THERMAL PHYSICS REVIEW 2012

1. The volume of an ideal gas in a container is increased at constant temperature. Which of the following statements is/are correct about the molecules of the gas?

I. Their speed remains constant.

II. The frequency of collisions of molecules with unit area of the container wall decreases.

III. The force between them decreases.

A. I only

B. I and II only

C. I and III only

D. II and III only

(Total 1 mark)

2. Oil with volume V has specific heat capacity c at temperature T. The density of oil is ρ. Which of the following is the thermal capacity of the oil?

A. ρcV

B. $\frac{cV}{\rho}$

C. ρcVT

D. $\frac{cV}{\rho T}$

(Total 1 mark)

3. What is the mass of carbon-12 that contains the same number of atoms as 14 g of silicon-28?

A. 6 g

B. 12 g

C. 14 g

D. 24 g

(Total 1 mark)

4. This question is about internal energy and thermal energy (heat).

(a) Distinguish between internal energy and thermal energy.

.....

.....

.....

.....

.....

(3)

(b) Describe, with reference to the energy of the molecules, the difference in internal energy of a piece of iron and the internal energy of an ideal gas.

.....

.....

.....

.....

(2)

(c) A piece of iron is placed in a kiln until it reaches the temperature θ of the kiln. The iron is then quickly transferred to water held in a thermally insulated container. The water is stirred until it reaches a steady temperature. The following data are available.

Thermal capacity of the piece of iron	$= 60\ \text{J K}^{-1}$
Thermal capacity of the water	$= 2.0 \times 10^3\ \text{J K}^{-1}$
Initial temperature of the water	$= 16\ ^\circ\text{C}$
Final temperature of the water	$= 45\ ^\circ\text{C}$

The thermal capacity of the container and insulation is negligible.

(i) State an expression, in terms of θ and the above data, for the energy transfer of the iron in cooling from the temperature of the kiln to the final temperature of the water.

.....

(1)

(ii) Calculate the increase in internal energy of the water as the iron cools in the water.

.....

.....

(1)

(iii) Use your answers to (c)(i) and (c)(ii) to determine θ.

.....

.....

.....

(2)

(Total 9 marks)

5. This question is about change of phase of a liquid and latent heat of vaporization.

(a) State the difference between evaporation and boiling with reference to

(i) temperature.

.....

.....

.....

(1)

(ii) surface area of a liquid.

.....

.....

.....

(1)

(b) A liquid in a calorimeter is heated at its boiling point for a measured period of time. The following data are available.

Power rating of heater	= 15 W
Time for which liquid is heated at boiling point	= 4.5×10^2 s
Mass of liquid boiled away	= 1.8×10^{-2} kg

Use the data to determine the specific latent heat of vaporization of the liquid.

.....

.....

.....

.....

.....

(3)

(c) State and explain **one** reason why the calculation in (b) will give a value of the specific latent heat of vaporization of the liquid that is greater than the true value.

.....

.....

.....

.....

(2)

(Total 7 marks)

6. This question is about internal energy, heat and ideal gases.

(a) The internal energy of a piece of copper is increased by heating.

(i) Explain what is meant, in this context, by internal energy and heating.

Internal energy: .....

.....

.....

Heating: .....

.....

.....

(3)

(ii) The piece of copper has mass 0.25 kg. The increase in internal energy of the copper is 1.2×10^3 J and its increase in temperature is 20 K. Estimate the specific heat capacity of copper.

.....

.....

.....

.....

(2)

(b) An ideal gas is kept in a cylinder by a piston that is free to move. The gas is heated such that its internal energy increases and the pressure remains constant. Use the molecular model of ideal gases to explain

(i) the increase in internal energy.

.....

.....

(1)

(ii) how the pressure remains constant.

.....

.....

.....

.....

.....

(3)
(Total 9 marks)

7. This question is about thermal energy transfer.

(a) A piece of copper is held in a flame until it reaches thermal equilibrium. The time it takes to reach thermal equilibrium will depend on the thermal capacity of the piece of copper.

(i) Define *thermal capacity*.

.....

.....

(1)

(ii) Outline what is meant by thermal equilibrium in this context.

.....

.....

.....

(1)

(b) The piece of copper is transferred quickly to a plastic cup containing water. The thermal capacity of the cup is negligible. The following data are available.

Mass of copper	= 0.12 kg
Mass of water	= 0.45 kg
Rise in temperature of water	= 30 K
Final temperature of copper	= 308 K
Specific heat capacity of copper	= 390 J kg K^{-1}
Specific heat capacity of water	= 4200 J kg K^{-1}

(i) Use the data to calculate the temperature of the flame.

.....

.....

.....

.....

.....

(3)

(ii) Explain whether the temperature of the flame is likely to be greater or less than your answer to (b)(i).

.....

.....

.....

(2)
(Total 7 marks)

8. Specific heat and a domestic shower

(a) Define *specific heat capacity*.

.....

.....

.....

(1)

(b) Equal masses of two different solid substances A and B are at the same temperature. The specific heat capacity of substance A is greater than the specific heat capacity of substance B. The two substances now have their temperatures raised by the same amount.

Explain which substance will have the greater increase in internal energy assuming both remain in the solid phase.

.....

.....

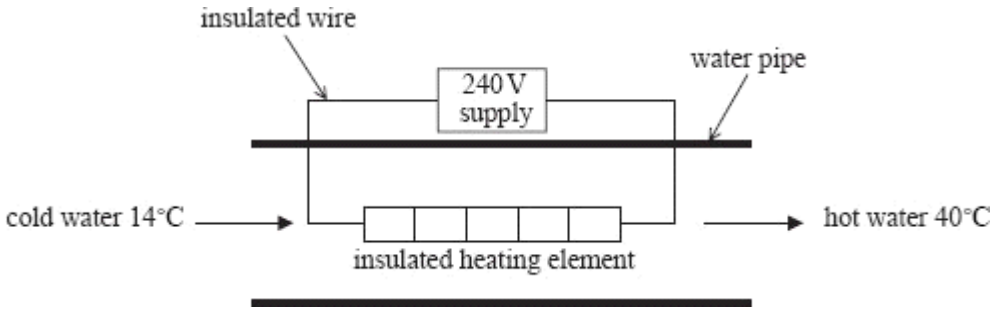
.....

.....

.....

(2)

(c) The diagram below shows part of the heating circuit of a domestic shower.



Cold water enters the shower unit and flows over an insulated heating element. The heating element is rated at 7.2 kW, 240 V. The water enters at a temperature of 14 °C and leaves at a temperature of 40 °C. The specific heat capacity of water is 4.2×10^3 J kg^{-1} K^{-1}.

(i) Estimate the flow rate of the water.

.....

.....

.....

.....

.....

.....

(4)

(ii) Suggest **one** reason why your answer to (c)(i) is only an estimate.

.....

.....

(1)
(Total 8 marks)