SUMMER-15 EXAMINATION

Model Answer

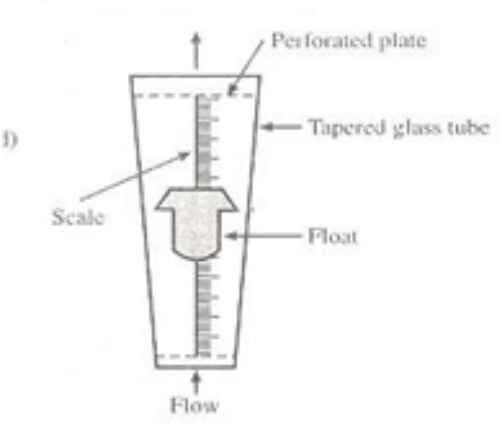
Subject code :(17206)

Important Instructions to examiners:

1) The answers should be examined by key words 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 be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the 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 answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q No.	Answer	marks	Total marks
1-a	**Four methods of expressing concentration of solutions are:** 1. Molarity 2. Molality 3. Normality 4. Concentration	½ mark each	2
1-b	**Packed column:**  **Ball mill:** 	1 1	2
1-c	**Chemical Reaction for esterification:** $CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$ **Chemical Reaction for hydrogenation:** $CH_2= CH_2 + H_2 \rightarrow CH_3\text{-}CH_3$ $C_6H_6 + 3H_2 \rightarrow C_6H_{12}$	1 1mark for any 1	2
1-d	**Yield is more important than conversion** because yield of a desired product	2	2

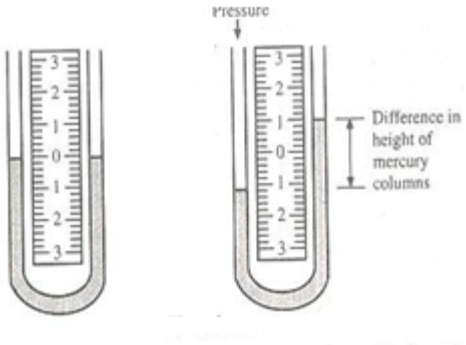
	tell us how efficient a given process is in terms of the reaction product. The percent yield shows the efficiency of a chemical reaction. Whereas conversion gives an idea regarding how efficient a given process is from the point of view of raw materials.		
1-e	180^0C $^0F = 1.8\ ^0C + 32$ $= 1.8 * 180 + 32$ $= 356\ ^0F$ $K = ^0C + 273$ $= 180 + 273$ $= 453\ K$	1 1	2
1-f	**Personnel Protective equipment** for (i) Working on a height: Helmet, Safety shoes (ii) High decibel noise: Ear plug/ ear muff	 1 1.	2
1-g	**Fertilizer industries:** Rashtriya Chemicals & Fertilizers(RCF) Deepak Chemicals & Fertilizers Fertlizer corporation of India Gujarat State Fertilizer Corporation	1 mark each for any two	2
1-h	Rotameter:	2	2

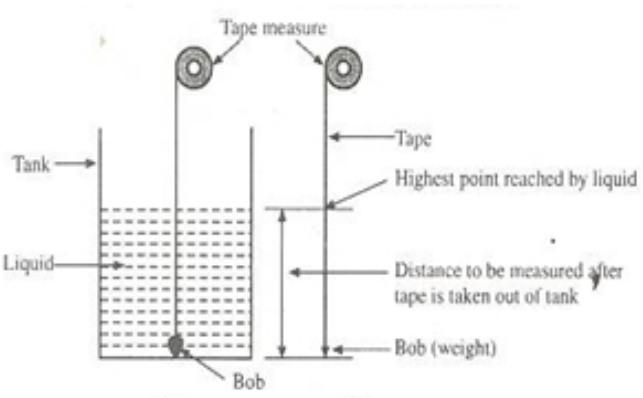
			
1-i	Pressure is 2 kg/cm^2 g Absolute pressure = Gauge pressure + atmospheric pressure = 2 kg/cm^2 + 1.032 kg/cm^2 = **3.032** kg/cm^2	 1 1	2
1-j	**Average molecular weight of air:** Air contains 79 mol% N_2 and 21 mol% O_2 $M_{av} = M_A X_A + M_B X_B$ = 28 * 0.79 + 32* 0.21 = 28.84 ***Since not specified in the curriculum, due consideration should be given***	 1 1	2
1-k	**Unit Operation**: Operations carried in chemical industries involving physical change and no chemical changes are called unit operations. Eg: Distillation, mechanical separation, size reduction, drying, Absorption,	1 1 mark for any one	2
1-l	**Dalton's law:** Dalton's law states that total pressure of a gas mixture is equal to the sum of partial pressure of its components.	 1	2

