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.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q No	Sub q.no	Answer	marks
1		**Any five**	**10**
1	a	**Chemical Kinetics**: It is the study of the rates at which chemical reactions occur and the effect of parameters such as temperature, pressure, reactant concentration/ composition on the reaction rates. **Use:** 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.	1 1
1	b	**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	c	**Unsafe conditions in a laboratory :** 1. Wet and slippery floor 2. Improper ventilation 3. Unavailability of personal protective equipment 4. Insufficient information about chemical hazard 5. Unsafe acts 6. Lack of written procedures regarding safety and emergency **7.** Improper material handling	½ mark each for any 4
1	d	**Hazard Symbol of** : **Flammable material**	

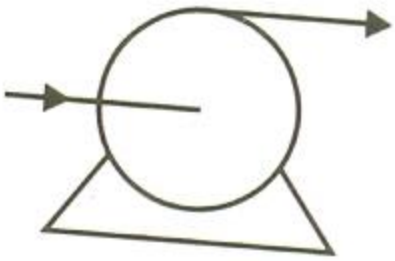
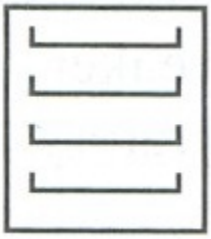
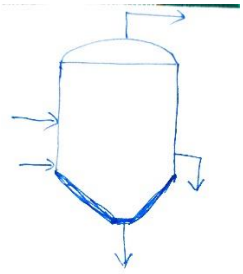
		 **Toxic material** 	1 1
1	e	**Definition of specific gravity:** Specific gravity is the ratio of density of substance to density of water at 4^0C	2
1	f	**Dalton's law:** It states that the total pressure exerted by a gas mixture is equal to the sum of partial pressures of its component gases. $P = P_1 + P_2 + P_3$ Where P is total pressure of gas mixture P_1 , P_2 , P_3 are the partial pressures.	2
1	g	**Definition 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 $$\text{Refractive index} = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}}$$	2
2		**Any three**	**12**

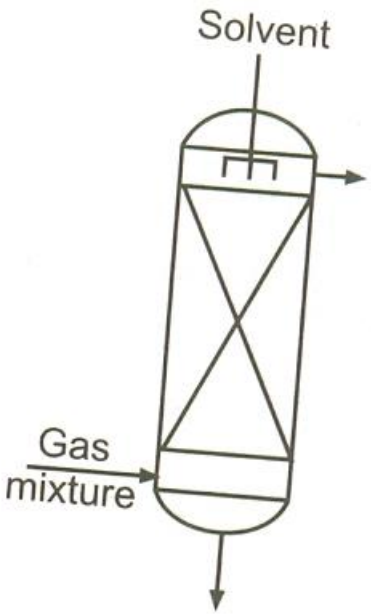
2	a	**Relation between Chemical Kinetics and Thermodynamics:** Chemical kinetics is a study of the rates at which chemical reactions occur and the effect of parameters such as temperature, pressure and reactant concentration on reaction rates. Thermodynamics provide us information about the feasibility of a reaction, the heat absorbed or liberated during the course of reaction and the maximum possible extent of a reaction. We need information from thermodynamics and chemical kinetics for the designing of a chemical reactor. According to chemical kinetics, for a reaction to take place, the reacting molecules have to overcome the energy barrier in the path of reaction to products. The energy barrier or the minimum amount of energy possessed by the reacting molecule is known as activation energy or free energy of activation. Lower the activation energy, higher will be the rate at which a given reaction proceeds. Thus for a reaction to proceed faster, its activation energy must be low. Activation energy is the minimum energy required to start a reaction.	4
2	b	**First aid measures for:** **i)Eye injury :** a) Have the person immediately rinse the eye with clean water. b) Flush with lukewarm water for 15-30 minutes c) Flush the eye to remove contact lenses. d) Do not rub the eye or place a bandage over the eye. e) While waiting for medical care, have the person wear sun glasses. f) Get doctor's help immediately. g) Make sure you know what chemical got into the eye.	2

