MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

SUMMER-13 EXAMINATION

Model Answer

Subject code : FCE(12030)

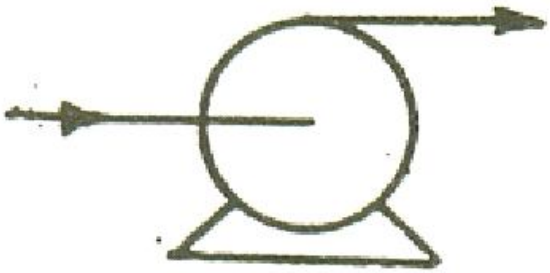
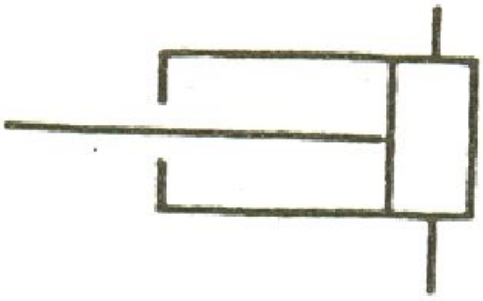
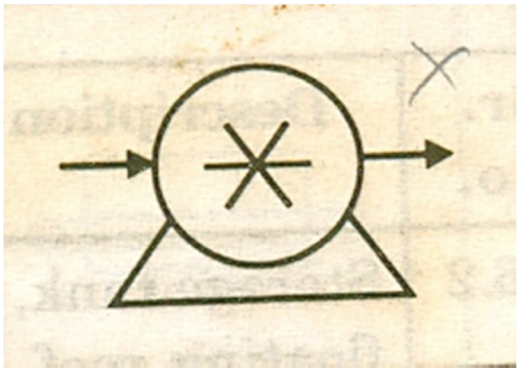
Important instructions to examiners :

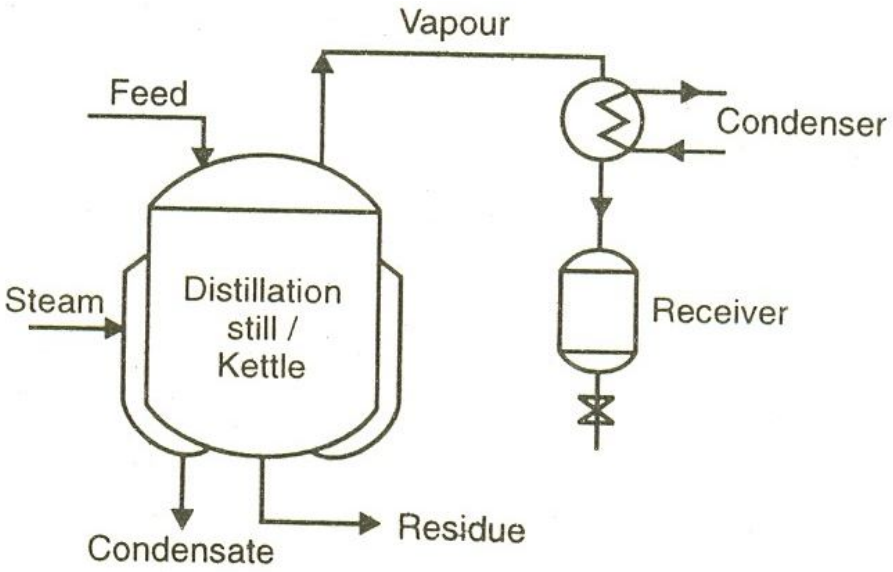
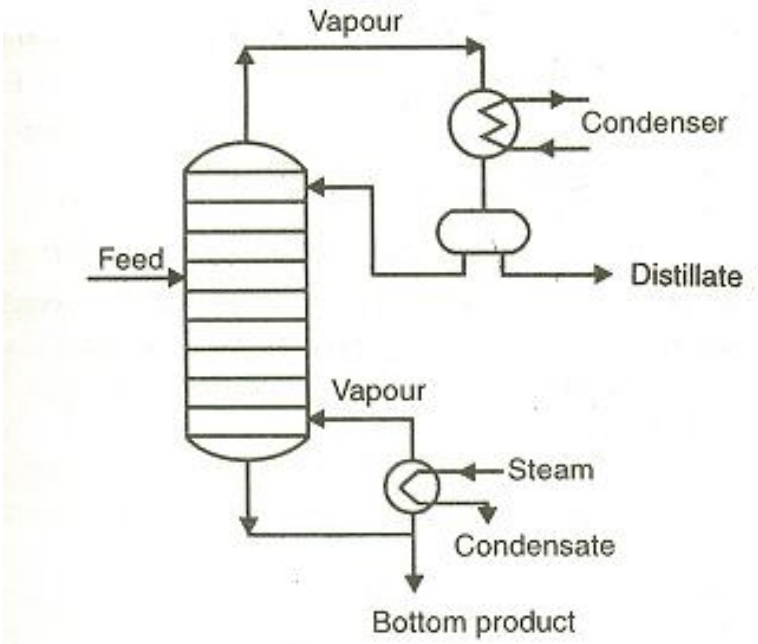
1. The answers should be examined by keywords and not as word to word as given in the model answer scheme.
2. The model answer and the answer written by candidate may vary, but the examiner may try to assess the understanding level of the candidate.
3. The language errors such as grammatical, spelling errors should not given more importance.
4. While assessing figures, examiner may give credit for principal components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5. Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answer and model answer.
6. In case of some questions credit may be given by judgment of relevant answer based on candidates understanding.