	$P = P_A + P_B + P_C$ Where P is the total pressure of gas mixture and P_A , P_B , P_C are partial pressures.	1	
2-a	**Gram mole** Gram mole = weight in grams /molecular weight. Basis: 5 lit of 2N NaOH soln N= (gmeq of NaOH/ Lit of soln) 2= gm.eq of NaOH/ 5 Gmeq of NaOH = 2*5 = 10 gms of NaOH = g eq of NaOH* eq.wt of NaOH = 10*40 = **400 gms**	1 1 1 1	4
2-b	Basis: 200 gm NaCl and 600 gm KCl Total weight of mixture = 800 gm Weight % of NaCl = (wt of NaCl/ Total wt)*100 = (200/800)* 100 = **25 %** Weight % of KCl = (wt of KCl/ Total wt)*100 = (600/800)* 100 = **75%** gmoles of NaCl = Weight/ mol.wt = 200/58.5= 3.42 gmoles of KCl = Weight/ mol.wt = 600/74.5 = 8.05 Total moles = 3.42+8.05 =11.47	 1 1 1	4

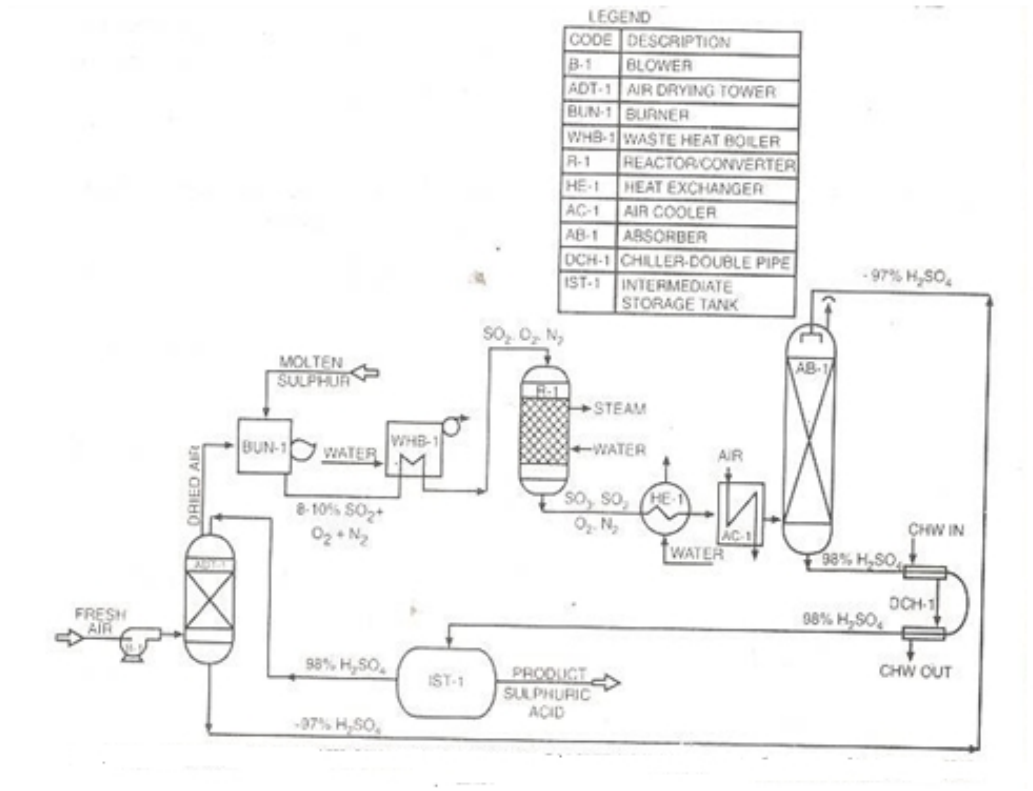
	Mol% of NaCl = (Moles of NaCl/Total mole)*100 = (3.42/11.47)* 100 = **29.82%** Mol% of KCl = (Moles of KCl/Total mole)*100 = (8.05/11.47)* 100 = **70.18%**	1	
2-c	**Modes of heat transfer are:** Conduction Convection Radiation 1. Conduction: It is the transfer of heat without the movement of particles. Eg: heating of a metal rod 2. Convection: It is the transfer of heat within a fluid by the actual migration of particles of hot fluid with cold fluid because of change of density of molecules of fluid by application of heat. Eg. Boiling of liquid 3. Radiation: It is the transfer of heat through space by electromagnetic waves. When radiation passes through matter, it is transmitted, reflected or absorbed. Eg. Transport of energy from the sun to earth.	2 2 marks for any one explanation	4
2-d	**Size reduction:** It is an operation wherein large solid particles are subdivided to smaller ones. **Methods to size reduction**: 1. Compression (Crushing) 2. Impact (Grinding) 3. Attrition/ Rubbing(Ultra fine grinding) 4. Cutting	2 2	4

