B.Sc.(Honours)Examination, 2018

Semester–I

Physics (Honours)

Course: BPC-13

(Thermal Physics)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.

Answer**any*four*** questions

1. a) Derive the expression of Maxwell velocity distribution law for the ideal gas from the assumptions of kinetic theory of gasses. 4
   b) From the Maxwell velocity distribution law, find out the average speed and expression of root mean square velocity of the molecules in terms of absolute temperature. 4
   c) Show graphically how the distribution of velocities of Maxwell's gas changes with absolute temperature. 2

2. a) Derive the van der Waal's equation state for the real gas by incorporating the necessary corrections in the perfect gas equation. 5
   b) What do you mean by 'point of inflection' of the critical isotherm? From the definition of point of inflection, find out the expression of critical volume 'V_c', critical temperature 'T_c' and critical pressure 'P_c'. 4
   c) Find out the Boyle temperature in term of critical temperature 'T_c' for the real gas. 1

3. a) What do you mean by quasistatic process? Is quasistatic process always reversible? 2
   b) Show that the adiabatic curves are steeper than isothermal curves with proper diagram. 2
   c) Immediately on explosion of an atom bonb, the ball of the fire produced had a radius of 100 m and a temperature of 10^5 K. What will be the temperature when the ball of fire expands adiabatically to 1000 m radius? Use $\gamma = 5/3$. 3
   d) One mole of an ideal gas is heated isobarically till its volume is doubled. Find out the amount of heat absorbed. Given $C_V = 20.9$ J/mol/K, $R = 8.3$ J/mol/K. 3

4. a) Show that 'entropy' is an exact differential. 2.5
   b) Draw the '*T-S*' indicator diagram of Carnot engine with explicit nomenclature of all the steps. Find out the net entropy change from the diagram. 2
   c) A body of mass '*m*', specific heat '*c*' and temperature 'T_1' is kept in contact with a heat reservoir (infinite thermal capacity) at a temperature 'T_2'. Find out the entropy change of the body and also of the universe. 2.5
   d) '*m*' gram mass of water at a temperature $T_1 K$ is mixed adiabatically with an equal mass of water at a temperature $T_2 K$ at constant pressure. Show the net entropy change of the universe is $2mCp\,ln\left[\frac{(T_1+T_2)/2}{\sqrt{T_1T_2}}\right]$ and is positive. Terms are of usual meaning. 3

5. a) Show the 'zeroth law' of thermodynamics is necessary to justify the basis of temperature.1.5
   b) What do you mean by first order phase change? Derive the second latent heat equation (Clausias equation) for the first order phase change. 4.5
   c) Why specific heat of saturated vapour pressure is negative? 1.5
   d) The vapour-exit tube of a pressure cooker has a radius of 2 mm and is closed by a mass of 140 gm fitted at its mouth. What is the boiling point of water inside the cooker? Given latent heat of vapourisation of water 540 cal and specific volume of water vapour is 1674 c.c. 2.5

6. a) Derive the Maxwell's thermodynamic relations. 4

b) Prove that $C_P - C_V = -T\left(\frac{\partial V}{\partial T}\right)_P^2 \left(\frac{\partial P}{\partial V}\right)_T$, where the terms are of usual meaning. Is $C_P - C_V$ a negative quantity? Explain properly. For water, mention the temperature with proper reason at which $C_P - C_V$ is zero. 4

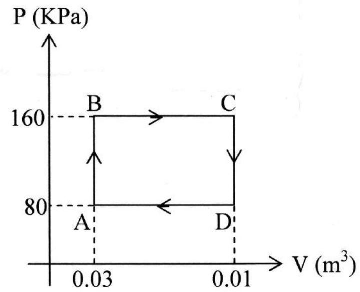
c) Prove that $C_P - C_V = 9TV\delta^2 E_T$, where '$E_T$' and 'δ' are the isothermal bulk modulus and linear expansion of the system. 2

7. a) From the kinetic theory establish the relation: pressure of a gas is two-third of the mean kinetic energy of translation of the molecules per unit volume. 1.5

b) A beam of particle is passed through a low pressure gas. The mean free path of particles in the gas is 5×10^{-4} m. Find the fraction of attenuation in the number of particles after traversing a distance 10^{-2} mm through the gas. 1.5

c) Show that the combined efficiency of two Carnot engines, one operating between T_3k and T_2K and other one between T_2K and $T_1K\left(T_1K < T_2K < T_3K\right)$, will be lower than that of the single engine operating between T_3K and T_1K. 3

d) The *P-V* diagram (figure adjacent) represents an ideal monatomic gas cycle for 1 mole of



gas. Calculate, in terms of gas constant *R*, the temperatures at points *A*, *B*, *C* and *D*. Also calculate the heat rejected and absorbed during the cycle and the efficiency of the cycle. 4