IB PHYSICS SL: Thermal Physics Review

1. The specific latent heat of vaporization of a substance is the quantity of energy required to

A. raise the temperature of a unit mass of a substance by one degree Celsius.

B. convert a unit mass of liquid to vapour at constant temperature and pressure.

C. convert a unit mass of solid to vapour at constant temperature and pressure.

D. convert a unit mass of liquid to vapour at a temperature of 100 °C and a pressure of one atmosphere.

(1)

2. When a gas in a cylinder is compressed at constant temperature by a piston, the pressure of the gas increases. Consider the following three statements.

I. The rate at which the molecules collide with the piston increases.

II. The average speed of the molecules increases.

III. The molecules collide with each other more often.

Which statement(s) correctly explain the increase in pressure?

A. I only

B. II only

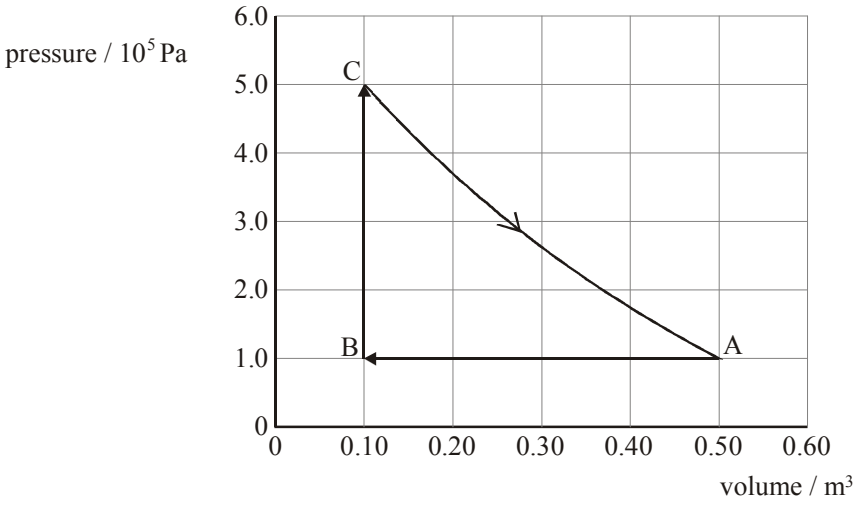
C. I and II only

D. I and III only

(1)

3. This question is about a heat engine.

A certain heat engine uses a fixed mass of an ideal gas as a working substance. The graph below shows the changes in pressure and volume of the gas during one cycle ABCA of operation of the engine.



(a) For the part A → B of the cycle, explain whether

(i) work is done **by** the gas or work is done **on** the gas.

(1)

(ii) thermal energy (heat) is absorbed **by** the gas or is ejected **from** the gas to the surrounding.

(1)

(b) Calculate the work done during the change A $\rightarrow$ B.

(2)

(c) Use the graph to estimate the total work done during one cycle.

(2)

(d) The total thermal energy supplied to the gas during one cycle is 120 kJ. Estimate the efficiency of this heat engine.

(2)

(Total 8 marks)

4. The kelvin temperature of an object is a measure of

A. the total energy of the molecules of the object.

B. the total kinetic energy of the molecules of the object.

C. the maximum energy of the molecules of the object.

D. the average kinetic energy of the molecules of the object.

(1)

5. The temperature of an ideal gas is reduced. Which **one** of the following statements is true?

A. The molecules collide with the walls of the container less frequently.

B. The molecules collide with each other more frequently.

C. The time of contact between the molecules and the wall is reduced.

D. The time of contact between molecules is increased.

(1)

6. A liquid is contained in a dish open to the atmosphere.

Which **one** of the following contains three factors that affect rate of evaporation of the liquid?

A.	Temperature of the liquid	Surface area	Specific latent heat of vaporisation
B.	Temperature of the liquid	Mass of liquid	Specific latent heat of vaporisation
C.	Surface area	Mass of liquid	Temperature of the liquid
D.	Mass of liquid	Surface area	Specific latent heat of vaporisation

(1)

7. Which of the following is **not** an assumption on which the kinetic model of an ideal gas is based?

A. All molecules behave as if they are perfectly elastic spheres.

B. The mean-square speed of the molecules is proportional to the kelvin temperature.

C. Unless in contact, the forces between molecules are negligible.

D. The molecules are in continuous random motion.

(1)

8. This question is about specific heat capacity and specific latent heat.

(a) Define *specific heat capacity*.

(1)

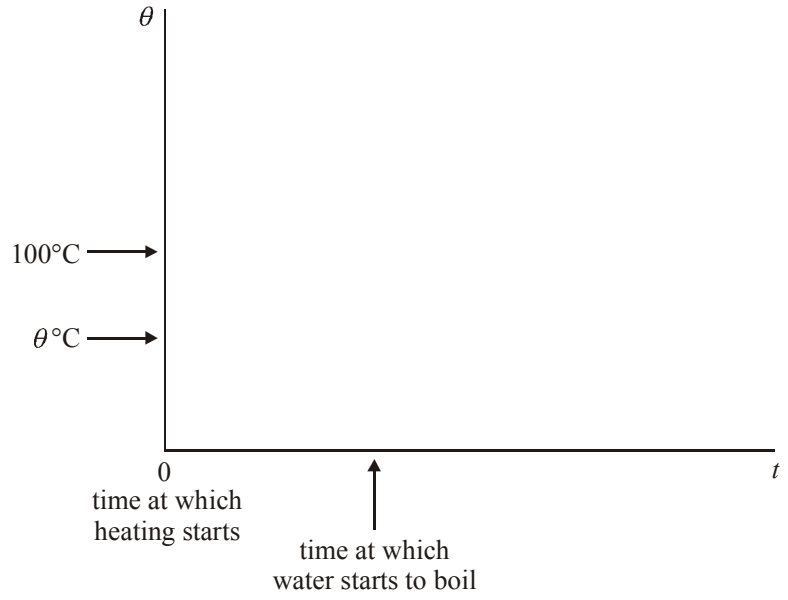
(b) Explain briefly why the specific heat capacity of different substances such as aluminium and water are not equal in value.