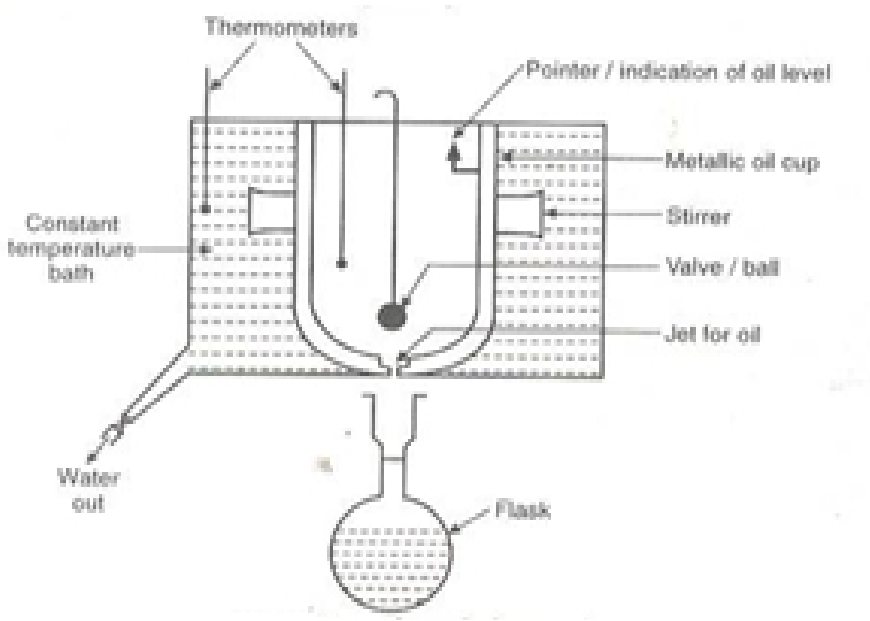
2-e	**Gas Absorption:** -This operation is used to separate the components of gas mixture . -It is carried out for the recovery or the removal of a soluble components of a gas mixture depending upon the situation. -Absorption is an operation in which a gas mixture is contacted with a liquid solvent for the purpose of dissolving a definite component of the gas mixture in the liquid. - Gas absorption is usually carried out in packed columns. Example: 1) Absorption of ammonia from an air- ammonia mixture by water 2) Removal of hydrogen sulfide from naturally occurring hydrocarbon gases. **Drying :** Drying refers to the removal of moisture of a substance by thermal means (i.e. with the help of thermal energy). In drying the wet material is placed in a dryer and hot air is passed through it to remove the moisture. Eg: Drying of pharmaceuticals, dyes, paper, cloth	2 1 1	4
2-f	**Block Diagram:** A block diagram is the simplest form of presentation of the process. **Advantages of Block Diagram:** Block diagrams are useful for presenting a process in a simplest form in reports. In block diagrams, blocks or boxes represent various stages of the process or equipment involved in the process, While lines joining the boxes/blocks represent the streams that go between the block s. Such diagrams are often used in survey studies to management, research summaries, process proposals and to talk out a processing idea.	1 3	4
3-a	**Process Flow Diagram:** A process flow diagram is the road map of a	4	4

	manufacturing process. This diagram gives the idea regarding the operations to be performed on raw materials in a correct sequence from the raw material to the finished product. It shows the arrangement of the equipment selected to carry the process, all incoming and outgoing materials, utilities required for each operation, quantity of each stream, stream composition, heat added or removed to and from the process equipment and the operating conditions such as temperature and pressure. In a qualitative flow sheet, the streams, stream flow rates, unit operations with necessary equipment and information regarding operating conditions are shown. In this diagram, the process equipment is indicated by a suitable flow sheet symbol. Quantitative flow diagrams show the quantitative material and energy balances where equipments may be represented by rectangular blocks.		
3-b	**U tube manometer:**  Formula to calculate pressure: $\Delta P = P_1 - P_2 = h(\rho_m - \rho)\, g$ Where , ΔP= Pressure difference, h= difference in levels of two arms ρ_m= density of manometric fluid	2 2	4
3-c	**Direct level measuring devices :** 1. Bob and tape measurement	2	4

