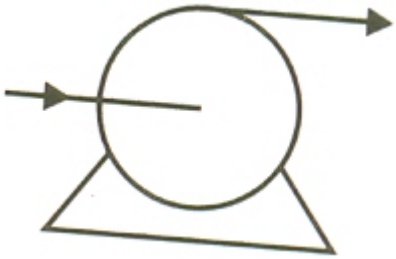
Important Instructions to examiners:

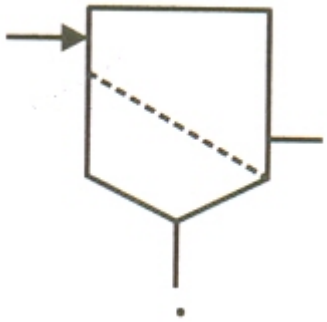
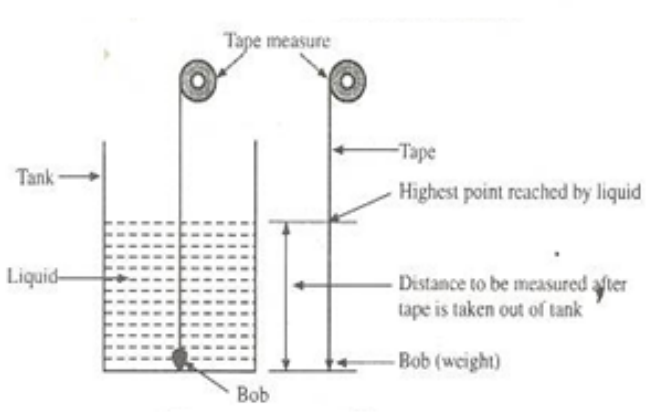
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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	**Molecular weight** : It is the sum of atomic weights of all elements present in a compound. **Equivalent weight** : Equivalent weight = molecular weight/ valency.	1 1	2
1-b	**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.	1 1	2
1-c	$^0F = 1.8\ ^0C + 32$ $105 = 1.8 * ^0C + 32$ $^0C =$ **40.56** $^0F = 1.8\ ^0C + 32$ $240 = 1.8 * ^0C + 32$ $^0C =$ **115.56**	 1 1	2
1-d	**Large scale industries:** 1.Deepak Fertilizers 2. Reliance Industries	½ mark each for any 4	2

	3. Supreme petrochem 4. Vinati Organics 5. Tata Consultancy 6. Godrej Soaps		
1-e	**Basic unit:** These are the units for the basic quantities such as Mass, Length, Time and Temperature **Derived unit:** These are the units obtained by multiplying and dividing basic units or which are derived from basic units.	1 1	2
1-f	**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.	2	2
1-g	**Excess reactant**: It is the reactant added in excess quantity than the theoretical requirement. **Limiting reactant**: It is the reactant which is added in limited quantity or that disappears first in a chemical reaction.	1 1	2
1-h	**Catalytic cracking thermal cracking:** Thermal decomposition of alkane is known as thermal cracking. If cracking is carried out in presence of catalyst , it is called catalytic cracking, which requires less temperature.	2	2
1-i	**Specific gravity of liquid:** It is the ratio of density of a liquid to density of water at 4^0C	2	2
1-j	**Principle of mercury thermometer:** All liquids expand with rise in temperature and this volumetric expansion of liquid is proportional to rise in	2	2

