Seat No: _____________ Enrollment No: ___________________

PARUL UNIVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

B.Tech. Summer 2018 – 19 Examination

Semester: 3 **Date:25/05/2019**

Subject Code: 03103203 **Time:02:00pm to 04:30pm**

Subject Name: Process Calculation **Total Marks: 60**

Instructions:

1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.
4. Start new question on new page.

Q.1 Objective Type Questions – (All are compulsory) (Each of one mark) **(15)**

1Differentiate fundamental unit and derived unit.

2.Convert 499 gram of $CuSO_4.5H_2O$ into moles.

3.State Dalton's law and Henry's law.

4.Increasing the temperature of an aqueous solution will cause decrease in its

(a) Molality (b) Mole fraction (c) Weight percent (d) Molarity

5.What is the value of R in J/mol.K?

6.According to Raoult's law, "The vapor pressure exerted by component in a solution is proportional to the mole fraction of that component.'' Raoult's law is not applicable under the following assumption/condition.

(a) No component is concentrated at the surface of the solution.

(b) The component molecules are nonpolar and are of almost equal size.

(c) In the formation of solution, chemical combination/molecular association between unlike molecules takes place.

(d) The attractive forces between like and unlike molecules are almost equal.

7.Express normality and molarity.

8.What is the unit Cp in S.I. system.

9.Define mole fraction and weight fraction with appropriate formula.

10.Cp-Cv for an ideal gas is equal to ……………….

11. In a chemical process, the recycle stream is purged for

(a) Increasing the product yield

(b) Enriching the product

(c) Limiting inerts

(d) Heat conservation

12.Normality of a solution does not change with the increase in the

(a) Pressure (b) Temperature (c) Solute concentration (d) Dilution of the solution

13. Define yield and selectivity in multiple reactions.

14.State ideal gas law.

15………. Are the basic concepts of measurement such as length, time, mass, temperature etc.

Q.2 Answer the following questions. (Attempt any three) **(15)**

A) Assuming air to contain 79% N_2 and 21% O_2 by volume, Calculate the density of air at NTP?

B) Aqueous solution of triethanolmine (TEA), i.e. $N(CH_2CH_2OH)_3$, contains 50% TEA by mass. Find the molarity of the solution if the density of the solution is 1.05 kg/L.

C) In a textile mill, a double-effect evaporator system concentrates weak liquor containing 4% (by mass) caustic soda to produce a lye containing 25% solids (by mass). Calculate the evaporation of water per 100 kg feed in the evaporator.

D) 2000 kg of wet solids containing 70% solids by weight are fed to a tray dryer where it is dried by hot air. The product finally obtained is found to contain 1% moisture by weight. Calculate

(a) The kg of water removed from wet solids

(b) The kg of product

Q.3 A) Sodium chloride weighing 600 kg is mixed with 200 kg of potassium chloride. Find the composition of the mixture in (a) mass % and (b) mole %. **(07)**

B)1000 kg/hr of a mixture containing equal parts by mass of benzene and toluene is distilled to get overhead product containing 95% benzene (weight basis). The flow rate of bottom stream being 512 kg/hr. Calculate **(08)**

(i) The percentage of toluene in the bottom product (weight basis)

(ii) Flow rate of overhead product and its molar composition

(iii) Molar percentage of benzene in the feed

Datas: Molecular weight of benzene = 78

Molecular weight of toluene = 92

OR

B) A solution containing 55% benzene, 28% toluene and 17% xylene by weight is in contact with its vapour at 373K (100^o C). Calculate the total pressure and molar composition of the liquid and vapour?Data: Vapour pressure data at 373 K (100^o C), Benzene = 178.60 kpa , Toluene = 74.60 kpa, Xylene = 28 kpa. **(08)**

Molecular wt. of benzene = 78, Molecular wt.of toluene = 92, Molecular wt. of xylene = 106.

Q.4 A) Monochloroacetic acid (MCA) is manufactured in a semibatch reactor by the action of glacial acetic acid with chlorine gas at 100^oC (373K) in the presence of PCl_3 catalyst. MCA thus formed will further react with chlorine to form dichloroacetic acid (DCA). To prevent the formation of DCA, excess acetic acid is used. A small-scale unit which produces 5000 kg/d MCA, requires 4536 kg/d of chlorine gas. Also, 263 kg/d of DCA is separated in the crystallizer to get almost pure MCA product. Find the % conversion, % yield of MCA and selectivity. **(07)**

Reactions: $CH_3COOH + Cl_2 = CH_2ClCOOH + HCl$

$CH_2ClCOOH$ (MCA) + Cl_2 = $CHCl_2COOH$(DCA) + HCl

Datas: Molecular weight of MCA= 94.5, DCA = 128.94 and acetic acid = 60

OR

A) What will be the yield of glauber salt ($Na_2SO_4.10H_2O$) if a pure 32% solution is cooled to 20^o C (293.15 K) without any loss due to evaporation? **(07)**

Data: Solubility of Na_2SO_4 in water at 20^o C (293.15 K) is 19.4 kg per 100 kg water.

B) Soyabean seeds are extracted with hexane in batch extractors. The flaked seeds are found to contain 18.6% oil, 69% solid and 12.4% moisture (by weight). At the end of the extraction process, cake (meal) is separated from hexane-oil mixture. The cake is analysed to contain 0.8% oil, 87.7% solids and 11.5% moisture (by weight).Find the percentage recovery of oil. **(08)**