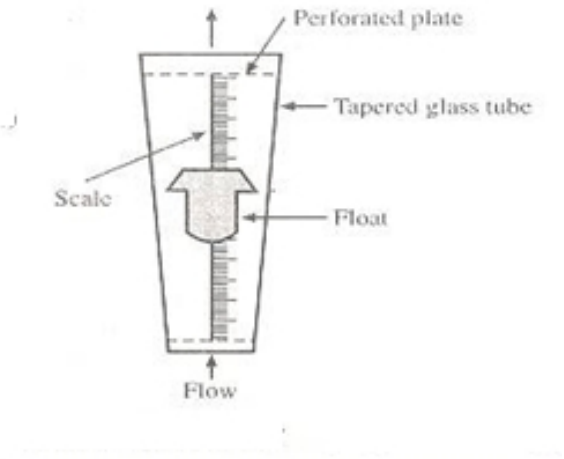
	2. Float and tape measurement 3. Sight glass method **Bob and tape method:** Bob and tape is the most simple direct liquid level measurement devices. It is consist of a bob (Weight) suspended from a tape marked in centimeter and meter. Bob is lowered to the bottom of a tan or vessel containing liquid. The liquid in the tank wets the part of the tape that is dipped into the pool of liquid. 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	
3-d	**Pyrolysis:** The decomposition of a compound by heat is called pyrolysis. Large alkane molecules are broken down to give lower molecular weight alkanes, alkenes and hydrogen. Eg: When ethane is heated to 500 ^{0}C in the absence of air, it gives a mixture of methane, ethylene and hydrogen. $C_2H_6 \rightarrow C_2H_4 + CH_4 + H_2$ **Saponification**	1 1	4

	The alkaline hydrolysis of an ester to form sodium salt of the parent acid and alcohol is referred to as saponifiaction. Eg: $CH_3COOC_2H_5 + NaOH \rightarrow CH_3COONa + C_2H_5OH$	1 1	
3-e	Basis: 100 gms solution Weight of sulfuric acid= 15 gms Density of solution = 1.1 g/ml Volume of solution = weight of soln/ density of soln = 100/1.1 = 90.91ml = 0.091 lit Gram equivalent of sulfuric acid = 15/ 49 = 0.306 Normality = gram equivalent/ Vol. of soln in lit = 0.306/ 0.091 = **3.36 N**	 1 1 1 1	4
3-f	**Partial Pressure:** Partial pressure of a component gas is the pressure that would be exerted by that component gas if it alone was present in the same volume and at the same temperature as the gas mixture. **Vapor pressure** : It is the pressure exerted by vapor on the surface of liquid at equilibrium conditions. OR It is the absolute pressure at which the liquid and its vapour are in equilibrium at a given temperature.	2 2	4
4-a	**Flow sheet for manufacturing of H_2SO_4:**	4	4

			
4-b	**Filtration:** The separation of solid from a suspension in a liquid with the help of a porous medium which retains the solid and allows the liquid to pass through it is termed as filtration. Filtration involves the separation of solids from a liquid and is effected by passing the slurry through a porous medium. **The pressure difference** set up across the filter medium causes the fluid to flow through the small holes of a filter cloth or screen which blocks the passage of the larger solid particles. Application: Separation of suspended impurities from water, separation of organic or inorganic materials from their slurry. **Sedimentation:** The separation of solids from a suspension in a liquid by	1 1 1	4

	gravity settling is called sedimentation. The force responsible for sedimentation is gravitational force. Application: Removal of solids from liquid sewage waste, removal of suspended impurities from water.	1	
4-c	**Redwood Viscometer:**  **Working :** 1) Oil at given temperature is filled into the oil cup upto the tip of the pointer. 2) The temperature of oil is kept at a constant temperature by the addition of hot water in the heating bath. 3) When the oil temperature remains constant at a desired value for five minutes, the oil is allowed to flow through the jet by lifting the metal ball. 4) The time in seconds required to fill the oil in the flask up to the	4	4