Q No :	**Answer**	**Mark**	**Total marks**
1.a	Father of Indian Chemical Engineering is Dr.H.L..Roy . He started chemical engineering discipline at National Council of Education , Bengal .	2	2
1.b	Four products which are coming out from chemical industries are : 1. Cement 2. Paper 3. Glass 4. Petrol 5. Diesel	½ mark each for any four	2

	6. LPG 7. Medicines 8. Food items		
1.c	Investment limits for : 1. Medium Scale Industries is between 5 crores and 10 crores 2. Large scale industries is above 10 crores.	 1 1	2
1.d	S.I.Unit for force : Newton S.I.Unit for pressure: Newton / m^2 (Pscal)	1 1	2
1.e	**Molality :** Molality = gm moles of solute / kg of solvent **Molarity** Molarity = gm moles of solute / volume of solution in litre.	1 1	2
1.f	Equipments used for grinding : 1. Hammer mill 2. Ball mill 3. Pebble mill 4. Rod mill	1 mark for any 2	2
1.g	**Rotameter** : Rotameter is a variable area meter. It is used to measure volumetric flow rate of a flowing fluid.	2	2
1.h	$^oF = 1.8\ ^oC+32$ $^oA= 273+\ ^oC$ or $K= 273+\ ^oC$	1 1	2
1.i	**Pressure measurement scales** : 1. Absolute scale. 2. Gauge scale. 3. Vacuum.	1 mark each for any 2	2

1j	**Viscosity** : Viscosity is defined as the resistance offered by a fluid to its own flow. **Unit of viscosity** : Poisa(gm/cm.sec.)	1 1	2
1.k	**Heat** : Heat is a form of energy. **Temperature :** Temperature is a measure of hotness or coldness of a body.	1 1	2
1.l	**Vapour pressure** : It is the pressure exerted by vapour. **Partial pressure** : It is the pressure exerted by a component gas if it was alone present at temperature and volume as that of gas mixture.	1 1	2
2.a	Flow rate = $6300m^3/hr$ $1m^3$ = 1000 lit. 1 hr = 3600 sec. $6300m^3/hr$ = 6300*1000/3600 = 1750 lit/sec	 1 1 1 1	4
2.b	**gmoles of oxygen in 200 gm**. gmoles = weight/molecular weight gmoles = 200/32 = **6.25 gmol** **gm of CO_2** weight = gmol*molecular weight weight = 2.5*44 = **110gm.**	 1 1 1 1	4
2.c	Two operations by which particle size can be reduced : 1. Crushing. Equipment: Jaw crusher, gyratory crusher	2 marks each	4

