MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

Summer-13 EXAMINATION

Model Answer

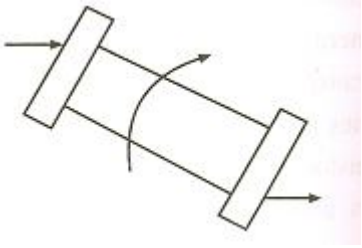
Subject & code:FCE(17206)

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	Molarity= gmoles of solute/ volume of solution in litre Unit: M Molality= gmoles of solute/ weight of solvent in Kg Unit: gmol/Kg	1 1	2
b	$^0F=1.8\ ^0C + 32$ $60\ ^0F = 60-32/1.8$ **$= 15.55^0C$**	1 1	2
c	**Liquid- liquid separation:** 1. Distillation 2. Liquid- liquid extraction **Gas- gas separation:**	1	2

	1. Gas absorption	1	
d	**Personal protective equipment:** 1. Helmet 2. Hard hat 3. Apron 4. Ear plug 5. Goggles 6. Welding shield 7. Hand gloves 8. Boot	½ mark each for any four	2
e	**Relative volatility**: It is defined as the ratio of volatility of more volatile component to that of less volatile component	2	2
f	**Dalton's law:** It states that the total pressure exerted by a gas mixture is equal to the sum of partial pressures of its components.	2	2
g	**Oxidation:** $S + O_2$----→ SO_2 . Here S is oxidized. **Reduction:** $C_6H_5NO_2$+ 2Fe + HCl------→$C_6H_5NH_2$ + $2H_2O$ + 2 $FeCl_3$. Here nitro benzene is reduced	1 mark for any oxidation and I mark for any reduction	2
h	**Conversion:** % conversion= moles of reactant reacted *100/ moles of reactant fed **Yield:** % yield= moles of reactant reacted to form desired product *100/ total moles of reactant reacted	1 1	2

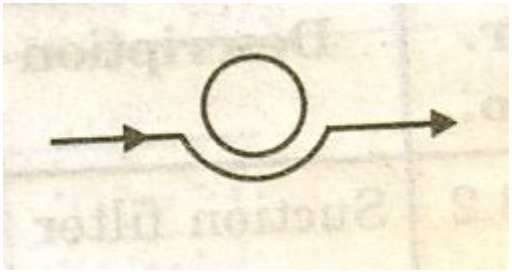
<table>
<tr><td>i</td><td><table><tr><th>Catalytic cracking</th><th>Thermal cracking</th></tr><tr><td>Carried out in presence of catalyst</td><td>Carried out at high temperature</td></tr><tr><td>Catalyst regeneration is required</td><td>Catalyst regeneration is not required</td></tr><tr><td>Economical</td><td>Costlier than catalytic cracking</td></tr></table></td><td>1 mark each for any two</td><td>2</td></tr>
<tr><td>j</td><td>Unit operation involving heat and mass transfer:
1. Distillation
2. Drying
3. Crystallization</td><td>1 mark each for any two</td><td>2</td></tr>
<tr><td>k</td><td>Principle of mercury thermometer:
Liquid(mercury) expands with increase in temperature</td><td>2</td><td>2</td></tr>
<tr><td>l</td><td>Pressure filter:
 
Rotary dryer:
  </td><td>1

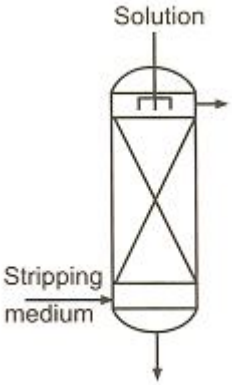
1</td><td>2</td></tr>
<tr><td>2.a</td><td>N= gm equivalent of solute/ volume of solution in litre
1=gm eq. of HCl/3
Or gm eq of HCl= 3
Eq. wt of HCl= 36.5/1=36.5
Wt of HCl= eq. wt of HCl * gm eq
36.5 * 3 = 109.5gm</td><td>1

