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.

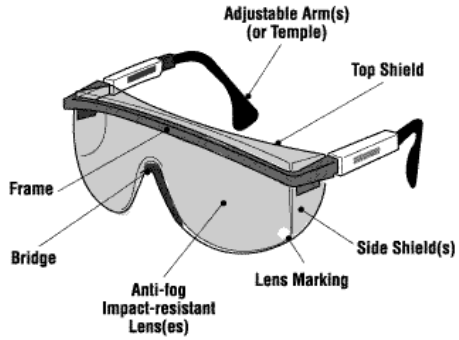
Q No	Sub q.no	Answer	marks
1		**Any five**	**10**
1	a	**Types of chemical industries on the basis of application**: On the basis of application, Chemical industries are classified as 1. Industries manufacturing Basic chemicals 2. Industries manufacturing Fine chemicals 3. Industries manufacturing Specialty chemicals	2
1	b	**Different types of accidents:** 1. Near accident 2. Trivial accident 3. Minor accident 4. Serious accident 5. Fatal accident	2
1	c	Hazards symbols: 1. Flammable materials  2. Toxic material 	1 1

1	d	**Unsafe act:** It is the violence of commonly accepted safe procedure. These include 1. Working at unsafe speed 2. Loading machines beyond capacity 3. Not using safety devices 4. Making use of improper tools 5. Adopting unsafe procedures	2
1	e	**Molarity of solution=** It is the number of gram moles of solute present in one litre of solution. M= gram moles of solute/ volume of solution in litres	2
1	f	**pH of solution**: It is defined as the negative logarithm of hydrogen ion concentration. $pH= - \log[H^+]$ **Scale:** It is a logarithmic scale ranging from 0 to 14 used to measure the concentration of hydrogen ion in a solution. Water has a pH of 7, acidic solution has a low pH value (0-7) and basic solution has a high pH value(7-14).	1 1
1	g	**Different unit operations(any 4)** 1. Size reduction 2. Size separation or screening 3. Mixing 4. Filtration 5. Sedimentation 6. Extraction 7. Distillation 8. Drying **9.** Crystallization **10.** Gas absorption	½ mark each

1	h	**Evaporation:** It is a unit operation in which a weak solution is concentrated by boiling off the solvent. The product is concentrated solution. **Leaching:** Leaching is an operation in which a solid mixture is contacted with a liquid solvent for the removal of one or more constituent of the solid mixture. The process of removing a solute from the solid by treating it with a liquid solvent is called leaching.	1 1
2		**Any three**	**12**
2	a	**Chemical Kinetics:** It is a study of the rates at which chemical reactions occur and the effect of parameters such as temperature, pressure and reactant concentration/ composition on the reaction rate. **Importance:** Chemical kinetics provides us information about the reaction mechanism, speed of a chemical reaction and type of rate equation which is to be used in the design of reactors.	2 2
2	b	**Diagram of personal protective device(any 2)**   Helmet hand gloves	2 mark each

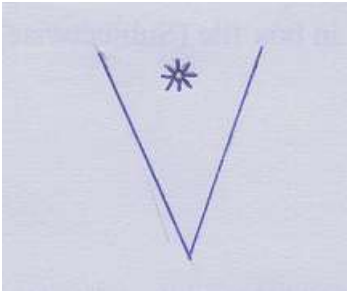
Ear plug

Apron(suit)



Goggle

Safety shoes

2	c	i) Size reduction: 	2

		ii) Ball mill 	2
2	d	**Working Principle of conductivity meter**: Two electrodes (platinum plates) are placed in a sample, a potential is applied across the electrodes, and the current is measured. The probe(two electrodes) is placed in the solution such that the solution covers the electrodes and an alternating voltage is applied by the meter to the electrodes. The meter measures the resulting current that flows between the electrodes and uses Ohm's law to calculate first the conductance of the solution and then the conductivity of the solution using the conductance and cell constant.	4
3		**Any three**	**12**
3	a	**Dalton's law:** It states that the total pressure exerted by a gas mixture is equal to the sum of partial pressures of its component gases. $P = P_1 + P_2 + P_3$ Where P is total pressure of gas mixture P_1 , P_2 , P_3 are the partial pressures. **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 is Total Volume,	2 2

