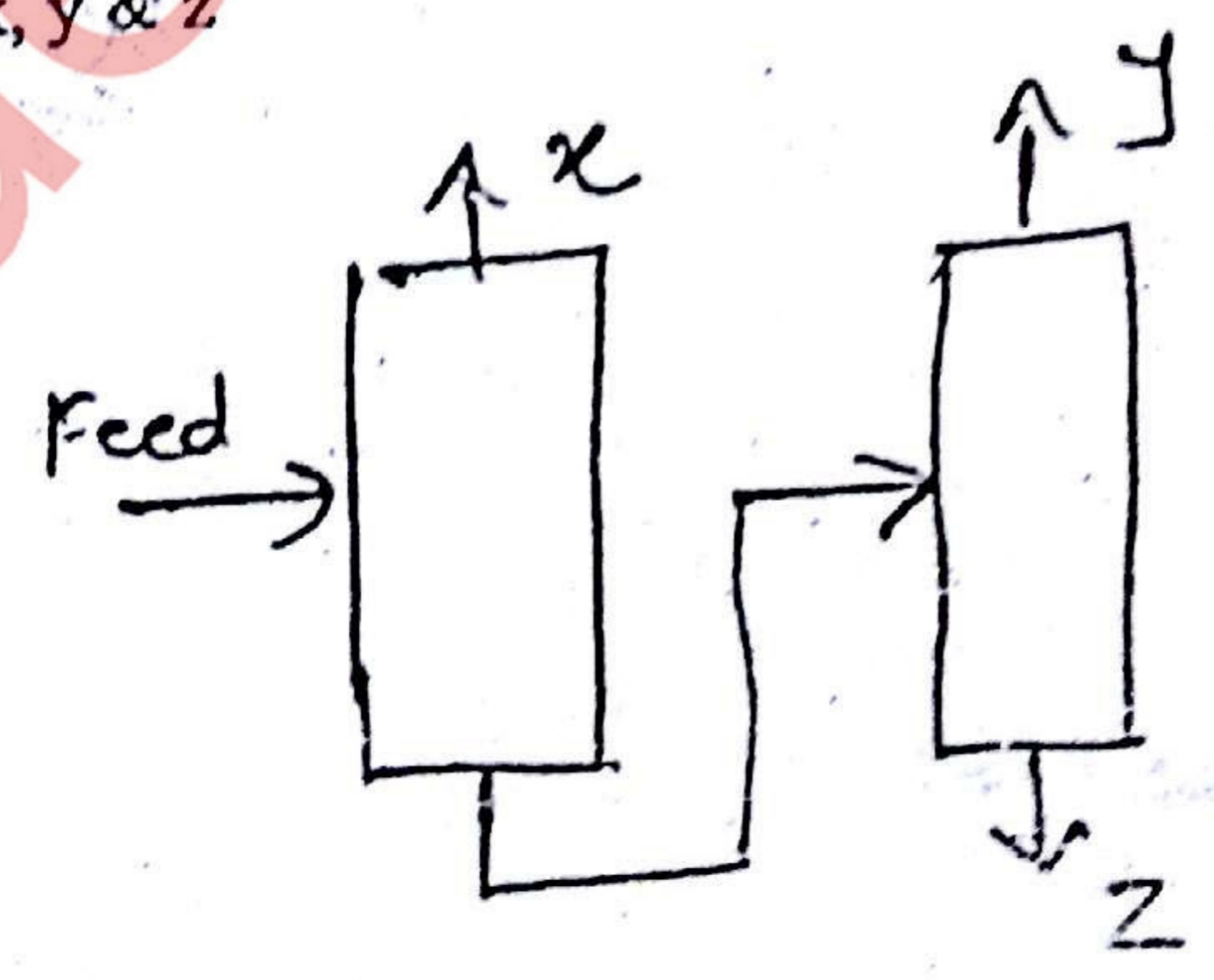06/15

Process calculation

① ㉗ Chem./III./CBGS/PC
Q.P. Code : **4911**

(3 Hours) [Total Marks : 100

N.B. : (1) Question No. 1 is compulsory.
(2) Attempt any **three** of the remaining questions.
(3) Each questions carries equal **marks**.
(4) Make suitable assumptions if required and mention them properly.

1. (a) The superfacial mass velocity is found to be 200 ℓb/hr ft². Find its equivalent 5
in kg/s.m².

(b) How many grams of liquid propane will be formed by the liquifaition of 5
500 lit of the gas at NTP?

