West Bengal State University

B.A./B.Sc./B.Com. (Honours, Major, General) Examinations, 2010

PART – I (Honours)

CHEMISTRY

Paper – I

Duration : 4 Hours] [Maximum Marks : 100

Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

GROUP - A

(Marks : 50)

Answer any *three* questions taking one question from each of the *three* Units.

Unit - 1

1. (a) (i) Write down Maxwell's expression for the distribution of molecular speeds in three dimensions and obtain an expression for the distribution of translational kinetic energy.

(ii) Derive an expression for the number of molecules with translational kinetic energy greater then ϵ' assuming $\epsilon' >> kT$, k = Boltzmann constant. 2 + 4

(b) If compressibility factor, Z, for a van der Waals gas be 1·000056 at 0°C and 1 atmosphere and the Boyle temperature be 107 K, calculate neglecting higher terms of P, the values of the van der Waals constants a and b. 4

(c) Draw the one dimensional velocity distribution curve of the molecules of an ideal gas at two different temperatures and comment on the area under each curve. 3

(d) Apply the equipartition principle to calculate the average energy per molecule of CO_2 gas at T K. 3

2. (a) A gas obeys equation $P(V-b)=RT$.

(i) Is it possible to liquefy the gas ? Justify your answer. 2

(ii) Show that the gas does not have the Boyle temperature. 2

(b) Define mean free path of a gas molecule. Derive a relation between mean free path and collision diameter of gas molecules. 1 + 3

(c) Obtain expressions for the van der Waals constants in terms of critical constants. 6

(d) Give a schematic plot of Z *vs* P to show the effect of temperature on deviation of a real gas from ideal behaviour. 2

Unit - 2

3. (a) One mole of an ideal monatomic gas at 298K expands to double its volume at constant pressure. Calculate the heat absorbed by the gas. 2

(b) Show that $(\partial U/\partial V)_T = 0$ for a gas obeying $P(V-nb)=nRT$ [Derivation of Maxwell relation is not necessary]. Evaluate $(\partial U/\partial V)_T$ for an ideal gas. 2 + 2

(c) Calculate the change in entropy when 10 g of tin is heated from 293 K to 573 K. The melting point of tin is 505 K. The latent heat of fusion of tin is 14 cal g^{-1} and specific heats of solid and liquid tin are 0·055 cal g^{-1} and 0·064 cal g^{-1} respectively. 4

(d) One mole of an ideal gas is expanded adiabatically but irreversibly from V_1 to V_2 and no work is done.

(i) Does the temperature of the gas change ?

(ii) What is ΔS for the gas and the surroundings ? 4

(e) If a reversible Carnot cycle working between two temperatures T_1 and T_2 ($T_2 > T_1$) is plotted on a T – S diagram, show that the area enclosed is equal to the work done in the reversible cycle. Indicate the efficiency of the process as a ratio of two areas in the properly drawn diagram. 4