SUMMER-2018 EXAMINATION

Model Answer

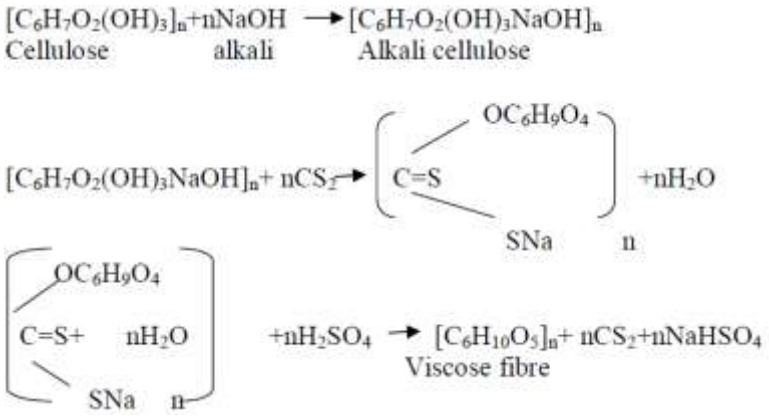
Subject Name: Chemical Process Technology **Subject Code:** 17427

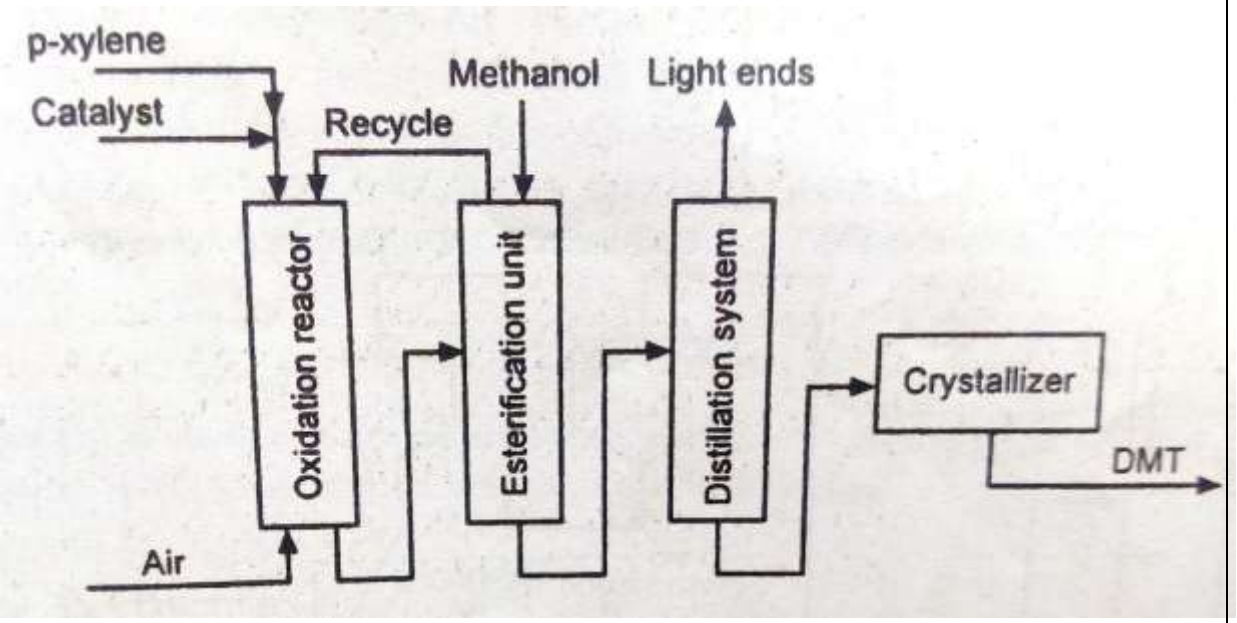
Important Instructions to examiners:

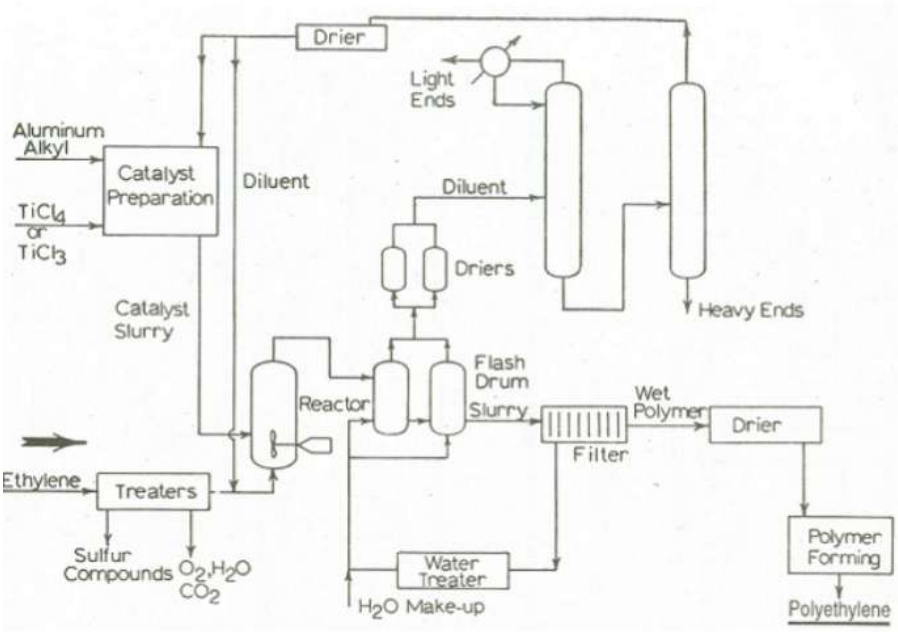
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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.

<table>
<tr><th>Q. No.</th><th>Sub Q. N.</th><th>Answer</th><th>Marking Scheme</th></tr>
<tr><td>1</td><td>A</td><td>Attempt any six</td><td>12</td></tr>
<tr><td></td><td>a</td><td>Comparison between addition and Condensation polymerization
<table>
<tr><th>Addition polymerization</th><th>Condensation polymerization</th></tr>
<tr><td>In this the monomer molecules simply add together to form chains under suitable conditions of temperature and pressure and initiator</td><td>In this a new bond is formed between the monomers by elimination of small molecules like water under suitable conditions of temperature and pressure</td></tr>
<tr><td>This type of polymerization can only occur when monomer molecule is unsaturated</td><td>The reaction by which this polymerization takes place is condensation reaction</td></tr>
<tr><td>Polymers formed by addition polymerization are thermoplastics.</td><td>Condensation polymerization is used to form simple hydrocarbons</td></tr>
<tr><td>Ex. Polyethylene is produces by the addition polymerization of ethylene monomers.</td><td>ex. Production of phenol formaldehyde from phenol and formaldehyde monomers with condensation of water</td></tr>
</table></td><td>1 mark each for any two differences</td></tr>
</table>

	b	**Uses of paper** 1. Newspaper 2. Books and magazine 3. Currency printing 4. Packaging 5. Cleaning 6. Decorative	½ mark each for any four
	c	**Raw material for Paper** • Babmoo • Agricultural residue • Bagasse, • Cereal straw • Reeds • Esparto grass • Jute • Flax • Sisal • Softwood (spruce, pine, fir, larch, aspen, eucalyptus)	2
	d	**Uses of phenol** for production of • formaldehyde • epoxy resins • herbicides, • insecticide In pharmaceutical industry	½ mark each for any four
	e	**Saponification value** It is the no. of milligrams of KOH required to saponify one gram of an oil or fat.	1

		Iodine value Iodine value is the no. Of grams of iodine absorbed by 100 grams of oil or fat for its complete saturation.	1
	f	**Reaction for manufacturing of Viscos Rayon**  	2
	g	**Difference between paint and varnish** **Paint** / **Varnish** Paint is the mechanical dispersion mixture of one or more pigments in a vehicle. / Varnish is a homogenous colloidal dispersion solution of resin in oils or thinner or both. A paint contains pigment. / Varnishes do not Contain Pigments. Paint Produce an opaque film. / Varnish produces transparent film. In paints pigments are dispersed in drying oils. / In varnishes resins are dispersed in oils or spirits.	1 mark each for any two
1	**B**	**Attempt any two**	**8**
	a	**Constituents of paint** **Pigments: -** It is finely divided solids generally made up metal oxides .It is used to give color to paint. **Drying oil: -** These are unsaturated oils. It is used to form protective film and give gloss.	1 mark each