	2. Grinding Equipment : Hammer mill, ball mill 3. Attrition/Rubbing Equipment : Fluid energy mill 4. Cutting Equipment : Knife cutter.	for any 2	
2.d	Pumps used in chemical industries.: 1. Centrifugal pump.  2. Reciprocating pump.  3. Rotary pump 	2 marks each for any 2 with symbol	4

2.e	**Simple distillation** :  **Fractional distillation** :  	2 2	4
2.f	In extraction process solvent is used to dissolve one or more constituents	2	4

<table>
<tr><td></td><td>of the liquid mixture to accomplish the separation.
Industries in which solvent extraction process is used are:
1. Oil industry
2. Pettroleum / petrochemical industry
3. Pharmaceutical industry</td><td>2</td><td></td></tr>
<tr><td>3.a</td><td>Modes of heat transfer:
1. Conduction
2. Convection
3. Radiation
Mode of heat transfer used in boiling water is convection.
Convection : It is the mode heat transfer with the movement of particles. If the fluid motion is caused by differences in density resulting from temperature difference in a fluid , the heat transfer is called natural conduction. If the fluid motion is artificially created by means of an external agency, the heat transfer is called forced convection.</td><td>1

1

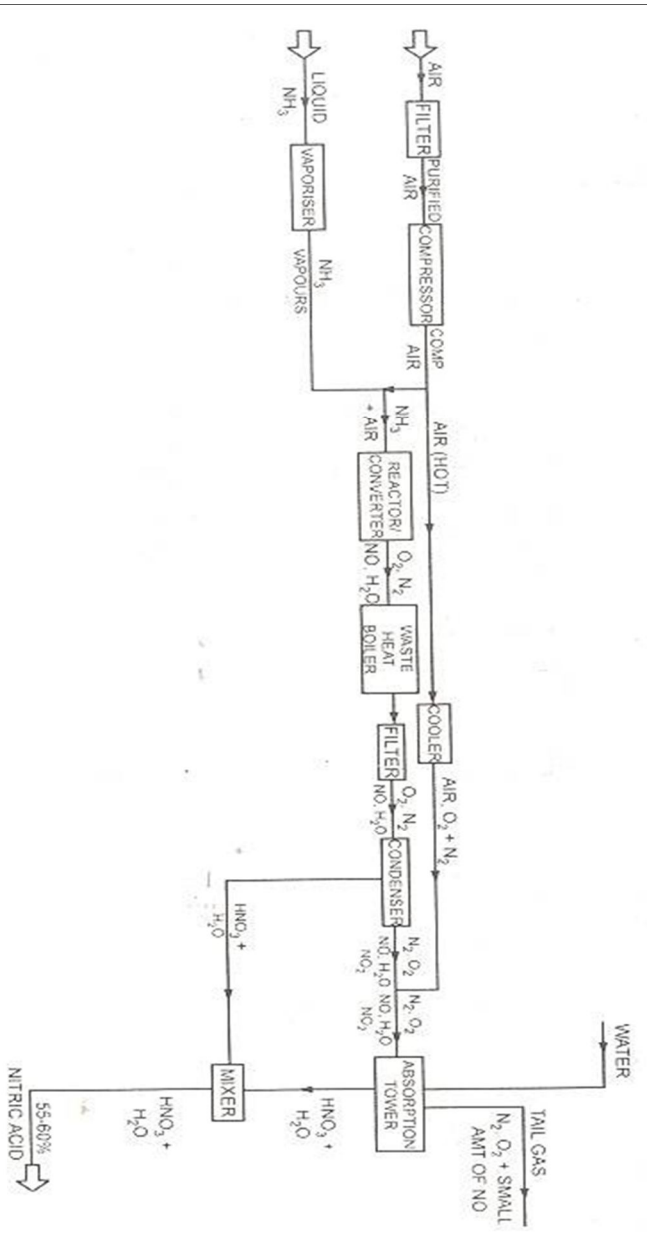
2</td><td>4</td></tr>
<tr><td>3.b</td><td>Crystallization :
It is a operation in which solid particles are formed in a liquid solution. In this operation the dissolved solids of the solutions are separated out by solubility differences at different temperatures. This operation involve concentration of the solution and cooling of solution until the concentration of the solute becomes higher than its solubility at that temperature. The solute then comes out of the solution in the form of pure crystals.</td><td>4</td><td>4</td></tr>
<tr><td>3.c</td><td><table><tr><th>Point</th><th>Sedimentation</th><th>Filtration</th></tr><tr><td>Filter medium</td><td>Not required</td><td>Required</td></tr><tr><td>Nature of process</td><td>Action of gravitational force</td><td>Action of pressure difference.</td></tr></table></td><td>2 marks each</td><td>4</td></tr>
<tr><td>3.d</td><td>Dalton’s Law :</td><td></td><td>4</td></tr>
</table>