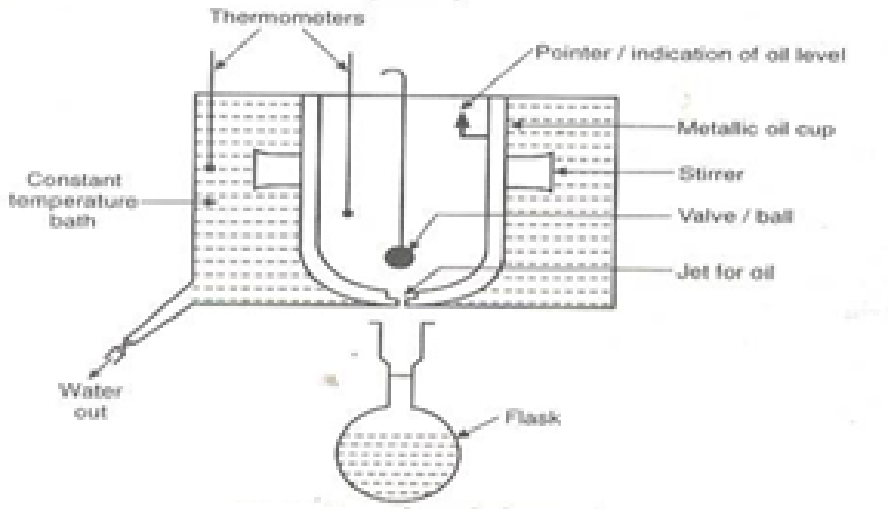
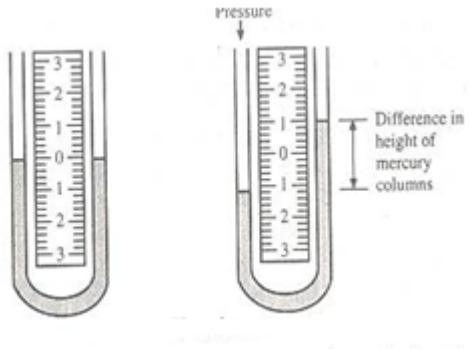
	temperature.		
1-k	**Conversion** is the ratio of the amount of reactant reacted to the initial amount of the reactant **Yield** of a desired product is the ratio of the quantity of the desired product actually obtained to its quantity maximally obtainable.	1 1	2
1-l	**Unit operations in chemical engineering** : 1. Size reduction 2. Size separation or screening 3. Mixing 4. Filtration 5. Sedimentation 6. Extraction 7. Distillation 8. Drying 9. Crystallization	½ mark each for any 4	2
2-a	**Personal protective equipments used in Chemical industries :** The purpose of PPE is to provide a safety barrier a hazard and the body of a person working in a hazardous environment. **1) Hard hat** : It is used for protection of head **2) Safety goggles :** It is used for protection of eye **3)Safety shoes:** It is used for protection of legs and foot **4)work clothes:** It is used for protection of whole body **5)Ear muff:** It is used for protection of ear **6)Ear plug :** It is used for protection of ear **7)Guard cuff's :** It is used for protection of body **8)Face Shield:** It is used for protection of face	1 mark each for any 4	4

2-b	**Packed column:**  **Ball mill:**  **Centrifugal pump**  **Screen**	1 mark each	4

			
2-c	**Bob and tape Method**  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

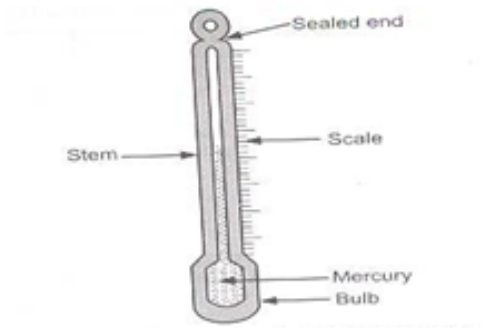
2-d	**Modes of heat transfer are:** Conduction Convection Radiation 1. Conduction: It is the transfer of heat without the movement of particles. Eg: heating of a metal rod 2. Convection: It is the transfer of heat within a fluid by the actual migration of particles of hot fluid with cold fluid because 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.	4	4
2-e	**Screening:** It is a method of separating solid particles according to size alone by means of screens of known aperture. Sieves and screens are used industrially for the separation of solid particles according to their sizes, for production of closely graded materials and for carrying out size analysis. In industrial screening, solids are dropped on a screening surface. The material retained on the screen surface are called oversize material, while materials passing through screen are called undersize particle. A single screen can make the separation of material into two fractions.	4	4
2-f	**Uses of Sulfuric acid:** a) It is used as a dehydrating agent drying agent acidifying agent and neutralizing agent. b) It is used in the manufacture of fertilizer.	1 mark each for any 4	4