		Thinners or solvent: - It is alcohols or turpentine. is used to dissolve polymers in paint and to disperse pigments (emulsion formation).It adjust viscosity, form thin film. **Plasticizer: -** These are polymers. Used to impart elasticity to paint.	
	b	**Manufacturing process of acetic acid from acetaldehyde** The continuous oxidation of CH_3CHO in liq. phase is carried out by using air or O_2 in presence of manganous acetate. The reaction mix containing CH3CHO diluted with crude acid & manganous acetate solution is circulated upward through oxidation tower. Reaction condition when air is used 55^oC-65^oC & 5 atm. Press and when O_2 used then temp 700c-800c and press sufficient to keep the acetaldehyde in liquid state. The reaction mix is drawn off from top of oxidation tower and distilled continuously in three distillation columns. The crude acetic acid is fed to the top of distillation column and other volatile components are withdrawn as overhead and residue containing manganous acetate is removed at the bottom. **Reaction** $CH_3CHO + ½ O2 = CH_3COOH$	4
	c	**PFD of DMT manufacturing** 	4
2		**Attempt any four**	**16**

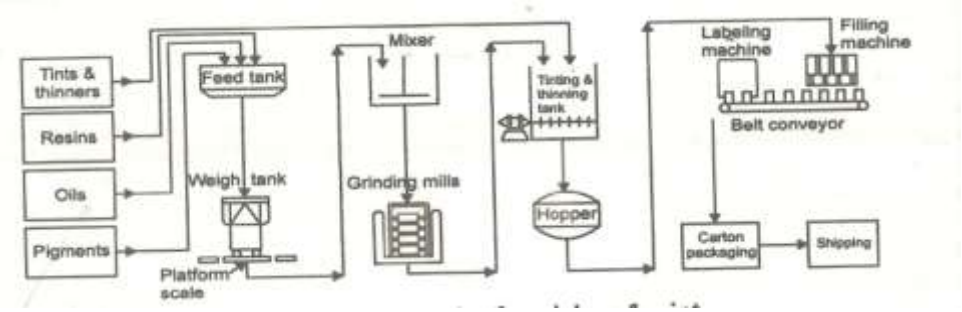
	a	**Ziegler process for the manufacturing of polyethylene**  	4
	b	**Hydrogenation of Oil** The dry pure oil and nickel catalyst is taken in an iron cylinder. The cylinder has two inlets & outlets. One inlet is used for the introduction of oil & the other to introduce dry hydrogen. Unused hydrogen is removed through the upper outlet, while lower outlet is used to take the hydrogenated oil. The cylinder is provided with stirrer inside it. The temp. is regulated between140^{o}C-180^{o}C. From the second inlet, pure hydrogen gas is well mixed with the oil. In the cylinder oil &dry hydrogen gas are well mixed with mechanical stirrer. After certain time a sample of hydrogenated oil is taken through outlet is situated at the bottom of the cylinder. The iodine value of the hydrogenated oil is determined. If it is 60, the process of hydrogenation is stopped. And all the hydrogenated oil is taken out It is passed through cooler then filter pressed to remove nickel particles.	4
	c	**Properties of phenol** 1. Molecular wt =94.11 2. MP = 42oC 3. BP =181.4oC	1 mark each for any four