	Mark is noted accurately with the help of a stop-watch. 5) The viscosity of oil is described in Redwood seconds.		
4-d	**Nitration reactions** : It is the reaction with nitrating mixture to introduce nitro(NO_2) group into an organic compound. $C_2H_6 + HNO_3$ ------>$C_2H_5NO_2 + H_2O$ **Reduction:** Reduction is defined as the addition of hydrogen, removal of oxygen, addition of metallic element or addition of electrons. Eg. Reduction of ethyl bromide $CH_3CH_2Br + 2H$ ----→ $C_2H_6 + HBr$ $C_6H_5NO_2$+ 2Fe + HCl------→$C_6H_5NH_2 + 2H_2O$ + 2 $FeCl_3$. Here nitro benzene is reduced	1 1 1 1	4
4-e	**Distillation:**- Distillation is an operation in which the components of a liquid mixture are separated using thermal energy. It depends upon the difference in boiling points of the individual components. The difference in vapour pressure of the components of a liquid mixture at the same temperature is responsible for separation by distillation. In this operation, liquid and vapour phases are involved. The vapour phase is created by supplying heat to the liquid phase. The concentration of more volatile component of the liquid mixture is higher in vapour phase than in the feed solution, while that of the less volatile component is higher in the liquid phase. When a liquid mixture containing more volatile and less volatile components are heated, more volatile component will vaporize first and the vapours are collected and condensed to get it in pure form.	3	4

	Application: Separation of crude petroleum into fractions Separation of ethanol- water mixture	1	
4-f	**Selectivity:** It is the ratio of the moles of the desired product to the moles of undesired or by product produced in the reaction. Selectivity = (moles of desired product produced/ moles of undesired product produced) **Selectivity can be increased by:** 1. By selecting proper catalyst for the reaction 2. By properly maintaining process conditions	2 2	4
5-a	**Rotameter:**  	4	4
5-b	**General steps in manufacturing of any chemical** **Step 1: Physical Treatment to Raw material**-The raw material undergoes physical treatment in order to put them in the form in which they can be very easily reacted. **Step2 : Chemical Treatment –**The suitable prepared reactant pass through the reactor where they reacted with one other. **Step3: Physical Treatment to Product-**The product mixture comprising of the products produced and unreacted reactants undergoes further physical steps in order	4	4

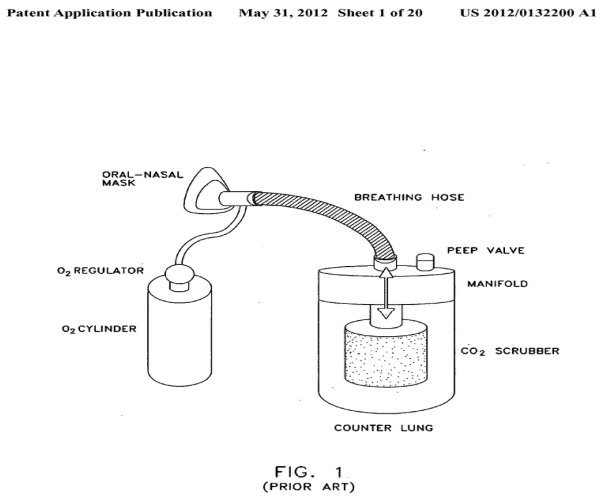
	to obtain the final product.		
5-c	**Basis:** 80 moles of Ethanol feed Moles of ethanol reacted is = 80 moles Moles of ethanol reacted for acetaldehyde(desired product) =60 moles Moles of ethanol reacted % conversion of ethanol =---------- X 100 Moles of ethanol feed 80 =---------- X 100 = 100% 80 % yield of acetaldehyde= Moles of ethanol reacted for acetaldehyde/ total moles of ethanol reacted 60 = ---------- X 100 = 75 % 80	1 1 1 1	4
5-d	**Manufacturing Process of Nitric acid:** In manufacturing of Nitric acid by Oxidation of ammonia ,air is thoroughly purified in a filter and is then compressed by a centrifugal compressor to about 8 atm. Liquid ammonia is filter and then vaporized in a vaporizer and is then mixed with air. The ammonia-air mixture containing 9to 10% NH3by volume is passé to converter. In converter the ammonia is oxidized with air over platinum –rhodium catalyst at870-900^{o}C.the gases containing No,N_2,O_2 and H_2O gaes at 900^{o}C are passed to a waste heat boiler .The gases are cooled in the waste heat boiler by way of giving heat to	4	4

