*General Instructions (if any):****1. OPEN BOOK Examinations, 2. ….***

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| Q. No. | | Sub- division | | Question Text | Marks | Unit / Module No. | HOTS? (Y/N) | Difficulty  Level  E/A/T | SLO |
| Answer **Any Three** Questions Total Marks: 3 X 10 Marks = 30 | | | | | | | | | |
|  | a) | | In a combined water electrolysis and its reverse fuel cell process (equation given below) of Unitized Regenerative Fuel Cell, considered that splitting of water equation (i), and combination of O2 and H2 to form H2O and electricity equation (ii) alternatively in the same Fuel cell stack. The whole process is assumed to be ideally.    H2O H2 + O2 ΔU = 282.13 kJ….(i)  H2 + O2 H2O ΔU = -282.13 kJ…(ii)     * 1. Identify which is (i) work done on the system and (ii) work done by the system. (5 marks)  1. Prove that the total process is an isolated system. (5 marks) | | **10** | **1** | Y | T | 1 |
|  |  | |  | |  |
|  |  | | **(OR)** | |  |
|  | b) | | (i) For an ideal gas of n moles, prove Cp/Cv = 5/3. (5 marks)  (ii) A O2 molecule having symmetrical vibrations exhibited conservative (process is reversible) type of force. What is the total net work done? Derive and Prove. (5 marks) | | **10** |
|  |  | | **(OR)** | |  |
|  | c) | | Consider an ideal gas system with heat transfer (q) and work done (W) at constant temperature about 273 K.   1. Calculate its internal energy change. (5 marks)   (ii) Derive the work done in vacuum. (5 marks) | | **10** |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | d) | | A sample of an ideal gas is initially at a volume of 4 m3. The gas expands to a volume of 8 m3 when 2.0 J of heat is applied or transferred to the system against a constant external pressure of 0.5 Pa. Calculate the change in internal energy for this gas. 1.0 Pa. m3 = 1.0 J.   1. Whether the work is done by the system or work done on the system? (5 marks) 2. Prove that the process is happening at fixed temperature (5 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | e) | | Melting of ice at 00C at constant temperature with 6010 J and at 1 atm.   1. Find its entropy and (5 marks) 2. Gibbs free energy of the system. (5 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | f) | | 1 mole of an ideal monoatomic gas at 27 οC expands reversibly and adiabatically from a volume of 10 dm3 to a volume of 20 dm3.Calculate q, U, W and H. Given Cv/R= 3/2. (10 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | g) | | Ghee is melted from 283 K to 30 0C.   1. What is its efficiency? (3 marks) 2. Entropy of a spinel structure of solid with microstates (W) is 1. Consider that absolute temperature was achieved in this case. Boltzmann constant k = 1.381 x 10-23J K-1. Calculate its entropy and discuss its details. (7 marks)  |  |  | | --- | --- | |  |  | | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | h) | | (i) Calculate the efficiency of a certain power station operates with superheated steam at 300 (Th = 573 K) and discharges the waste heat into the environment at 20 (T = 303 K). Consider that there is a efficiency loss due to mechanical friction is 4%. (5 marks)  (ii) Internal energy of a O2 molecule is U=6.235 J/mol. Then, the oxygen molecule is exhibited a symmetric vibration of conservative type of forces with complete reversibility. Calculate its enthalpy. (5 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | i) | | Consider that a caesium chloride crystalline compound is the highest possible crystalline nature and its microstates (W = 1). Boltzmann constant k = 1.381 x 10-23J K-1.   1. Calculate its entropy and (5 marks) 2. Discuss its entropy at absolute temperature. (5 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | j) | | Consider an Irreversible Isothermal expansion of H2 at   1. Constant pressure of 1.5 Pa with change in volume about 20 m3. (marks) 2. The same process under vacuum with appropriate explanation (5 marks) | |  |  |  |  |  |
|  |  | |  | |  |  |  |  |  |
| 2. | a) | | Explain the condition at which high yield of product formation in the enzyme catalysis using the Michaelis-Menten Mechanism.  Discuss the condition using the rate constant at which slow enzyme reaction takes place. | | **10** | **1,2** | Y | T | 1,2 |
|  |  | | **(OR)** | |  |
|  | b) | | 1. In the reaction H2O2(*aq*) → H2O(*l*) + ½ O2(*g*), the initial concentration of H2O2 is 0.2546 M, and the initial rate of reaction is 9.32×10–4 M s–1. What will be [H2O2] at *t* = 35 s? (4 marks) 2. What is the order of the above reaction? What is its concentration at 70s? (6 marks) | | **10** |
|  |  | | **(OR)** | |  |