1
1

1</td><td>4</td></tr>
</table>

2.b	**Chemical Industries according to size:** 1. Large scale industry 2. Medium scale industry 3. Small scale industry **Chemical Industries according to product:** 1. Pharmaceutical industry 2. Cement industry 3. Plastic industry 4. Fertilizer industry 5. Paper industry 6. Food industry 7. Petroleum industry 8. Petrochemical industry **Large scale industry:** These are the industries whose annual turn over is more than 100 crores. **Medium scale industry**: These are the industries whose annual turn over lies between 10 crore and 100 crores. **Small scale industry**: These are the industries whose annual turn over is less than 10 crores.	1 1 2	4
2.c	**Procedure to measure viscosity using viscometer:** 1. Fill the oil cup with oil whose viscosity is to be measured up to the pointer mark, keeping the agate jet closed. 2. Keep the kohlrausch flask below the opening 3. When the required temperature is attained, open the agate jet by lifting the rod. 4. Start stop watch 5. Collect 50 ml oil in the flask and note down the time required for collecting the oil. 6. Express the viscosity in redwood seconds.	4	4

2.d	**Principle of gas absorption:** Gas absorption is an operation in which gas mixture is contacted with a liquid to preferentially dissolve one or more soluble components of the gas mixture in the liquid. The differences in solubility of gases in a given solvent are exploited to effect such a separation. In absorption, the soluble component is called solute, the insoluble component is called inert gas and the liquid used for absorption is called solvent. **Uses:** Absorption of ammonia from ammonia- air mixture Removal of hydrogen sulfide from hydrocarbon gases Removal of SO_2 from flue gas	3 1 mark for any one	4
2.e	**Packed column :**  Packed column is used in absorption and distillation **Drum Dryer:**  Drum drier is used in drying **Jaw crusher:**	1 mark each	4

	 Jaw crusher is used in crushing **Stripper:**  Stripper is used in desorption		
2.f	**Importance of size reduction:** It helps in 1. Easy transportation 2. Easy handling 3. Increase in reaction rate 4. Easy storage **Importance of size separation:** 1. Impurities can be removed 2. Over loading of equipment can be avoided 3. Particles of uniform size can be obtained 4. Customer demand can be satisfied.	2 2	4

<table>
<tr><td>3.a</td><td>i) Units of Temperature

^0C, ^0A, ^0F

ii) Units of pressure
Atmosphere, cm of Hg, KPa , Bar, Kgf/m^2

iii) Units of viscosity

poise, kg/m sec., gm/cm.sec

iv) Units of density
gm/cm^3, kg/m^3</td><td>1 mark each</td><td>4</td></tr>
<tr><td>3.b</td><td>100 moles of gas mixture
<table><tr><td>component</td><td>moles</td><td>Mole fraction</td></tr><tr><td>A</td><td>10</td><td>0.1</td></tr><tr><td>B</td><td>20</td><td>0.2</td></tr><tr><td>C</td><td>70</td><td>0.7</td></tr></table>Partial pressure=Total pressure*mole fraction
Partial pressure of A= 2 atm*0.1= 0.2 atm
Partial pressure of B = 2 atm*0.2 = 0.4 atm
Partial pressure of C = 2atm*0.7 = 1.4 atm</td><td>1

1

1

1</td><td>4</td></tr>
<tr><td>3.c</td><td>200 Kg of NaCl and 300Kg of NaOH
Molecular wt of NaOH = 40
Moleculat wt of NaCl = 58.5
Moles of NaOH=300/40=7.50
Moles of NaCl=200/58.5=3.41
Total moles=7.50+3.41=10.91

