



বিদ্যাসাগর বিশ্ববিদ্যালয়

VIDYASAGAR UNIVERSITY

B.Sc. Honours Examination 2021

(CBCS)

1st Semester

CHEMISTRY

PAPER—C2T & C2P

PHYSICAL CHEMISTRY - I

Full Marks : 60

Time : 3 Hours

The figures in the right-hand margin indicate full marks.

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

THEORY : C2T

Group - A

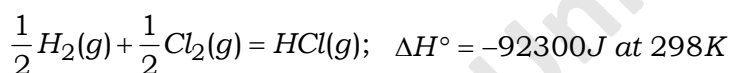
Answer any *three* questions.

3×12

1. (a) Deduce the expression of Boyle's temperature in terms of a , b , and R where a , b are Van der Waal constant and R is universal gas constant.

- (b) The value of compressibility factor z $\left(z = \frac{PV}{nRT}\right)$ for N_2 at 223 K at 800 atm. pressure is 1.95 and the value of z changes to 1.10 when the temperature and pressure value changes to 373 K and 200 atm. A fixed mass of N_2 occupied a volume of 1 lit. at 223 K and 800 atm. Calculate the volume occupied by the same quantity of N_2 at 373 K and 200 atm. pressure.
- (c) A gas follow the equation of state $P(V - b) = RT$. Can the gas be liquefied – explain.
- (d) The value of Van der Waal constant ‘a’ for the two real gases are 1.333 $\text{lit}^2 \text{ atm mol}^{-2}$ and 1.521 $\text{lit}^2 \text{ atm mol}^{-2}$ respectively. Explain which of these gas can be liquefied easily. 4+3+3+2

2. (a) Calculate the heat of formation of HCl at 348 K from the following data–



The mean heat capacity over this temperature range are –

$$H_2 (g); C_p = 28.53 \text{ JK}^{-1} \text{ mol}^{-1}$$

$$Cl_2 (g); C_p = 32.26 \text{ JK}^{-1} \text{ mol}^{-1}$$

$$HCl (g); C_p = 28.49 \text{ JK}^{-1} \text{ mol}^{-1}$$

- (b) Show that decrease in Gibbs energy value is equal to the maximum net work obtainable from the system.
- (c) Under what condition an extensive property may become intensive property? Give an example.

(d) Derive the expression of Joule-Thomson co-efficient for Van der Waal gas and explain the idea of inversion temperature. 3+3+2+4

3. (a) Write the differences between molecularity and order.

(b) Explain the Lindeman theory of unimolecular reaction with mathematical derivation.

(c) How do you determine the order of a chemical reaction using differential method?

(d) The rate of the reaction $2A + B \rightarrow C$ becomes doubled when the concentration of B is only doubled and the rate becomes eight fold when the concentration of both A and B are doubled. Find the order of the reaction with respect to A and B. 2+4+3+3

4. (a) What is protolytic and prototropic mechanism of acid catalyzed reaction? — Explain.

(b) Mathematically explain the mechanism of enzyme catalysis and establish the Michaelis-Menten equation. What is turnover number?

(c) The temperature coefficient of a reaction, $\frac{k_{[T+10]}}{K_T}$, at T = 298 K is 2.00.

What will be its value at T = 243K?

(d) Prove that $\left(\frac{\delta s}{\delta p}\right)_T = -\left(\frac{\delta V}{\delta T}\right)_P$. 2+4+3+3

5. (a) Explain the Carnot's theorem and find expression of efficiency of Carnot's engine.

- (b) For two constituent gases entropy of mixing per mole becomes maximum when constituents are present in equal mole ratio. – Explain.
- (c) Describe the Arrhenius concept on the dependence of reaction rate with temperature.
- (d) 'Reaction of 3rd order are uncommon while those of still higher order are unknown' — Correct or Justify. 4+3+3+2
6. (a) Derive the Kirchhoffs equation and briefly describe the effect of pressure on enthalpy of reaction.
- (b) Establish the equation to calculate the number of binary collision among similar molecules.
- (c) 'The pressure correction term $\left(\frac{a}{V^2}\right)$ present in the one mole van der Waal equation will be valid if we consider ternary collision among gas molecule' — explain whether the statement is true or false.
- (d) Calculate the value of C_v , C_p and γ using the idea of equipartition of energy principle. 4+3+2+3

Group - B

Answer any *two* questions. 2×2

7. Calculate ΔU and ΔS when one mole of an ideal gas undergoes isothermal free expansion from volume V_1 to V_2 .
8. In order to increase the efficiency of a Carnot engine which one of the following will be the better choice.
- (a) Increasing the temp of hot reservoir.
- (b) Decreasing the temp of the cold reservoir.

9. Write down the expression of frequency of binary collision of two dissimilar molecule. State each terms involved in the expression.
10. A first order reaction can never be completed. — Justify or Critricize.

PRACTICAL : C2P

Answer any *one* question.

1×15

1. Describe the principle and brief process of determination of pH of unknown buffer by colour matching method.
2. Describe the principle and brief process of kinetics of acid-catalyzed hydrolysis of methyl acetate.
3. Describe the principle and brief process of kinetics of decomposition of H_2O_2 . Find the $t_{\left(\frac{1}{2}\right)}$ of a nth order reaction.

Answer any *one* question.

1×5

4. What is buffer capacity? Calculate the pH of 0.01M acetic acid solution.
5. What is pseudo order reaction? Describe the idea of Ostwald dilution method. 2.5+2.5
6. Briefly describe the order determination process using $t_{\frac{1}{2}}$ value of a reaction. 2.5+2.5

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