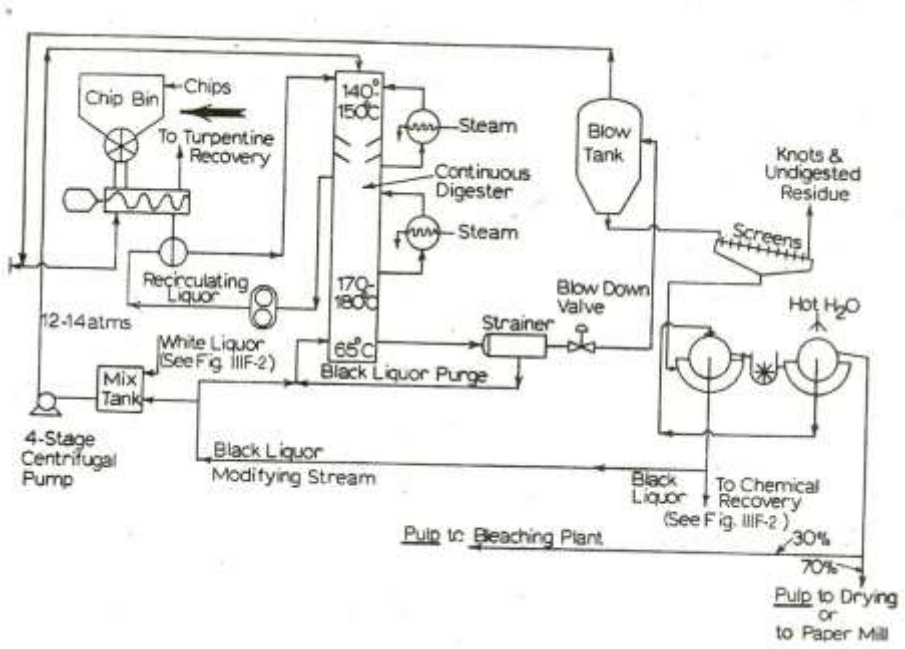
<table>
<tr><td></td><td></td><td>4. Density @25oC = 1.07
5. Appreciably soluble in water
6. Toxic in nature</td><td>properties</td></tr>
<tr><td></td><td>d</td><td>Lacquers : They are dispersion of cellulose or other cellulose derivatives, resins and plasticizers in solvents
Constituents of lacquers and their functions.
<table>
<tr><th>Constituent</th><th>Function</th></tr>
<tr><td>1. Film forming material</td><td>Durability, Hardness, adhering capacity, water resistance</td></tr>
<tr><td>2. Extenders</td><td>To reduce cost and viscosity</td></tr>
<tr><td>3. Solvents</td><td>To suspend pigment and to dissolve film forming material.</td></tr>
<tr><td>4. Plasticizer</td><td>To reduce brittleness and to improve adherence</td></tr>
<tr><td>5. Pigments</td><td>To give aesthetic- appearance to reflect light etc</td></tr>
</table></td><td>1

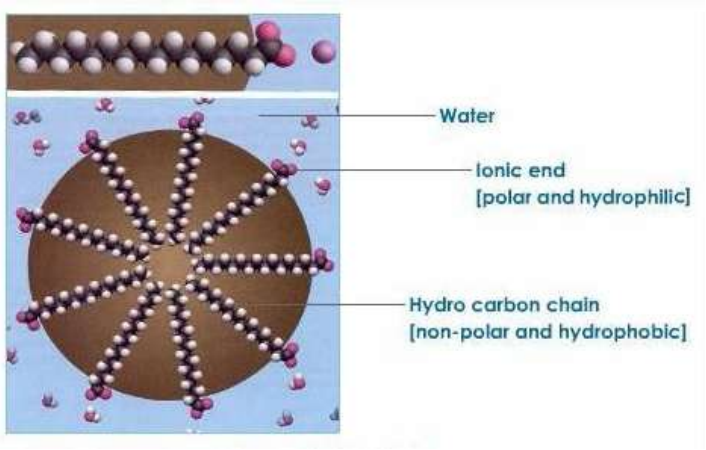
1 mark each for any three</td></tr>
<tr><td></td><td>e</td><td>Classification of detergents
Anionic Detergents
Anionic means a negatively charged molecule. In the early days I always remembered this by <u>an</u>ionic (<u>a</u> <u>n</u>egative). The detergency of the anionic detergent is vested in the anion. The anion is neutralised with an alkaline or basic material, to produce full detergency.
e.g. linear alkylbenzene sulfonates
Cationic Detergents
Cation means positively charged. The detergency is in the cation, which can be a substantially sized molecule. Strong acids are used, such as Hydrochloric Acid to produce the Cl anion as the “neutralising” agent, although in essence, no neutralisation takes place in the manufacturing process.
e.g cetyltrimethylammonium bromide
Nonionic Detergents</td><td>4</td></tr>
</table>

