

STOICHIOMETRY, 5TH EDITION

BY

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OBJECTIVE QUESTIONS

Chapter-1

- 1.1 If the compressor of an airconditioner having 1.5 TR refrigeration duty runs for 1 h, then it consumes nos. of electricity units approximately.
- (a) 2 units (b) 5 units
(c) 10 units (d) 20 units
- 1.2 1 Btu is nearly equal to
- (a) 1 J (b) 1 kJ
(c) 1 kW (d) 1 kCal
- 1.3 1 m³ is nearly equal to ft³
- (a) 30 ft³ (b) 35 ft³
(c) 33 ft³ (d) 10 ft³
- 1.4 1 Btu/(h·ft²·°F) is equivalent to kcal/(h·m²·°C)
- (a) 1.49 (b) 1.73
(c) 4.882 (d) 6
- 1.5 1 Btu/(h·ft²·°F) is equivalent to W/(m²·°C)
- (a) 1.49 (b) 4.88
(c) 5.678 (d) 6.125
- 1.6 1 Btu/(h·ft²·°C) is equivalent to W/(m²·°C)
- (a) 1.49 (b) 1.7307
(c) 4.88 (d) 2
- 1.7 1 Btu/(lb·°F) is equivalent to kcal/(kg·°C)
- (a) 1 (b) 2.52
(c) 4.1868 (d) 1.49
- 1.8 8 in NB pipe size is expressed in SI system as mm NB.
- (a) 203.2 (b) 200
(c) 25 (d) 132.5
- 1.9 Body pressure measures by Doctor is in and it is pressure.
- (a) atm, absolute (b) kPa, guage
(c) Torr, gauge (d) mmWC, absolute

- 1.10 Body temperature measured by a doctor is in
- (a) $^{\circ}\text{C}$ (b) K
(c) $^{\circ}\text{F}$
- 1.11 A metre measure is _____ than yard.
- (a) equal (b) bigger
(c) smaller (d) can't say
- 1.12 Hectare is nearly equal to _____ acres.
- (a) one (b) two
(c) two and half (d) five
- 1.13 Nano technology deals with particle size of about _____ m size.
- (a) 10^{-3} (b) 10^{-6}
(c) 10^{-9} (d) 10^{-12}
- 1.14 1 Coulomb =
- (a) 1 J·s (b) 1 W·s
(c) 1 ampere·s (d) 1 N·s
- 1.15 Triple point of water is $^{\circ}\text{C}/\text{K}$
- 1.16 A new linear temperature scale, denoted by $^{\circ}\text{S}$ has developed where the freezing point of water is 200°S and the boiling point is 400°S . On this scale, 500°S corresponds in degrees Celsius, to
- (A) 100°C (B) 125°C
(C) 150°C (D) 300°C (GATE: 2010)
- 1.17 For watery solutions ppm (i.e. mg/L) = 1% by mass

Chapter-2

- 2.1 $^{\circ}\text{API}$ of Kerosene is 10
(a) greater than (b) less than (c) equal to
- 2.2 Concentration difference in $^{\circ}\text{Tw}$ is difference in $^{\circ}\text{Be}$.
(a) equal to (b) greater than (c) less than
- 2.3 Concentration difference in $^{\circ}\text{Be}$ is difference in specific gravity.
(a) equal to (b) greater than (c) less than
- 2.4 For acidic solution pH is 7.
(a) equal to (b) less than (c) greater than
- 2.5 pH of 0.01 M HCl solution is
(a) -2 (b) 2 (c) 0.01
- 2.6 On mixing equal volumes of two solutions having pH 1 and 2, pH of the resulting solution will be
(a) 1.5
(b) less than 1
(c) In between 1 and 2 but nearer to 1
(d) In between 1 and 2 but nearer to 2.
- 2.7 For dilute gas-liquid system, it is better to userather than to find equilibrium data.
(a) Raoult's law, Henry's law
(b) Henry's law, Raoult's law
(c) Dalton's law, Raoult's law
- 2.8 Average molar mass of gas mixture having 50% O_2 and 50% N_2 (by mole) is
(a) 29 (b) 30
(c) 28 (d) 32
- 2.9 At the same temperature and pressure, density of chlorine (Cl_2) is the same of oxygen.

(c) vapour pressure / operating pressure

(d) none of these.

2.18 Two parameter Corresponding State Principle (CSP) based equation of state considers _____ and _____ for evaluation of gas properties.

(a) pressure and temperature

(b) reduced pressure and reduced temperature

2.19 Three parameter CSP based equation of state takes into consideration of _____ in addition to two parameters specified in Question 2.20 above.

(a) activity coefficient (γ_i)

(b) acentric factor (ω_i)

(c) fugacity coefficient (f_i)

2.20 Modified Raoult's takes into consideration _____ in addition to mole fraction of a species in solution and its temperature.

(a) activity coefficient

(b) fugacity coefficient

(c) acentric factor

2.23. Two pipelines carry equal mass flow rates of air and chlorine. Hence, pipeline, carrying _____ will have nearly _____ times volumetric flow rate than other.

2.24. Define following terms.

(a) COD (b) BOD (c) ThOD (d) VOC (e) SO_x (f) NO_x

2.25. Which compounds cause hardness (temporary and permanent) in tap water?

2.26. Differentiate hard and soft waters in terms of chemical compounds.

2.27. Which of the following statements are true/false?

(i) Partial pressure of ideal and non-ideal gases are obtained by multiplying mole fraction of a species to system pressure.

(ii) Partial pressure and pure component pressure of a species in a mixture of non-ideal gases are same.

(iii) A gas normally behaves ideal at high pressure and low temperature.

(iv) Equal volumes of nitrogen and sulphur dioxide are filled in two containers. Container with nitrogen will weigh more than other.

