

**Scheme – I**  
**Sample Question Paper**

**Program Name** : Diploma in Chemical Engineering  
**Program Code** : CH  
**Semester** : Third  
**Course Title** : Industrial Stoichiometry  
**Marks** : 70

22315

**Time: 3 Hrs.**

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**Instructions:**

- (1) All questions are compulsory.
- (2) Illustrate your answers with neat sketches wherever necessary.
- (3) Figures to the right indicate full marks.
- (4) Assume suitable data, if necessary.
- (5) Preferably, write the answers in sequential order.

**Q.1) Attempt any FIVE of the following.**

**10 Marks**

- a) Define Power and write its SI unit.
- b) State Dalton's law and Amagat's law.
- c) List out different unit operations used in the chemical industry (Any four).
- d) Write the stoichiometric coefficients for the given reaction  
$$4\text{FeS}_2 + 11\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3 + 8\text{SO}_2.$$
- e) Define calorific value.
- f) Define heat of formation.
- g) Convert a pressure of 800mmHg to the following units: (i) atm (ii) kPa

**Q.2) Attempt any THREE of the following.**

**12 Marks**

- a) An evaporator is concentrating 5% solution of NaCl to 25% NaCl by weight. Calculate the quantity of water evaporated for evaporator fed with 5000kg/hr of feed solution.
- b) Describe Distillation operation with the help of block diagram and overall material balance equation.
- c) Carbon monoxide is reacted with hydrogen to produce methanol Calculate  
(i) the stoichiometric ratio of H<sub>2</sub> to CO  
(ii) kg mole CH<sub>3</sub>OH produced per kg mole CO reacted

- d) Calculate heat capacity at constant pressure at room temperature of oxygen if the oxygen is assumed to be an ideal gas.

**Q.3) Attempt any THREE of the following.**

**12 Marks**

- a) Calculate the actual urea content in the urea sample if available nitrogen in given sample is found to be 45% .
- b) A dryer handle 1000kg/hr of wet solids containing 50% solid to be dried to 20% moisture calculate percentage of original moisture removed.
- c) In production of sulfur trioxide 100kmol of SO<sub>2</sub> and 200 kmol of O<sub>2</sub> are fed to reactor. The product stream is found to contain 80kmol SO<sub>3</sub>. Calculate % conversion of SO<sub>2</sub>.
- d) Calculate the heat needed to raise the temperature of 1kmol of ammonia from 311K to 422K using following mean molal heat capacity data,
- Cp<sub>m</sub><sup>0</sup> of NH<sub>3</sub> between 311 and 298K = 35.86 kJ/mol K
  - Cp<sub>m</sub><sup>0</sup> of NH<sub>3</sub> between 422 and 298K = 3537.70kJ/mol K

**Q.4) Attempt any THREE of the following.**

**12 Marks**

- a) A force equal to 19.65kgf is applied on a piston with a diameter of 5cm. Calculate the pressure exerted on the piston in kPa.
- b) Air contains 21% oxygen and 79% Nitrogen (by vol) calculate average molecular weight of air.
- c) Describe Extraction operation with the help of block diagram and overall material balance equation.
- d) In electrolytic manufacturing of chlorine gas from a sodium chloride solution suppose that 50kg of NaCl reacts with 10kg of H<sub>2</sub>O (i) Identify limiting and excess reactant (ii) List out components of product stream if the reaction is 60% complete.  
 $2\text{NaCl} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2 + \text{Cl}_2$
- e) State classification of fuels with four examples of each class used in the Chemical industry.

**Q.5) Attempt any TWO of the following.**

**12 Marks**

- a) In the manufacturing of Nitric Acid Initially ammonia and air are mixed at 7atmg and 650<sup>0</sup>c the composition of the mixture (on vol basis) is as follows N<sub>2</sub> 70.5%, O<sub>2</sub> 18.8%, H<sub>2</sub>O 1.2%, NH<sub>3</sub> 9.5%. Calculate the density of the gas mixture

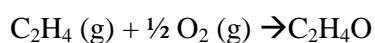
using ideal gas law.

- b) In a chemical fertilizer industry a mixed fertilizer having the NPK composition 10:26:26 as %N<sub>2</sub>, %P<sub>2</sub>O<sub>5</sub> and %K<sub>2</sub>O by weight respectively is to be formulated by mixing ammonia, phosphoric acid and potassium chloride. If anhydrous ammonia, anhydrous phosphoric acid and 100% pure potassium chloride is used for mixing. Calculate the amount of each of them required for formulating 100Kg mixed fertilizer assume that the filler will make up the balance.
- c) The burning of limestone, CaCO<sub>3</sub> → CaO+CO<sub>2</sub>, goes only 70% to completion in a certain kiln. (i) Determine the composition (wt %) of the solid withdrawn from the kiln. (ii) Calculate kilogram of CO<sub>2</sub> produced per kilogram of limestone fed assuming that the limestone is pure.