		ii) Skin Burn: a) Most chemical burns of the skin are treated first by rinsing the chemical off your body with a large amount of room temperature water. b) Flood affected area with cool water for 20 minutes. c) Make sure water doesnot flow into other parts of the person s body or onto you. d) Remove the chemical causing burn. e) Remove contaminated clothing or jewellery. f) Loosely apply a bandage. g) Consider a tetanus shot.	2
2	c	Basis: 100 ml solution. Weight of NaOH = 4 gm Molecular weight of NaOH = 40 Gram moles of solute = 4/40 = 0.1 Molarity = Gram moles/ Volume of solution in lit 0.1/0.1 = **1 M** Normality = gram equivalent of solute/ volume of solution in lit = 0.1/0.1 = **1N**	1 1 1 1
2	d	**Applications of Electrical Conductivity measurement**: (any 4) 1. Water treatment: In controlling and monitoring drinking water quality, water for pharmaceutical products, water from waste water treatment and sewage treatment plants, medical water. 2. Leak detection: Leakage of cooling water into process fluid which affects production process.	1 mark each

		3. Desalination: Drinking water desalination plants make use of conductivity measurement to monitor how completely dissolved ionic solids are removed. 4. Interface detection: A conductivity sensor can easily detect the interface between two liquids if they have appreciably different conductivities.	
3		**Any three**	**12**
3	a	**Formulas for:** 1**. weight %** Let a mixture contains components A,B & C of weights W_A, W_B & W_C Weight % of A =(Weight of A/ Total weight of mixture) * 100 = $W_A/(W_A+W_B+W_C)*100$ **2. mole %** Let the moles of the components be n_A,n_B & n_C Mol% of A = (moles of A/total moles)*100 = $(n_A/n_A+n_B+n_C)$ *100	2 2
3	b	Weight of NaCl = 300 kg Weight of KCl = 600 kg Total weight = 900 kg Weight % of NaCl = (300/ 900) * 100 =**33.33%** Weight % of KCl = (600/ 900) * 100 = **66.67%** Molecular weight of NaCl = 58.5 k moles of NaCl = 300/58.5 = 5.13 Molecular weight of KCl = 74.5 k moles of KCl = 600/74.5 = 8.05 Total moles = 5.13+8.05 = 13.18 Mol % of NaCl = (moles of NaCl / Total moles)*100	1 1 1

		= (5.13/ 13.18)*100 = **38.92%** Mol % of KCl = (moles of KCl / Total moles)*100 = (8.05/ 13.18)*100 = **61.07%**	1
3	c	**pH meter:** **Construction:** pH meter consists of (i)a glass electrode, (ii)reference electrode and (iii)an electronic meter- it measures and displays the pH reading. The glass electrode consists of a strong and thick walled glass tube. A very thin glass bulb which is sensitive to hydrogen ion is connected to the lower end of glass tube. A silver wire which is coated with AgCl at the end is immersed in a 0.1M HCl solution of constant pH contained in the glass tube. The potential of this electrode changes with a change in the pH value of a sample solution. Reference electrode consist of a Ag wire with its lower portion covered with AgCl and immersed in a saturated KCl solution contained in a glass tube which is fitted with porous plug at the bottom. The potential of this electrode is constant. Each of these electrodes is a half cell. The two half cells arranged together constitute an electrochemical cell in which one of the half cells is at a constant potential and the potential of the other half cell varies with pH value of the test sample. **Working:** In order to measure the pH of a test solution, electrodes are dipped into the test solution. The difference in the hydrogen ion concentration in the test solution and the inside solution in the glass tube creates a potential difference at the glass bulb. The glass electrode gives this signal to the meter which then displays the pH of the test solution corresponding to the potential difference created.	2 2

3	d	**Symbols of:** **i) Centrifugal Pump**  **(ii) Tray Drier**  **(iii)Evaporator**  **(iv) Spray Column**	1 mark each