2.28 Specific gas constant for ammonia is $\text{m}^3 \cdot \text{kPa}/(\text{kg} \cdot \text{K})$.

2.29 Joule-Tomson effect relates to temperature change in gas due to pressure reduction. True/False?

- 2.30 44.8 Nm³/h of air is equivalent to kmol/h of air.
- (a) 1 (b) 1.5
(c) 2 (d) 2.5
- 2.31 Critical pressure is the maximum pressure at which a fluid can be liquefied. True/False
- 2.32 In the context of the chemical process industries, the term BOD is normally associated with
- (a) Characterization of solid waste.
(b) The organic concentration in gaseous effluents.
(c) Characterization of liquid effluent.
(d) Characterization of boiler feed water. (GATE: 1998)
- 2.33 The vapour pressures of benzene and toluene are 3 and 4/3 atmospheres, respectively. A liquid feed of 0.4 moles of benzene and 0.6 moles of toluene is vaporized. Assuming that the products are in equilibrium, the vapour phase mole fraction of benzene is
- (a) 0.4 (b) 0.6
(c) 0.8 (d) 0.2 (GATE: 1999)
- 2.34 The mass fraction of methanol in an aqueous solution is 0.64. The mole fraction of methanol (x_{Me}) satisfies
- (a) $x_{Me} < 0.5$ (b) $x_{Me} = 0.5$
(c) $0.5 < x_{Me} < 0.64$ (d) $x_{Me} \geq 0.64$ (GATE: 2004)
- 2.35 An aqueous solution of 2.45% by mass H₂SO₄ has a specific gravity of 1.011. The composition expressed in normality is
- (a) 0.2500 (b) 0.2528
(c) 0.5000 (d) 0.5055 (GATE: 2003)
- 2.36 A liquid mixture of benzene and toluene is in equilibrium with its vapour at 101 kPa and 100°C (373 K). The vapour pressure of benzene and toluene at 100°C (373 K) are 156 and 63 kPa, respectively. Assuming that the system obeys Raoult's law, the mole fraction of benzene in liquid phase is
- (a) 0.65 (b) 0.41
(c) 0.065 (d) 0.04 (GATE: 2005)
- 2.37 The molar density of water vapour at the normal boiling point is 33 mol/m³. The compressibility factor under these conditions is close to which one of the following? [$R = 8.314 \text{ J}/(\text{mol}\cdot\text{K})$]
- (a) 0.75 (b) 1
(c) 1.25 (d) 1.5 (GATE: 2006)

2.38 Assuming that CO_2 obeys perfect (ideal) gas law, calculate the density (ρ) of CO_2 (in kg/m^3) at 263°C (536.15 K) and 2 atm .

- (a) 1
- (c) 3

- (b) 2
- (d) 4

(GATE: 1995)

2.39 An equimolar liquid mixture of species 1 and 2 is in equilibrium with its vapour at 400 K . At this temperature, the vapour pressures of the species are $p_1^{sat} = 180\text{ kPa}$ and $p_2^{sat} = 120\text{ kPa}$. Assuming that Raoult's law is valid, the value of y_1 is

- (a) 0.30
- (c) 0.50

- (b) 0.41
- (d) 0.60

(GATE: 2010)

Chapter-3

- 3.1 For an overdefined system, degree of freedom is
- (a) zero (b) positive
(c) negative (d) not possible to calculate
- 3.2 For an equilibrium adiabatic flashing of saturated steam condensate in flash vessel, degree of freedom is
- (a) 2 (b) 1
(c) 0 (d) -1
- 3.3 Mass flow rate and composition of any stream can be obtained from diagram.
- (a) P&I (b) PFD
(c) Material balance (d) none of these
- 3.4 Information about pipe size and its material can be obtained from
- (a) P&I (b) PFD
(c) Piping (d) none of these
- 3.5 A material which does not change in terms of its quantity during the particular operation, is called material for material balance.
- (a) constant (b) main
(c) tie (d) unreacted
- 3.6 Quantities of water to be evaporated in concentrating NaOH solution from 10% to 20% and from 20% to 30% are
- (a) same (b) different (c) almost same
- 3.7 F kmol/h of feed stream contains 0.1% impurity. Maximum permissible limit of impurity in recycle loop is 10%. P kmol/h of purge stream from this recycle loop is equal to
- (a) F (b) $0.1 F$
(c) $0.01 F$ (d) $0.001 F$
- 3.8 Purpose of purge stream from recycled loop in a continuous process is
- (a) to separate out the impurities/inerts completely from the loop.
(b) to control the accumulation of impurities/inerts up to certain limit.
(c) to separate out the impurities/inerts from product stream.
(d) to separate out the impurities/inerts from feed stream.