**Q.6) Attempt any TWO of the following.**

**12Marks**

- a) In a oxidation process during production of chlorine gas by oxidation of hydrochloric acid gas. Air is used 30% in excess of that theoretically required, based on 4kmol HCl, if oxidation is 80% complete find the composition of product stream on mole basis.
- b) A coke containing 90% carbon and 10% noncombustible ash (by weight), is burned in air. If 50% excess air is supplied, calculate kmol of air actually supplied.
- c) Using following data , Calculate the change in enthalpy of reactant and product if both are at 298 K and if 5 moles of ethylene oxide is produced as per the following reaction



Component	$\Delta H_f$ , at 298K kJ/mol
C <sub>2</sub> H <sub>4</sub>	52.50
C <sub>2</sub> H <sub>4</sub> O	-52.63

**Scheme – I**  
**Sample test Paper - I**

**Program Name** : Diploma in Chemical Engineering  
**Program Code** : CH  
**Semester** : Third  
**Course Title** : Industrial Stoichiometry  
**Marks** : 20

22315

**Time: 1 Hour.**

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**Instructions:**

- (1) All questions are compulsory.
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**Q.1 Attempt any FOUR.**

**08 Marks**

- a) List out any four fundamental quantities.
- b) Make conversion of  $1\text{N/m}^2$  Pressure to  $\text{Dyne/cm}^2$ .
- c) Write mathematical equation of law that is obeyed by real gas.
- d) State Raoult's law and give its mathematical expression.
- e) Define steady state operation.
- f) State law of conservation of mass.

**Q.2 Attempt any THREE.**

**12 Marks**

- a) In a double effect evaporator plant, the second effect is maintained under vacuum of 475mmHg. Find the absolute pressure in mmHg and kPa.
- b) Calculate the weight of chlorine in a vessel having volume of  $5\text{m}^3$ , the temperature and pressure being 400K and 100kPa.
- c) Give the value of Universal gas constant in SI system and calculate value of volume occupied by 1mol of gas at NTP.
- d) Illustrate the importance of recycling operation in chemical industry. (Any four Points)
- e) In a distillation unit 1000 kg/hr of mixture of benzene and toluene containing 60% benzene by wt. is distilled to give a distillate containing 90% benzene and 90% toluene in residue by weight. Calculate kg/hr of distillate.
- f) An evaporator is concentrating 5% solution of NaCl to 25% NaCl by weight. Calculate the quantity of water evaporated for evaporator fed with 5000kg/hr of feed solution.

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**Q.1 Attempt any FOUR.**

**08 Marks**

- a) Define the term 'Limiting Reactant'.
- b) In the following reaction write stoichiometric ratio of H<sub>2</sub> and O<sub>2</sub>  $H_2 + \frac{1}{2} O_2 \rightarrow H_2O$
- c) Define GCV.
- d) Choose the solid and liquid fuel from the following: saw dust, Producer gas, kerosene, Gasoline and coke.
- e) State Law of Conservation of Energy.
- f) Define Heat of Reaction.

**Q.2 Attempt any THREE.**

**12Marks**

- a) If 1kg of benzene is oxidized with oxygen, how many kilograms of oxygen b) Calculate the NCV at 25<sup>0</sup>C of a sample of fuel oil having C/H ratio 9.33(by wt) and containing sulfur to the extent of 1.37% by wt using following data.
  - i) Gross calorific value of fuel oil at 25°C = 9980kcal/kg
  - ii) Latent heat of water vapour at 25°C=538.2 kcal/kg Latent heat of water vapour at 25°C=538.2 kcal/kg are needed to convert all the benzene to CO<sub>2</sub> and H<sub>2</sub>O.
- c) Prove that, for an ideal gas, C<sub>p</sub> – C<sub>v</sub> = R.
- d) Write stepwise procedure to solve material balance with chemical reaction carried out in chemical industry.

- e) Water at one atm pressure and  $90^{\circ}\text{C}$  is cooled to  $60^{\circ}\text{C}$  at constant pressure, calculate the enthalpy change.
- f) The carbon monoxide is reacted with hydrogen to produce methanol calculate for the reaction a) the stoichiometric ratio of  $\text{H}_2$  to  $\text{CO}$  b) kg mole  $\text{CH}_3\text{OH}$  produced per kgmole  $\text{CO}$  reacted