

22315

**11920**

**3 Hours / 70 Marks**

Seat No.

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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) Use of Non-programmable Electronic Pocket Calculator is permissible.

**Marks**

**1. Attempt any FIVE of the following :**

**10**

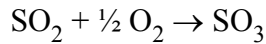
- (a) Convert a pressure 800 mm Hg to the following units :
  - (i) PSi
  - (ii) kPa
- (b) State Raoult's law and Ideal gas law.
- (c) Draw block diagram for evaporation.
- (d) Write the stoichiometric coefficient of the given reaction. Also write weight ratio of CO to H<sub>2</sub> CO + 2H<sub>2</sub> → CH<sub>3</sub>OH
- (e) Define Net Calorific value.
- (f) Define latent heat & sensible heat.
- (g) Define force and write its SI unit.

**2. Attempt any THREE of the following :**

**12**

- (a) A distillation column fed with 5000 kg/hr of Benzene-toluene mixture containing 40% Benzene. The distillate obtained contains 30% Benzene & bottom product contains 90% toluene. Calculate flow rate of top & bottom product.

- (b) Describe Recycle and Bypass operation.
- (c)  $\text{SO}_3$  is prepared by following reaction :



If 10 kmol of  $\text{SO}_2$  reacts with 100 kmol air.

Calculate % excess air used.

- (d) Calculate the heat of formation of  $\text{C}_7\text{H}_6\text{O}_2$  at 298.15 K using following data :

Std. heat of formation of  $\text{CO}_2(\text{g}) = -393.51 \text{ kJ/mol}$

Std. heat of formation of  $\text{H}_2\text{O}(\text{l}) = -285.83 \text{ kJ/mol}$

Std. heat of combustion of  $\text{C}_7\text{H}_6\text{O}_2 = -3226.95 \text{ kJ/mol}$

**3. Attempt any THREE of the following :**

**12**

- (a) Air contains 21%  $\text{O}_2$  and 79%  $\text{N}_2$  by volume. Calculate average molecular weight of air.
- (b) Describe stepwise procedure for material balance without chemical reaction for the chemical system.
- (c) In the manufacture of acetic acid by oxidation of acetaldehyde 100 kmol of acetaldehyde are fed to a reactor per hour. The product leaving the reactor contains 14.81% acetaldehyde, 59.26% acetic acid, rest oxygen (on mole basis). Calculate the % conversion of acetaldehyde.
- (d) Calculate std. heat of reaction of following reaction :



Data given as follows :

Component	$\Delta H^\circ \text{C kJ/mol}$
$\text{C}_2\text{H}_5\text{OH}(\text{g})$	- 1410.09
$\text{CH}_3\text{CHO}(\text{g})$	- 1192.65
$\text{H}_2(\text{g})$	- 285.83

**4. Attempt any THREE of the following :****12**

- (a) A force equal to 20 kgf is applied on a piston with a diameter of 5 cm. Calculate the pressure exerted on a piston in kPa.
- (b) A gas mixture contain 0.274 kmol HCl, 0.337 kmol N<sub>2</sub> and 0.089 kmol O<sub>2</sub>. Calculate : (a) Average molecular weight of gas (b) Volume occupied by this mixture at 405.3 kPa and 303 K.
- (c) Waste acid from nitrating process containing 30% H<sub>2</sub>SO<sub>4</sub>, 35% HNO<sub>3</sub> and 35% H<sub>2</sub>O by weight. The acid is to be concentrated to contain 39% H<sub>2</sub>SO<sub>4</sub> & 42% HNO<sub>3</sub> by addition of conc. sulphuric acid containing 98% H<sub>2</sub>SO<sub>4</sub> and conc. nitric acid containing 72% HNO<sub>3</sub> by weight. Calculate the quantities of acids to be mixed to get 1000 kg of desired mixed acid.
- (d) Feed containing 60% A, 30% B and 10% inerts entering a reactor. The product stream leaving the reactor is found to contain 2 mole % A. Reaction is  $2A + B \rightarrow C$ . Find % conversion of A.
- (e) State classification of fuels with four example of each class used in Chemical Industry.

**5. Attempt any TWO of the following :****12**

- (a) Calculate the vapour pressure of pure butane at 20 °C if its partial pressure is 698 mm Hg in a butane-acetone mixture. The mole-fraction of acetone in the mixture is 0.577.
- (b) An evaporator is fed with 15000 kg/hr of 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 45% NaOH, 2% NaCl & rest water.
- Calculate (i) kg/hr water evaporated (ii) kg/hr salt precipitated (iii) kg/hr thick liquor.

**P.T.O.**

- (c) Ethylene oxide is produced by oxidation of ethylene. 100 kmol of ethylene are fed to reactor and product is found to contain 80 kmol ethylene oxide and 10 kmol  $\text{CO}_2$ . Calculate (i) % conversion of ethylene (ii) % yield of ethylene oxide.

**6. Attempt any TWO of the following :**

**12**

- (a) In the manufacturing of chlorine, feed containing hydrochloric acid gas and air are fed an oxidiser. The product gases leaving the oxidiser are found to contain 13.2% HCl, 6.3 %  $\text{O}_2$ , 42.9%  $\text{N}_2$ , 30%  $\text{Cl}_2$ , 7.6%  $\text{H}_2\text{O}$  by weight. Calculate :
- (i) The % excess air used.
- (ii) The composition by wt. of gases entering the oxidiser.
- (b) A coke containing 90% carbon and 10% non-combustible ash (by wt.) is burned in air. If 50% excess air is supplied. Calculate kmol of air actually supplied.
- (c) A steam of carbon dioxide flowing at rate of 100 kmol/min is heated from 298 K to 383 K. Calculate the heat that must be transferred using  $C_p^\circ$ .

Data :  $C_p^\circ = a + bT + cT^2 + dT^3$ , kJ/(kmol.K)

Gas	a	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
$\text{CO}_2$	21.3655	64.2341	- 41.0506	9.7999

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