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(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)

SUMMER-14 EXAMINATION
Model Answer

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.

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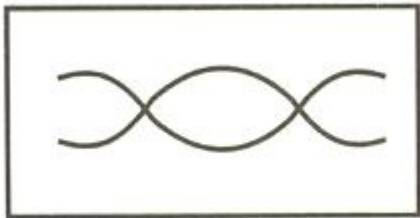
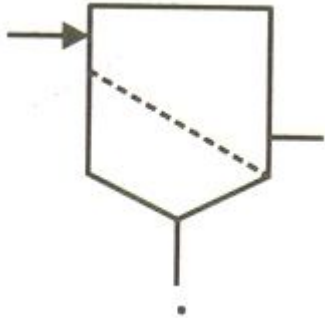| Q No.	Answer	marks	Total marks
1-a	**Petrochemical Industry:** 　1. Reliance Industries Ltd 　2. Supreme Petrochemical Ltd. 　3. NOCIL 　4. IPCL	1 mark each for any 2	2
1-b	1atm=760mm of Hg 2atm=1520mm of Hg	1 1	2
1-c	**Unit operations in chemical engineering** : 　1. Size reduction 　2. Size separation or screening 　3. Mixing 　4. Filtration 　5. Sedimentation 　6. Extraction 　7. Distillation 　8. Drying 　9. Crystallization	½ mark each for any 4	2
1-d	**Thermometric fluid used in gas filled thermometer:** 　1. Nitrogen 　2. Argon	1 mark each	2
1-e	**Direct level measuring devices :** 　1. Bob and tape measurement 　2. Float and tape measurement 　3. Sight glass method	1 mark each for any two	2

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1-f	**Volume**	1	2
	Unit: m^3		
	Density:		
	Unit: Kg/m^3	1	
1-g	**Reaction of Calcination :**	2	2
	$Ca\ CO_3 + heat \longrightarrow CaO + CO_2$		
	Lime stone (lime)		
1-h	**i) Ribbon blender**		2
		1	
	ii) Screen		
		1	
1-i	Heat, 500^0C	2	2
	CH_3CH_3 --------------------------------$\rightarrow CH_2{=}CH_2 + CH_4 + H_2$		
	In absence of air		
1-j	**Equipment used for handling of liquids.** :	1 mark	2
	1. Pump	each for	
	2. Pipe lines	any two	

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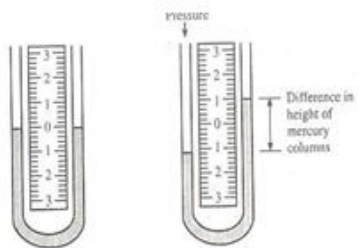|			
	3. Valves 4. Tank 5. fittings		

1-k	**Causes of accidents** :
	
	  1. **Mechanical causes** :
	    a) Un safe mechanical design.
	    b) Improper machine guarding.
	    c) Improper material handling
	    d) Leaking acid valve
	
	  2. **Environmental causes** :
	    a) Too low temperature
	    b) Too high temperature
	    c) Too high humidity
	    d) Presence of dust, fumes
	    e) Defective and inadequate illumination
	
	  3. **Human causes** :
	    a) Age
	    b) Health
	    c) Financial possession
	    d) Careless
	    e) Improper use of tools
	    f) Lack of knowledge and skill
		½ mark
		each for
		any 4
				2

1-l	**Importance of size reduction** :
	  1. Easy handling
	  2. Easy transportation
	  3. Increase in reaction rate
	  4. For having intimate mixing of solid
		½ mark
		each for
		any 4
				2

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	5. To separate various ingredients.		
2-a	**Molarity** : gram moles of solute/ volume of solution in litres	1	4
	Normality : gram equivalent of solute/ volume of solution in litres	1	
	Normality = gram equivalent of NaOH/ volume of solution in litres		
	1= gram equivalent of NaOH/ 1 ltre		
	gram equivalent of NaOH= 1		
	gram equivalent of NaOH=weight of NaOH/molecular weight of NaOH	1	
	1=weight of NaOH/40		
	Weight of NaOH= **40 grams.**	1	
2-b	**Dalton's law:**		4
	Daltons law states that total pressure of a gas mixture is equal to the sum of partial pressures	2	
	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	2	
	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.		
2-c	**U –tube manometer :**	1	4

