This question paper contains **4** printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : **848**

Unique Paper Code : **222304** **G**

Name of the Paper : **Thermal Physics (PHHT-309)**

Name of the Course : **B.Sc. (Hons.) Physics**

Semester : **III**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *Five* questions in all,

including Question No. **1** which is compulsory.

All questions carry equal marks.

1. Attempt any *five* of the following : 5×3

(*a*) Show graphically the variation of Temperature with Entropy for a Carnot cycle.

(*b*) Find an expression for the work done in an adiabatic process.

(*c*) Obtain the relation :

$$F = U + T\left(\partial F/\partial T\right)_V .$$

(*d*) Define the principle of increase of entropy.

(*e*) Calculate the 'Lapse Rate' for dry air, taking M = 0.0029 kg/mole and $\gamma = 1.4$.

P.T.O.

(*f*) Calculate the coefficient of thermal conductivity of Helium at zero degree Celsius, taking $M = 4$ kg/mole, $C_V = 12.5 \times 10^3$ Jkmole^{-1} K^{-1}, $\eta = 18.6 \times 10^{-6}$ Nsm^{-2}.

(*g*) Define third law of thermodynamics.

2. (*i*) Using first law of thermodynamics, derive the following relations : 3×3

(*a*) $dQ = C_V dT + \left[(\partial U/\partial V)_T + P\right]dV$

(*b*) $C_P = C_V + \left[(\partial U/\partial V)_T + P\right]V\alpha$

(*c*) $dQ = C_V dT + \left[(C_P - C_V)/V\alpha\right]dV$.

(*ii*) A cylinder contains 1 mole of oxygen gas at a temperature of 27°C and 1 atmospheric pressure. It is heated till its temperature becomes 127°C. Calculate : 3×2

(*a*) Work done by the gas

(*b*) Change in internal energy

(*c*) Heat transfer to the gas.

3. (*a*) Write Kelvin-Planck and Clausius statements of the second law of thermodynamics. 3

(*b*) Show that above statements are equivalent. 6

(*c*) State and prove Carnot's theorem. 6

4. (*a*) Calculate the entropy of 1 mole of perfect gas in terms of temperature and pressure. 5

(*b*) Using Carnot's theorem, prove the Clausius inequality. 4

(*c*) Calculate the increase in entropy when the temperature of 1 kg of ice is raised from –10°C to 10°C. Given that : 6

Specific heat of ice = 2.09×10^3 J/kg/K

Specific heat of water = 4.18×10^3 J/kg/K

Latent heat of ice = 3.35×10^5 J/kg.

5. (*a*) Define Thermodynamic potentials. 3

(*b*) Derive Maxwell's relations using thermodynamic potentials. 6

(*c*) Using Maxwell's relations, show that : 6

$$C_P - C_V = TV\alpha^2/K_T$$

where K_T is isothermal compressibility and α is volume expansivity.

6. (*a*) Using the Maxwell's law of distribution of molecular speed; derive expression for :

(*i*) Average speed

(*ii*) Most probable speed,

(*iii*) Root mean square speed. 6

(*b*) Derive an expression for coefficient of thermal conductivity of gases on the basis of kinetic theory. 5

(*c*) Prove : 4

$$V_{Average} \times (1/V_{Average}) = 4/\pi.$$

7. (*a*) Describe experimentally the process of cooling due to adiabatic demagnetization. 4

(*b*) What are second order phase transitions ? Derive Ehrenfest's equations for second order phase transitions. 7

(*c*) Obtain van der Waals equations in terms of reduced parrameter P_r, V_r and T_r. 4

8. (*a*) Compare the p-v diagrams obtained from CO_2 in Andrews experiment with those obtained using van der Waals equations. 8

(*b*) What is Brownian motion ? Explain with example. 4

(*c*) Explain mathematically, the Joule-Thomson effect in terms of Deviation from Boyle's law and Joule's law. 3