23124

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions : (1) All Questions are *compulsory.*

(2) Figures to the right indicate full marks.

(3) Assume suitable data, if necessary.

Marks

1. Attempt any FIVE of the following : **10**

(a) Give the SI unit of force & energy.

(b) What are products of complete and incomplete combustion ?

(c) Draw the block diagram of distillation unit showing all input and output.

(d) Define : (i) Limiting component (ii) Excess component

(e) Define : (i) Partial pressure (ii) Pure component volume

(f) Calculate the volume occupied by 20 kg of chlorine gas at a pressure of 100 KPa and 298 K.

(g) Name any two each of fundamental quantity and derived quantity.

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

(a) State Dalton's law and Amagat's law. Give their mathematical equations.

(b) Ammonia is produced by the following reaction : $N_2 + 3\ H_2 \rightarrow 2\ NH_3$

Calculate :

(i) Molal flow rate of hydrogen corresponding to nitrogen. Feed rate of 25 k_{mol}/h, if they are fed in the stoichiometric proportions.

(ii) Kg of NH_3 produced per hour if conversion is 25% and nitrogen feed rate is 25 k_{mol}/h.

(c) An evaporator is fed with 15000 kg/h 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 45% NaOH, 2% NaCl and rest water.

(i) Draw the detail block diagram of this operation.

(ii) Calculate kg/h. of thick liquor

(d) Explain different types of fuels with example.

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

(a) Define :

(i) Yield (ii) Conversion

(iii) Selectivity (iv) Stoichiometric ratio

(b) State & explain Hess's law of constant heat summation.

(c) Convert following pressure values in KPa.

(i) 100 mm of Hg (ii) 2 atm

(d) In the production of Sulphur trioxide, 100 k_{mol} of SO_2 and 100 k_{mol} of O_2 are fed to a reactor. If the percent conversion of SO_2 is 80, calculate the composition of product stream on mole basis.

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

(a) Define :

(i) Sensible heat (ii) Latent heat

(iii) Specific heat (iv) Heat of reaction

(b) 2000 kg of wet solids containing 70%, solid 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 :

(i) Kg of water removed

(ii) Kg of dried product obtained

(c) Explain bypass & recycle operation with block diagram.

(d) Define gross and net calorific value.

(e) Convert the following :

(i) 1000 kg/m^3 into gram/cm^3

(ii) 10 m^3/hr. into lit/sec.

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

(a) A natural gas has the following composition by volume

CH_4 – 82%, C_2H_6 – 12% & N_2 – 6%

Calculate :

(i) Density of gas at 288 K and 101.325 KPa

(ii) Composition in weight percent

(b) Soyabean seeds are extracted with hexane in batch extractor. The flaked seeds are found to contain 18.6% oil, 69% solid and 12.4% moisture. At the end of process, cake is separated from hexane – oil mixture.

The cake is analysed to contain 0.8% oil, 87.7% solid and 11.5% moisture (by weight).

Calculate the percentage recovery of oil.

(c) C_2H_4O is prepared by oxidation of C_2H_4, 100 k_{mol} of C_2H_4 and 100 k_{mol} of O_2 are fed to a reactor. The conversion of C_2H_4 is 85% and yield of C_2H_4O is 94.12%. The reactions taking place are

$C_2H_4 + ½\ O_2 \rightarrow C_2H_4O$

$C_2H_4 + 3\ O_2 \rightarrow 2\ CO_2 + 2\ H_2O$

Calculate the composition of product stream leaving the reactor.

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

(a) Pure ethylene is heated from 303 k to 523 k at atmospheric pressure.

Calculate the heat added per k_{mol} of ethylene using heat capacity data given below.

$C_p^\circ = 4.1261 + 155.0213 \times 10^{-3}\ T - 81.5455 \times 10^{-6}\ T^2$

$+ 16.9755 \times 10^{-9}\ T^3$

(b) A combustion reactor is fed with 50 k_{mol}/h of butane and 2000 k_{mol}/h of air. Calculate % excess air used and composition of the gases leaving reactor, assuming complete combustion of butane.

(c) The waste acid from nitrating process containing 20% HNO_3, 55% H_2SO_4 & 25% H_2O by weight is to be concentrated by addition of concentrated H_2SO_4 acid containing 95% H_2SO_4 and concentrated HNO_3 acid containing 90% HNO_3 to get desired mixed acid containing 26% HNO_3 & 60% H_2SO_4.

Calculate quantities of waste and concentrated acids required to get 1000 kg of desired mixed acid.