- 3.9 In ammonia synthesis loop purge stream is taken out from the recycled loop to avoid the accumulation of
- (a) Oxygen (b) Methane & Argon
(c) Argon (d) Carbon dioxide
- 3.10 Explain in brief the reasons why pressure purging of a vessel containing explosive gas mixture is preferred over 'sweep' purging (Example 3.20).
- 3.11 Osmotic pressure (π) chiefly depends on _____ in case of inorganic solids.
- (a) concentration (b) temperature
(c) type of solids
- 3.12. For determining vapour-liquid equilibrium of a binary mixture, forming an immiscible mixture, degree of freedom is _____.
- (a) one (b) three
(c) two
- 3.13 A liquid mixture contains 30% *o*-xylene, 60% *p*-xylene and 10% *m*-xylene (all percentages are by mass). Which of the following statements would be true in respect of this mixture?
- (a) The mixture exhibits an azeotrope at 101.3 kPa.
(b) The composition of the mixture in percent by volume is: *o*-xylene 30, *p*-xylene 60 and *m*-xylene 10.
(c) The composition of the mixture in mole per cent is: *o*-xylene 30, *p*-xylene 60 and *m*-xylene 10.
(d) The mixture contains optical isomers. (GATE: 1998)
- 3.14 A wet pulp contains 75% water. After 100 kg of water is removed in dryer, it is found that the pulp is now containing 30% water. The mass of original pulp is (GATE: 1991)
- 3.15 It is desired to make 100 kg of a solution containing 40% salt by mixing solution A containing 25% salt and solution B containing 50% salt. The mass in kg of solution A required is (GATE: 1992)
- 3.16 1000 kg of wet solids are to be dried from 60% to 20% moisture (by mass). The mass of moisture removed in kg is
- (a) 520 (b) 200
(c) 400 (d) 500 (GATE: 1995)
- 3.17 Pure O₂ is mixed with air to produce an enriched air containing 50 volume % of O₂. The ratio of moles of air to O₂ used is
- (a) 1.72 (b) 0.58
(c) 0.5 (d) 0.2 (GATE: 1995)
- 3.18 A saturated solution at 30°C contains 5 moles of solute (molar mass = 50 kg/kmol) per kg of solvent (molar mass = 20 kg./kmol). The solubility at 100°C (373 K) is 10 moles of the solute per kg of the

solvent. If 10 kg of the original solution is heated to 100°C (373 K), then the mass of the additional solute that can be dissolved in it is

(A) 0.25 kg
(C) 2 kg

(B) 1 kg
(D) 3.34 kg

(GATE: 2010)

technique depends on

- (a) temperature, pressure (b) temperature, concentration
- (c) pressure, concentration

4.9 Refer following chemical reaction.



- (i) If 1 mol of A and 1 mol of B are reacted which is the excess reactant?
- (ii) If 1 mol of A and 1.5 mol of B are reacted which will be the excess reactant?
- (iii) For carrying out forward reaction, what parameters are favoured?

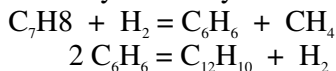
4.10 Pure A in gas phase enters a reactor. 50% of this A converted to B through the reaction $A = 3B$. Mole fraction of A in the exit stream is

- (a) 1/2 (b) 1/3
(c) 1/4 (d) 1/5 (GATE: 1999)

4.11 From among the following choose one that is not an exothermic process.

- (a) methanol synthesis
(b) catalytic cracking
(c) ammonia synthesis
(d) Synthesis of sulphur trioxide (GATE: 2002)

4.12 In the hydrodealkylation of toluene to benzene, the following reactions are known to occur



Toluene and hydrogen are fed to a reactor in a molar ratio 1:5. 80% of the toluene gets converted and the selectivity of benzene (defined as moles of benzene formed / moles of toluene converted) is 90%. The fractional conversion of hydrogen is

- (a) 0.16 (b) 0.144
(c) 0.152 (d) 0.136 (GATE: 2002)

4.13 6 g of carbon is burnt with an amount of air containing 18 g oxygen. The product contains 16.5 g CO_2 and 2.8 g CO besides other constituents. What is the degree of conversion on the basis of disappearance of the limiting reactant?

- (A) 100% (B) 95%
(C) 75% (D) 20% (GATE: 2003)

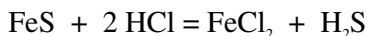
4.14 A feed stream F at 100 kg/h and containing only A is mixed with recycle stream R before entering to reactor, where the reaction $A = B$ takes place. Operation is at steady state. Stream P_1 leaving the reactor is separated, without either phase or composition change into two streams P_2 and R . Mass fraction of B in P_2 is 0.95 and flow rate of R is 10 kg/h, then the ratio of flow rates of streams P_1/R , and flow rate of A in P_1 are, respectively

- (a) 11 and 110 kg/h (b) 24 and 240 kg/h
 (c) 11 and 5.5 kg/h (d) 70 and 330 kg/h . (GATE: 2005)

4.15 For a reversible exothermic gas phase reaction $A + B \rightleftharpoons C$, the equilibrium conversion will increase with

- (a) increase in pressure and increase in temperature.
 (b) decrease in pressure and increase in temperature.
 (c) increase in pressure and decrease in temperature.
 (d) decrease in pressure and decrease in temperature. (GATE: 2006)

4.16 H_2S is produced from the reaction



120 kg of FeS react with 150 kg of HCl and 0.5 kmol of H_2S has been produced. The degree of completion of reaction is and the limiting reactant is (GATE: 1991)

4.17 1.2 g atom of carbon and 1.5 mol of oxygen are reacted to give 1 mol of carbon dioxide. The limiting reactant is The percent excess reactant supplied is (GATE: 1992)

4.18 A gaseous reaction $A \rightleftharpoons 2 B + C$ takes place isothermally in a constant pressure reactor. Starting with a gaseous mixture containing 50% A (rest inerts), the ratio of final to initial volume is found to be 1.6. The percentage conversion of A is therefore

- (a) 30 (b) 50
 (c) 60 (d) 74 (GATE : 1992)

