WEST BENGAL STATE UNIVERSITY

B.Sc. Honours 3rd Semester Examination, 2021-22

PHSACOR06T-PHYSICS (CC6)

THERMAL PHYSICS

Time Allotted: 2 Hours | Full Marks: 40

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

1. Answer any ***ten*** questions from the following: 2×10 = 20

(a) Find the temperature at which the RMS velocity of a gas will be $^1/_4{}^{th}$ of that at zero degree Celsius.

(b) Calculate what fraction of gas molecules dies out in moving a distance of mean free path.

(c) Show that the number of molecules obeying Maxwell distribution law strike unit area per sec is given by $p/\sqrt{2\pi mkT}$.

(d) What are the corrections added to the perfect gas equation so as to get Van der Waals equation for real gas.

(e) Show that at the critical temperature the departure of Van der Waals law from ideal gas law is 62.5%.

(f) What is quasi-static process? Is this process always reversible one?

(g) Deduce the expression for the work done in the adiabatic expansion of a perfect gas in terms of temperature.

(h) Show that an isothermal curve for an ideal gas drawn on a P-V diagram is isenthalpic.

(i) "Specific heat at constant pressure is always greater than the specific heat at constant volume"— Explain.

(j) Find the efficiency of a Carnot's engine working between 127 °C and 27 °C. It absorbs 80 cal of heat. How much heat is rejected?

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

(l) Calculate the change in entropy when 10 gram of ice at 0 °C is converted into the vapour at 100 °C.

(m) State the law of corresponding state.

(n) Derive the following *TdS* equation. Terms have their conventional meaning.

$$TdS = C_P dT - T\left(\frac{\partial V}{\partial T}\right)_P dP$$

2. (a) If the equation of state for a real gas is given by $P=\frac{RT}{V-b}e^{-\frac{a}{RTV}}$, obtain the virial expansion in power series of $(1/V)$. Find the second and third virial co-efficients. 2+1+1

   (b) Show the variation of the second virial coefficient with absolute temperature T and hence obtain the Boyle temperature. 1+1

   (c) For a thermodynamic system $U=\frac{3}{2}PV$ and $P=AT^4V$, find the Gibbs' potential G and Helmholtz function F. 2+2

3. (a) Show that the mean square displacement of a Brownian particle suspended in a liquid is directly proportional to the absolute temperature of the liquid. 4

   (b) Draw the Carnot cycle in the T-S diagram. Derive the expression for the efficiency of the Carnot engine directly from this diagram. 1+2

   (c) A reversible engine converts $^1/_6{}^{th}$ of heat which it absorbs at heat source into work. When the temperature of the heat sink is reduced by 82 °C, its efficiency is doubled. Calculate the temperature of the source and the sink. 3

4. (a) Draw the Maxwell's velocity distribution curve at different temperature. Discuss the shifting of the peak of the curve and also the broadening of the curve with temperature variation. 1+2

   (b) Using Maxwell thermodynamic relation establish Clausius-Clapeyron equation. 4

   (c) Show that in case of vapourization of liquid this equation reduces to $\ln P=-L/RT$ + constant. (assuming the vapour to behave as a perfect gas of one mole) 3

5. (a) Calculate the mean free path and collision frequency of hydrogen molecules at STP. Given: coefficient of viscosity = 0.00008 CGS unit, density (ρ) of hydrogen at STP = 0.00009 gm/cc. 4

   (b) For an isentropic transformation show that, 3+3

   (i) $\left(\frac{\partial V}{\partial T}\right)_S=-\frac{C_V}{C_P-C_V}\left(\frac{\partial V}{\partial T}\right)_P$ and

   (ii) $\left(\frac{\partial P}{\partial T}\right)_S=\frac{C_P}{C_P-C_V}\left(\frac{\partial P}{\partial T}\right)_V$

N.B. : *Students have to complete submission of their Answer Scripts through E-mail / Whatsapp to their own respective colleges on the same day / date of examination within 1 hour after end of exam. University / College authorities will not be held responsible for wrong submission (at in proper address). Students are strongly advised not to submit multiple copies of the same answer script.*

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