	Construction : 1) U-tube manometer is simplest form of manometer 2) It consists of small diameter U-shaped glass tube. 3) The tube is clamped on a wooden board and between two arms or leg of the manometer. 4) A scale is fixed on the same board, scale is marked in centimeters 5) On the scale the zero is marked in the center. 6) Manometric fluid is mercury.	1.5	
	Working: 1) The pressure in the inlet line can be measured by connecting it by plastic tubing to one of the U-tube 2) By measuring the difference in the height of the fluid in two arms of the U-tube. 3) If manometric fluid is mercury, when each arm of the U-tube is connected to separate regions of the same line. 4) Then the manometer measures differential pressure. 5) $\Delta P = P_1 - P_2 = h \, (\rho_m - \rho) \, g$ Where , ΔP = differential pressure ρ_m = density of manometric fluid , ρ= density of process fluid	1.5	
2-d	**Modes of heat transfer are:** 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. 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	4	4

	or absorbed.		
	Eg. Transport of energy from the sun to earth.		
2-e	**Equipment used for :**		4
	1. Size reduction (any one)	1	
	Jaw crusher		
	Ball mill		
	Hammer mill		
	2. Filtration (any one)	1	
	Plate and frame filter press		
	Drum filter		
	3. Distillation (any one)	1	
	Distillation column (Plate column)		
	Packed column		
	4. Absorption (any one)	1	
	Packed column		
	Agitated tank		
2-f	**Salient feature of unit operations** :	1 mark	4
	1. No chemical reactions are involved	each	
	2. Only physical changes occur		
	3. These are common to all types of industries.		
	4. Practical methods of carrying out may be different in different imdustries.		
3-a	**Vapor pressure** :	2	4
	It is the pressure exerted by vapor on the surface of liquid at equilibrium conditions.		
	Boiling point of liquid :	2	
	It is the temperature at which the liquid boils or it is the temperature at which		

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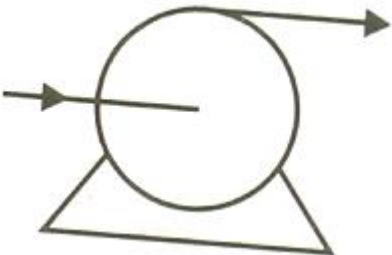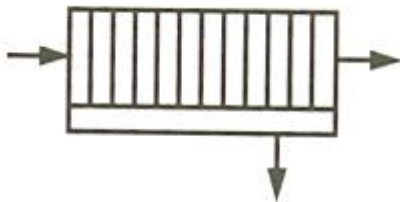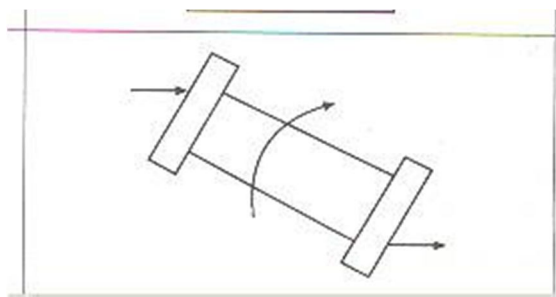
	vapor pressure equals to atmospheric pressure.		
3-b	Molecular weight of $KMnO_4$ =39+55+(16*4) =**158** Molecular weight of H_2SO_4 =(1*2)+32+(16*4) =**98**	2 2	4
3-c	Basis 100 kmol solution : Moles of methanol = 20 Weight of methanol = 20*32 =640 kg. Moles of water = 80 Weight of water = 80*18 =1440kg. Total weight = 2080kg. Weight % of methanol=640*100/2080=**30.77%** Weight % of water =1440*100/2080=69.23%	1 1 1 1	4
3-d	Packed column : 	1	4

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	Centrifugal Pump:	1	
	Plate & Frame filter press:	1	
	Rotary dryer	1	
3-e	**Nitration reactions** : It is the reaction with nitrating mixture to introduce nitro(NO_2) group into an organic compound. $C_2H_6 + HNO_3 ------> C_2H_5NO_2 + H_2O$	2 2	4

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3-f	**Sulfonation reactions** :		4
	It is the reaction with sulfuric acid to introduce sulfonic (SO_3H) group into a compound.	2	
	$C_6H_6 + H_2SO_4 ------> C_6H_5SO_3H + H_2O$	2	
	Benzene benzene		
	sulfonic acid		
4-a	**Filtration:**	3	4
	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.		
	Equipment used for filteration :	1mark for	
	1. Plate and frame filter press.	any 1	
	2. Drum filter		
4-b	**Normality** = gram equivalent of HCl/ volume of solution in litres	1	4
	2= gram equivalent of HCl/ 1 litre		
	gram equivalent of HCl= 2	1	
	gram equivalent of HCl=weight of HCl/molecular weight of HCl	1	
	2=weight of HCl/36.5		
	Weight of HCl= **73 grams.**	1	
4-c	**Atomic weight** :	1	4
	It is the weight of an atom of an element measured on a scale which assigns 12		