		V_A, V_B, V_C = Pure components volumes of component gases	
3	b	Basis: 100 kmole air Kmoles of O_2 =21 Kmoles of N_2 =79 Weight of O_2 =21x32=672 kg Weight of N_2 =79x28=2212 kg Total weight =2884 kg Weight% of O_2 = (weight of O_2/ total weight)x100 = (672/2884)x100 = **23.3%** Weight% of N_2 =(weight of N_2/ total weight)x100 = (2212/2884)x100 = **76.7%**	1 1 1 1
3	c	**Application of pH measurement in Industry: (any 4)** pH measurement is essential in : 1) Waste water treatment, municipal sewage treatments. 2) Boiler feed water treatment. 3) Drinking water purification. 4) Production of Ultra pure water. 5) Aquariums and swimming pools. 6) Cooling tower water. 7) Checking freshness of raw incoming milk. 8) Desulphurization process that removes sulfur from oil in oil refineries. 9) Process of drying in textile industries. 10) Checking chemical reaction in production of drugs. 11) Determining plant nutrients in soil. 12) Digestion and bleaching processes in the manufacturer of pulp and	½ mark each

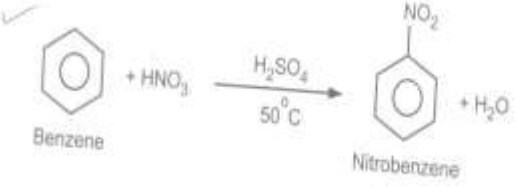
		papers. **Effect of pH on electrical Conductivity:** The conductivity of solution depends upon the concentration of all the ions presents. The conductivity increases with increase in concentration of ions. These ions contribute differently to the conductivity depending upon their mobilities through the solution. The most mobile cation is the hydrogen ion [H^+]. pH is measurer of the concentration of the hydrogen ions for an acidic solution, Thus solutions having lower pH values are having higher conductivity values.	2
3	d	**Unit Operation**: It is the operation in which only physical changes occur, but no chemical changes **Classification of Unit operation:** 1. Mechanical Operations: Transportation of materials, size reduction, screening, filtration, conveying, mixing, froth floatation 2. Electro mechanical operations: Magnetic separation, electrostatic separation, electro dialysis 3. Thermal operations: Evaporation, condensation, drying, distillation, crystallization, gas absorption etc.	1 3
4		**Any three**	**12**
4	a	**Laws of thermodynamics:** 1. First law: Energy can neither be created nor destroyed, but it can be converted from one form to another. 2. Second law: Entropy of an isolated system tends to increase and reaches a maximum value. Entropy of universe is always increasing. 3. Third law: Entropies of all pure crystalline solids may be taken as zero at absolute zero temperature.	4

4	b	**Causes of accident in Chemical industries:** **1.** Unsafe physical conditions: It includes improper machine guards, improper ventilation, inadequate ventilation, unsafe clothing etc. **2.** Personal factors: Sometimes accidents occur due to personal problems like lack of knowledge, physical weakness, age, health etc. **3.** Poor design and construction of equipment and machinery. **4.** Untested boiler and pressure vessels **5.** Unsafe acts. It is the violence of commonly accepted safe procedure. These include a. Working at unsafe speed ,loading machines beyond capacity, not using safety devices b. Exposure to harmful substances c. Insufficient information about chemical hazard d. Inadequately trained man power e. Inadequate safety and emergency equipment f. Lack of written procedures regarding safety and emergency 6. Exposure to harmful substances 7. Insufficient information about chemical hazard 8. Inadequately trained man power 9. Inadequate safety and emergency equipment 10. Lack of written procedures regarding safety and emergency.	½ mark each for any 8
4	c	Basis: 3.48 m^3 CO_2 at NTP $C + O_2$ ----→CO_2 V= 3.48 m^3 P=101.325 kPa T=273K R=8.314 m^3 kPa/ kmol K n = PV/RT n = 101.325 x 3.48 / (101.325 x 273) = 0.155 kmol	1 1

