Date:04/01/2017

**Total Marks: 70** 

14

04

# **GUJARAT TECHNOLOGICAL UNIVERSITY**

## **BE - SEMESTER-III(New) • EXAMINATION - WINTER 2016**

Subject Code:2130504

Subject Name: Process Calculation

Time:10:30 AM to 01:30 PM

## **Instructions:**

Q.1

- 1. Attempt all questions.
- 2. Make suitable assumptions wherever necessary.
- **3.** Figures to the right indicate full marks.
- 4. Mol. Wt: C=12, O=16, N=14, H=1, Na=23, K=38, Cl=35.5, S=32,

Answer the following:

- (i) The SI unit of pressure is \_
  - (ii) Density is a fundamental quantity. (True/False).
- (iii) 1 atm = \_\_\_\_\_ bar.
- (iv) Unit of Luminous intensity is \_\_\_\_
- (v) Number of mol of solute dissolved in 1 kg of solvent is known as \_\_\_\_\_.
- (vi) Chlorine and Oxygen are monoatomic elements. (True/False).
- (vii) What is the use of pH measurement?
- (viii) Name equation of states for non-ideal gases.

(ix) Define limiting reactant.

x) The heat capacity of 1 kg of dry air and the moisture comtained in it is known as \_\_\_\_\_

xi) Define relative humidity.

- xii) Name the parameters determined in proximate analysis of coal.
- xiii) Which is better for combustion process, gaseous fuel or liquid fuel?

xiv) External agent added to separate liquid mixtures by extraction process is known as \_\_\_\_\_.

- Q.2 (a) A mixture of NaOH (M = 40.0 g/mol) and KOH (M = 56 g/mol) contains
   60% of KOH. Calculate the content of both components in the mixture in mol%.
  - (b) Explain (i) Boyle's law, (ii) Dalton's law.
  - (c)  $750m^3$  of air of  $40^{0}C$  and 740mm Hg is flowing through a pipeline. **07** Calculate the molar flow rate and mass flow rate. What are the partial pressures of O<sub>2</sub> and N<sub>2</sub>?

OR

- (c) Describe the different methods to solve material balance problem with 07 examples.
- Q.3 (a) Metallic Aluminium weighs 100lb and occupies a volume of 16.8 L. Find
   03 the density of Aluminium in kg/m<sup>3</sup>.
  - (b) Aqueous solution of triethanolmine (TEA) of molar mass 149 contains 50% 04 TEA by mass. Find the molarity of the solution if the density of the solution is 1.05 kg/L.
  - (c) A coal containing 85% Carbon, & 8% H<sub>2</sub> and remaining ash is burnt in a furnace with 30% excess air. Assume complete combustion. Calculate:
    (i) the quantity of air supplied per kg of coal burnt.
    - (ii) the composition of flue gases in wt%.

#### OR

Q.3 (a) A salt solution is to be made containing 65% by weight of salt. The two solutions available contain 48% by weight of salt and 73% by weight of salt.

In what proportion these streams are to be mixed to get te desired solution. 04 **(b)** Answer in brief: (i) Differentiate between fundamental quantity and derived quantity. (ii) What is Joule-Thompson effect in gas throttling? Pure methane is completely burned with air in a combustor. The outlet gas 07 (c) from the combustor is passed through a cooler where some of the moisture is removed. The gas leaving the cooler contains 0.8335 mol. fraction of Nitrogen. The combustion reaction taking place is:  $CH_4 + 2O_2 \rightarrow CO_2 + 2 H_2O$ . Calculate: (i) analysis of gas leaving the cooler (ii) weight of water condensed per mole of methane burnt. 0.4 Write a short note on classification of fuels. 03 (a) Answer in brief: 04 **(b)** (i) Define GCV and NCV. (ii) How to decide the quantity of excess air for combustion process? (c) Vapor phase oxidation of ethyl alcohol using Copper catalyst at  $550^{\circ}$ C 07 produces acetaldehyde by the following reaction:  $C_2H_5OH + 0.5 O_2 \rightarrow CH_3CHO + H_2O.$ The conversion is 30% and excess air supplied is 10%. Calculate the composition of product stream if 100kg of C<sub>2</sub>H<sub>5</sub>OH per hour is fed to the reactor. OR (a) Explain ultimate analysis of coal. 03 **Q.4** Answer in brief: **(b)** 04 (i) Differentiate between sensible heat and latent heat. (ii) Define yield and conversion. (c) Pure methane is heated from 303K to 523K at atmospheric pressure. 07 Calculate the heat added per kmole methane using C<sub>P</sub> data.  $C_P = a + bT + cT^2 + dT^3$ . Data for methane: a = 19.2494,  $b \times 10^{3} = 52.1135$ ,  $c \times 10^{6} = 11.973$ ,  $d \times 10^{9} = -11.3173$ Q.5 (a) Explain extraction process. 03 100 kg of Cadmium at 27<sup>o</sup>C is to be melted. The heat is supplied by steam. **(b)** 04 Calculate mass of steam to be supplied. Data: Melting Point of Cadmium is 320.9 °C. At. wt of Cadmium = 112. Use  $Cp = 6 + 0.005T \text{ kcal/kmol}^{\circ}C$  where T is in  $^{\circ}C$ . Latent heat of fusion = 2050 kcal/kmol. Latent heat of steam = 210 kcal/kg15000 kg/day of a mixture containing methyl ethyl ketone (MEK) and 07 (c) butanol is to be separated into top product containing 99.5 mole% MEK. The bottom product should not contain more than 1% of MEK. Feed mixture contains 68 mole % of MEK. If 475 kmoles of vapor/day are leaving the column, calculate: (i) top and bottom product obtained per day.( ii) reflux ratio. Data: Mol. Wt. of MEK = 72 and butanol = 74.

## OR

- **Q.5** (a) Explain the significance of a Psychrometric chart.
  - (b) Show the material balance of a distillation column with a neat sketch.
    (c) A multiple contact counter current extractor is employed to extract oil from
    07
  - (c) A multiple contact counter current extractor is employed to extract oil from halibut livers with the help of ethyl ether. The fresh livers are charged to the

2

03

extractor at the rate of 1000 kg.h and contains 25.7% oil. Pure ether enters the bottom of the extractor. The overflow from the extractor contains 70% oil. The underflow rate is 0.23 kg solution/kg oil-free solids and is known to contain 12.8% oil. All % are by mass. Determine:

(i) the percentage recovery of oil.

(ii) the flow rate of ether to the extractor.

\*\*\*\*