

**CHEMICAL PROCESS TECHNOLOGY - I  
(CHEN 3101)**

**Time Allotted : 3 hrs**

**Full Marks : 70**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group - A  
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Boiler feed water must be free from  
 (a) temporary hardness (b) permanent hardness  
 (c) dissolved oxygen (d) all of (a), (b), (c).
- (ii) TDS in water can be removed by  
 (a) coagulation & flocculation (b) adsorption in activated carbon  
 (c) ultrafiltration (d) ion-exchange method.
- (iii) Caustic soda is obtained in the purer form when produced by  
 (a) Diaphragm cell method (b) Mercury-Cell method  
 (c) Membrane cell method (v) Lime-soda process.
- (iv) Dissolution of carbondioxide in sodium chloride solution can be increased commercially by  
 (a) lowering the temperature of the salt solution  
 (b) dissolving ammonia before Carbondioxide in water at lower temperature  
 (c) dissolving hydrochloric acid before carbondioxide in water at low temperature  
 (d) increasing the pressure of carbondioxide over salt solution.
- (v) In Solvay tower, Temperature for the manufacturing of Sodium hydrogen carbonate, is kept highest at the  
 (a) middle (b) top (c) bottom (d) (b) & (c).
- (vi) During absorption of HCl gas in water (to produce HCl solution), the gas is kept above dew point to  
 (a) avoid corrosion  
 (b) increase the rate of absorption  
 (c) reduce cooling water rate  
 (d) reduce the strength of acid.

- (vii) DAP is the abbreviated form of  
 (a) dissolved ammonium phosphate (b) diammonium phosphate  
 (c) diacidic phosphate (d) dry ammonium phosphate.
- (viii) The major constituents of fertiliser is  
 (a) carbon, sulphur and calcium  
 (b) nitrogen, phosphorous & potassium  
 (c) nickel, iron & calcium  
 (d) organic waste & clay.
- (ix) Dry grinding is preferred to wet grinding in modern cement manufacturing because of  
 (a) Scarcity of water  
 (b) Smaller particle size  
 (c) Saving heat, less water to evaporate & accurate control of composition  
 (d) Wet grinding is energy deficient.
- (x) Silica brick refractories can be used in the reactor for the manufacture of  
 (a) basic Bessemer converter for steel manufacturing  
 (b) dorr strong acid process for phosphoric acid  
 (c) aluminium by extractive hydro-metallurgy  
 (d) cement Rotary Kiln.

**Group - B**

2. (a) How would you express hardness of water? What do you understand by water conditioning?  
 (b) Describe the Ion-exchange process with the help of a flow chart for the production of demineralised water. Differentiate and explain the differences of different types of hardness present in water.  
**(2 + 3) + (4 + 3) = 12**
3. (a) Describe caustic soda manufacturing process in a membrane cell. What are the characteristics of the membrane? Outline the merits and demerits of mercury cell for production of caustic soda.  
 (b) Define (i) voltage efficiency, (ii) current efficiency, (iii) energy efficiency, and (iv) decomposition efficiency of an electrolytic cell for manufacturing caustic soda.  
**(3 + 2 + 3) + 4 = 12**

**Group - C**

4. (a) Elaborately explain the factors that affect the equilibrium conversion of SO<sub>2</sub> to SO<sub>3</sub> by oxygen/air in presence of a catalyst.

- (b) Describe the manufacturing process of HNO<sub>3</sub> acid by the catalytic oxidation of NH<sub>3</sub> with a neat sketch of the process layout. Mention the thermodynamic and kinetic considerations for the overall process.

$$6 + 6 = 12$$

5. (a) Discuss the commercial production of hydrochloric acid for industrial and laboratory grade.
- (b) What are the engineering problems associated with production of hydrochloric acid?
- (c) Why SO<sub>3</sub> is absorbed in 98% H<sub>2</sub>SO<sub>4</sub> instead of water in a sulphuric acid plant?

$$5 + 5 + 2 = 12$$

#### Group - D

6. (a) How can we overcome the major engineering problems associated with the manufacture of Urea?
- (b) What are the essential ingredients of synthetic fertilizers? What is the implication of 'Bone Phosphate of Lime' in fertiliser industry?
- (c) How is the proportion of hydrogen improved in the synthesis gas obtained by steam reforming of naphtha for the manufacture of ammonia by Haber's process?

$$(3 + 2) + (2 + 2) + 3 = 12$$

7. (a) Discuss in detail the engineering problems and economics of the manufacturing of ammonia by Haber's process with special reference to kinetics & thermodynamics of the reactions involved. Explain the necessity of purging the recycle gas mixture after condensation of ammonia with the help of a thermodynamic expression.
- (b) How would you produce triple superphosphate from a very low grade ore?
- (c) What is the composition of NPK for effective applications in agricultural productivity?

$$6 + 4 + 2 = 12$$

#### Group - E

8. (a) What are the major compounds present in Portland cement? Discuss the setting and hardening of cement. What are the differences in properties between cement & concrete?

- (b) Compare the advantages & disadvantages of the dry and wet process involved in the manufacture of Portland cement.

$$(2 + 2 + 2) + 6 = 12$$

9. (a) What is refractoriness? Classify different types of refractory materials used in the industry and other areas. Define the terms RUL, PCE (seggar cone) & porosity with reference to refractory materials.
- (b) What are primary considerations for the selection of refractory linings in various reactors or furnaces in the industry?

$$(2 + 3 + 4) + 3 = 12$$