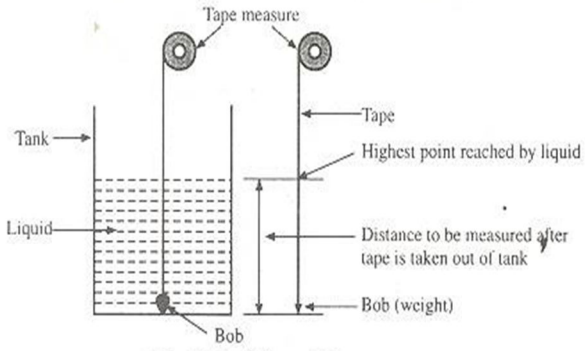
	Dalton's law state that the total pressure exerted by a gas mixture is equal to the sum of partial pressures of its components. $P = P_1 + P_2 + P_3$ Where P is total pressure of gas mixture P_1 , P_2 , P_3 are the partial pressures.	2 2	
3.e	i) A saturated solution can be converted into a super saturated solution by either by adding more solute into it or by removing some amount of solvent from it by evaporation. ii) A saturated solution can be converted into an un saturated solution by adding more solvent into it.	2 2	4
3.f	**Desorption** : The reverse of absorption is called desorption . It is an operation in which a dissolved gas a solution is removed from the liquid by contacting it with an inert gas. e.g. 1. Removal of volatile components of oil by steam. 2. Removal of ammonia from aqua-ammonia solution by air.	 2 2	4
4.a	i) $V_1 N_1 = V_2 N_2$ V_1 = 2 litres. N_1 = 1N V_2 = ? N_2 = 10N $V_2 = V_1 N_1 / N_2$ = 2*1/10 **= 0.2 lit.** ii) Normality= gm. eq of solute/ vol of solvent in kg 0.5=gm eq/0.5 Gm.eq of NaOH = 0.5*0.5=0.25 Gm. eq = weight/ eq.wt 0.25 = wt/40 Weight = 0.25*40	1 1 1 1 1 1 1	8

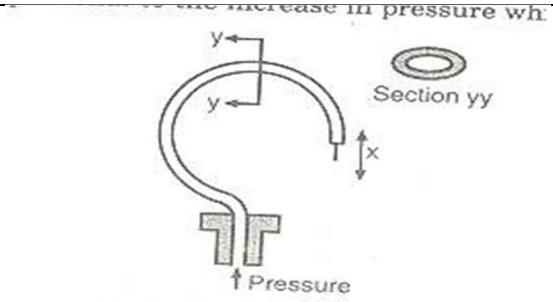
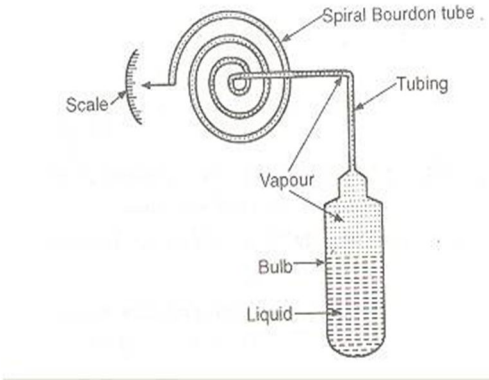
	= **10 gm**	1	
4.b	Precautions to be taken while handling sulfuric acid: 1. It should be kept in closed container. 2. It should not come in direct contact with human body. 3. If the body comes in contact with sulfuric acid , wash the body part thoroughly with running water . 4. It should not fall on precious metals. 5. It should not be stored in metallic container. 6. While handling sulfuric acid hand gloves should be used. **Applications of sulfuric acid** : 1. In fertilizer 2. As drying agent 3. In paint industries 4. In pharmaceutical industries 5. In processing metals 6. As acidifying agent	1 mark each for any 4 1 mark each for any 4	8
4.c	**Fuming nitric acid** is concentrated nitric acid. Nitric acid is concentrated by 1. By treating with H_2SO_4 2. By treating with $Mg(NO_3)_2$ Properties of nitric acid 1. Highly corrosive and poisonous liquid. 2. Colourless to yellow in colour. 3. It is toxic and can cause severe burns. 4. It has unpleasant odour. 5. Density = 1.41g/ml. Uses of nitric acid 1. In production of explosives. 2. In the production of nitrogen fertilizers. 3. In the purification of gold, silver and platinum. 4. As laboratory reagent.	1 2 1 mark each for any 2 1 mark each for any 3	8

