

**SARDAR PATEL UNIVERSITY**

M. Sc. SECOND SEMESTER Examination 2016

Monday, 11<sup>th</sup> April 2016,

10.30 a.m. to 1.30 p.m.

Course – PS02CCHE03, Physical Chemistry – II, Selected Topics

N.B. Figures to the right of each of the question indicate marks.

**I. Choose appropriate answer of the following: 08**

- (i) The point group for  $H_2$  is:  
 (a)  $C_{\infty h}$  (b)  $D_{\infty h}$  (c)  $C_{2h}$  (d)  $C_{\infty v}$
- (ii) Which of the following is true for a second order reaction?  
 (a)  $k$  in  $\text{mol}^{-1}\text{lit}^1\text{sec}^{-1}$   
 (b) conc. of reactant is a linear function of time  
 (c) reciprocal of reactant conc. is linear function of time  
 (d) both a and c
- (iii) In DNA chemical structure, the sugar part is linked to:  
 (a) phosphate (b) nucleotide base  
 (c) both phosphate and nucleotide base (d) nucleic acid
- (iv) Which of the following phenomenon is inversely proportional to viscosity of the medium?  
 (a) electroosmosis (b) sedimentation potential  
 (c) electrophoresis (d) streaming potential
- (v) The rate law for the product formation,  $\frac{d[p]}{dt} = k_r[A]$  in a unimolecular reaction of type:  $A \rightarrow P$ , is first order when,  
 (a) rate of unimolecular decay is greater than rate of deactivation  
 (b) rate of deactivation is much greater than rate of unimolecular decay  
 (c) rates of deactivation and unimolecular decay are equal  
 (d) if mechanism involves only bimolecular step
- (vi) Number of irreducible representation in a group is equal to:  
 (a) the order of the group (b) dimension of  $i^{\text{th}}$  representation  
 (c) number of characters in a group (d) number of classes in the group
- (vii) The rate constant in an ionic reaction is proportional to:  
 (a)  $I^{3/2}$  (b)  $I$  (c)  $I^2$  (d)  $I^{1/2}$

(viii) Which one of the following carries the amino acid during protein synthesis?

- (a) *m*RNA (b) *r*RNA (c) DNA (d) *t*RNA

2. **Attempt any SEVEN**

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(i) Show that  $C_3^2\sigma_v C_3^{-1} = \sigma_v$  for the  $NH_3$ .

(ii) Taking example of  $H_2O_2$ , show that  $S_2 = C_2 + \sigma_h$ .

(iii) For an opposing reaction,  $A \xrightleftharpoons[k_2]{k_1} B$ ,  $k_1 = 3 \text{ sec}^{-1}$ ,  $k_2 = 1 \text{ sec}^{-1}$ , calculate  $[A]_{eq}$ , given  $[A]_0 = 1 \times 10^{-4} \text{ mol. dm}^{-3}$ .

(iv) Give the three advantages of stopped flow method over continuous flow method for monitoring fast reactions.

(v) Illustrate the hydrogen bonding patterns in anti parallel and parallel  $\beta$  - sheets of proteins chains.

(vi) What are supramolecular systems? Give two such examples.

(vii) What is  $\xi$  potential? How it determines the charge on a particle surface?

(viii) Give the two examples of transport proteins.

(ix) What is a diagonal plane? Explain symmetry elements of methane molecule.

3. (a) The matrix for E:  $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ , and i:  $\begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$  Explain how they are derived? 06

And why and how they are different giving examples?

(b) i. Is diborane,  $B_2H_6$  a planar molecule? Show the axis of rotation and  $\sigma_{xy}$ ,  $\sigma_{yz}$  and  $\sigma_{xz}$  planes and explain why it belongs to  $D_{2h}$  point group? 03

ii. Ethylene,  $N_2O_2$ ,  $Ni(CN)_4$  have common symmetry element – elaborate and explain the feature. 03

**OR**

(b) i. Enlist and depict the symmetry elements present in  $PCl_5$ . 03

ii. What do subscripts,  $v$ ,  $d$  and  $h$  stands for a plane of symmetry? Show each of it with suitable example. 03

4. (a) Show that for parallel reaction involving reactant A and products C and D, the concentrations, [C] and [D] are equal to: 06

$$[C] = \frac{k_1[A]_0}{(k_1+k_2)}(1-e^{-(k_1+k_2)t}) \quad \text{and} \quad [D] = \frac{k_2[A]_0}{(k_1+k_2)}(1-e^{-(k_1+k_2)t})$$

- (b) i. Estimate the time required for the 70 % consumption of A in a first order reaction type,  $A \xrightarrow{k_1} B \xrightarrow{k_2} C$ , given  $[A]_0 = 1.0 \text{ mol.dm}^{-3}$ ,  $k_1 = 0.5 \text{ sec}^{-1}$ . 03
- ii. Enlist the special techniques used to follow fast reactions and how pressure jump and temperature jump methods are useful for liquid phase reaction? 03

OR

- (b) i. The rate constant of a reaction,  $A^{+1} + B^{-1} \rightarrow \text{Product}$ , is measured at two ionic strengths of 0.001 and 0.01 at 25°C in water. Calculate expected ratio of rate constants. 03
- ii. Demonstrate that unimolecular reactions are first order type even through mechanism involves a bimolecular step. 03
5. (a) The movement of charged particles under applied field is governed by electro kinetic phenomenon. Discuss and explain four such phenomenon that are usually observed. 06
- (b) i. How surface charge can be made from positive to negative? 03
- ii. How  $\xi$  potential is defined using Stern model for electrical double layer? 03

OR

- (b) i. What is a peptide bond ? Give its nature, explain the conformation of the peptide bond back bone in details. 03
- ii. Give the structure of back bone of a DNA molecule. Write down the structure of the nucleotide bases that are linked to back bone. 03
6. (a) Explain why DNA takes double helical conformation ? How DNA can be hydrolyzed ? Give the description of hydrolysis products. 06
- (b) i. How many forms of phosphates are available in biological systems? Give their importance. 03

- ii. Prove that  $\Delta G$  is additive and  $K_{eq}$  is multiplicative for the **03**  
following reactions: ( $R = 1.98 \text{ cal deg}^{-1} \text{ mol}^{-1}$ ,  $T = 298.15 \text{ K}$ )
- 1)  $A + P_i \leftrightarrow A - P_i + H_2O$ ,  $\Delta G_1^0 = 3138 \text{ cal/mol}$
- 2)  $B + H_2O \leftrightarrow C + P_i$ ,  $K_{eq} = 4.42 \times 10^5$
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- 3)  $A + B \leftrightarrow A - P_i + C$ ,  $\Delta G_3^0 = -4537.2 \text{ cal/mol}$

**OR**

- (b) i. The transport of an uncharged molecule under a concentration **03**  
gradient ( $C_1 = 0.001M$  and  $C_2 = 0.1M$ ) occurs across a membrane.  
Calculate  $\Delta G_{transport}$ , given  $\Delta V = 0.001 \text{ Volt}$ ,  $F = 96.5 \text{ kJ V}^{-1} \text{ mol}^{-1}$   
( $R = 8.314 \text{ J deg}^{-1} \text{ mol}^{-1}$ ,  $T = 298.15 \text{ K}$ ).
- ii. Which are the conventions used in biochemical energetics? **03**

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