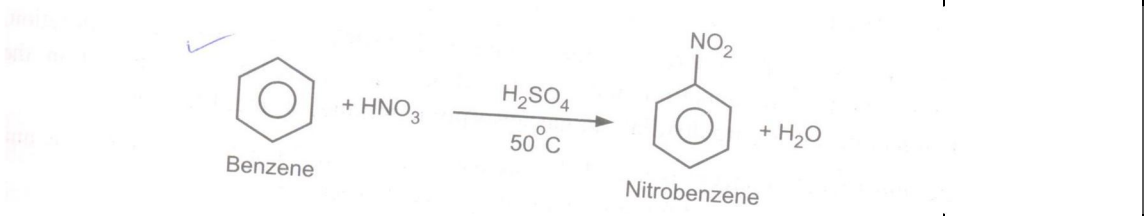
Mole% NaOH=3.41/10.91*100=31.25%
Mole% NaCl=7.50/10.91*100=68.74%</td><td>

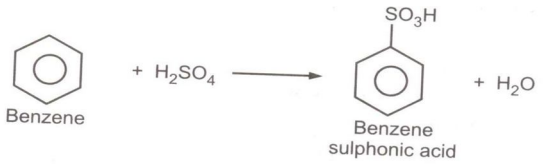
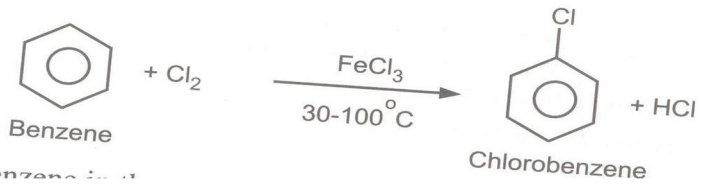
1
1