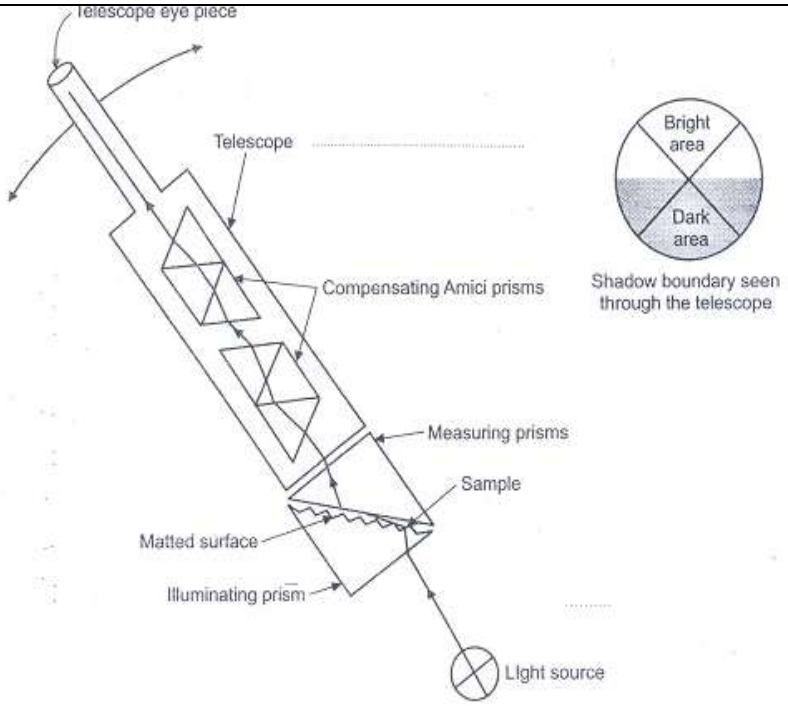
<table>
<tr><td></td><td></td><td>Carbon reacted = 0.155 kmol
= 0.155 x 12 = 1.86 kg
% C in coal = (1.86 / 2.68)x100
= 69.55 %</td><td>1
1</td></tr>
<tr><td>4</td><td>d</td><td>Differentiate between filtration and sedimentation
<table>
<tr><th>Sedimentation</th><th>Filtration</th></tr>
<tr><td>Gravitational 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></tr>
<tr><td>4</td><td>e</td><td>Solubility:
Solubility of a solute is the maximum amount of solute that can be dissolved in a given amount of solvent at a specific temperature and pressure.
OR
It is the amount of solute dissolved in a given quantity of solvent to produce a saturated solution at a specific temperature and pressure.
It is expressed as parts by weight of solute per 100 parts by weight of the solvent at a given temperature. Another way to express solubility in in gm/ litre of solution.
Effect of temperature on solubility:
Solubility increases as temperature increases.</td><td>2

2</td></tr>
<tr><td>5</td><td></td><td>Any two</td><td>12</td></tr>
<tr><td>5</td><td>a</td><td>Measurement of Refractive Index:
The Refractive index of a medium is defined as the ratio of speed of lignt in vacuum to the speed of light in the medium</td><td>2</td></tr>
</table>

		Speed of light in vacuum Refractive index = ---------- Speed of light in medium • The refractive index is a dimensionless number. • It describe how light propagates through the medium . • The refractive index determines how much light is bent or refracted ,when entering a medium. • The refractive index measurement are reported in the literature at $20^{O}C$ or 25 ^{O}C . **Dependence of Refractive Index on Temperature:** As the temperature increases, density of liquid medium decreases. It means that liquid becomes less dense with increasing temperature .Since the liquid is less dense, the speed of light through it increases or light travels through it faster. As a result of this ,the refractive index decreases since it is inversely proportional to the speed of light through the liquid. Thus the refractive index of liquid or solution decreases with increasing temperature. **Dependence of Refractive Index on Concentration:** As the concentration of solution increases, density of liquid medium increases. It means that liquid becomes more dense with increasing temperature .Since the liquid is more dense, the speed of light through it decreases. As a result of this ,the refractive index increases since it is inversely proportional to the speed of light through the liquid. Thus the refractive index of liquid or solution increases with increasing concentration.	2 2
5	b	**Reduction:** Reduction is defined as the addition of hydrogen, removal of oxygen, addition	1

