

**Post Graduate Teaching Department of Chemistry**  
(An Autonomous Department)  
**Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur**  
End Semester Examination Winter-2022  
**M.Sc. (Chemistry)- Physical Chemistry (3T2)**  
**Semester – III (Special Paper -II)**

Time: - 3 Hours

Maximum Marks: 60

---

**Instructions: -**

- 1) Solve either 'EITHER' part or 'OR' part.
- 2) Draw neat well labelled diagram wherever necessary.
- 3) All questions from are compulsory and carry equal marks

- Q. 1    A)    Write down an expression for average energy of  $H_2^+$  molecule [by LCAO-MO] method and give the meaning of symbols involved in the equation.    4M
- B)    Explain the Russel-Saunders terms and coupling scheme. Write down the term symbol of  $Fe^{+2}$ ,  $Cr^{+3}$ , and  $Ni^{2+}$     4M
- C)    Construct  $sp$  and  $sp^2$  hybrid orbitals by combining one  $3s$  and one/two  $3p$  atomic orbitals and give the value of angle between the obtained hybrid orbitals    4M

**OR**

- D)    Explain the Variation principle for linear and non-linear functions    4M
- E)    Give a detailed account for perturbation theory and its application for first order perturbation    4M
- F)    Calculate the delocalization energy of ethylene molecule by using Huckel theory of molecular orbital.    4M
- Q. 2    A)    Describe the kinetics of solid-state reaction and explain the factors affecting on it.    4M
- B)    Explain photographic process and determination of surface activity.    4M
- C)    Explain the principle and working of Scanning electron microscopy with suitable diagram.    4M

**OR**

- D)    Discuss the general principle of both decomposition and phase transition reaction    4M
- E)    Describe the Sol-gel method of synthesis of nanoparticles.    4M
- F)    Give detailed account of various types of application for nanoparticles.    4M

- Q.3    A)    Explain Helmholtz Perrin model and Stern model for electric double layer.    6M  
           B)    Give detailed account of Exchange current density.    4M  
           C)    Describe in detailed the electrocapillary phenomenon with the help of    4M  
                  electrocapillary curve.

**OR**

- D)    Derive Butler-Volmer equation under near equilibrium and non-    6M  
           equilibrium conditions.  
           E)    Explain in detail about Outer Helmholtz plane and Inner Helmholtz plane    3M  
                  and specify their different region with the help suitable diagram  
           F)    What is zetapotential? How it is measured by using electrophoresis?    3M

- Q.4    A)    Explain the concept of electrokinetic effect and derive the Saxen's relations    6M  
                  with the help of irreversible thermodynamics.  
           B)    Derive phenomenological equation for flux, force relationship    3M  
           C)    What are coupled reactions, Discuss the case of urea formation on account    3M  
                  of burning of sugar

**OR**

- D)    Derive the expression for the rate of entropy production for spatially non    4M  
           uniform system.  
           E)    Discuss principle of microscopic reversibility and Onsager's reciprocity    4M  
                  relations.  
           F)    Derive Clausius-Duhem inequality used in spatially non-uniform systems.    4M

- Q.5    A)    Apply simple Huckel theory to butadiene molecule and calculate its    3M  
                  delocalization energy.  
           B)    Describe in detailed about the Tarnish reaction    3M  
           C)    Define overvoltage. What are the factors affecting on overvoltage?    3M  
           D)    Discuss the physical significance of phenomenological coefficients.    3M

---

**@ All the Best @**

---