			
4		**Any three**	**12**
4	a	**Classification of chemical reactors**: 1. Based on shape of reactor a) Tank reactor b) Tubular reactor 2. Based on mode of operation a) Batch reactor b) Semi batch reactor **c)** Continuous reactor	4
4	b	**Emergency exit routes:** An emergency exit is an exit other than regular exit in a workplace which is used for prompt evacuation of employees from the workplace during emergencies such as fire, explosion etc. Exit route must be unobstructed by materials, equipment etc., it must be separated from explosives and flammable	2

		materials and it must not be locked. Adequate lighting must be provided for exit route and the EXIT sign must be able to be seen from a distance. **Assembly point**: Assembly point is a predetermined safe area outside the building where all occupants of the building should assemble / gather and remains there till the end of the emergency. In the event of a fire or emergency, whenever it is necessary to evacuate the building, people must move promptly to the assembly point of the building. Assembly point should be easily and safely accessible and must have sufficient space to accommodate all occupants. It should have unobstructed pathway to them and should be located away from power lines.	2
4	c	**Importance of safety in chemical industries**: 1. To increase the rate of production 2. To reduce the cost of production 3. To reduce the damage to equipment and machinery 4. To protect the life and limbs of the workers	4
4	d	Basis: 100 kg spent acid Weight of HNO3 = 35 kg Weight of H2SO4 = 35 kg Weight of H2O =30 kg Moles of HNO3 = 35/63= 0.556 kmoles Moles of H2SO4 = 35/98= 0.357 kmoles Moles of H2O =30/18= 1.667 kg Total Moles = 2.58 kmoles **Mole% of HNO3 =(0.556/2.58)*100 = 21.55%** **Mole% of H2SO4 =(0.357/2.58)*100 = 13.84%** **Mole% of H2O =(1.667/2.58)*100 = 64.61%**	1 1 2

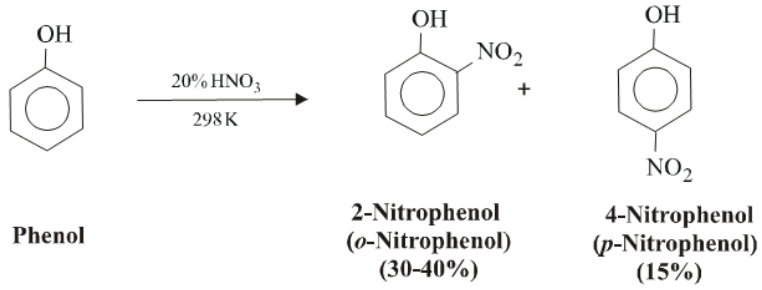
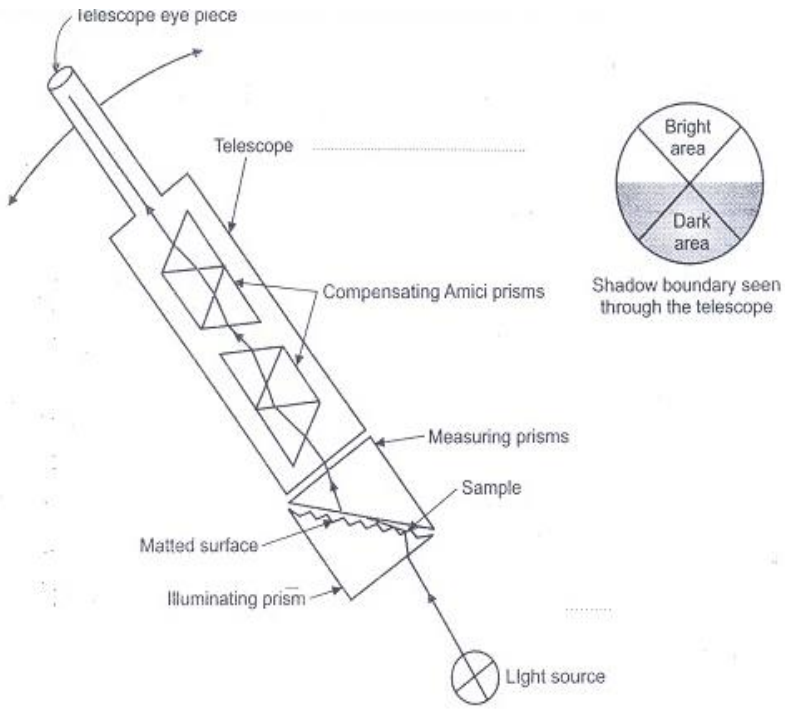
4	e	**Different unit processes used in Chemical Industries(Any 4)** 1. Oxidation 2. Reduction 3. Nitration 4. Sulphonation 5. Hydration 6. Hydrogenation 7. Dehydrogenation 8. Esterification 9. Calcination 10. Pyrolysis 11. Halogenation **Nitration reaction of phenol:** Phenol is reacted with con.HNO_3 to produce **2,4,6 trinitro phenol.** Phenol is reacted with dil.HNO_3 to produce **2,4,nitro phenol.** The mixture of nitrophenols so obtained is separated using steam distillation. Both these products show hydrogen bonding.  **Phenol** **2-Nitrophenol (*o*-Nitrophenol) (30-40%)** **4-Nitrophenol (*p*-Nitrophenol) (15%)**	½ mark each 2
5		**Any two**	**12**
5	a	**Abbes Refractometer:**	