Chapter-5

- 5.1 For an ideal gas $C_p - C_v$ is equal to
- (a) 1.4 (b) R
(c) 0 (d) none of these
- 5.2 For an ideal gas C_p/C_v is equal to
- (a) 1.4 (b) R
(c) 0 (d) none of these
- 5.3 Heat capacitywhile latent heat with increase in temperature.
- (a) increases, decreases (b) increases, increases
(c) decreases, decreases (d) decreases, increases
- 5.4 At critical state of the fluid, latent heat of vaporization (λ_v) is
- 5.5 A graph having $\text{Log}P_v$ (or $\ln P_v$) on y-axis and $1/T$ on x-axis is called
- (a) Antoine chart (b) Cox chart
(c) Mollier's chart (d) none of these
- 5.6 For an equilibrium binary vapour-liquid mixture, vapour is at temperature and liquid is at temperature.
- (a) condensation, boiling (b) dew point, bubble point
(c) condensation, bubble point (d) dew point, boiling
- 5.7 At bubble point of liquid mixture
- (a) $T = \sum x_i \cdot T_{is}$ (b) $\sum x_i \cdot p_{is} = p$
(c) $\sum y_i \cdot P = P_{is}$ (d) $\sum y_i \cdot p_{is} = P$
- 5.8 Partial pressure of i th component (p_i) is equal to according to Dalton's law and the same equal to according to Raoult's law.
- (a) $x_i \cdot p, y_i \cdot p$ (b) $y_i \cdot p, x_i \cdot p$
(c) $x_i \cdot p_i, y_i \cdot p_{vi}$ (d) $y_i \cdot p, x_i \cdot p_{vi}$
- where p = total pressure, p_{vi} = vapour pressure
- 5.9 Standard heat of formation data are normally available at temperature and pressure.
- (a) $0^\circ\text{C}/273.15 \text{ K}$, 1 bar a (b) $15^\circ\text{C}/288.15 \text{ K}$, 1 bar a
(c) $25^\circ\text{C}/298.15 \text{ K}$, 1 bar a (d) $15^\circ\text{C}/288.15 \text{ K}$, 100 kPa a
- 5.10 Standard heat of formation is normally expressed in literature in
- (a) J (b) kJ
(c) kJ/mol (d) kJ/kmol

- 5.11 If specific gravity of given petroleum fraction at 15.55°C/288.7 K is 0.667, then carbon to hydrogen weight ratio for the same fraction is
- (a) 4.5 (b) 5
(c) 5.6 (d) 5.25
- 5.12 Hess's law relates to
- 5.13 Enthalpy of the compound over 0 K can be termed as
- (a) heat of formation (b) change in enthalpy
(c) excess enthalpy (d) absolute enthalpy
- 5.14 The values of $(H^\circ - H_0^\circ + \Delta H_f^\circ)$ for a organic compound at 400 K and 500 K are 23 000 kJ/kmol and 26 000 kJ/kmol, respectively. Mean heat capacity of the same compound in the prescribed range of temperature is
- (a) 30 kJ/(kmol·K) (b) 0.8 kJ/(kg·°C)
(c) 100 kJ/(kmol·K) (d) 1 kJ/(kg·°C)
- 5.15 All oxidation reactions are and all cracking reactions are
- (a) endothermic, endothermic (b) endothermic, exothermic
(c) exothermic, endothermic (d) exothermic, exothermic
- 5.16 Adiabatic reaction temperature is without heat exchange with surroundings.
- (a) average temperature of reactor
(b) temperature of reactant
(c) temperature of products
(d) none of these
- 5.17 Actual flame temperature is the adiabatic flame temperature.
- (a) equal to (b) greater than (c) less than
- 5.18 When a solid or gas is dissolved in the solvent, the heat evolved or absorbed is called
- (a) heat of solution (b) heat of mixing
(c) excess enthalpy (d) Both (a) & (c)
- 5.19 Excess enthalpy of an ideal solution is
- (a) called absolute enthalpy (b) called ideal enthalpy
(c) zero (d) extra enthalpy
- 5.20 Refer following chemical reaction.
- $$A + 2 B = 1.5 C \quad (\text{exothermic})$$
- (i) Increase in pressure will favour the reaction. True/False
- (ii) Heating will favour the reaction. True/False

- 5.21 Dew point (of water) of a gas is _____ on its molar lass.
- (a) dependent (b) independent
(c) proportional
- 5.22 Dew point (of water) of a gas at higher pressure is _____ than at lower pressure for the same moisture content.
- (a) lower (b) higher
(c) equal
- 5.23 According to Le Chatelier's Principle, endothermic reaction will be favoured by heat _____.
- (a) extraction from system (b) input to system
- 5.24 Approach to equilibrium is 50°C (50 K) for a gaseous endothermic reaction, It is carried out at 850°C (1148 K). This means equilibrium constant of reaction at _____ °C should be considered for calculating product composition.
- (a) 1000°C (1273 K) (b) 900°C (1173 K)
(c) 800°C (1073 K)
- 5.25 List at least three types of reactions which are endothermic in nature.
- 5.26 Heat capacity of a compound in its condensed phase is _____ than gas phase.
- (a) equal (b) lower
(c) higher
- 5.27. All pressure reduction processes (closed system) are isenthalpic. True/False
- 5.28 Riedel equation relates to _____ while Watson equation relates to _____.
- 5.29 Normal vapour pressure vs saturation temperature when plotted on a semi-log paper is a straight line. True/False
- 5.30 Two liquids are mixed without any heat exchange with surroundings. Liquid A has heat capacity of 3.5 kJ/(kg·K) while liquid B has heat capacity of 3 kJ/(kg·K). If excess enthalpy of mixing (H^E) is -25 kJ/kg mixture for a mixture containing 30 mass % A at 25°C (298.15 K), what will be the enthalpy of the mixture at 25°C (298.15 K) over 0°C (273.15 K)?
- 5.30. Heat of dilution at a specified temperature of a binary solution of specified strength is the heat effect of solution when two pure species are mixed in stoichiometric proportions at the same temperature. True/False?
- 5.31 If excess enthalpy of a binary distillate mixture is negative and if excess enthalpy of feed binary mixture is positive, heat load of a reboiler can be substantially erroneous if it is calculated considering them as ideal liquid mixtures. True/False?