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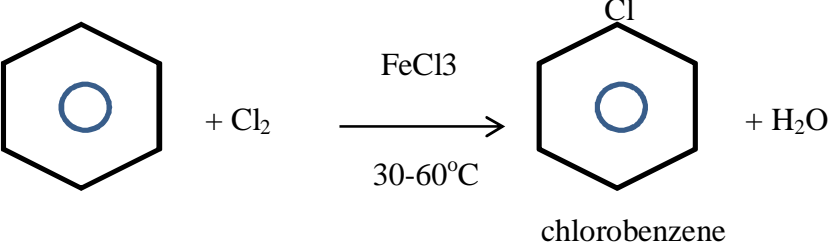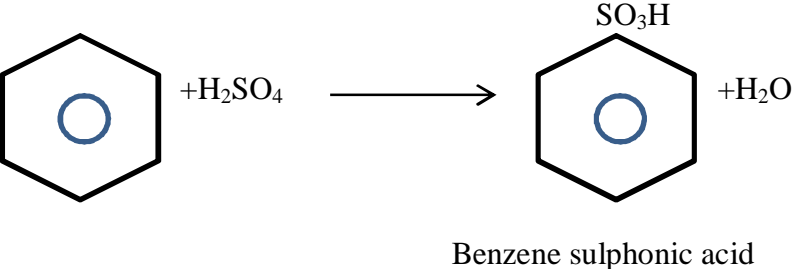
	for carbon atom.		
	Molecular weight :	1	
	It is the sum of atomic weights of all elements present in a compound.		
	Gram atom :	1	
	Gram atom = weight in gram of atom/atomic weight.		
	Gram mole	1	
	Gram mole = weight in grams /molecular weight.		
4-d	**Screening** :	1	4
	Screening is used to separate solid mixture based on size.		
	Filtration :	1	
	Filtration is used to separate solid liquid mixture or slurry using pressure force.		
	Froth flotation :	1	
	Froth flotation is used to separate solid mixture based on surface properties.		
	Mixing :	1	
	Mixing is used to mix different materials for producing simple mixtures.		
4-e	**Storage of liquids**:	2	4
	1. Open atmospheric tanks are used for storing liquids that will not be harmed by water or atmospheric prolusion.		
	2. Closed tanks with fixed roof .		
	3. Closed tanks with floating roof.		
	4. Tanks with curved surface.		
	Storage of Gas :	2	
	1. Stored by dissolving in liquid.		
	2. Stored under high pressure in pressure vessels.		
	3. Small portable pressure vessels.		
	4. Pipes buried under ground		

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4-f	**Benzene react with chlorine**		4
	chlorobenzene	2	
	Benzene heated with con. H_2SO_4 at 160^0C		
	Benzene sulphonic acid	2	
5-a	**Esterification reaction:-**The reaction of an alcohol with a carboxylic acid to produce an ester is termed as esterification.	2	4
	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.	1	
	CH_3COOH + C_2H_5OH ----------$\rightarrow$ $CH_3COOC_2H_5$ + H_2O acetic acid ethanol ethyl acetate	1	
5-b	**Distillation:**-	1	4
	- Distillation is an operation in which the components of a liquid mixture are separated using thermal energy.		
	- In this operation, liquid and vapour are involved. The vapour phase is created by supplying heat to the liquid phase.	1	

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	-This unit operation is also termed as fractionation and with this technique it is possible to separate a liquid mixture into its components in almost pure forms.		
	- In this operation mass is transferred from both the phases to one another by vaporization from the liquid phase and by condensation from the vapour phase.	1	
	- Separation of crude petroleum into a number of fractions such as gasoline, kerosene, fuel oils, lubricating oils and asphalt.	1	
	- Distillation kettles, packed columns and plate columns are used for distillation.		
5-c	**Flow sheet of manufacturing of Nitric acid:**	4	4

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PROCESS FLOW SHEET FOR PRODUCTION OF NITRIC ACID BY
OXIDATION OF AMMONIA

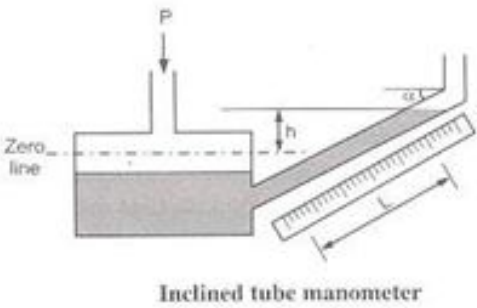|			
5-d	**Oxidation:** It is defined as the addition of oxygen or removal of hydrogenation from organic compounds. - Oxidation reaction may involve the introduction of oxygen in the molecule of a compound. Oxidation of acetaldehyde: CH_3CHO + $\frac{1}{2} O_2$ ---------→ CH_3COOH Acetaldehyde acetic acid - Oxidation reaction may involve the removal of hydrogen from the molecule	1 1 1	4

