Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

IV SEMESTER B.TECH. (CHEMICAL ENGINEERING)

MAKE-UP EXAMINATIONS

SUBJECT: INTRODUCTION to CHEMICAL ENGINEERING [CHE3281]

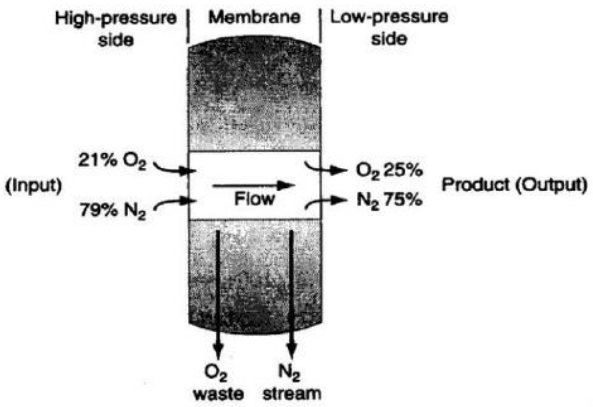
REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A.	Potassium superoxide, KO_2, is used in rebreathing gas masks to generate oxygen. $KO_2(s) + H_2O(l) \rightarrow KOH(s) + O_2(g)$ (Atomic Mass K-39.1, O-16, H-1) a. How many moles of O_2 can be produced from 0.15 mol KO_2 and 0.10 mol H_2O? b. Determine the limiting reactant. c. Suppose the theoretical yield for an experiment was calculated to be 19.5 grams, and the experiment was performed, but only 12.3 grams of product were recovered. Determine the % yield	**3**
1B.	What are various modes of heat transfer? Write about Fourier's law of heat conduction. Define mass transfer and explain about Fick's law of diffusion.	**3**
1C.	Given that basalt seems to well up when ocean crust pulls apart at Mid-Ocean ridges, you might decide that maybe the entire Earth is made of basalt. On your bathroom scale, a 64 in^3 (4in x 4in x 4in) block of basalt weighs 116 ounces. Use this information to calculate whether the average density of the Earth in g/cm^3.	**4**
2A.	With the help of a neat flow diagrams explain how a chemical engineer helps in designing, developing and commercializing a product.	**3**
2B.	Methane (CH_4) is burned with atmospheric air. The analysis of the products on a dry basis is as follows: CO_2- 10.00% O_2- 2.37 CO- 0.53 N_2- 87.10 $aCH_4 + bO_2 + cN_2 \rightarrow 10.0CO_2 + 0.53CO + 2.37O_2 + dH_2O + 87.1N_2$ Calculate the air-fuel ratio and the percent theoretical air, and determine the combustion equation.	**4**
2C.	(i) How many grams of testosterone, $C_{19}H_{28}O_2$, a nonvolatile, nonelectrolyte (MW = 288.4 g/mol), must be added to 207.8 grams of benzene to reduce the vapor pressure	**3**

	to 71.41 mm Hg? (Benzene = C_6H_6 = 78.12 g/mol. The vapor pressure of benzene is 73.03 mm Hg at 25.0 °C.) (ii) What mass in milligrams of potassium nitrate is present in 0.25kg of a 500ppm $KNO_{3(aq)}$?	
3A.	Calculate the equivalent weights of H_2SO_3 (MW=82) and LiOH(MW=24) in the following reactions and explain the reason behind this. a)$H_2SO_3 + 2\ LiOH \rightarrow 2\ H_2O + Li_2SO_3$ b) $H_2SO_3 + LiOH \rightarrow H_2O + LiHSO_3$	**3**
3B.	A textile dryer is found to consume 4 m^3/hr of natural gas with a calorific value of 800 kJ/mole. If the throughput of the dryer is 60 kg of wet cloth per hour, drying it from 55% moisture to 9% moisture, estimate the overall thermal efficiency of the dryer taking into account the latent heat of evaporation only. Latent heat of evaporation = 2257 kJ/K	**4**
3C.	If a mixture of gases consists of three components A,B,C derive The mole fraction of component A is $X_A = \frac{n_A}{n_{tot}} = \frac{P_A}{P_{tot}} = \frac{V_A}{V_{tot}}$	**3** **1+2)**
4A.	Figure below illustrates a nanoporous membrane that is made by coating a very thin layer of polymer on a porous graphite supporting layer. What is the composition of the waste stream if the waste stream amounts to 80% of the input stream? 	**4**
4B.	I. Calculate the mole fraction of ethanol and water in a sample of rectified spirit which contains 95% of ethanol by mass. II. What volume (L) of O_2 gas is needed to completely react with 15.0 g of aluminum at STP? $Al(s) + O_2(g) \rightarrow Al_2O_3(s)$	**3** **(1+2)**
4C.	If a 70% (by weight) solution of glycerol has a specific gravity of 1.184 at 15°C, what is the density of the solution in (a) g/cm^3 (b) lbm/ft^3 and (c) kg/m^3?	**3**
5A.	What mass of carbon dioxide is produced when 96.1 g of propane react with sufficient oxygen? $C_3H_8+O_2 \rightarrow CO_2+H_2O$	**3**
5B.	A particular coal has the following ultimate analysis on a dry basis, percent by mass: **Component** — **Percent by mass** Sulfur — 0.6 Hydrogen — 5.7	**4**

		Carbon: 79.2 Oxygen: 10.0 Nitrogen: 1.5 Ash: 3.0	
5C.	Define Newtonian and non-Newtonian fluids. A reservoir of oil has a mass of 825 kg. The reservoir has a volume of 0.917 m^3. Compute the density, specific weight, and specific gravity of the oil.		**3 (1+2)**