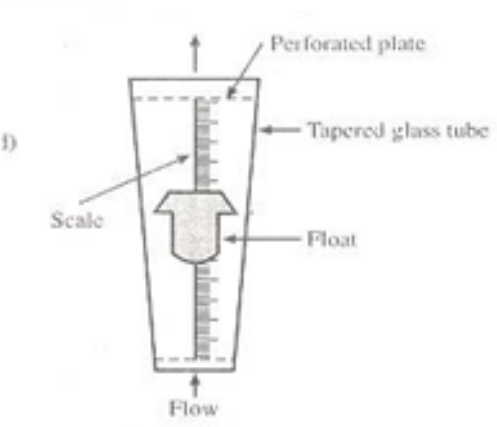
	c) Sulphuric acid is used for pickling iron and steel before galvanizing. d) It is used in processing metals. e) It is used in the manufacture of lead acid batteries .		
3-a	Molecular weight of H_2SO_4 =(1*2)+32+(16*4) =**98** Molecular weight of $KMnO_4$ =39+55+(16*4) =**158**	2 2	4
3-b	Basis: 500 ml solution. Weight of solute = 20 gm Molecular weight of NaOH = 40 Gram moles of solute = 20/40 = 0.5 Molarity = Gram moles/ Volume of solution in lit 0.5/0.5 = **1 M** Normality = gram equivalent of solute/ volume of solution in lit = 0.5/0.5 = **1N**	 1 1 1 1	4
3-c	**Redwood Viscometer:**	4	4

			
3-d	**U tube manometer**:  **Working :** 1)The pressure in the inlet line can be measured by connecting it by plastic tubing to one of the arms of the U-tube. 2) By measuring the difference in the height of the fluid in two arms of the U-tube pressure can be measured by the equation. $\Delta P = P_1 - P_2 = h(\rho_m - \rho)\, g$ Where , ΔP= Pressure difference, h= difference in levels of two arms ρ_m= density of manometric fluid	2 2	4

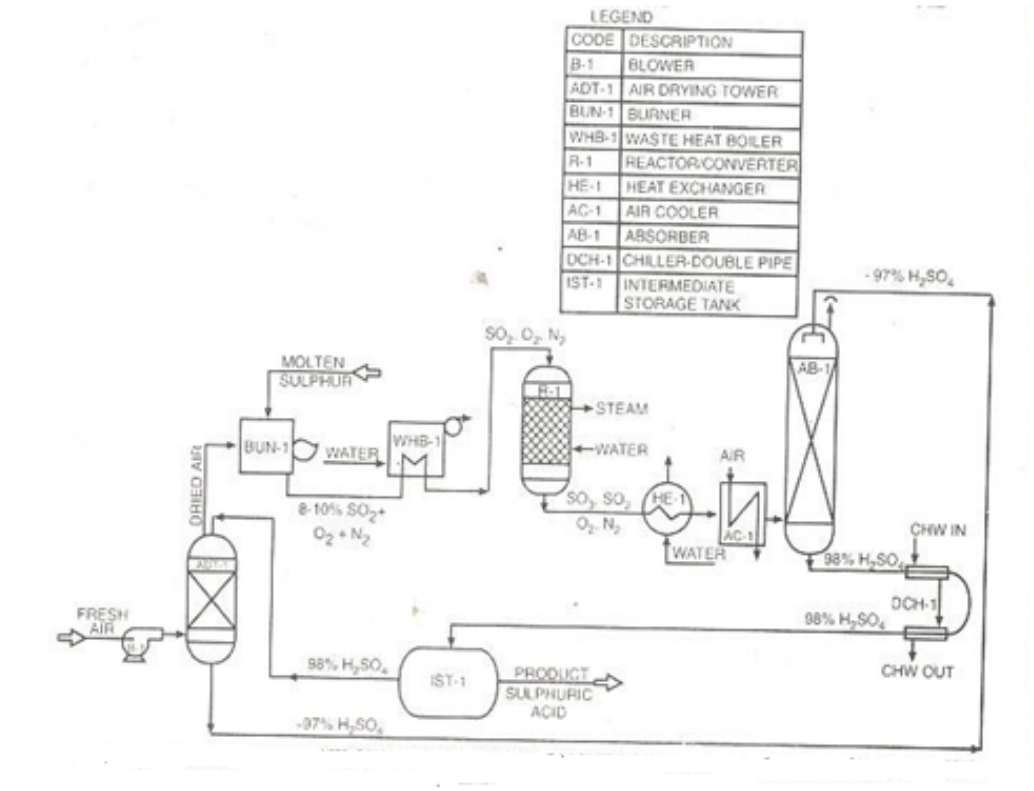
3-e	**Oxidising Agents employed in chemical Industries:** -Potassium Permanganate with sulphuric acid - Potassium dichromate with sulphuric acid **Reducing Agents employed in chemical Industries:** - Fe + HCl or Zn + HCl - Lithium aluminium hydride	2 2	4
3-f	**Pyrolysis:** The decomposition of a compound 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. $C_2H_6 \rightarrow C_2H_4 + CH_4 + H_2$ **Cracking**: Pyrolysis when applied to alkane is called cracking	2 2	4
4-a	**Principles by which solid mixture can be separated are:** 1. Difference in size : Screening 2. Magnetic properties: Magnetic separation 3. Electrostatic properties: Electrostatic separation 4. Surface properties: Froth floatation	1 mark each	4
4-b	**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	2	4

