

UG 3rd Semester Examination 2021

PHYSICS (Honours)

Paper : DC - 6

[CBCS]

Full Marks : 25

Time : Two Hours

The figures in the margin indicate full marks. Candidates are required to give their answers in their own words as far as practicable.

1. Answer any **five** questions : 2×5=10
- (a) Calculate the molecular diameter of nitrogen molecule if its number density $n=2.7 \times 10^{25}$ per m^3 and the mean free path $\lambda=8 \times 10^{-8}$ m.
- (b) 1 kg of ice at 0°C is melted and converted to water at constant temperature. Compute its change in entropy, assuming that melting is done reversibly. The heat of fusion of water is 3.34×10^5 J/kg.
- (c) Prove that in a T - S diagram the slope of isochoric curve is T/C_V , terms being usual.
- (d) Show that at critical point of a van der Waals' gas, the laws have a departure of 62.5% from those of perfect gas.
- (e) If $f(P, V, T) = 0$, prove that $\left(\frac{\partial P}{\partial V}\right)_T \left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial T}{\partial P}\right)_V = -1$.
- (f) Using Maxwell's relations prove that $\left(\frac{\partial C_V}{\partial V}\right)_T = T \left(\frac{\partial^2 P}{\partial T^2}\right)_V$.
- (g) Obtain the Joule-Thomson coefficient for an ideal gas.
- (h) State the differences between first order and second order phase transitions.

2. Answer any *three* questions :

5×3=15

(a) For a group of particles,

n_i	v_i (m/s)
2	1.0
4	2.0
8	3.0
6	4.0
3	5.0

where, n_i is the number of particles with speed v_i .

[i] Compute the average speed.

[ii] Compute the r.m.s. speed

[iii] Find out the most probable speed.

2+2+1=5

(b) [i] For an ideal gas, if E_T and E_S denote respectively the isothermal and the adiabatic moduli of elasticity, prove that $E_S/E_T = \gamma$, where γ is the ratio of molar specific heats of the gas.

[ii] Show that for a hydrostatic system

$$\frac{dV}{V} = \beta_P dT - \frac{1}{\beta_T} dT$$

where β_P is the coefficient of volume expansion at constant pressure and β_T is the isothermal bulk modulus.

3+2=5

(c) [i] Prove that, working between the same two heat reservoirs, no engine can be more efficient than a Carnot engine.

[ii] Explain the concept of entropy in terms of disorder.

3+2=5

(d) [i] Prove that for a system undergoing isothermal isochoric transformation, the Helmholtz free energy remains constant.

[ii] If G represents the Gibbs' free energy of the system, show that $C_P = -T \left(\frac{\partial^2 G}{\partial T^2} \right)_P$,

terms being usual.

2+3=5

(e) [i] What is inversion temperature? Show that the expression for inversion temperature for a van der Waals' gas is $T_i = \frac{2a}{Rb}$.

[ii] Naphthalene melts at $80^\circ C$. The increase in specific volume is 0.146 cc. Assuming $L=35.6$ cal/gm, find the change in melting point per atmosphere pressure change.

(1+2)+2=5