	water to produce steam. The nitrous gases are passed through a catalyst recovery filter and are then fed to a cooler –condenser. The temperature of nitrous gases is reduced in the waste heat boiler and condenser which result s in the oxidation of NO to NO_2.Some of the NO_2 is absorbed in water to produce nitric acid in condenser. The nitrous gases leaving condenser at 40^oC are fed to an absorption tower along with the air from an air cooler for further oxidation of No to NO_2 in the absorption tower. The air from the compressor is splited in the two streams-one stream mixes with the ammonia and other goes to the tower via air cooler. In the absorber ,the majority of NO gets converted to NO_2 and all of the NO_2 produced is absorbed in water to produce nitric acid .The nitric acid from absorber and condenser is mixed in a mixer to obtain the product nitric acid containing 55-60% NO_3		
5-e	**Size Separation :** This operation is used for solid –solid separation on the basis of size . Screening is the a method of separating solid particles according to size alone by means of screens of known apertures. In industrial Screening ,Solids are dropped on a Screening surface that acts as a multiple go and no-go gauge .The material on the screen surface is called oversize while material passing through screen is called under size. **Necessity:** This operation is carried out to remove the fines from a feed material before a reduction equipment..This operation is also used fines from a finished product **Fluid Transportation :** In industry , pumps fans ,blowers and compressors .Pipelines, ducts ,valves and fittings are the essential components of a system used for transportation of fluid s from one location to another. **Necessity:** This operation is necessary to transport fluid from one location to another	1 1 1 1	4

	location		
5-f	**Mechanical operation used for Water treatment :** -Sedimentation -Filtration -Mixing **Mechanical operation used in stone crushing unit :** -Size Reduction by Crushing and Grinding - Screening	2 2	4
6-a	**Determination of 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 = $\frac{\text{Mass}}{\text{Volume}} = \frac{W_2 - W_1}{V}$	3	4

	To avoid error due to the volume ,a certificate regarding the exact, accurate volume of the bottle should be taken from the supplier $\text{Specific gravity of liquid} = \frac{\text{Density of the liquid}}{\text{Density of the water}}$ Density of the liquid = Specific gravity of liquid x Density of the water = 1.84 x 1000 = 1840 kg/m^3 = 1.84 gm/cm^3	1	
6-b	**Mixing :** Mixing is a process in which at least two separate materials such as two different fluids, fluid and a powdered solid or two different or same solids are taken and forced them to be randomly distributed through one another by some mechanical means **Necessity of Mixing in process industry** Mixing is carried for producing simple mixtures, accomplishing dispersions, and promoting chemical reactions	2 2	4
6-c	**Oxidation:** It is defined as the addition of oxygen or removal of hydrogenation from organic compounds. - Oxidation reaction may involve the introduction of oxygen in the molecule of a compound. Oxidation of acetaldehyde: $CH_3CHO + ½ O_2 \dashrightarrow CH_3COOH$ Acetaldehyde acetic acid - Oxidation reaction may involve the removal of hydrogen from the molecule of a compound.	2	4

	Oxidation of methane: Metal oxide $CH_4 + O_2$ ----------→ HCHO + H_2O Methane Heat Formaldehyde **ii) Hydration:** It refers to a unit process of adding a water molecule to an Organic Compound. **Reaction involving Hydration :** Ethanol can be produced by hydration of ethylene in the presence of phosphoric acid catalyst at about 300°C H_3PO_4 $C_2H_4 + H_2O$ ----------> C_2H_5OH Ethylene ethanol Or any other example student can write	2	
6-d	**Types of Chemical Process Industry :** Chemically industry embraces a wide range of industries, according to the industrial classification types of chemical process industries are: i) Fertilizer industry eg: Rashtriya Chemicals and fertilizers ltd. Deepak Chemicals and fertilizers ltd. ii) Petrochemical Industry eg: Reliance Industries ltd. Supreme Petroleum ltd. iii) Pharmaceutical industries eg: Hindustan Antibiotics ltd. iv) Paper industries eg: Mysore Paper Mills LTD.	4 Any example given should be given marks	4

	v) Paint Industries eg: Asian Paints Limited.		
6-e	R= 0.08206 atm. lit/ mol.K R= 0.08206*10330*9.8/ (1000*4.2) R= 1.987Cal/mol.K	4	4
6-f	**Self Contained breathing Apparatus:**  FIG. 1 (PRIOR ART) It is used : 1.When work condition is “Oxygen deficient atmosphere” . 2.When hazardous gas leakage accident occur in Chemical Industry. 3.For Salvage and clean-up operations. ***Not included in curriculum***	2 2	4