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(Held in 2023)

PHYSICS

Paper : PHYHC3066

(Thermal Physics)

Full Marks : 60

Pass Marks : 24

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

1. Choose the correct option from the following :

1×5=5

(a) If T is the absolute temperature of gases, according to the kinetic theory of gases, the r.m.s. speed of gas molecule is directly proportional to

(i) T

(ii) \sqrt{T}

(iii) T^2

(iv) $\frac{1}{\sqrt{T}}$

(2)

(b) The efficiency of a Carnot heat engine working between the temperatures 127 °C and 27 °C is

(i) $\frac{100}{127}$

(ii) $\frac{27}{127}$

(iii) $\frac{100}{400}$

(iv) $\frac{300}{400}$

(c) According to Maxwell's law of distribution of molecular velocities in gas

(i) the number of molecules with most probable velocity is finite

(ii) the number of molecules with most probable velocity is small

(iii) the number of molecules with most probable velocity is constant

(iv) All of the above

(d) What is the unit of entropy?

(i) Jmol^{-1}

(ii) JKmol^{-1}

(iii) $\text{J}^{-1}\text{K}^{-1}\text{mol}^{-1}$

(iv) $\text{JK}^{-1}\text{mol}^{-1}$

(e) An adiabatic process occurs at constant

(i) temperature

(ii) pressure

(iii) heat

(iv) None of the above

(3)

2. Answer the following questions : 2×5=10

(a) Explain the extensive and intensive thermodynamic variables with one example of each.

(b) At what temperature will the root-mean-square velocity of nitrogen molecule double its value at NTP, pressure remaining constant?

(c) Formulate the second law of thermodynamics in terms of entropy.

(d) State the first law of thermodynamics and explain its physical significance.

(e) Mention the necessary conditions for reversibility of a process.

3. Answer any five of the following questions :

5×5=25

(a) Derive an expression for the work done during an isothermal process by an ideal gas.

(b) Define the mean free path of gas molecules and obtain an expression for it.

1+4=5

(c) Write a short note on thermodynamic scale of temperature and its equivalence to perfect gas scale.

(d) Using Maxwell's velocity distribution law, deduce an expression for root-mean-square velocity of gas molecules of a perfect gas.

- (e) State and prove Carnot's theorem. 1+4=5
- (f) Obtain the Clausius inequality relation of thermodynamics.
- (g) Derive Ehrenfest's equation for a second-order phase transition.

4. Answer any *two* of the following questions :

10×2=20

(a) Derive the relations

$$(i) \left(\frac{\delta T}{\delta V} \right)_S = - \left(\frac{\delta P}{\delta S} \right)_V$$

$$(ii) \left(\frac{\delta S}{\delta V} \right)_T = \left(\frac{\delta P}{\delta T} \right)_V$$

where the symbols have their usual meanings.

5+5=10

(b) (i) Distinguish between first- and second-order phase transitions with the help of necessary diagram.

(ii) Derive Clausius-Clapeyron equation of latent heat.

4+6=10

(c) Calculate the critical constants of van der Waals' gas in terms of constants a and b , and hence derive the reduced equation of state.

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