(c) A solution of caustic soda in water contains 20% NaOH by weight. The 5
density of the solution is 1196 kg/m³. Find the molarity, normality and
molality of the solution.

(d) The gas obtained from a furnace fired with a hydrocarbon fuel oil analyses 5
$CO_2 \rightarrow 10.2\%$, $O_2 \rightarrow 7.9\%$, $N_2 = 81.9\%$
Calculate percent excess air used

2. (a) A tank of weak H_2SO_4 contains 12.43% acid. If 200kg of 77.7% H_2SO_4 8
are added to the tank and the final acid is 18.63%, how many kg of weak
acid have been made up?

(b) The feed to a fractionating system is 30000kg/hr of 50% benzene, 30% 12
toluene and 20% xylene. The fractionating system consists of two towers
No. I and No. II. The feed enters tower I. The overhead product from I is x
kg/hr of 95% benzene, 3% toluene and 2% xylene. The bottom product
from I is fed to II resulting in an overhead product f y kg/hr of 3% benzene,
95% toluene and 2% xylene. While the bottom from II tower is Z kg/hr of
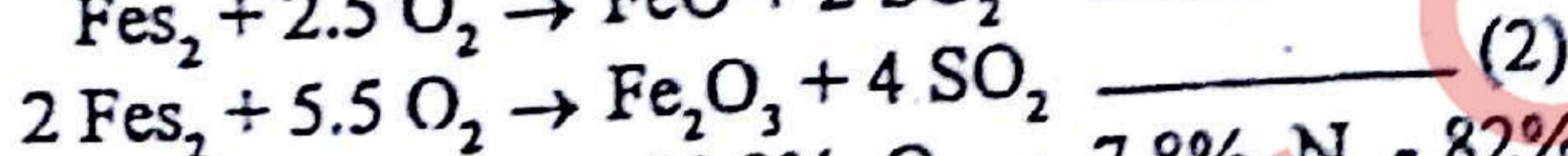1% benzene, 4% toluene & 95% xylene.
Find   x, y & z

TURN OVER

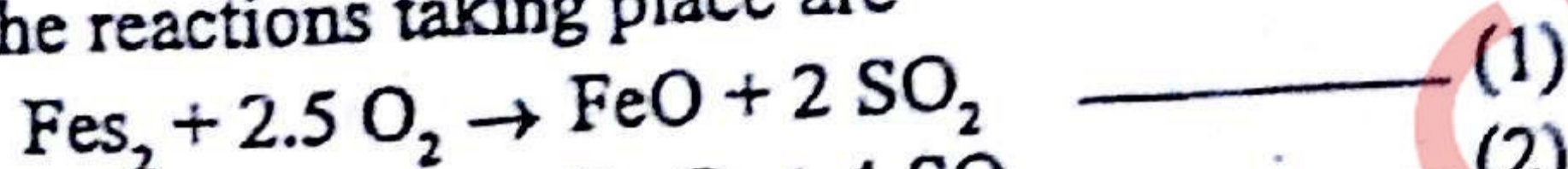JP-Con. 11389-15.

3. (a) The first step in the manufacture of H_2SO_4 from pyrites consists of burning   10
pyrites in air. The reactions taking place are
$$Fe_2 + 2.5\ O_2 \rightarrow FeO + 2\ SO_2 \quad \text{———— (1)}$$
$$2\ Fe_2 + 5.5\ O_2 \rightarrow Fe_2O_3 + 4\ SO_2 \quad \text{———— (2)}$$
The flue gas analysis shows SO_2 - 10.2%, $O_2 \rightarrow$ 7.8%, N_2 - 82% on dry
basis at 600°C & 780 mm hg
  (i) In what ratio does the two reactions take place?
  (ii) How much excess air was fed if the reaction (2) is desired?

(b) Calculate the theoretical flame temperature of a gas having 20% CO and   10
80% N_2 When burnt with 150% excess air. Both air and gas being at 25°C.
Data :   Heat of formation of CO_2 = -94052
         CO = -26412 cal/g mol at 25°C
Cp of CO_2 = 12.1, $O_2 \rightarrow$ 7.9, $N_2 \rightarrow$ 7.55 cal/gmol K