- 5.32 If the heat of solution of an ideal gas in a liquid is negative, then its solubility at a given partial pressure varies with the temperature as
- (a) Solubility increases as temperature increases.
 (b) Solubility decreases as temperature increases.
 (c) Solubility is independent of temperature. (GATE: 1998)

- 5.33 If the specific heats of gas and a vapour are 0.2 kJ/(kg·K) and 1.5 kJ/(kg·K), respectively and the humidity is 0.01 kg/kg dry gas, the humid heat in kJ/(kg·K) is
- (a) 0.31 (b) 0.107
 (c) 0.017 (d) 0.215 (GATE: 1999)

- 5.34 One mole of methane undergoes complete combustion in a stoichiometric amount of air. The reaction proceeds as $\text{CH}_4 + 2 \text{O}_2 = \text{CO}_2 + 2 \text{H}_2\text{O}$

$$\Delta H_f^\circ = -730 \text{ kJ/mol of methane}$$

- (i) Mole fraction of water vapour in the product gases is about
- (a) 0.19 (b) 0.33
 (c) 0.4 (d) 0.67
- (ii) If the average molar heat capacity of all product gases is 40 J/(mol·K), the maximum temperature rise of the exhaust gases in °C would be approximately equal to
- (a) 1225 (b) 1335
 (c) 1525 (d) 1735 (GATE: 2004)

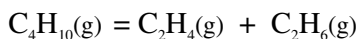
- 5.35 The vapour pressure of water is given by

$$\ln p^{\text{sat}} = A - (5000/T)$$

Where A is constant, p^{sat} is vapour pressure in atm, and T is temperature in K. The vapour pressure of water in atm at 50°C (323.15 K) is approximately

- (a) 0.07 (b) 0.09
 (c) 0.11 (d) 0.13 (GATE: 2004)

- 5.36 The heat absorbed for isothermal reaction



At 25°C (298.15 K) and 1 atm pressure is

Data: Standard heat of combustion (ΔH_c°), kJ/mol.

for $\text{C}_4\text{H}_{10}(\text{g}) = -2873.5$

for $\text{C}_2\text{H}_4(\text{g}) = -1411.9$

for $\text{C}_2\text{H}_6(\text{g}) = -1561.0$

(GATE: 1991)

Chapter-6

- 6.1 A minimum boiling azeotrope of a binary mixture will have boiling point less than that of two mixing species. True/False
- 6.2 Dew point (of water) of a gas is _____ on its molar lass.
 (a) dependent (b) independent
 (c) proportional
- 6.3 Dew point (of water) of a gas at higher pressure is _____ than at lower pressure for the same moisture content.
 (a) lower (b) higher
 (c) equal
- 6.4 Increase in amount of reflux of distillation column increases
 (a) only a heat duty of condenser.
 (b) heat duty of condenser and reboiler both.
 (c) only a heat duty of reboiler.
 (d) none of these.
- 6.5 Reverse operation of gas absorption is called
 (a) scrubbing (b) drying
 (c) stripping (d) adsorption
- 6.6 is used as stripping medium.
 (a) hot water (b) saturated steam
 (c) superheated steam (d) none of these
- 6.7 Feed to a distillation column contains 50% benzene and 50% toluene. If top product of this column is nearly pure benzene, then bottom product is
 (a) nearly pure toluene
 (b) mixture of benzene & toluene
 (c) not possible to find (its composition)
- 6.8 If top product from distillation column is nearly pure benzene and bottom product is nearly pure toluene, then composition of feed to this column is
 (a) 50% benzene and 50% toluene.
 (b) not possible to find because it depends on amount of reflux.
 (c) not possible to find.
- 6.9 If $F = 100$ mol/h, $x_F = 0.5$, $D = 30$ mol/h and $x_D = 0.667$ for distillation column, then $x_W =$
 (a) $3/7$ (b) $2/7$
 (c) 0.333 (d) 0.5

- 6.10 100 kmol/h of wet chlorine is introduced from the bottom of packed tower type absorber at 1.2 atm a pressure. Partial pressure of water vapour in wet chlorine is 0.12 atm. 1000 kg/h concentrated sulphuric acid containing 80% H₂SO₄ (by mass) is introduced from the top. For nearly 100% absorption, mass flow rate of sulphuric acid solution at bottom is and concentration of H₂SO₄ in this stream is mass %.
- (a) 1010 kg/h, 76% (b) 1180 kg/h, 68%
(c) 1010 kg/h, 66% (d) 1180 kg/h, 76%
- 6.11 Extract phase is
- (a) lighter phase (b) solvent rich phase
(c) both (a) & (b) (d) heavier phase
- 6.12 Feed to an extractor is 100 kg and it contains 69% isopropyl alcohol and 31% toluene. 200 kg of water is added as a solvent. Extract phase contains 20% isopropyl alcohol. Amount of raffinate phase is and concentration of isopropyl alcohol in the same is % (consider toluene and water as completely immiscible liquids).
- (a) 69 kg., 25% (b) 50 kg., 38%
(c) 69 kg., 38% (d) 50 kg., 25%
- 6.13 50 m³ of wet air at 30°C (303.15 K) and at 1 atm a is found to contain 1 kg of water vapour. Vapour pressure of pure water at 30°C (303.15 K) is 4.25 kPa. Relative humidity (*RH*) of this air is
- (a) 52.8% (b) 65.8%
(c) 40.3% (d) 32.8%
- 6.14 Relative humidity of atmospheric air is 85% at 30°C (303.15 K). Vapour pressure of water at 30°C (303.15 K) is 4.25 kPa. Its molar humidity is and absolute humidity is
- (a) 0.037, 0.023 (b) 0.057, 0.035
(c) 0.85, 0.53 (d) 0.015, 0.009
- 6.15 A drier must remove 100 kg/h of water from an organic dye. Air at 40°C (313.15 K) and 80% relative humidity enters the drier and leaves at 80°C (353.15 K) and 60% relative humidity. Operating pressure is 105 kPa a. Mass flow rate of air through drier iskg/h. (Vapour pressures of water at 40°C & 80°C are 7.375 kPa and 47.36 kPa, respectively)
- 6.16 A cooling tower is designed for 4°C (4 K) approach. If ambient temperature is 31°C at the time of raining (nearly 100% *RH*) then expected temperature of cooling water from cooling tower is
- (a) 31°C (b) 35°C
(c) 27°C (d) 25°C
- 6.17 Adiabatic saturation temperature is wet bulb temperature.

