^3$ is 3.20×10^5 Pa when the temperature is 285 K.

(a) (i) Calculate the number of moles of air in the tyre.

answer = ... mol
(1 mark)

(a) (ii) After the bicycle has been ridden the temperature of the air in the tyre is 295 K.
Calculate the new pressure in the tyre assuming the volume is unchanged.
Give your answer to an appropriate number of significant figures.

answer = ... Pa
(3 marks)

(b) Describe **one** way in which the motion of the molecules of air inside the bicycle tyre is similar and **one** way in which it is different at the two temperatures.

similar .....

.....

different .....

.....
(2 marks)

3 Jun 2008 PA02 Q5

(a) 6.7 mol of an ideal gas in a rigid container exerts a pressure of 110 kPa at a temperature of 25°C.

(a) (i) Calculate the volume of the container.

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(a) (ii) Calculate the average kinetic energy of a molecule of the gas.

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(a) (iii) Deduce the pressure exerted by the gas if the average kinetic energy of the gas molecules is doubled.

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(5 marks)

(b) Two of the assumptions about the behaviour of the molecules of an ideal gas are that they move with *random motion* and make *elastic collisions* with the walls of the container.

State and explain what is meant by

(b) (i) random motion,

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(b) (ii) elastic collisions.

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(3 marks)

4 (Jun 2007 PA02 Q4)

Ice of mass 22 g at temperature –12 °C is taken from a freezer and placed in a polystyrene cup containing water at a temperature 22 °C.

specific heat capacity of ice = 2100 J kg^{-1} K^{-1}
specific latent heat of fusion of ice = 3.3 × 10^{5} J kg^{-1}

(a) Calculate the quantity of heat needed

(i) to raise the temperature of the ice from –12 °C to 0 °C,

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(ii) to change the ice to water without an increase in temperature.

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(4 marks)

(b) The temperature of the water in the cup falls after the ice has been added.

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

(i) Calculate the mass of the water in the cup if the lowest temperature reached by the water is 8 °C.

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(ii) State an assumption you have made in part (b)(i).

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(4 marks)

5 June 2007 PA02 Q3

A cylinder of fixed volume 8.2×10^{-3} m^3 contains gas at a temperature of 295 K and a pressure of 4.2×10^5 Pa.

(a) Calculate

(i) the amount of gas in the cylinder in moles,

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(ii) the average kinetic energy of the gas molecules.

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(3 marks)

(b) The temperature of the gas in the cylinder is decreased.

You may be awarded additional marks to those shown in brackets for the quality of written communication in your answer.

(i) How does this change affect the motion of the gas molecules?

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(ii) State and explain, using the kinetic theory, the effect this has on the pressure of the gas.

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(4 marks)

(c) Another cylinder of the same volume contains a gas at the same temperature and pressure as the original gas but whose molecules have a greater mass. Explain why the amount of energy required to raise the temperature of both gases by the same amount is identical.

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(2 marks)

Total = 35 marks