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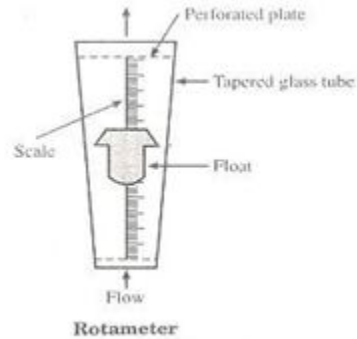|			
	of a compound.		
	Oxidation of methane:		
	Metal oxide		
	CH_4 + O_2 ----------------------$\rightarrow$ HCHO + H_2O		
	Methane Heat Formaldehyde	1	
	Any example written by the student should be given marks.		
5-e	**Yield:**	2	4
	-Yield of desired product is the ratio of the quantity of product actually obtained to its maximally obtainable quantity.		
	OR		
	Yield of desired product is defined as the ratio of amount of a limiting reactant reacted to form the desired product to total reacted quantity of limiting reactant by all possible reaction.		
	-The term yield is applicable to the desired product of a chemical process.		
	- This term is applicable to desired product of reaction.		
	Selectivity: Selectivity may be defined as the ratio of the moles of the desired product to undesired or by product produced in a sid reaction.	2	
	-Selectivity are applicable to a set of chemical reaction-complex reaction		
5-f	**Gas Absorption:**	3	4
	-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 dissolved a definite component of the gas mixture in the liquid.		
	- Gas absorption is usually carried out in packed columns.		
	Example:		

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|			
	1) Absorption of ammonia from an air- ammonia mixture by water	1	
	2) Removal of hydrogen sulfide from naturally occurring hydrocarbon gases.		
6-a	**Gauge Pressure:** The gauge pressure is the pressure above the atmospheric pressure.	1	4
	Absolute Pressure: The absolute pressure is the actual pressure. It is also called 'True total pressure'	1	
	Atmospheric Pressure: Atmospheric pressure is the pressure exerted by air present in atmosphere on earth surface	1	
	Relationship among them : Absolute Pressure = Gauge Pressure + Atmospheric Pressure Absolute Pressure = Atmospheric Pressure - Vacuum	1	
6-b	**Diagram of Inclined tube manometer:** Inclined tube manometer	4	4
6-c	**Rota meter:**	2	4

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-state, it is recorded as rotameter reading from the scale provided. It is used for flow measurements of liquids and gases.

| 6-d | **Measurement of Viscosity of liquid using Redwood Viscometer:** | | 4 |

: Redwood viscometer
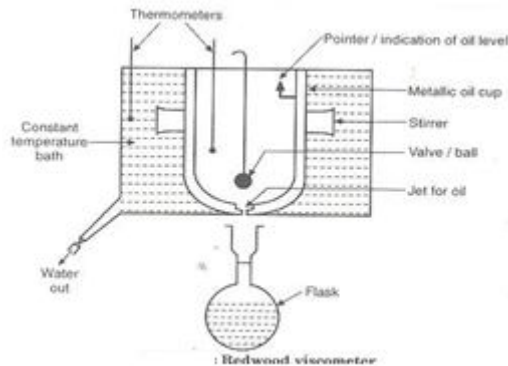
Working of Redwood Viscometer:

1. Oil at given temperature is filled into the oil cup upto the tip of the pointer.

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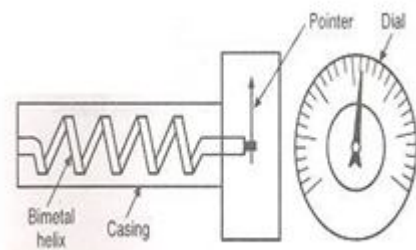
	2. The temperature of oil is kept at a constant temperature by the addition of hot water in the heating bath. 3. When the oil temperature remains constant at a desired value for five minutes, the oil is allowed to flow through the jet by lifting the metal ball. 4. The time in seconds required to fill the oil in the flask up to the Mark is noted accurately with the help of a stop-watch. 5. The viscosity of oil is described in seconds		
6-e	**Purpose of personal protective devices 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	4	4
6-f	**Bimetallic Thermometer:**		4
		2	

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Working of Bimetallic Thermometer:

1. When the thermometer is put into a hot bath, inside bimetal expands.
2. Because the helical element starts to rotates at the free end.
3. This free end rotation, coupled to a pointer via steam Pointer moves on calibrated dial scale to indicate the temperature.

2