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PRESIDENCY UNIVERSITY BENGALURU

SCHOOL OF INFORMATION SCIENCE

MAKE-UP EXAMINATION - JULY 2024

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| **Semester :** VI | **Date : 05/07/2024** |
| **Course Code :** PET 316 | **Time : 9:30 AM to 12:30 PM** |
| **Course Name** : Fundamentals of Process Engineering Calculations | **Max Marks : 100** |
| **Program :** B.Tech | **Weightage : 50%** |

**Instructions:**

1. *Read all questions carefully and answer accordingly.*
2. *Question paper consists of 3 parts.*
3. *Scientific and non-programmable calculator are permitted.*
4. *Do not write any information on the question paper other than Roll Number.*

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| **PART A** | | | |
| **ANSWER ANY 5 QUESTIONS 5Q X 2M=10M** | | | |
| 1 | An aq. solution of K2CO3 is prepared by dissolving 43 kg K2CO3 in 100 kg water at 293 K. The density of the solution is 1.3 kg/L. Find the molarity, normality and molality of the solution. | (CO1) | [Knowledge] |
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| 2 | A gas mixture at 1 atm and 273 K has the following composition by volume.  Ethylene – 30.6 %, Benzene – 24.5 %, Oxygen – 1.3 %, Methane – 15.5 %,  Ethane – 25 %, Nitrogen – 3.1 %. Find the average molecular weight, density and composition by weight of the gas mixture. | (CO1) | [Knowledge] |
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| 3 | Write a note on specific gravity scales. | (CO2) | [Knowledge] |
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| 4 | What are the fundamental elements of block diagram? | (CO3) | [Knowledge] |
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| 5 | State and prove Amagat’s law. | (CO3) | [Knowledge] |
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| 6 | State and explain Kay’s rule. Write its application. | (CO4) | [Knowledge] |
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| 7 | Derive Clausius-Clapeyron equation. Write its significance. | (CO4) | [Knowledge] |
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| **PART B** | | | |
| **ANSWER ANY 5 QUESTIONS 5Q X 10M=50M** | | | |
| 8 | A hot solution of Ba(NO3)2 from an evaporator contains 30.6 kg of Ba(NO3)2 per 100 kg of water and goes to a crystallizer where the solution is cooled and Ba(NO3)2 crystallizes. On cooling 10% of the original water present evaporates. For a feed solution of 100 kg, calculate the yield of crystals and water evaporated if the solution is cooled to 290 K. Solubility of Ba(NO3)2 is 8.6 kg per 100 kg total water at 290 K. | (CO1) | [Comprehension] |
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| 9 | Ammonia is recovered from a gas mixture containing 25% (volume) CO2 and  75% (volume) NH3 by scrubbing with water. Assuming that CO2 is insoluble in water, determine the percent of ammonia in the entering gas that is absorbed if the gas leaving the scrubber analyses 35% NH3. | (CO2) | [Comprehension] |
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| 10 | An air- water vapour sample at 1 atm has a dry bulb temperature of 328 K and is 10% saturated with water vapour. Using psychrometric chart, determine (i) the absolute humidity, (ii) partial pressure of water vapour, (iii) absolute saturation humidity at 328 K, (iv) the vapour pressure of water at 328 K, (v) percent relative saturation and (vi) dew point of the system. | (CO2) | [Comprehension] |
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| 11 | A distillation column separates 10,000 kg/hr of 50% benzene - 50 % toluene  mixture. The product recovered from the top contains 95% benzene while the bottom product contains 96% toluene. The stream entering the condenser from the top of the column is 8000 kg/hr. Find the reflux ratio. | (CO3) | [Comprehension] |
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| 12 | 1. Explain recycle, bypass and purge operations with examples. 2. State and explain Hess’s law of constant heat summation. | (CO3) | [Comprehension] |
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| 13 | The available nitrogen in the urea sample is found to be 45% by weight. Calculate the actual urea content in the sample. | (CO4) | [Comprehension] |
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| 14 | A natural gas has the following composition by volume Methane -83.5%, Ethane – 12.5% and Nitrogen – 4%. Calculate the composition in (1) Mole% (2) Weight % (3) Average molecular weight. | (CO4) | [Comprehension] |
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| **PART C** | | | |
| **ANSWER ANY 2 QUESTIONS 2Q X 20M=40M** | | | |
| 14 | A chemist is interested in preparing 500 ml of 1 normal, 1 molar and 1 molal solution of H2SO4. Assuming the density of H2SO4 solution to be 1.075 g/cm3 , calculate the quantities of H2SO4 to be taken to prepare these solutions. | (CO2) | [Application] |
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| 15 | A mixture of gases has the following composition by weight Cl2 = 65% Br2 = 25% and O2= 5%. Using ideal gas law calculate  (i) Composition of the gas mixture by volume %  (ii) Density of the gas mixture in kg/m3 at 250C & 740 mm Hg.  (iii) Specific gravity of the gas mixture. | (CO3) | [Application] |
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| 16 | CO and hydrogen reacts to give methanol. The conversion of CO entering the reactor is only 20%. A feed stream consisting of 33% CO, 66.5% H2 and 0.5% CH4 are mixed with a recycle stream and sent to a reactor. The methanol leaving the reactor is separated and the unconverted gases are recycled. A portion of the recycle stream is blown off to prevent the accumulation of CH4 and to keep its concentration in the recycle stream at 3%. For 100 moles of fresh feed, determine: (i) the moles of recycle and purge stream, (ii) composition of purge stream and (iii) the moles of methanol. | (CO4) | [Application] |