		As the name implies, no ionic constituents are present. They are "ionically" inert. e.g Alcohol Ethoxylate **Amphoteric Detergents** These contain both acidic and basic groups in their molecule, and can act as cationic or anionic detergents, depending on the pH of the solution, or as both cation and anion. e.g Amine oxide	
	f	**Oxo Process** Propylene is compressed to 250 atms and cobalt napthenate added to give 0.5-1 % Co in solution. This stream is passed co currently through packed tower containing porous carrier with 2% metallic cobalt deposited. The reaction is highly exothermic & temp. of 170 deg.C is controlled by recycle of a portion of the product streams after cooling. The liquid fraction is mixed with steam at 180 deg.C & low pressure of 20atm.to decompose the Co carbonyl & naphthenate, depositing the Co on porous carrier as the oxide. These CO is dissolved periodically in an acid wash & converted to the naphthenate for reuse. The unconverted synthesis gas from the oxo converter is recompressed & recycled. The crude butyraldehyde can be fractionated for product sale or continuously hydrogenated using fixed bed Ni catalyst,100 atm,H_2 press., & 150^0C. The resulting butanols are fed to distillation section comprising several fractionating columns in series. Light & heavy ends as by-product obtained in addition to the purified alcohol.	4
3		**Attempt any four**	**16**
	a	**Production of paper from pulp** Conversion of fibre suspension into paper sheet incorporates three principal steps. i) **Forming wet-web** : A wet sheet is formed by running 99.5% water-fibre slurry evenly into a moving endless belt of wire cloth at speed of 50 m/min for a fine paper to 500 m/min for newsprint. Water drain by gravity , apart is next removed by a pressure roll and then by suction roll. The screen also has a side wise shaking motion to give better interlocking of fibre on the mat. The water collected in this section of machine is called white water and is reused to obtain maximum recovery of fibre.	4

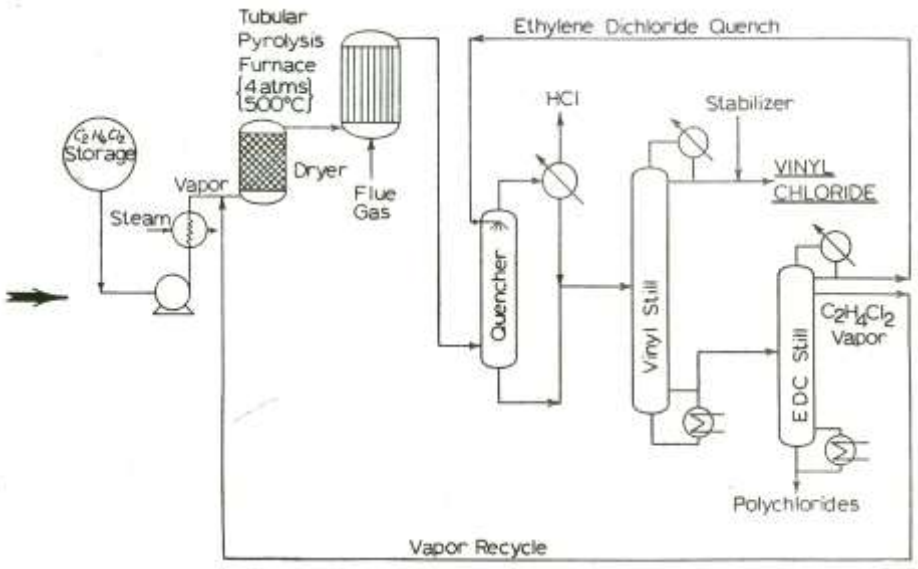
		ii) **Pressing the wet sheet** : The wet paper wheet containing about 80% water is fed via felt roll to the press section where water is removed by mild pressure to reduce content to 60-65% water. Bond or water mark, if needed is formed on sheet during pressing. iii) **Drying of sheet** : The sheet from the press section has sufficient strength to carry its own weight as it passed through smoothing rolls, then a series of steam heated metal cylinders where heat and moisture are transferred to a felting or canvas belt running on top of the paper. As the sheet leaves the east drying roll with 5-6% water, it passes through final series of pressure or calendaring rolls to produce a smooth well-finished paper. It is wound on large roll and transferred to finishing department where it may be cut, coated and packaged.	
	b	**Phenol by toluene oxidation process** A two-stage air oxidation process is used. In the first stage, fresh plus recycle toluene are mixed with a small quantity of cobalt naphthenate catalyst and charged to the reactor which is a liquid-filled tower through which air is sparged. Cooling tubes are provided to remove the exothermic heat of reaction. The reactor is run at 150^{o}C and 3 atms. Excess air is used, but toluene conversion is limited to 40% to avoid excessive side reactions, These give by-products such as benzaldehyde, benzyl alcohol, benzyl benzoate, CO and CO_2.With conversion of toluene at 40% the ultimate yield of benzoic acid is about 90%. Off-gases from the reactor are vented through a water-cooled condenser to remove water and to allow return of toluene. Liquid from the reactor continuously passes to a distillation column which strips the toluene and other volatile by-products from the acid fraction in the bottoms. Purified benzoic acid is separated by extracting the bottoms with hot water, then crystallizing and filtering the crude benzoic acid. The latter can be recrystallized to meet USP specifications as a market outlet for benzoic acid. To make phenol, the crude acid is melted, mixed with cupric benzoate catalyst, then charged to an air-sparged tower containing cooling tubes and mechanical agitation,. Reactor	4

