A **Reg. No. :** | | | | | | | | | | |

Question Paper Code: 54902

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2018

Fourth Semester

Chemical Engineering

15UCH402 - CHEMICAL PROCESS CALCULATIONS

(Regulation 2015)

(Necessary Data book must be provided)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions
PART A - (10 x 1 = 10 Marks)

1. One mole is defined based on the number of elementary entities present in _____ atom. CO1- R

   (a) carbon – 14 (b) carbon – 6 (c) carbon – 12 (d) carbon – 18

2. In an ideal gas mixture, the total pressure is the sum of the partial pressures exerted by each component. This is the statement of ____ law. CO1- R

   (a) Dalton's (b) Amagat's (c) Vanderwaal's (d) Joule - Thomson

3. In material balance equations, the _____ term becomes zero at steady state. CO2- R

   (a) input (b) output (c) out – turn (d) accumulation

4. A limiting component decides the _____ in the reactions. CO2- R

   (a) yield (b) conversion (c) stoichiometric number (d) temperature

5. When the partial pressure of the vapor in the gas is the same as the vapor pressure of the substance, then the relative saturation is CO3- R

   (a) 0% (b) 50% (c) 30% (d) 100%

6. Sling psychrometer is used to measure _____. CO3- R

(a) wet – bulb temperature (b) dew point

(c) humid volume (d) humid heat

7. The ultimate analysis of coal is not used to measure ____. CO4- R

(a) carbon (b) nitrogen (c) volatile matter (d) sulfur

8. The gas which is present in very low concentration in the flue gases is _____. CO4- R

(a) CO_2 (b) N_2 (c) SO_2 (d) SO_3

9. The standard heat of reaction is measured at _____. CO5- R

(a) 100^oC and 100 atm (b) 25^oC and 1 atm

(c) 25^oC and 10 atm (d) 0^oC and 1 atm

10. Compressing a gas in a cylinder is an example for _____ system. CO5- R

(a) closed unsteady (b) open steady (c) closed steady (d) open unsteady

PART – B (5 x 2= 10Marks)

11. Iron metal weighing 500 pounds occupies a volume of 29.25 liters. Calculate the density of iron in kg/m^3. CO1- R

12. What is recycling operations? Why it is carried out? CO2- R

13. What properties of an air – water vapor mixture are displayed on a humidity chart? CO3- R

14. What is theoretical air and excess air? CO4- R

15. Define heat of formation. CO5- R

PART – C (5 x 16= 80Marks)

16. (a) (i) A saturated solution of salicylic acid in methanol contains 64 kg salicyclic acid per 100 kg methanol at 25^oC. Find the mass % and mole % composition of the solution. Molecular formula for salicyclic acid is HOC_6H_4COOH and for methanol is CH_3OH. CO1- App (8)

(ii) Explain the calculation of following for aqueous solutions: molarity, molality, normality and concentration in gm/liter. CO1- App (8)

Or

(b) Cracked gas from a petroleum refinery has the following composition by volume: CH_4 = 45, C_2H_6 = 10, C_2H_4 = 25, C_3H_8 = 7, C_3H_6 = 8 and C_4H_{10} = 5. Find average molar mass of the gas mixture, composition by mass and specific gravity of the gas mixture. (16 marks) CO1- App (16)

17. (a) (i) 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. CO2- App (6)

(ii) Explain the following terms: limiting reactants, excess reactants, bypass stream and purge stream. CO2- App (10)

Or

(b) It is required to make 1000 kg mixed acid containing 60% H_2SO_4, 32% HNO_3 and 8% water by blending the spent acid (containing 11.3% HNO_3, 44.4% H_2SO_4, 44.3% H_2O), an aqueous acid 90% HNO_3 and an aqueous 98% H_2SO_4. All percentages are by mass. Calculate the quantities of each of the three acids required for blending. (16 marks) CO2- Ana (16)

18. (a) The weather office reports a temperature of 90°F, relative humidity of 85% and a barometric pressure of 14.696 psia. Calculate the following:
(i) molal humidity,
(ii) humidity (weight basis) and
(iii) molal humidity and dew point if the air is cooled to 60°F, the pressure remaining steady. Data's: partial pressure of water vapor in gas mixture at 90°F = 0.6982 psia. CO3- Ana (16)

Or

(b) Describe the following terms in humidification operations: humid heat, humid volume, dry bulb temperature and wet bulb temperature. CO3 -U (16)

19. (a) (i) In a combustion test, 20 kg of propane (C_3H_8) is burned with 400 kg of air to produce 44 kg of CO_2 and 12 kg of CO. What CO4- App (8)

was the percent excess air? The reaction involved is:

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

(ii) Explain the principle for Orsat analysis of flue gases. CO4- U (8)

Or

(b) Describe the calculation of heat capacity of gases, solids and liquids. CO4- U (16)

20. (a) (i) Calculate the heat of formation of methane (CH4) from the following heat of formation of other compound data's: CO5-App (8)

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(liq); \quad \Delta H_a = -212{,}805\ cal$

$C + O_2(g) \rightarrow CO_2(g); \quad \Delta H_b = -94{,}030\ cal$

$2H_2(g) + O_2(g) \rightarrow 2H_2O(liq); \quad \Delta H_c = -136{,}640\ cal$

(ii) Write short notes about unsteady state energy balance equations. CO5-U (8)

Or

(b) (i) Discuss the effect of temperature and pressure on heat of reaction. CO5-U (7)

(ii) Explain the applications of energy balance equation without chemical reaction for: closed system, open system with heat transfer and open – steady state flow system. CO5-U (9)