	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.	2	
4-c	**Size reduction:** It is an operation wherein large solid particles are subdivided to smaller ones. **It is carried out in industry to make it** : 1. Easy handling 2. Easy transportation 3. Increase in reaction rate 4. For having intimate mixing of solid 5. To separate various ingredients.	2 2	4
4-d	**Block Diagram:** A block diagram is the simplest form of presentation of the process. 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. **Process Flow Diagram:** A process flow diagram is the road map of a 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	2 2	4

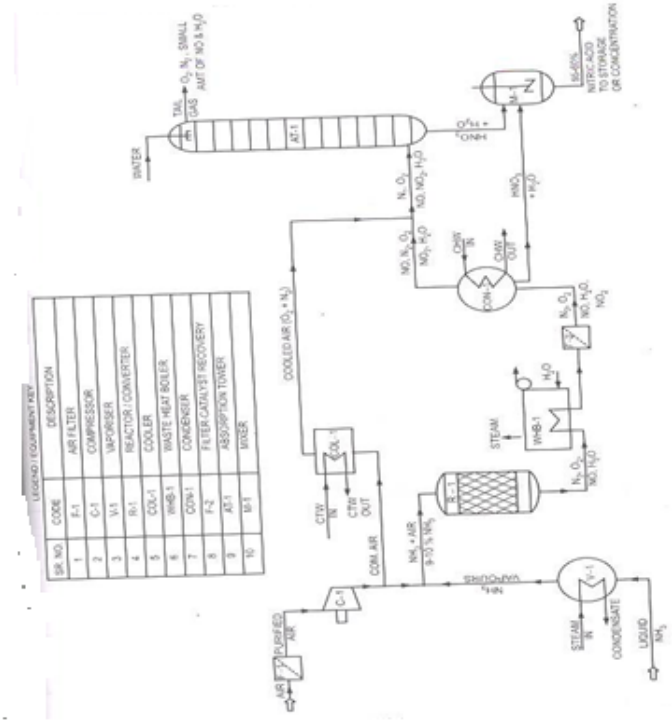
	carry the process, all incoming and outgoing materials, utilities required for each operation, quantity of each stream, stream composition, heat added or removed to and from the process equipment and the operating conditions such as temperature and pressure.		
4-e	**Mercury thermometer:** **Construction:** It consists of a glass stem having fine capillary and glass bulb. The bulb is at lower end of glass stem. Mercury is filled in the bulb; after filling, open end of capillary is sealed under vacuum so that no air is left in capillary.  **Working:** When the thermometer bulb gets heated after immersion in a bath .The mercury expands much more than the glass and is therefore forced to rise up the stem to indicate the temperature .For each particular temperature, the mercury rises to a certain point in the stem.	2 2	4
4-f	**Sulfonation reactions** : It is the reaction with sulfuric acid to introduce sulfonic (SO_3H) group into a compound. $C_6H_6 + H_2SO_4$ ------>$C_6H_5SO_3H + H_2O$	2	4

