

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-IV • EXAMINATION – WINTER • 2014****Subject Code: 140504****Date: 02-01-2015****Subject Name: Fundamental of Chemical Engineering Calculations
And Stoichiometry****Time: 02:30 pm - 05:00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1 (a) Define the following terms: 07
 (1) Yield (2) Dew point (3) Latent heat (4) Dry-bulb temperature
 (5) Absolute humidity (6) Wet bulb temperature (7) Limiting component
- (b) (1) Convert the heat transfer coefficient of value 100 Btu/ hr. ft². °F into 04
 W/ m². °C.
 (2) Iron metal weighs 500 lb and occupies a volume of 29.25 litres. Find 03
 the density in Kg/ m³.
- Q.2 (a) A solution of NaCl in water contains 30% NaCl (by mass) at 65°C. The density 07
 of the solution is 1.25 Kg/ lit. Find the molarity, normality and molality of
 solution.
- (b) Sodium chloride weighing 600 Kg is mixed with 200 Kg of Potassium 07
 Chloride. Find the composition of mixture in (i) mass % and (ii) mole %.
- OR**
- (b) A mixture of gases is obtained having following % composition by weight. The 07
 composition is chlorine (Cl₂) = 67, bromine (Br₂) = 28 and oxygen (O₂) = 5.
 Using the ideal gas law, calculate (i) composition of the gas by volume and (ii)
 density of the mixture in gm/ litre at 25° C and 740 mm Hg pressure. Take
 atomic weights of Cl, Br and O are 35.5, 80 and 16 respectively
- Q.3 (a) Cracked gas from petroleum refinery has following composition by volume: 07
 45% methane, 10 % ethane, 25% ethylene, 7% propane, 8% propylene and 5% n
 - butane. Find (i) the average molar mass of the gas mixture (ii) the composition
 by mass and (iii) specific gravity of the gas mixture.
- (b) What is material balance? What is process flow chart? Explain importance of 07
 process flow chart in chemical industry.
- OR**
- Q.3 (a) The spent acid from a nitrating process contains 33% sulphuric acid, 36% nitric 07
 acid and 31% water by weight. This acid is to be strengthened by the addition of
 concentrated sulphuric acid containing 95% H₂SO₄ and concentrated HNO₃
 containing 78% HNO₃. The strengthened mixed acid is to contain 40% H₂SO₄
 and 43% HNO₃. Calculate the quantities of spent acid and concentrated acids
 that should be mixed together to yield 1500 Kg of the desired mixed acid.
- (b) Explain recycling and bypassing with reference to chemical industry with 07
 suitable diagram.
- Q.4 (a) A solution contains 50% benzene, 30% toluene and 20% xylene by weight at 07
 temperature of 100° C. The vapours are in contact with the solution. Calculate
 the total pressure and the molar % compositions of liquid and the vapour. The
 vapour pressure data for different components at 100° C are as follows:
- | Component | Benzene | Toluene | Xylene |
|-------------------------|---------|---------|--------|
| Vapour press., mm of Hg | 1340 | 560 | 210 |
- (b) Define the following unit operations with suitable diagram and example: 07
 Distillation, Absorption, Extraction, Crystallization and Evaporation.

OR

- Q. 4 (a) (1) A compound whose molecular weight is 103 analyses C - 81.5; H - 4.9; N - 13.6. What is the formula of compound? 04
(2) A solution of naphthalene ($C_{10}H_8$) in benzene contains 25 mole %. Express the composition of mixture in weight %. 03
- (b) The feed to a fractionating system is 30,000 Kg/ hr of 50% benzene, 30% toluene and 20% xylene. The fractionating system consists of two towers no.1 and no.2. The feed enters tower 1. The overhead product from 1 is X Kg/ hr of 95% benzene, 3% toluene and 2% xylene. The bottom product from 1 is feed to 2 resulting in an overhead product of Y Kg/ hr of 3% benzene, 95% toluene and 2% xylene while the bottom from tower 2 is Z Kg/ hr of 1% benzene, 4% toluene and 95% xylene. Find X, Y and Z? 07
- Q.5 (a) A solution of Potassium dichromate in water contains 13% $K_2Cr_2O_7$ by weight. 1000 Kg of this solution is evaporated to remove some amount of water. The remaining solution is cooled to $20^\circ C$. If the yield of $K_2Cr_2O_7$ is 80%. Calculate the amount of water evaporated. Solubility of $K_2Cr_2O_7$ is 0.39 Kg mole per 1000 Kg water at $20^\circ C$. Take atomic weights of K and Cr is 39 and 52 respectively. 07
- (b) A distillation column separates 10,000 Kg/ hr of 50% benzene and 50% toluene. The product recovered from the top contains 95% benzene while the bottom product contains 96% toluene. The stream entering the condenser from top of the column is 8000 Kg/ hr. A portion of the product is returned to column as reflux and the remaining withdrawn as top product. Find the ratio of the amount refluxed to the product. 07

OR

- Q.5 (a) Define sensible heat, latent heat, heat of formation, heat of combustion and standard heat of reaction. 07
- (b) In crystallization process a solution of $CaCl_2$ in water contains 62 parts of $CaCl_2$ per 100 parts of water. Calculate the weight of solution necessary to dissolve 250 Kg $CaCl_2 \cdot 6H_2O$ crystal at temperature of $25^\circ C$. Solubility of $CaCl_2$ at $25^\circ C$ is 7.38 Kg mole of $CaCl_2$ per 1000 Kg of H_2O . 07