	5. To dissolve noble metals.		
5.a	**Amagat's Law :** It state that the total volume occupied by a gaseous mixture is equal to the sum of the Pure components volumes of component gases. Mathematically, $V= V_A+V_B+V_C+$----- Where V = Total Volume, V_A, V_B, V_C = Pure components volumes of component gases	2 2	4
5.b	**Basis :** 100 Kmol a gas mixture at NTP It contain CO_2 = 20 Kmol N_2 = 40 Kmol O_2 = 40 Kmol at NTP , P=101.325 KPa and T = 273.15 K Total Pressure = P = 101.325 KPa Mole fraction of CO_2 = 20/100 = 0.2 Mole fraction of N_2 = 40/100 = 0.4 Mole fraction of O_2 = 40/100 = 0.4 Partial Pressure CO_2 = Mole fraction of CO_2 X Total Pressure = 0.2 X 101.325 = **20.265 KPa** Partial Pressure N_2 = Mole fraction of N_2 X Total Pressure = 0.4 X 101.325 = **40.53 KPa** Partial Pressure O_2 = Mole fraction of O_2 X Total Pressure = 0.4 X 101.325 = **40.53 KPa**	1 1 2	4
5.c	**Polymerization:** Polymerization is defined as the process by which small simple molecules join together to produce very large molecules. The compounds composed of very large molecules are called polymers. **Methods of polymerization :** 1) Addition Polymerization 2) Condensation polymerization	2 2	4

5d	**Saponification:** The alkaline hydrolysis of an ester to form sodium salt of the parent acid and alcohol is referred to as saponification Example : $CH_3COOC_2H_5 + NaOH \xrightarrow[H_2O\ ,\ Heat]{reflux} CH_3COO\ Na + C_2H_5OH$ Ethyl acetate — Sodium acetate **Esterification:** The reaction of an alcohol with a carboxylic acid to produce an ester is termed as esterification Example : $CH_3COOH + C_2H_5OH \underset{\leftarrow}{\overset{N^+}{\rightarrow}} CH_3COOC_2H_5 + H_2O$ Acetic acid — Ethanol — Ethyl acetate	1 1 1 1	4
5.e	**Industrial process where oxidation is involved** 1. Acetic acid is produced by air oxidation of acetaldehyde 2. Sulfur dioxide is oxidized to sulfur trioxide **Oxidising agents:** 1. Potassium permanganate 2. Potassium dichromate	2 2	4
5.f	**Hydrogenation :** 1) Ethylene can be hydrogenated to ethane under pressure in the presence of Ni catalyst $CH_2= CH_2 + H_2 \xrightarrow[Heat]{Ni} CH_3\text{-}CH_3$ Ethylene — Ethane 2) Cyclohexane can be produced by hydrogenation of benzene at 150 ^oC using Ni catalyst $C_6H_6 + 3H \xrightarrow[150\ ^oC]{Ni} C_6H_{12}$	2mark for any one	4
6.a	**Block Diagram for production of nitric acid**	4	4