4. (a) Metallic silver may be obtained from sulphide ores by roasting to sulphates   12
and leaching with water and subsequently precipitating silver with copper.
In the figure shown below the material leaving the second seperator was
found to contain 90% silver and 10% copper. What percentage excess copper
was used? If the reaction goes to 75% completion based on the limiting
agent Ag_2SO_4, what is the recycle-stream in kg/tonne of product? Molecular
wt Ag $\rightarrow$ 107.88, Cu = 63.54.
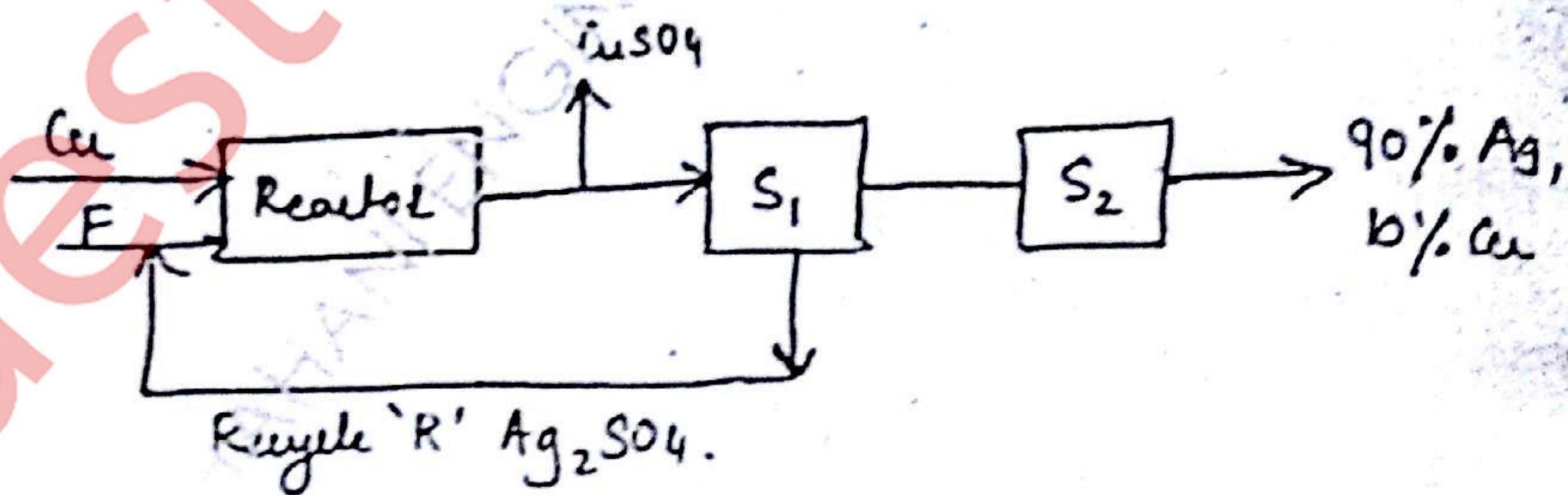
(b) Define   8
  (i) Absolute Humidity   (ii) Relative Humidity
  (iii) Humid Heat   (iv) Dew Point

5. (a) A storage tank of demineralized (DM) water has a holding capacity of $1500m^3$ **12** upto an overflow point. The inflow of DM water to the tank is 25 ℓ/s having silica content (as SiO_2) of 0.005 mg/ℓ. The supply of DM water to the high pressure boliers from the tank amounts to 25 dm³/s. With time the DM water quality deteriorates and the silica content in the feed DM water inerased to 0.02 mg/ℓ. Assume that the inflow into and outflow from the tank remains constant at 25 ℓ/s. Calculate the time for the silica content in the storage tank to increase to 0.01 mg/ℓ.

(b) Calculate the standard heat of reaction at 298.15 K, when gaseous ammonia **8** is dissolved in water to form 2% by weight of its solution for the regeneration of a weak anion exchanger of a water treatment plant.
ΔH_f^0--- for NH3 (g) → -45.94 kJ/mol
N2O (e) → -285.83 kJ/mol
NH4OH (ℓ) → -361.20 kJ/mol

6. (a) An absorption tower is used to absorb carbon dioxide in an aqueus **14** monoethanol amine (MEA) solution. The volumetric flow rate of the incoming dry gas mixture is 1000 m³/hr at 318K & 1013 KPa a. The CO_2 content of the gas is 10.4 mol%, while the outgoing gas mixture contains 4.5 mol% CO_2. A 3.2 M MEA solution is introduced at the top of the tower at the rate of 0.625 lps. Dissolved CO_2 concentration of the entering solution is 0.166 kmol/kmol MEM. Find the concentration of dissolved CO_2 in the solution leaving the tower.

(b) Define **6**
(i) Datton's law   (ii) Amagat's law
(iii) Raoult's law   (iv) Henry's law