- (a) equal to (b) greater than
(c) less than or equal to (d) greater than or equal to
- 6.18 Wet bulb temperature is dry bulb temperature.
(a) equal to (b) greater than
(c) less than or equal to (d) greater than or equal to
- 6.19 At 100% relative humidity dry bulb temperature..... wet bulb temperature dew point temperature.
(a) =, = (b) ≠, =
(c) =, ≠ (d) <, <
- 6.20 Absolute humidity in chlorine atmosphere will be than that in air at same pressure and temperature.
- 6.21 Absolute humidity in carbon dioxide atmosphere will be than that in air at same pressure and temperature.
- 6.22 Mechanical vapour recompressor or thermocompressor is used to of multiple-effect evaporation system.
(a) decrease capacity (b) decrease heat load
(c) increase economy (d) increase fixed cost
- 6.23 Triple effect evaporator is used to concentrate 1000 kg/h of 4% (by mass) caustic soda solution to 30% (by mass) solution. If the vaporization rates in all effects are same, than % by mass of caustic soda leaving the 1st effect is for forward feed arrangement.
(a) 10% approx. (b) 8.2% approx.
(c) 5.6% approx. (d) 6.5% approx.
- 6.24 Name three solvents which can be dehydrated by pervaporation
- 6.25 A binary mixture is fractionated by distillation.
(i) What will be change in overhead condenser duty when a condensed phase feed is compared with vapour feed for a given reflux ratio?
(ii) A choice exists for the reboiler steam pressure between 3 bar g and 6 bar g. Which steam pressure will be preferred? Why?
- 6.26 Fresh orange juice contains 12% (by mass) solids and rest water. 90% of the fresh juice is sent to an evaporator to remove water and subsequently mixed with the remaining 10% of fresh juice. The resultant product contains 40% solids. The kg of water removed from 1 kg fresh juice is
(a) 0.4 (b) 0.5
(c) 0.6 (d) 0.7 (GATE: 2002)
- 6.27 1 kg of a saturated aqueous solution of a highly soluble component A at 60°C (333 K) is cooled to 25°C (298.15 K). The solubility limits of A are 0.6 kg A/kg water at 60°C (333 K) and 0.2 kg A/kg water at 25°C (298.15 K). The amount in kg of the crystals formed is

- (A) 0.4 (B) 0.25
(C) 0.2 (D) 0.175 (GATE: 2002)

6.28 A distillation column separates benzene-toluene mixture.

$$F = 10\,000 \text{ kg/h}, x_F = 0.5, x_D = 0.95, x_W = 0.05$$

Where x_D , x_W and x_F are mass fractions.

Mass flow rate of overhead vapour from distillation column is $V = 8000 \text{ kg/h}$

The reflux ratio is

- (a) 0.5 (b) 0.6
(c) 1.0 (d) 2.0 (Gate : 2004)

6.29 An air-water vapour mixture has a dry bulb temperature of 60°C (333 K) and a dew point temperature of 40°C (313 K). The total pressure is 101.3 kPa and the vapour pressures of water at 40°C (313 K) and 60°C (333 K) are 7.3 kPa and 19.91 kPa, respectively.

- (i) The humidity of air sample expressed as kg of water vapour/kg of dry air is
(a) 0.048 (b) 0.079
(c) 0.122 (d) 0.152
- (ii) The wet bulb temperature t_w for the above mixture would be
(a) Less than 40°C (313 K) (b) 40°C (313 K)
(c) 40°C (313 K) $< t_w < 60^\circ\text{C}$ (333 K) (d) 60°C (333 K) (GATE: 2004)

6.30 80 kg of Na_2SO_4 (molar mass = 142) is present in 330 kg of an aqueous solution. The solution is cooled such that 80 kg of $\text{Na}_2\text{SO}_4 \cdot 10 \text{H}_2\text{O}$ crystals separate out. The mass fraction of Na_2SO_4 in the remaining solution is

- (a) 0.00 (b) 0.18
(c) 0.24 (d) 1.00 (GATE: 2004)

6.31 Air at a temperature of 20°C (293 K) and 750 mmHg pressure has a relative humidity of 80%. What is its percentage humidity? Vapour pressure of water at 20°C (293 K) is 17.5 mmHg.

- (a) 80.38 (b) 80
(c) 79.62 (d) 78.51 (GATE: 2003)

6.32 $\text{Na}_2\text{SO}_4 \cdot 10 \text{H}_2\text{O}$ crystals are formed by cooling 100 kg of 30% (by mass) aqueous solution of Na_2SO_4 . The final concentration of the solute in the solution is 10%. The mass of crystals is

- (a) 20 kg (b) 32.2 kg
(c) 45.35 kg (d) 58.65 kg (GATE: 2003)

6.33 Solvent S is used to extract solute B selectively from 100 kg/h feed mixture ($A + B$) in a steady state continuous extraction system. S and A are completely immiscible. The extract is distilled in distillation column to recover B in the bottom product. Distillate of distillation column is recycled back to the extractor. The loss of solvent in the bottom product of distillation column is compensated by make up of pure solvent S_d . Total flow rate of solvent going to extractor is 50 kg/h. Mass fraction of A in feed is 0.6 and in bottom product from distillation column is 0. Mass fraction of solute B in bottom product from distillation is 0.8.