	Benzene benzene sulfonic acid **Chlorination:** It refers to the process in which one or more chlorine atoms are introduced into an organic compound. **Chlorination of methane:** Chlorination of methane in presences of ultraviolet light or at a temperature of 300 – 400 C results in the formation of polyhalogen derivatives. U.V.light $CH_4 + Cl_2$ ----------> $CH_3Cl + CH_2Cl_2 + CHCl_3 + CCl_4 + HCl$ 300-400 C	2	
5-a	**Rotameter**  **Working:** 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-	2 2	4

	state, it is recorded as rotameter reading from the scale provided. It is used for flow measurements of liquids and gases		
5-b	**Drying:** Drying is an operation in which the moisture of a substance is removed by means of thermal energy. In this operation, moisture is removed by circulating hot air or gas over the material in order to carry away the water vapour. In this operation, heat and mass transfer occur simultaneously. Heat is transferred from the gas phase to the solid phase and mass is transferred from the solid phase to the gas phase. Usually a solid or nearly solid materials are processed in dryer. Drying operations may be carried out for i)reducing the transportation cost, ii)making materials more suitable for handling and storage, iii)preventing corrosion arising due to the presence of moisture and iv)providing definite properties to materials.	4	4
5-c	**Flow sheet for manufacturing of H_2SO_4:**	4	4

			
5-d	**Normality:** N = gmequivalent of solute/ volume of solution in liter **Molarity:** M = gmmole of solute/ volume of solution in liter **Molality:** Molality = gm moles of solute/ weight of solvent in kg **Boiling point:** It is the temperature at which vapour pressure equal to atmospheric pressure(the temperature at which liquid boils)	1 1 1 1	4
5-e	**Dalton's law:** Daltons law states that total pressure of a gas mixture is equal to the sum of	4	4

<table>
<tr><td></td><td>partial pressures
$P=P_1+P_2+P_3$
where P is total pressure of gas mixture and P_1,P_2,P_3 are partial pressures.
Amagat's law:
Amagats law states that total volume of a gas mixture is equal to the sum of pure component volumes
$V=V_1+V_2+V_3$
where V is total volume of gas mixture and V_1,V_2,V_3 are pure component volumes.</td><td></td><td></td></tr>
<tr><td>5-f</td><td><table>
<tr><th>Sedimentation</th><th>Filtration</th></tr>
<tr><td>Gravitational force is acting</td><td>Pressure force is acting</td></tr>
<tr><td>Sedimentation tanks or settling tanks are used.</td><td>Filters are used</td></tr>
<tr><td>No filter medium is used</td><td>Filter medium is used</td></tr>
</table></td><td>4</td><td>4</td></tr>
<tr><td>6-a</td><td>Flow sheet for manufacturing of Nitric acid:</td><td></td><td>4</td></tr>
</table>

			
6-b	**Unit Process and unit operation:** **Unit process** / **Unit operation** Chemical changes takes place / Physical changes takes place, Chemical reactions involved / no chemical reactions involved Eg; oxidation, reduction, nitration, sulphonation / Eg; drying, distillation, mechanical separation	4	4
6-c	**2 atm pressure** 1tm = 760 mm Hg 2 atm = **1520 mm Hg** 1 atm= 101.325 KPa 2 atm = **202.65 KPa**	1 1 1 1	4

6-d	**Force**: A push or a pull is called force. F= ma	½	4
	Unit: Newton(N)	½	
	Pressure: It is force acting per unit area	½	
	Unit: N/m^2	½	
	Work: It is product of force acting on a body and the distance travelled by the body in the direction of applied force	½	
	Unit: N.m or Joule	½	
	Power: It is work done per unit time	½	
	Unit: Watt(W)	½	
6-e	Basis: 200 kg NaCl and 600 kg KCl		4
	Total weight of mixture = 800 kg		
	Weight % of NaCl = (wt of NaCl/ Total wt)*100		
	= (200/800)* 100		
	= **25 %**	1	
	Weight % of KCl = (wt of KCl/ Total wt)*100		
	= (600/800)* 100		
	= **75%**	1	
	gmoles of NaCl = Weight/ mol.wt		
	= 200/58= 3.45		
	gmoles of KCl = Weight/ mol.wt		
	= 600/74.5 = 8.05		
	Total moles = 3.45+8.05 =11.5		
	Mol% of NaCl = (Moles of NaCl/Total mole)*100	1	
	= (3.45/11.5)* 100		
	= **30%**		
	Mol% of KCl = (Moles of KCl/Total mole)*100		

	= (8.05/11.5)* 100 = **70. %** ***Note:The data given is wrong. If student used the wrong value, due consideration should be given.***	1	
6-f	**Volatility**: It is the ratio of partial pressure of a component to mol fraction of that in liquid phase **Relative volatility**: It is the ratio of volatility of more volatile component to volatility of less volatile component	2 2	4