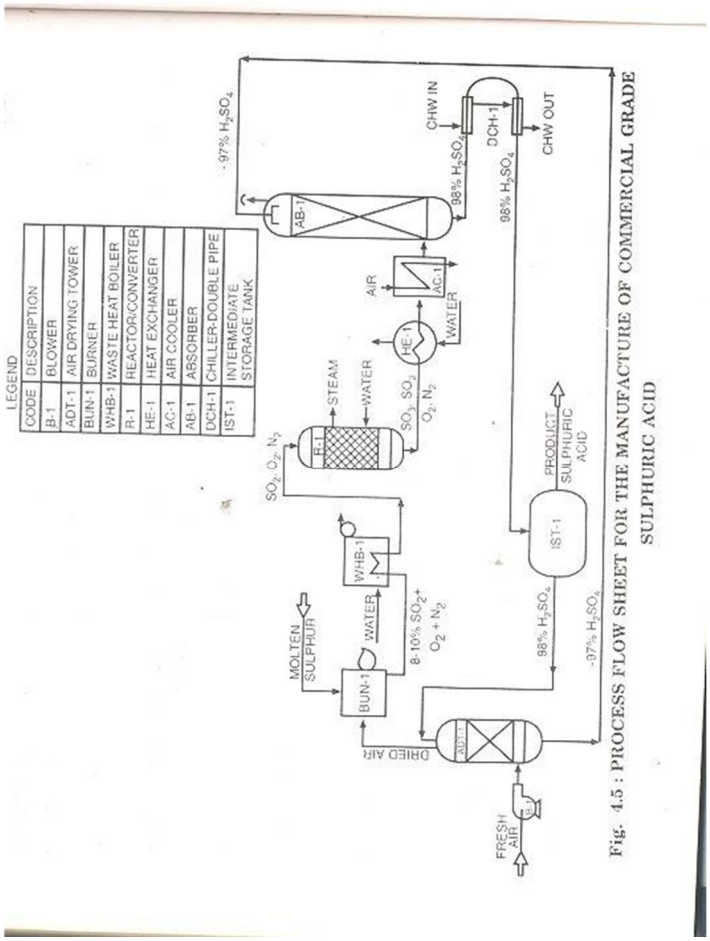
1

1</td><td>4</td></tr>
</table>

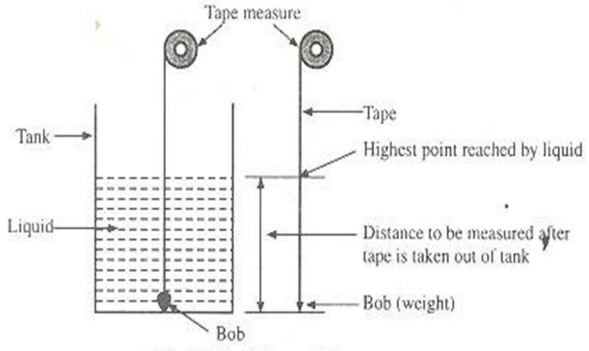
	Wt %NaOH=300/500*100=60% Wt %NaCl=200/500*100=40%		
3.d	**Conduction** is a mode of heat transfer in which heat is transferred in the form of vibration of molecules without actual movement. Example: Heating a metal rod. **Convection is** a mode of heat transfer in which heat is transferred by actual mixing of hot fluid with colf fluid because of change of density of molecules of fluid by application of heat. Example: Heating of a liquid in a container. **Radiation** is a mode of heat transfer where heat is transferred through space by electromagnetic waves. Example: heating of a cold room by electric heater	2 mark each for any two	4
3.e	**Amination by ammononalysis** is reaction of unsaturated compound by ammonia. $Cl.CH_2.CH_2.Cl + 4NH_3 \rightarrow NH_2.CH_2.CH_2.NH_2$ Ethylene dichloride ethylene diamine **Amination by reduction** is reaction of unsaturated compound with H_2. $CH_3.CH.NO_2.CH_3 + 3H_2 \rightarrow CH_3.CH.NH_2.CH_3$ 2-nitroparrafin isopropyamine	2 2	4
3.f	**Saponification** The alkaline hydrolysis of an ester to form sodium salt of the parent acid and alcohol is referred to as saponifiaction . $CH_3COOC_2H_5$ (ethyl acetate) + NaOH $\xrightarrow[H_2O,\ Heat]{reflux}$ CH_3COONa (sodium acetate) + C_2H_5OH **Nitration**	2 2	4

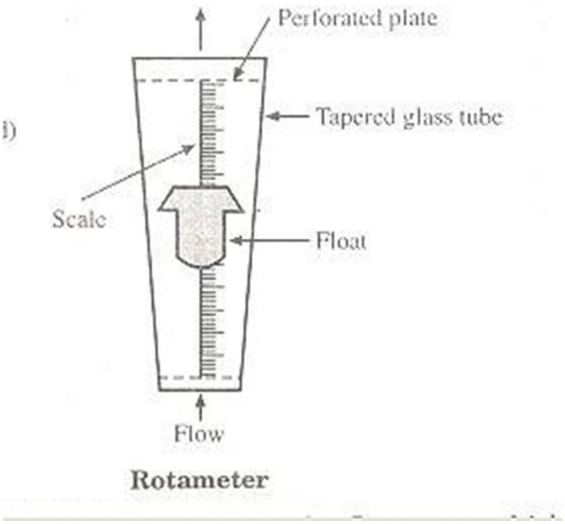
	Nitration is defined as unit process where one or more nitro groups are introduced into an organic compound. ……(1 mark)  		
4.a	**Principle involved in drying** is removal of moisture of a substance by passing hot air or hot gas over the material to carry away the water vapour. **Uses:** (Any Two) i)food industry ii)pharmaceutical iii)chemical iv)Textile	2 1 mark each	4
4.b	**Vapour pressure** is a pressure exerted by vapour in equilibrium with liquid at which it is boiled. Boiling point is the temperatue at which vapour pressure of the liquid equals the pressure at which it is boiled.	2 2	4
4.c	<table><tr><th>Petroleum refinery</th><th>Petrochemical plant</th></tr><tr><td>Refinery is separation of crude oil into its component.</td><td>It is used for processing of products coming from refineries</td></tr><tr><td>Crude oil is feed of refineries</td><td>Product from refineries is feed for petrochemical plant</td></tr></table> The biggest refineries in India are BPCL, HPCL, and Reliance.	2 2	4
4.d	**Principle:** Absorption is unit operation in which soluble component of a gas mixture is dissolved in a liquid (solvent).	2	4

