

M.E. Metallurgical Engineering First Year First Semester Examination 2024**SUBJECT: PHYSICO CHEMICAL PRINCIPLES OF METALLURGICAL PROCESSES****Time: Three Hours****Full Marks: 100****(Answer any three from Q 1 to Q4 and any two from Q5 to Q7)**

Q1. (a) What is the Ellingham Diagram? What is the basis of drawing this diagram? What do we understand from this diagram? 3+2+3 = 8

(b) What differences do we observe when the relevant data are plotted in the Ellingham diagram for the reactions: (i) $C + O_2 = CO_2$ and (ii) $2C + O_2 = 2CO$ and why? 4

(c) Find the relationship for the oxygen pressure in equilibrium with a metal oxide at any temperature T. What do you understand from this relationship? 4+2 = 6

(d) State the Free Energy criterion for equilibrium and spontaneous processes. 2

Q2. (a) For the reaction: $aA + bB = cC + dD$ find the relationship connecting standard free energy change with equilibrium constant. 5

(b) Derive Gibbs-Helmholtz relationship. 5

(c) Define C_p and C_v . For a chemical reaction derive the relationship for obtaining the change in enthalpy at higher temperature from the value at lower temperature. 2+3 = 5

(d) The standard free energies of formation of Cu_2O (s) and CuO (s) are as follows:



Find which oxide would form when oxygen at 20 mm Hg pressure is passed over pure copper at 900°C. 5

Q3. (a) What is known as "activity" of a component in a solution? How this activity is related to its chemical potential? 2+2 = 4

(b) What is known as 'ideal solution?' State the law applicable for ideal solution? 2+2 = 4

(c) Under what conditions a solution becomes non-ideal? How the law applicable for ideal solution is modified in case of non-ideal solution? 3+2 = 5

(d) What is known as partial molar free energy? Discuss how the partial molar free energy of the components in case of a binary solution of A and B having X_A mole fraction of A can be obtained. 7

Q4. (a) What is the purpose of roasting in case of hydrometallurgical processes? Name different types of roasting processes. 3+2 = 5

(b) Distinguish between 'roasting' and 'calcination' processes. 5

(c) Taking any one example discuss the "predominance area diagram" and its utility. 10

Q5. (a) State the advantages and disadvantages of hydrometallurgical processes for metal extraction. 5

(b) Give a general flow sheet showing various steps for hydrometallurgical extraction of metals. 7

(c) Discuss with necessary figures the kinetic steps involved in a general leaching process leaching. How can you accurately determine the rate controlling step in a leaching process? 8

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Q6. (a) Give an account of metallic reduction for recovery of metal values from leached solution. 6

(b) What are the ores from which aluminium is extracted? Discuss in detail the steps involved for extraction of aluminium from its ore. 2+12 = 14

Q7. (a) What is known as electrometallurgy? What is the difference between electro-winning and electro-refining processes? What is the theoretical cell voltage for electro-refining process? Explain whether this theoretical cell voltage is sufficient for electro-refining of metals? 3+4+3+2 = 12

(b) Discuss the processes involved in the extraction of gold from its ore. 8