(2)

A quantity of water at temperature θ h is placed in a pan and heated at a constant rate until some of the water has turned into steam. The boiling point of the water is 100 °C.

(c) (i) Using the axes below, draw a sketch-graph to show the variation with time θ of the temperature θ of the water. ***(Note**: this is a sketch-graph; you do not need to add any values to the axes.)*

(1)



(ii) Describe in terms of energy changes, the molecular behaviour of water and steam during the heating process.

(5)

Thermal energy is supplied to the water in the pan for 10 minutes at a constant rate of 400 W. The thermal capacity of the pan is negligible.

(d) (i) Deduce that the total energy supplied in 10 minutes is 2.4×10^5 J.

(1)

(ii) Using the data below, estimate the mass of water turned into steam as a result of this heating process.

initial mass of water	= 0.30 kg
initial temperature of the water θ	= 20 °C
specific heat capacity of water	= 4.2×10^3 J kg^{-1} K^{-1}
specific latent heat of vaporization of water	= 2.3×10^6 Jkg^{-1}

(3)

(iii) Suggest **one** reason why this mass is an estimate.

(1)

(Total 14 marks)

9. Thermal energy may be transferred

I. in a fluid as a result of density changes of the fluid.

II. in a non-metallic substance as a result of lattice vibrations.

Which of the following correctly identifies each of these energy transfers?

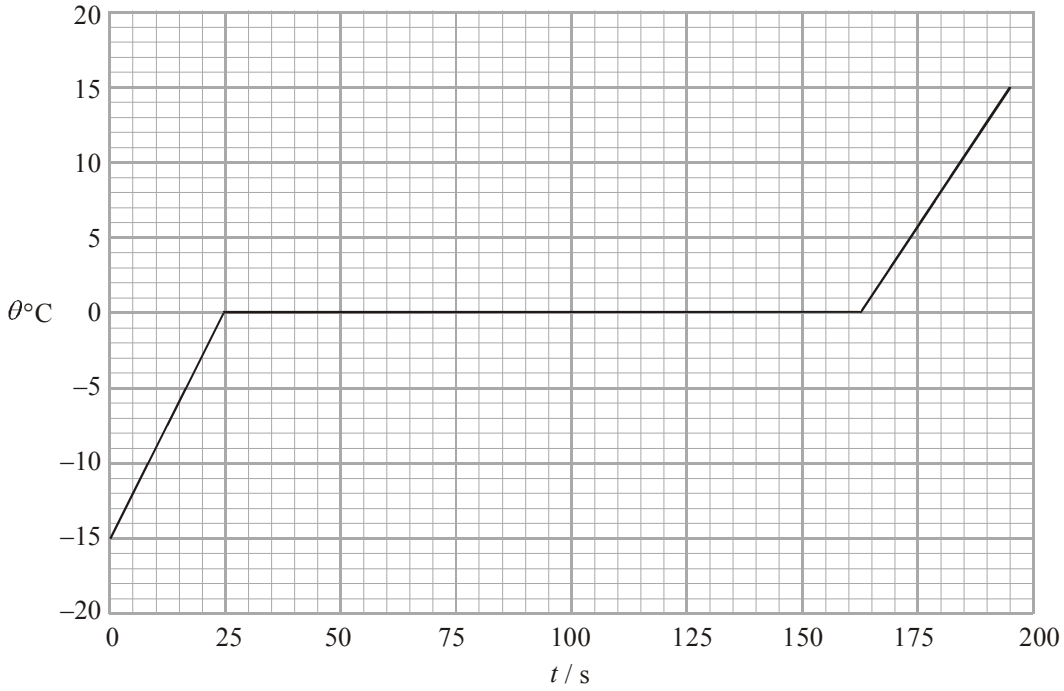
	Transfer I	Transfer II
A.	Convection	Convection
B.	Evaporation	Convection
C.	Convection	Conduction
D.	Evaporation	Conduction

(1)

10. This question is about the change of phase (state) of ice.

A quantity of crushed ice is removed from a freezer and placed in a calorimeter. Thermal energy is supplied to the ice at a constant rate. To ensure that all the ice is at the same temperature, it is continually stirred. The temperature of the contents of the calorimeter is recorded every 15 seconds.

The graph below shows the variation with time t of the temperature θ of the contents of the calorimeter. *(Uncertainties in the measured quantities are not shown.)*



(a) On the graph above, mark with an X, the data point on the graph at which all the ice has just melted.

(1)

(b) Explain, with reference to the energy of the molecules, the constant temperature region of the graph.

(3)

The mass of the ice is 0.25 kg and the specific heat capacity of water is 4200 J kg^{-1} K^{-1}.

(c) Use these data and data from the graph to

(i) deduce that energy is supplied to the ice at the rate of about 530 W.

(3)

(ii) determine the specific heat capacity of ice.

(3)

(iii) determine the specific latent heat of fusion of ice.

(2)

(Total 12 marks)