|  | c) | | (i) limitations of Crystal Field stabilization theory with explanation. (5 marks)  (ii) Compare Crystal Field stabilization theory and Sidgwick theory. (5 marks) | | **10** |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | d) | | (i) Calculate the half-life of the first order reaction from their rate constants given below: (i)200 s-1 (ii)2 min-1 (iii) year-1 (6 marks)  (ii)The half-life of a first-order reaction was found to be 20 min at a certain temperature. What is its rate constant? (2 marks)   1. Consider 14C rate constants is 2 year-1 of a shrine. What is the half-life period of the shrine? (2 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | e) | | 1. Assuming when *kb* >> *ka* ′. What will happened to the efficiency of the enzyme catalysis and rate of the formation Enzyme-substrate concentration formation. (5 marks) 2. Assuming when *kb* << *ka* ′. What will happened to the efficiency of the enzyme catalysis and its rate of the formation of the product. (5 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | f) | | Why do Mn3O4 is normal spinel and Fe3O4 is inverse spinel? Discuss properly with suitable explanation. (10 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | g) | | (i) How does d-transition metal complexes obey the Laporte rule? Give appropriate explanation? (5 marks)  (ii) What is the relation between the wavelength and strength of the ligand? Discuss briefly about it. (5 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | h) | | In a temperature dependent rate reaction, a plot of ln k against 1/T is a straight line. The slope of this reaction increases by 2-fold.  (i) Whether the rate constant of the reaction rate will increase or decrease? Discuss in detail. (5 marks)  (ii) Whether the temperature in this case decreases or increases? (5 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | i) | | (i) Compare the chemical catalysis with the enzyme catalysis. (5 marks)  (ii) Whether the transition state in the chemical catalysis and enzyme catalysis follow same path or different path? Explain why? (5 marks) | |  |  |  |  |  |
|  | j) | | (i) Compare (Co(NH3))+3 and (CoFe6)-3 with suitable CFSE and identify outer and inner orbital complexes among them. (5 marks)  (ii) Differentiate both outer and inner orbital complexes using the above complexes (4 marks). | |  |  |  |  |  |
| 3. | a) | | Calculate the crystal field stabilization energy for the d6, d7, d8, d9 and d10 complexes of octahedral complexes with diagram for the strong field. | | **10** | **2** | Y | T | 2 |
|  |  | | **(OR)** | |  |
|  | b) | | (i) Why do d8 forms mostly square planar symmetry? (5 marks)  (ii) Depict and explain the |Ni(CN)6|2+ (5 marks) | | **10** |
|  |  | | **(OR)** | |  |
|  | c) | | Calculate the crystal field stabilization energy for the d6 to d10 for tetrahedral complexes with suitable diagram. (10 marks) | |  |
|  |  | | **(OR)** | |  |
|  | d) | | (i) How does d-d orbital transition is allowed and most of the transition metal complexes shows the colour? (5 marks)  (ii) Explain the magnetic properties inner and outer orbital complexes using suitable energy level diagram. (5 marks) | | **10** |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | e) | | Compare to the d3 and d7 complexes. Although both exhibits 3 unpaired electrons. The ionic radius of the d3 is less and out of the trend. Explain why with necessary phenomenon involve. (10 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | f) | | (V(H2O)6)3+ is violet in colour and (V(H2O)6)2+ is yellow colour. Explain based on crystal field splitting how the colours formed and for each compound mention its wavelength region in nm. (10 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | g) | | (i) Why do Fe(CN)6]3- and [Co(NH3)6]2+  are exceptional for Sidgwick theory? Explain. (5 marks)  (ii) Compare poisonous nature of KCN and K4(Fe(CN)6). Explain in each case. (5 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | h) | | Consider an reactants A and B gives to C. After adding some of the substance which does not take part in the reaction and in final chemical it is unchanged, the activation energy is remains the same. What will be the rate of the catalysis before and after adding the catalysts? Explain with suitable protype diagram. (10 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | i) | | In a temperature dependent rate reaction, a plot of ln k against 1/T is a straight line. The slope of this reaction increases by 2-fold.   1. Whether the rate constant of the reaction rate will increase or decrease? Discuss in detail. (5 marks) 2. Whether the temperature in this case decreases or increases? (5 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | j) | | In these following complexes, give its wavelength in nm for the Crystal Field splitting based on the color of light transmitted in this transition.  [Co(NH3)63+][Cl-]3 orange-yellow  [Co(NH3)5(H2O)3+][Cl-]3  red  [Co(NH3)5Cl2+][Cl-]2 purple  [Co(NH3)4Cl2+][Cl-] green  (V(H2O)6)3+ Violet  (10 marks) | |  |  |  |  |  |
|  |  | | **(OR)** | |  |  |  |  |  |
|  | k) | | In the heme molecule of the porphyrin ligand with iron as central metal atom,   1. compare ligand strength of the O2 and CO with suitable crystal field stabilization energy diagram and (6 marks)   calculate its crystal field stabilization energy (Δo) (4 marks) | |  |  |  |  |  |



**Signature with date**