- (i) Distillation bottoms flow rate W and pure solvent dosing rate S_d in kg/h are
 (a) $W = 50, S_d = 50$ (b) $W = 100, S_d = 20$
 (c) $W = 10, S_d = 50$ (d) $W = 50, S_d = 10$
- (ii) Feed rate to distillation column and overhead product rate in kg/h are
 (a) $F = 90, D = 40$ (b) $F = 80, D = 40$
 (c) $F = 90, D = 50$ (d) $F = 45, D = 20$ (GATE: 2006)

6.34 If the percent humidity of air [30°C (303 K), total pressure 100 kPa] is 24% and the saturation pressure of water vapour at that temperature is 4 kPa, the percentage relative humidity and the absolute humidity of air are

- (a) 25.2, 0.0062 (b) 25, 0.0035
 (c) 20.7, 0.0055 (d) 18.2, 0.0035 (GATE: 2007)

6.35 It is desired to reduce the concentration of pyridine in 500 kg of aqueous solution from 20 mass percent to 5 mass percent in a single batch extraction using chlorobenzene as solvent. Equilibrium compositions (end points of tie line) in terms of mass percent of pyridine–water–chlorobenzene are (5, 95, 0) and (11, 0, 89).

The amount of pure solvent required in kg for the operation is:

- (a) 607 (b) 639
 (c) 931 (d) 1501 (GATE: 2007)

6.36 The weather bureau reports a dry bulb temperature of ambient air as 29°C (302 K) and relative humidity of 80%. The barometer reads 750 mmHg. The percentage humidity of ambient air is

(Vapour pressure of water at 29°C (302 K) = 30 mmHg) (GATE: 1991)

6.37 A multiple effect evaporator has a capacity to process 4000 kg of solid caustic soda per day, when it is concentrating from 10% to 25% solids. The water evaporated in kg per day is

- (a) 600 (b) 24 000
 (c) 60 000 (d) 48 000 (GATE: 1992)

6.38 An evaporator while concentrating an aqueous solution from 10 to 40% solids evaporates 30 000 kg of water. The amount of solids handled by the system in kg is

- (a) 4000 (B) 9000
 (c) 4600 (d) 3000 (GATE: 1995)

6.39 In a mixture of benzene vapour and nitrogen gas at a total pressure of 900 mmHg, if the absolute content of benzene is 0.2 kg benzene/kg nitrogen, the partial pressure of benzene in mmHg is

- (a) 180 (b) 60.3
 (c) 720 (d) 200 (GATE: 1996)

6.40 Air, initially at 101.3 kPa and 40°C (313 K) and with a Relative Humidity of 50% is cooled at constant pressure to 30°C (303 K). The cooled air has

- (a) a higher dew point
 (b) a higher absolute humidity

- (c) a higher relative humidity
- (d) a higher wet bulb temperature

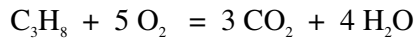
(GATE: 1998)

Chapter-7

- 7.1 All combustion reactions oxidation reactions. All oxidations reactions combustion reactions.
- (a) need not be, are
 - (b) are, are

- (c) are, need not be (d) are not, are not
- 7.2 If carbon monoxide appears in flue gas, combustion is termed as combustion.
 (a) complete (b) about to complete
 (c) partial (d) carbon
- 7.3 Coal is fuel and coke is fuel.
 (a) natural, natural (b) synthetic, natural
 (c) synthetic, synthetic (d) natural, synthetic
- 7.4 Calorific value of natural gas usually than that of coal.
- 7.5 Average molar mass of flue gas mixture of a furnace fired with lean fuel (such as lignite, bagasse, etc.) is lower than that of standard fuel. True/False
- 7.6 Theoretical CO₂ content of flue gas mixture of a fuel oil fired furnace is approximately% (by vol.).
- 7.7 Recycling of partial quantity of flue gas to a furnace can reduce NO_x emission. True or False?
- 7.8 Acid dew points due to presence of HCl vapour, SO₂ vapour or SO₃ vapour in flue gases are same. True/False?
- 7.9 Name two apparatuses used to measure CO₂ in flue gases.
- 7.10 Define boiler capacity From and At 100°C (373.15 K).
- 7.11 SO_x emission per GJ heat liberation from a Petcoke fired furnace is than that fired with coal.
- 7.12 Heat exchange rate in a regenerative type air preheater is than that in a non-contact type heat exchanger for the same temperature drop in flue gas.
- 7.13 For the case of a fuel gas undergoing combustion with air, if the air/fuel ratio is increased, the adiabatic flame temperature will
 (a) increase
 (b) decrease
 (c) increase or decrease depending on the fuel type.
 (d) not change. (GATE: 2001)
- 7.14 A sample of natural gas containing 80% methane (CH₄) and the rest nitrogen (N₂) is burnt with 20% excess air. With 80% of the combustibles producing CO₂ and the remainder going to CO the Orsat analysis in volume percent is
 (a) CO₂ : 6.26, CO : 1.56, O₂ : 3.91, H₂O : 15.66, N₂ : 72.6
 (b) CO₂ : 7.42, CO : 1.86, O₂ : 4.64, N₂ : 86.02
 (c) CO₂ : 6.39, CO : 1.60, O₂ : 3.99, H₂O : 15.46, N₂ : 72.06
 (d) CO₂ : 7.60, CO : 1.90, O₂ : 4.75, N₂ : 85.74 (GATE: 2004)

7.15 44 kg of C_3H_8 is burnt with 1160 kg of air (molar mass = 29) to produce 88 kg of CO_2 and 14 kg of CO.



(i) What is percent excess air is used ?

- (a) 55 (b) 60
(c) 65 (d) 68

(ii) What is the % carbon burnt ?