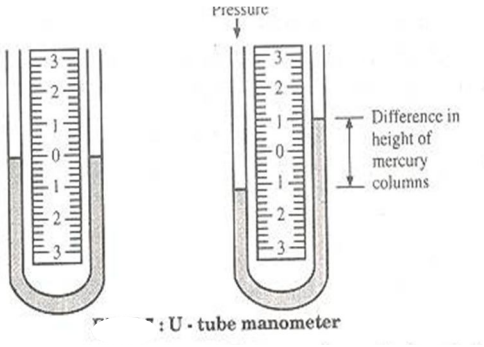
	It is useful to control pollution for dissolving toxic gases as SO_2, NO_2, CO which would pollute atmosphere by dissolving them in a suitable solvent.	2	
4.e	**Screening** is a method of separating of solid particles according to size alone by means of screen of known openings. **Size reduction** is unit operation in which large solid particles are subdivided into small ones to increase surface. **Importance of screening:** i) Separation of fine from feed material. ii) To produce material of specific size limits.	**1** **1** **2**	4
4.f	**Sulphonation:** Sulphonation is defined as any chemical process by which the sulphonic acid group is introduced into an organic compound.  **Chlorination:** It refers to the process in which one or more chlorine atoms are introduced into an organic compound .  	2 2	4
5.a	Yes , Fuel burning is oxidation process Burning of butane gives carbon-dioxide and water with liberation of heat. C_4H_{10} + $6.5O_2$ -----→ $4CO_2$ + $5H_2O$ Butane carbon-dioxide water	2 2	4

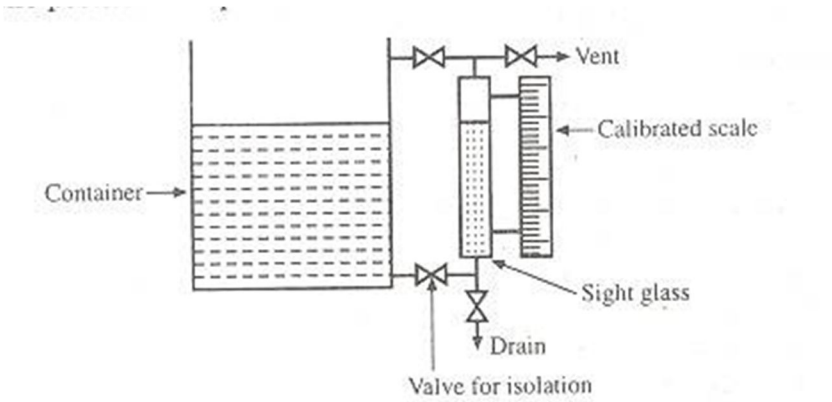
5.b	**Importance of distillation in chemical industries.** It is used in industries to separate volatile liquids from liquid mixture based on boiling point difference. **Principle of distillation** : The difference in vapour pressure of the components of liquid mixture at the same temperature is responsible for the separation by distillation. **Example** : In binary system of methanol and water , methanol (Boiling point=64^0C) is separated from water(boiling point =100^0C)	1 2 1	4
5.c	**Process flow diagram for manufacturing of Sulphuric Acid :**  Fig. 4.5 : PROCESS FLOW SHEET FOR THE MANUFACTURE OF COMMERCIAL GRADE SULPHURIC ACID	4	4

5.d	**Hydration :** It refers to a unit process of adding water to an Organic Compound **Hydration of Ehtylene :** Ethanol can be produced by hydration of ethylene in presence of a phosphoric acid at about 300^oC H_3PO_4 $C_2H_4 + H_20$ ----------→ C_2H_5 OH **Hydration of propylene :** $CH_3CH = CH_2 + H_2O$ ------→ $CH_3CH(OH)CH_3$	2 2 (any one example)	4
5.e	**Reaction involving in the production of Nitric acid:** 870-900 ^oC $4NH_3 + 5O_2$ ----------> $4NO + 6H_2O$ $4NH_3 + 3O_2$ ----------> $2\ N_2 + 6H_2O$ $2NO + O_2$ ----------> $2NO_2$ $3NO_2 + H_2O$ ----------> $2HNO_3 + NO$ **Uses of Nitric acid :** 1) It used in production of nitrogen fertilizer. 2) It is used in purification of gold , silver and platinum. 3) It is used as laboratory reagent. 4) It is used to prepare aqua-regia to dissolve nobel metals. 5) It is used in etching designs on copper and bronze wares.	2 2 marks any 2	4
5.f	**Important Heat transfer equipment :** 1.Shell and tube heat exchanger 2. Evaporator 3.Double pipe heat exchanger 4.Plate heat exchanger	½ marks each	4