Diagram:



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. 1

Construction:

The abbe refractometer is the critical angle refractometer the essential parts of this refractometer are : 3

i) light sources.

ii) illuminating prism.

iii) measuring prism.

iv) telescope.

v) two compensating Amici prisms.

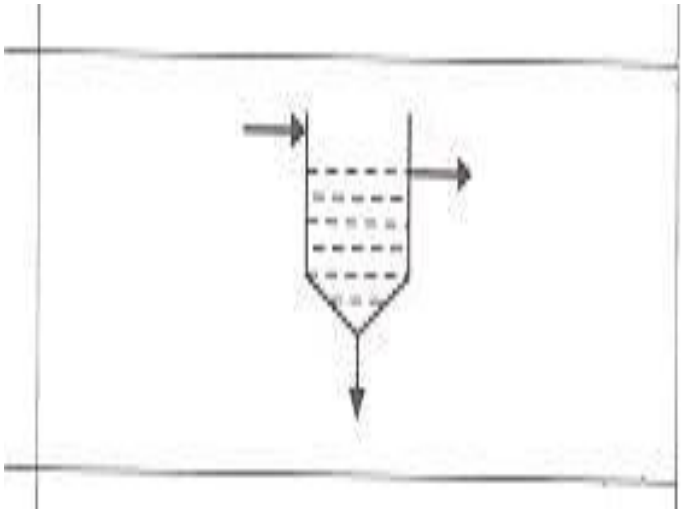
		The illuminating and measuring prisms are right angle prism, usually of 30-60-90^0 construction and made of flint glass. The refractive index of this prism (1.75) is higher then the upper limit of the instrument range (i.e., the refractometer is designed to use with samples having the refractive index smaller than that of the prism, i.e., smaller than 1.75). The surface of illuminating prism is matted so that the light enters the sample (from the prism) at all possible angles , including that almost parallel to the surface. The lower face of the measuring prism (also known as the refracting prism)is highly polished. Two compensating Amici prisms are provided to prevent the dispersion of light and thus to get a shadow boundary clear An eyepiece of telescope is provided with cross hairs. For controlling temperature during measurements, water from the thermostat is circulated through jackets surrounding the prisms. **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. The accuracy of this instrument is about $\pm$ 0.0002 .	2
5	b	**Operations used for solid-liquid separation:** 1. Sedimentation	2

2. Filtration
3. Centrifugation

Sedimentation:

The separation of solids from a suspension in a liquid by gravity settling is called sedimentation. The force responsible for sedimentation is **gravitational force**. In this operation, a dilute slurry is separated into the clear liquid and slurry of high solid contents. The simplest method of removing the suspended impurities from a liquid is by plain sedimentation. In the treatment of water, water is allowed to stand undisturbed or move very slowly through the basin until the suspended impurities settle to the bottom and relatively clear liquid is drawn off the top. Dorr thickener is the common equipment used for sedimentation.