		of metallic element or addition of electrons. Eg. Reduction of ethyl bromide $CH_3CH_2Br + 2H \longrightarrow C_2H_6 + HBr$ Nitrobenzene can be reduced to aniline by using Fe + HCl $C_6H_5NO_2 + 2Fe + 6HCl \longrightarrow C_6H_5NH_2 + 2\,H_2O + 2FeCl_3$ **Calcination:** is defined as the process by which Ore is subjected to the action of heat at high temperature in the absences of air. Reaction involved in calcinations of lime stone**:** $CaCO_3$ + heat $\longrightarrow$ $CaO + CO_2$ Lime stone (lime) **Nitration** is defined as unit process where one or more nitro groups are introduced into an organic compound. OR It is the reaction with nitrating mixture to introduce nitro(NO_2) group into an organic compound. Nitrating mixture is a mixture of con.Sulfuric acid and con. Nitric acid. Nitrating mixture is used in nitration reaction. $C_2H_6 + HNO_3 \longrightarrow C_2H_5NO_2 + H_2O$ Ethane nitro ethane  	1 1 1 1 1
5	c	**Dry bulb temperature:** Temperature recorded by ordinary thermometer is called dry bulb temperature.	1

		Measurement of DBT: The temperature of air measured by an ordinary thermometer without cover of bulb by wet cloth. **Wet bulb temperature:** It is the temperature indicated by thermometer whose bulb is covered with cotton or muslin wire wetted with moisture. **Measurement of WBT:** The temperature of air measured by an ordinary thermometer with cover of bulb by wet cloth or wick and is exposed to the air. The readings of Dry bulb and wet bulb temperatures are used to predict weather. A large difference between the readings of dry and wet bulb temperatures indicates a dry weather. A small difference indicates a sultry weather or possible rain. One condition for rain is abundance of water vapour in the atmosphere.	1 1 1 2
6		**Any two**	**12**
6	a	**Abbes Refractometer:** **Diagram:**	



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Principle:

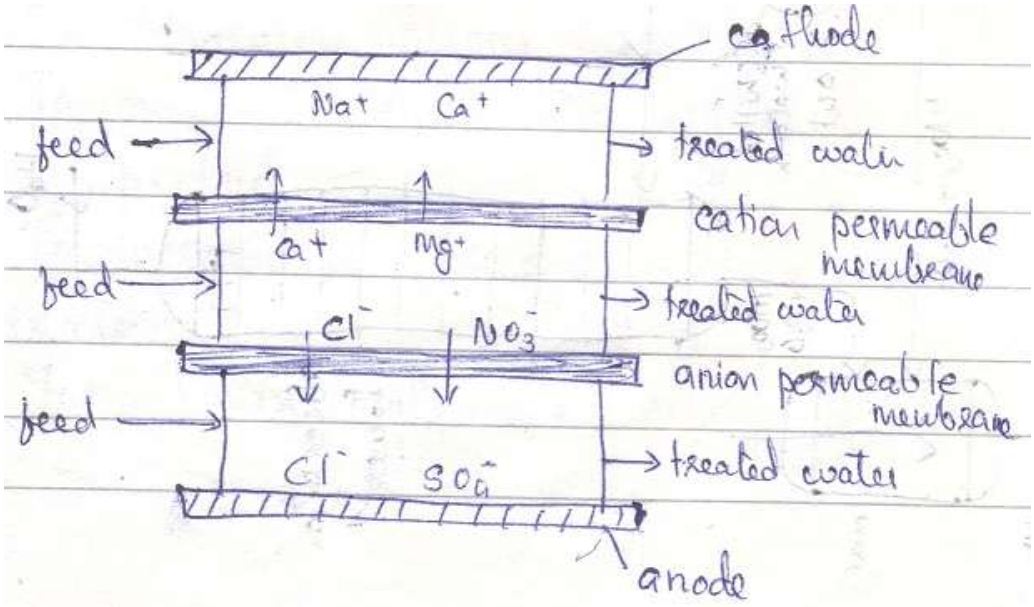
The refractive index of a sample is determined by measuring the critical angle made when the sample is brought into contact with the medium (measuring prism) of a known refractive index.

Working:

The sample is put between illuminating and measuring prisms in the form of film of thickness of about 0.10 to 0.14 mm. Light from a light source is directed towards the prisms. It enters the sample from illuminating prism and get refracted at critical angle at the bottom surface of the measuring prism, and then passes into a fixed telescope. The field of view gets divided into bright and dark areas. Using a rotating knob, the shadow boundary (border line)separating the bright and dark areas is placed exactly on the cross hairs of an eyepiece of the telescope and the refractive index is then read from the scale provided.

3

		The accuracy of this instrument is about + 0.0002 .	
6	b	**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. **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. Eg: Drying of pharmaceuticals, dyes, paper, cloth **Crystallization:**	2 2

		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.	2
6	c	**Electro- dialysis:** 	6