WEST BENGAL STATE UNIVERSITY

B.Sc. Honours 3rd Semester Examination, 2022-23

PHSACOR06T-PHYSICS (CC6)

Full Marks: 40

Time Allotted: 2 Hours

The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.

Answer Question No. 1 and any *two* questions from the rest

$2\times10 = 20$

1. Answer any ***ten*** questions from the following:

(a) At what temperature the molecular velocity (r.m.s.) of oxygen will become half as that of hydrogen?

[Molecular weight of oxygen and hydrogen are 32 and 2 respectively]

(b) Calculate the total random kinetic energy of one gm-mole of O_2 at 300 K.

(c) Calculate the number of collisions per second of a molecule of gas having mean free path 2×10^7 m. Given the average velocity 500 m/sec.

(d) What is Boyle's temperature? Find Boyle's temperature for Van der Waal's gas.

(e) What do you mean by critical temperature of a gas? What is its importance?

(f) What is degree of freedom? State the law of equipartition of energy.

(g) Show that the workdone in adiabatic expansion of an ideal gas from a state (P_1, V_1) to a state (P_2, V_2) is given by $W = \frac{1}{(\gamma-1)}[P_1V_1 - P_2V_2]$.

(h) A Carnot's engine has an efficiency of 30% when the temperature of the sink is 27°C. What must be the change in temperature of the source to make its efficiency 50%.

(i) Prove that in a T-S diagram the slope of isochoric curve is T/C_V.

(j) What is the physical significance of entropy?

(k) Why are the Helmholtz function F and Gibbs' function G called thermodynamic potentials? Explain.

(l) State the Gibbs' phase rule. Draw the P-T diagram of water indicating the triple point.

(m) Using Maxwell's relation prove that $\left(\frac{\partial u}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P$

(n) Show that the Joule-Thomson co-efficient is zero for ideal gas.

2. (a) Write down Maxwell's molecular speed distribution law and explain the symbols you use. 2

(b) Indicate graphically how the distribution changes with rise of temperature and pressure. 2+1

(c) Starting from speed distribution law of Maxwell, deduce the energy distribution law of the molecules of a gas. Draw energy distribution curves at different temperatures. 2+1

(d) What importance was obtained from Andrew's experiment? 2

3. (a) Represent a Carnot's cycle on a T-S diagram and hence find the efficiency of a Carnot's engine. 1+3

(b) Show that no engine between two given temperatures can be more efficient than a reversible Carnot's engine working between the same two temperatures. 3

(c) Calculate the change in entropy when 10 gm of ice at $-10°C$ is converted into water at $10°C$. 3

4. (a) Show that Joule-Thomson effect is an isenthalpic. 2

(b) Compare Joule-Thomson effect and adiabatic temperature. 2

(c) What is inversion temperature? Find its expression for Van der Waal's gas. 2+4

5. (a) Prove that $C_P - C_V = T\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial T}\right)_P$, where the symbols have their usual meaning. 3

(b) Using Maxwell's thermodynamic relation establish the Clausius-Clapeyron equation 4

$$\left(\frac{\partial P}{\partial T}\right) = \frac{L}{T(V_2 - V_1)}$$

(c) Calculate the change in boiling point of water when the pressure is increased by 1 atmosphere. Boiling point of water is $100°C$, specific volume of steam is $1.671\ m^3/kg$ and latent heat of steam $2.268 \times 10^6 J/kg$ 3

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