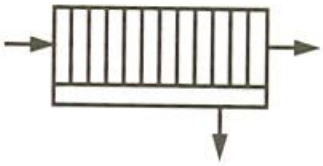
4



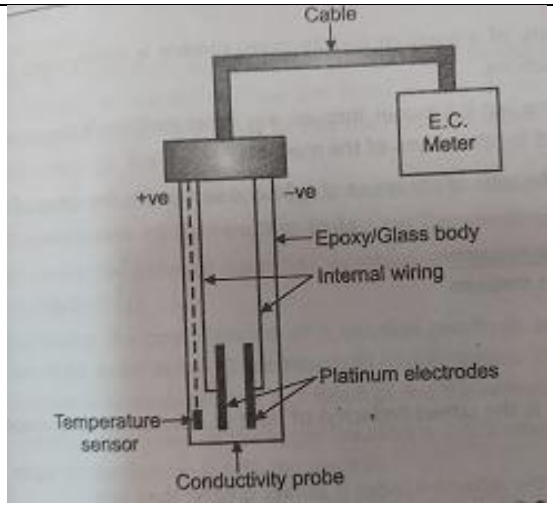
OR

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. Filter aids are used as a pre coat to the filter medium before the slurry is filtered. This will prevent small particles from plugging the filter medium and also give a clearer filtrate. Filters are of two types- Pressure filter and Vacuum filter. Different filters used in industry are drum filter, plate and frame filter press 	
5	c	**Principle of:** **ii) Adsorption:** Adsorption is a process that involves the accumulation of a substance in molecular species in higher concentrations on the surface. If we look at Hydrogen, Nitrogen and Oxygen, these gases adsorb on activated charcoal. Meanwhile, we have to note that adsorption is different from absorption. The two processes involve totally different mechanisms. iii) **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. iv) **Distillation** is an operation where by the components of a liquid mixture containing miscible and volatile substances are separated by partial vaporization by virtue of difference in vapour pressure. It is an operation in which the components of a liquid mixture are separated using thermal energy.	1.5 1.5 1.5 1.5

		v) **Sedimentation:** The separation of solids from a suspension in a liquid by gravity settling is called sedimentation. The force responsible for sedimentation is **gravitational force**.	
6		**Any two**	**12**
6	a	**Electrical Conductivity meter:** **Principle**: Two electrodes (platinum plates) are placed in a sample , a potential is applied across the electrodes, and the current is measured. **Construction :** The meter consists of a conductivity probe and an EC meter. The probe consists of two electrodes (platinum plates) set at a constant distance from each other. The probe is connected by a cable to the meter. **Working:** The probe is placed into the solution under consideration 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. R = V/I Conductance = I/resistance conductivity = Conductance * cell constant	2 2 2

			
6	b	**Reasons for carrying out size reduction** : Size reduction helps in: ► Easy handling ► Easy transportation ► Increase in reaction rate ► For having intimate mixing of solid ► To separate various ingredients **Crushing Operation:** Crushing is the process of reducing the size of materials so that they can be further processed. In addition to being used in the chemical industry, industrial crushing equipment can be very useful in a variety of businesses. These include, but are not limited to, waste and recycling, mining, food processing, construction, and coal. Industrial crushers are primarily used to take very large pieces of material and make them smaller. Having smaller pieces of the material allows for easier	3 3

		transportation, further processing, and/or better ability to differentiate the different compositions of the material. Principle used in crushing is Compression. Jaw crusher, gyratory crusher are industrially used crushers.	
6	c	**Reaction for preparation of ethane from ethylene:** **(i)Ethane is prepared from ethylene by Hydrogenation:** It refers to the chemical reaction of an organic compound with molecular hydrogen in the presence of a catalyst. $CH_2= CH_2 + H_2 \rightarrow CH_3\text{-}CH_3$ Ethylene ethane **(ii)Preparation of ethyl acetate from acetic acid and ethyl alcohol:** **Preparation of ethyl acetate from acetic acid and ethyl alcohol** is done by esterification. Esterification of an acid such as acetic acid by an alcohol such as ethyl alcohol results in the production of ethyl acetate. Sulphuric acid and hydrochloric acids are the catalysts used for esterification. $CH_3COOH + C_2H_5OH \text{ ----------}\rightarrow CH_3COOC_2H_5 + H_2O$ acetic acid ethanol ethyl acetate	3 3