

University of Mumbai
Examination Summer 2022

Program: Chemical Engineering

Curriculum Scheme: Rev 2019

Examination: SE Semester III

Course Code: CHC305 and Course Name: Process Calculations

Time: 2 hours 30 minutes

Max. Marks: 80

Q1.	Choose the correct option for the following questions. All the questions are compulsory and carry equal marks.
1.	A sample of copper weighing 6.93×10^{-3} kg contains how many moles of copper atoms? (Atomic mass of copper = 63.5)
Option A:	9.17 mol
Option B:	0.917 mol
Option C:	0.109 mol
Option D:	1.09 mol
2.	100 moles of O_2 is added to 50 moles of H_2 , how many moles of H_2O will it produce?
Option A:	50
Option B:	100
Option C:	150
Option D:	200
3.	_____ of desired product is the ratio of limiting reactant consumed to produce desired product to the limiting reactant consumed totally.
Option A:	Yield
Option B:	Selectivity
Option C:	Conversion
Option D:	% Conversion
4.	_____ gms of HCl needed to prepare 3 litres of 2 N HCl solution.
Option A:	219 gm
Option B:	146gm
Option C:	365 gm
Option D:	912gm
5.	Selectivity of desired product is the ratio of moles of _____ to the moles of undesired product produced.
Option A:	limiting reactant consumed to produce undesired product
Option B:	limiting reactant consumed totally
Option C:	desired product produced
Option D:	excess reactant consumed totally

6.	A reaction has reactants 4 moles of NaOH and 2 mole of H ₂ SO ₄ , and products Na ₂ SO ₄ and H ₂ O, what are the total moles of products?
Option A:	2
Option B:	4
Option C:	6
Option D:	8
7.	A system in which no condition vary with time is called _____
Option A:	Open system
Option B:	Closed system
Option C:	Steady state system
Option D:	Unsteady state system
8.	1 calorie = 4.184 x 10 ⁻³
Option A:	kJ
Option B:	J
Option C:	Cal
Option D:	Kcal
9.	Heating value is the negative of the -----.
Option A:	Standard Heat of Combustion
Option B:	Standard Heat of Reaction
Option C:	Standard Heat of Formation
Option D:	Heat of Formation
10.	In by-pass operations a fraction of the feed stream to a process unit is diverted around and combined with the _____ stream from the unit.
Option A:	Recycle
Option B:	Fresh
Option C:	Output
Option D:	Purge

Q2	Solve any Two out of Three	10 marks each
1	A gas mixture contains 0.3 kmol of HCl, 0.4 kmol of N ₂ and 0.1 kmol of O ₂ . Calculate, (i) Average molecular weight of gas, (ii) Volume occupied by this mixture at 504.3 kPa and 573 K (300°C).	
2	Nitrogen is to be marketed in cylinder having volume of 0.1 m ³ each containing 3.5 kg of nitrogen. Calculate the pressure for which cylinders must be designed if they are subjected to a maximum temperature of 323K.	
3	7,000 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 obtained.	

Q3	Solve any Two out of Three	10 marks each																				
1	An evaporator is fed with 90,000kg/hr of a solution containing 10% NaCl, 15% NaOH and rest water. In the operation, water is evaporated and NaCl is precipitated as crystals. The thick liquor leaving the evaporator contains 43% NaOH, 4% NaCl and rest water. Calculate: (a) kg/h water evaporated, (b) kg/h salt precipitated, (c) kg/h thick liquor.																					
2	A feed containing 75 mol % A, 15 mol % B and 10 mol % Inerts enters a reactor. The product stream leaving the reactor is found to contain 2 mol % A. Reaction taking place is : $2A + B \rightarrow C$ Find the percentage of original 'A' getting converted to C.																					
3	Wet solids containing 60% water and 40% solids are to be dried in a dryer to get solids containing 8% water by weight. The fresh air contains 0.015 kg water vapour per kg dry air and leaving the dry air contains 0.06kg water vapor per kg dry air. If the quantity of dry air entering the dryer per kg of solids (dry) is 100 kg, calculate: (a) the quantity of fresh air, (b) the fraction of air recirculated, and (c) the recycle ratio.																					
Q4	Solve any Two out of Three	10 marks each																				
1	A natural gas has the following composition on mole basis: CH ₄ = 84%, C ₂ H ₆ = 13 % and N ₂ = 3 %. Calculate the heat to be added to heat 10 kmol of natural gas from 298 K to 523 K using the heat capacity data given below: $C_p^\circ = a + bT + cT^2 + dT^3$, kJ/(kmol.K)	<table border="1"> <thead> <tr> <th>Gas</th> <th>a</th> <th>b x 10³</th> <th>c x 10⁶</th> <th>d x 10⁹</th> </tr> </thead> <tbody> <tr> <td>CH₄</td> <td>19.25</td> <td>52.11</td> <td>11.97</td> <td>-11.32</td> </tr> <tr> <td>C₂H₆</td> <td>5.41</td> <td>178.08</td> <td>-67.37</td> <td>8.71</td> </tr> <tr> <td>N₂</td> <td>29.59</td> <td>-5.14</td> <td>13.18</td> <td>-4.97</td> </tr> </tbody> </table>	Gas	a	b x 10 ³	c x 10 ⁶	d x 10 ⁹	CH ₄	19.25	52.11	11.97	-11.32	C ₂ H ₆	5.41	178.08	-67.37	8.71	N ₂	29.59	-5.14	13.18	-4.97
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2	10,000 kg/hr of methanol liquid at a temperature of 303 K is obtained by removing heat from saturated methanol vapour. Find the amount of heat to be removed in this case. Data: Boiling point of methanol = 337.8 K Latent heat of condensation of methanol = 1101.7 kJ/kg Specific heat of methanol = 2.72 kJ/(kg.K)																					
3	A natural gas has the following composition on mole basis: CH ₄ = 76%, C ₂ H ₆ = 17 % and N ₂ = 7 %. Calculate the heat to be added to heat 500 kg of natural gas from 311 K to 533 K. Data: C_{pm}° values in kJ/(kmol.K)	<table border="1"> <thead> <tr> <th>Gas</th> <th>C_{pm}° (311-298 K)</th> <th>C_{pm}° (533-298 K)</th> </tr> </thead> <tbody> <tr> <td>CH₄</td> <td>36.05</td> <td>41.78</td> </tr> <tr> <td>C₂H₆</td> <td>53.52</td> <td>67.49</td> </tr> <tr> <td>N₂</td> <td>29.13</td> <td>29.36</td> </tr> </tbody> </table>	Gas	C_{pm}° (311-298 K)	C_{pm}° (533-298 K)	CH ₄	36.05	41.78	C ₂ H ₆	53.52	67.49	N ₂	29.13	29.36								
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