- (a) 63.3 (b) 73.3
(c) 83.3 (d) 93.3

(GATE: 2007)

7.16 Pure carbon is completely burnt in oxygen. The dry flue gas analysis is 70% CO_2 , 20% CO and 10% O_2 . The percent excess oxygen used is

- (a) 20 (b) 12.5
(c) 0 (d) 10

(GATE: 1997)

7.17 The products of combustion of methane in atmospheric air (21% O_2 and 79% N_2) have the following composition on a dry basis.

<u>Products</u>	<u>mole %</u>
CO_2	10.00
O_2	2.37
CO	0.53
N_2	87.10

The ratio of the moles of CH_4 to the moles of O_2 in the feed stream is

- (a) 1.05 (b) 0.6
(c) 0.51 (d) 0.45

(GATE: 2010)

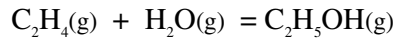
Chapter 8

8.1 Presence of water vapour in ammonia absorption system evaporator temperature.

- (a) Increases (b) Decreases
(c) No change

8.2 Compared to H_2O -LiBr absorption refrigeration system, NH_3 - H_2O system yields Coefficient of Performance (COP).

8.15 For the production of ethanol from ethylene following reaction is taking place in the reactor:



Conversion of ethylene in reactor is 30% and the scrubber following the reactor completely separates ethylene (as top stream) and ethanol-water as bottom. Water is used as solvent in scrubber. Ethanol-water solution from scrubber is sent to distillation column. Distillation column gives ethanol-water azeotrope (90 mole % ethanol) as top product and waste water as bottoms. Ethylene from the top of scrubber is recycled back to feed stream of reactor. Small fraction of recycled stream is purged out. The recycle to purge ratio is 34.

- (i) For an azeotrope product rate of 500 mol/h, the recycle gas flow rate in mol/h is
- | | |
|----------|----------|
| (a) 30 | (b) 420 |
| (c) 1020 | (d) 1500 |
- (ii) For the same process if fresh H_2O feed to the reactor is 600 mol/h and wash water for scrubbing is 20% of the condensibles coming out of the reactor, the water flow rate in moles/h from the distillation column as bottoms is
- | | |
|---------|---------|
| (a) 170 | (b) 220 |
| (c) 270 | (d) 430 |
- (GATE: 2007)

March 2010

ANSWER OF OBJECTIVE QUESTIONS

CHAPTER 1

(1.1) b (1.2) b (1.3) b (1.4) c (1.5) c (1.6) b (1.7) a (1.8) b (1.9) c (1.10) c (1.11) b (1.12) c (1.13) c (1.14) c (1.15) 273.16 K (1.16) c (1.17) 10 000

CHAPTER 2

(2.1) a (2.2) b (2.3) b (2.4) b (2.5) b (2.6) c (2.7) b (2.8) b (2.9) a (2.10) b (2.11) c (2.12) Henry's Law (2.13) b (2.14) c (2.15) c (2.16) b (2.17) b (2.18) b (2.19) b (2.20) a (2.21) b (2.23) air, 2.45 (2.27) (i) True (ii) False (iii) False (iv) False (2.28) 0.488 (2.29) True (2.30) c (2.31) False (2.32) c (2.33) b (2.34) b (2.35) d (2.36) b (2.37) b (2.38) b (2.39) d

CHAPTER 3

(3.1) c (3.2) b (3.3) b (3.4) a (3.5) c (3.6) b (3.7) b (3.8) b (3.9) b (3.11) a (3.12) a (3.13) c (3.14) 155.6 kg (3.15) 40 kg (3.16) d (3.17) a (3.18) c

CHAPTER 4

(4.1) c (4.2) a (4.3) 70 % (4.4) b (4.5) a (4.6) high (4.7) True (4.8) a (4.9) (i) a (ii) None (iii) High pressure and high temperature (4.10) c (4.11) b (4.12) b (4.13) b (4.14) c (4.15) c (4.16) 36.76%, FeS (4.17) Carbon, 25% (4.18) c

CHAPTER 5

(5.1) b (5.2) a (5.3) a (5.4) Zero (5.5) b (5.6) b (5.7) b (5.8) d (5.9) c (5.10) c (5.11) d (5.12) Standard heat of formation (5.13) d (5.14) a (5.15) c (5.16) c (5.17) c (5.18) d (5.19) c (5.20) (i) True (ii) False (5.21) b (5.22) b (5.23) b (5.24) b (5.26) c (5.27) True (5.29) True (5.30) 53.75 kJ/kg (5.30) True (5.31) True (5.32) b (5.33) d (5.34) (i) a (ii) d (5.35) d (5.36) +99.4 kJ/mol

CHAPTER 6

(6.1) True (6.2) b (6.3) b (6.4) b (6.5) c (6.6) c (6.7) c (6.8) c (6.9) a (6.10) b (6.11) b (6.12) b (6.13) b (6.14) a (6.15) 517.5 kg/h (6.16) b (6.17) c (6.18) c (6.19) a (6.20) Lower (6.21) Lower (6.22) c (6.23) c (6.26) d (6.27) c (6.28) b (6.29) (i) a (ii) c (6.30) b (6.31) c (6.32) d (6.33) (i) d (ii) a (6.34) a (6.35) b (6.36) 79.27 (6.37) b (6.38) a (6.39) b (6.40) c

CHAPTER 7

(7.1) c (7.2) c (7.3) d (7.4) Higher (7.5) True (7.6) 17% (7.7) True (7.8) False (7.9) Orsat and Fyrite (7.11) Higher (7.12) Lower (7.13) b (7.14) b (7.15) (i) d (ii) c (7.16) c (7.17) d

CHAPTER 8

(8.1) a (8.2) Lower (8.3) Lower (8.4) False (8.5) True (8.6) True (8.7) False (8.8) False
(8.9) Higher, Lower (8.10) Low (8.12) c (8.13) c (8.14) b (8.15) (i) c (ii) b