	Modes of heat transfer : 1.Coduction 2.Convection 3.Radiation	2	
6.a	**Bob and Tape level measurement:** **Diagram:** suspended from a tape marked in centimeters and meters.  : 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.b	**Difference between Absolute and Gauge pressure** : **Absolute pressure** : 1. It is total pressure exerted by the fluid including atmospheric pressure.	2	4

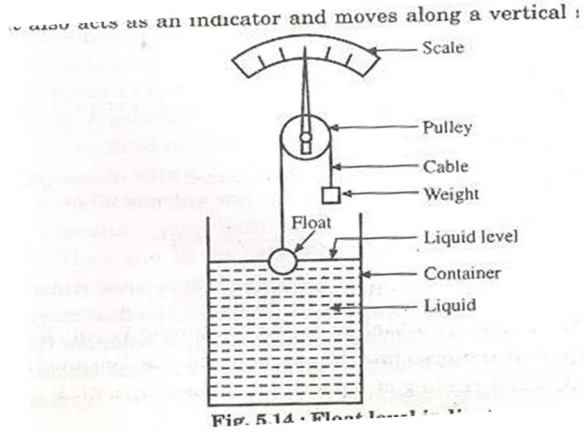
	2. Absolute pressure = Gauge pressure + Atmospheric pressure. **Gauge pressure** : 1. It is the pressure registered by the pressure gauge is called gauge pressure. 2. It is always above the atmospheric pressure. 3. The gauge pressure does not indicate true total pressure. **If Operating Pressure is at 5 bar absolute pressure :** Absolute pressure = 5 bar Atmospheric pressure = 1.103 bar Absolute pressure = Gauge pressure + Atmospheric pressure. Gauge pressure = Absolute pressure – Atmospheric pressure = 5 – 1.103 **= 3.897 bar**	2	
6.c	**Rotameter :** Flow rate can also be provided on the to  **Rotameter** In Rotameter as flow varies, the float rises or falls, thus altering the flow area, which is the annular space/opening between the float and tube. As the flow increases, the float moves upward, thus increasing the area. At a given flow rate, float stabilizes at a certain fixed position in the tube and at steady-state, it is recorded as rotameter reading from the scale provided. It is used for flow measurements of liquids and gases.	2 2	4

6.d	**U-tube Manometer :** **Diagram:**  : U - tube manometer **Working:** 1. It is the simplest form of manometer 2. When both the arms of U-tube are open to the atmosphere , the level of manometric fluid remains at zero 3. The pressure in the inlet line can be measured by connecting it by plastic tubing to one of the arms of the U-tube 4. By measuring the difference in the fluid in two arms of the U-tube 5. If manometric fluid is mercury lower by 1 cm. in one arm and raised by 1 cm in other arm, then the pressure in the inlet line is 2 cm gauge. 6. When each arm is connected to separate regions then the manometer measures differential pressure by equation $\Delta P = P_1 - P_2 = h(\rho_m - \rho)$ ρ_m = Density of manometric fluid ρ = Density of process fluid.	2 2	4
6.e			4



Sight glass level indicator

2



2

Float and Tape method for level measurement.

6.f Convert :

i) P=10 bar — 2

1.103 bar=1atm

10 bar = 10*1/1.103

= 9.066 atm

ii) P=5 MPa — 2

101.325 KPa =1.103bar

$5*10^{-3}$ KPa = $(5*10^{-3} *1.103)/ 101.325$

= $5.44*10^{-5}$ bar

4