	 Fig. 4.6 : BLOCK DIAGRAM FOR PRODUCTION OF NITRIC ACID BY OXIDATION OF AMMONIA		
6.b	**Conversion:** Conversion or Fractional Conversion is the ratio of the amount of a reactant reacted to the amount of the reactant charged or feed. **Yield:** Yield of desired product is the ratio of the quantity of product actually obtained to its maximally obtainable quantity. OR **Yield**: Yield of desired product is defined as the ratio of amount of a limiting reactant reacted to form the desired product to total reacted quantity of limiting reactant by all possible reaction.	1 1	4

	ii) Reactions involving in the production of Sulphuric acid: Burner reaction : $S + O_2 \xrightarrow{1000^oC} SO_2$ Converter reaction : $2SO_2 + O_2 \xrightarrow[V_2O_5]{450^oC} 2SO_3$ Absorber reaction : SO_3 absorbed in H_2SO_4-------> H_2SO_4	½ 1 1/2	
6.c	**Bob and Tape level measurement:** **Diagram:** suspended from a tape marked in centimeters and meters.  Fig. 5.12 : Bob and Tape 1)Bob and tape is the most simple direct liquid level measurement devices. 2)It is consist of a bob (Weight) suspended from a tape marked in centimeter and meter. 3) Bob is lowered to the bottom of a tan or vessel containing liquid. 4)The liquid in the tank wets the part of the tape that is dipped into the pool of liquid. 5) The bob and tape assembly is then removed from the tank and a reading of liquid level is made by noting the point on the tape reached by the liquid.	2 2	4
6.d	**Bourdon tube for pressure measurement :** **Diagram:**	2	4

	 (a) C-shaped Bourdon tube (b) S 1) The Bourdon tube is an elastic deformation element which subjected to pressure gets deformed. When this deformation is measured, it gives an indication of pressure. 2) Bourdon tube is of C-shaped, it is a thin walled metal tube having elliptical cross section. 3) It is formed into the shape by winding the tube to form a segment of a circle having arc-length of 270 ^{o}. 4) The tube is made up of brass, bronze, Monel or stainless steel. 5) One end of tube is sealed and is attached by a light link mechanism that operates a pointer. While other end of tube is fixed and open for application of pressure. 6) The Bourdon tube is in itself a spring that tends to straighten itself by an amount proportional to increase in pressure while vacuum causes it curl up. 7) When the fluid under pressure enters the tube, it tries to vary the section of the tube from elliptical to circular and this in turn tries to straighten out the tube. 8) As one end of the tube is fixed, Straightening of tube causes the free end to deflection.	2	
6.e	**Gas /Vapour filled thermometer:** **Diagram:**  1) This thermometer use an inert gas. Principle of its working is that the pressure of a gas increases with increase in temperature	2 2	4

	at constant volume 2) When the thermometer bulb is immersed in a bath, contents of equipments of which the temperature is to be measured. 3) The gas inside the bulb receives heat. 4) As the volume of the gas is fixed ,the gas pressure inside the system increases due to increases in the temperature of the bulb 5) This in turn unwinds the Bourdon tube there by deflecting a pointer on scale		
6.f	**Determination Density of a liquid using Specific gravity bottle:** 1) In order to determine the density by specific gravity bottle, first weigh the clean, dry, empty and stoppered bottle. 2) Then fill the bottle completely with the liquid ,stopper it ,clean the bottle from the outside with blotting paper to remove the excess liquid that spills on it outside 3) Weigh it again. Mass/Weight of empty bottle = W_1 g Mass/Weight of bottle filled with liquid = W_1 g Mass/Weight of the liquid = $W_2 - W_1$ Volume of the specific gravity bottle = V ml Density of the liquid in g/ml = $\frac{\text{Mass}}{\text{Volume}} = \frac{W_2 - W_1}{V}$ To avoid error due to the volume ,a certificate regarding the exact, accurate volume of the bottle should be taken from the supplier	1 1 2	4