Answer Question 1 and any <u>Three</u> from the rest.

1. **(Compulsory)** : Indicate only True (T) or False (F) against the following statements: [10]

   i) Goethite is an ore of iron

   ii) Aluminium cannot be obtained through electrolysis of aqueous solutions.

   iii) Electro-refining of copper requires more energy than electrowinning of copper from solution

   iv) A reaction is faster when thermodynamic driving force is greater

   v) Lead has low melting point as well as relatively low boiling point.

   vi) There is abundant reserve of copper ore in India

   vii) Rittinger's law of size reduction is applicable for coarse crushing only

   viii) Alumina in ore can be dissolved by alkaline leaching agent

   ix) Specific energy required (per unit weight) for crushing is more than that for grinding

   x) Pressure drop is inversely proportional to fluid velocity during the early stages of bed fluidization

   xi) In Ellingham diagram, the free energy of formation becomes less negative with rise in temperature, except in the case of Carbon oxidation

   xii) Application of vacuum promotes distillation process

2. Differentiate between the following briefly (ANSWER ANY FOUR):   [4×5=20]

   a. Extraction coefficient and Extraction factor during solvent extraction

   b. Electrolysis and electro refining

   c. Lamellar and turbulent flow

   d. Activation over potential and concentration over potential

   e. Acid and basic slag

   f. Slag and Matte

3. Answer ANY FOUR of the following questions.   [4×5=20]

   a. What are the basic postulates of the Temkin's model for ionic melts?
   b. Why radiative heat transfer depends on a 'view factor'?

   c. $\Delta G°$ vs T plots in the Ellingham diagram have similar slopes for metals and hydrogen but different slopes for carbon.

   d. Why ammonia needs to be added during precipitation of nickel from aqueous solutions by hydrogen gas?

   e. Porous refractories give better insulation-explain.

   f. Viscosities of silicate melts decrease up to a limit by addition of basic oxides.-justify.

g. Why electrolysis of aqueous acid solutions produce more acid whereas electrolysis of alkaline aqueous solutions consume more alkali ?

4. Answer ANY TWO of the following: [2 x 10=20]

   a) i) Calculate activities of various salts in a mixture containing 1 mole each of NaCl, Cd Br_2 and Ca F_2.

   ii). A metallothermic reduction reaction is written as: AO (s)+ B (s)= A (liq.) +BO (s)

   As per the Ellingham's diagrams , the values for free energy of formation of AO and BO are respectively – 184 KJ/ mole and – 364 KJ / mole .

   - Is this reaction feasible?
   - How will the equilibrium change if :
        (i) BO tends to combine with AO
        (ii) B dissolves in A
        (iii) Vacuum is applied

   b) Explain the conditions for a metal can be obtained from its aqueous solution by reduction with hydrogen gas, using suitable equations.

   c) What is Current efficiency? A metal (At. Wt. 31.8) is being electrolyzed. Applied voltage is 2.21∨. Calculate the energy required (KWR) and energy efficiency per ton of metal deposited when the theoretical decomposition voltage is 1.23 V and the current efficiency is 90 %.

5. a) 1000 kg chalcopyrite concentrate is charged in a matte smelter to produce matte of which 'matte grade' is 40. The concentrate analysis is: 24 % Cu and 38 % S while the matte contains 25 % S. Calculate (i) the amount of sulphur oxidized and (ii) the volume (m^3) of SO_2 produced.

   b) Name the factors on which the volumetric flow rate of a fluid in a smooth pipe depends. Write the simple form of Ergun equation for laminar flow.

   c) Discuss the phenomenon of fluidization of a bed of solids in terms of pressure drop across the bed. What are the practical applications of bed fluidization in metal extraction?

                                                                                       [6+5+9]

6. Attempt any FOUR: [4 x 5]

   a) What is the importance of mineral dressing in extraction of metals? State and explain the Bond's law of size reduction, clearly explaining the concept of Work Index.

   b) Explain the terms (any two): i) equal settling particles ii) principle of heavy media separation iii) free and hindered settling.

   c) Explain the mechanism by which particles of a specific mineral are lifted by air bubbles during froth flotation.

   d) Give a neat labeled flow chart for producing blister copper from chalcopyrite concentrate, indicating all the inputs and outputs.

   e) What is 'friction factor' and where would you use this parameter ? Discuss the phenomenon of fluidization of a bed of solids in terms of pressure drop across the bed.

   f) Explain how a metal-bearing mineral can be concentrated by applying the principle of classification ,