		conditions are 220°C and 13-17 atms. Excess air is again necessary to get a 70-80% conversion of benzoic acid with a yield of 90% phenol. The overall process yield for the two steps is about 80%. Phenol product is obtained by continuously distilling the reactor liquor into a fractionating column where unreacted benzoic acid is returned to the reactor. Non-condensable such as N_2, O_2 and CO_2 are vented through a condenser along with the condensable fraction phenol-water. Phenol is withdrawn as the bottom layer in a separator. This crude phenol is again fractionated with purified phenol coming off as bottoms and the overhead phenol-water azeotrope sent to another column for splitting. The heavy ends in the benzoic acid oxidation tower are water-extracted to recover phenol and benzoic acid which are then recycled, after concentration, to the second stage oxidation tower.	
	c	**Paint**  The weighing assembling, and mixing of the pigments and vehicles takes place on the top floor. The mixer may be similar to large dough kneader with sigma blades. The batch masses are conveyed to the floor below, where grinding & further mixing takes place. A variety of grinding mills are used. After mixing, the paint is transferred to the next to the next lower floor, where it is thinned & tinted in agitated tanks, which may hold batches of several thousand litres. The liquid paint is strained into a transfer tank or directly into the hopper of the filling machine on the floor below, centrifuges, screens or press. Filters are used remove non dispersed pigments. The paint is poured into cans or drums, labeled, packed & moved to storage each step being	2 2

		completely automatic.	
	d	**Uses of** *Polyethylene:* Household utensils, packaging films, bottles, bucket, tubes, cable sheeting storage tanks etc. *Polystyrene:* disposable plastic cutlery and dinnerware, CD "jewel" cases, smoke detector housings, license plate frames, plastic model assembly kits *Polyester:* Textile, fishing nets, filter cloth. Conveyor belt *Poly vinyl chloride:* Pipes, raincoats, cables, vinyl flooring	1 mark each for any one use of each
	e	**Pulp production by sulphate process**  	4
	f	**Applications of butanol (any four)** • As a fuel • As a solvent For production of ether • Plasticizer • Butyl acrylate • N butyl acetate	1 mark each for any four

		• glycols	
4		**Attempt any four**	**12**
	a	**Cleansing action of soap** The dirt on skin or cloth sticks due to greasy matter. When rubbed with soap solution, it is easily washed away. Soap molecule has a polar end (-COO-Na+) and a non polar end (a long carbon chain of 12 to 18 carbons). The polar end is water soluble while the non polar end is oil soluble. Normally oil droplets in contact with water tend to coalesce to form oil layer and aqueous layer. The non polar ends of soap molecules dissolve in the oil droplet leaving the carboxyl ate ends projecting into the surrounding water. Due to the presence of negatively charged carboxylic groups, each of the oil droplets surrounded by an ionic atmosphere. Oil droplets do not coalesce due to the repulsion between similar charges thus stable emulsion of oil in water is formed. In this way soap cleans by emulsifying the fat or grease containing dirt.  	3 1
	b	**Phenol production by Raschig process** The Raschig process has two vapour-phase catalyst stages. Purified benzene is fed to a heater, packed reactor containing ferric chloride & cupric chloride catalyst. Chlorination with HCl-O_2 at 220^0C occurs with a short residence time to produce 10-20% conversion of benzene. Fractionation separates unreacted benzene from chlorobenzene & polychlorobenzene. The crude chlorobenzene is scrubbed with phenol, water washed & sent to the second catalytic stage. Here it is hydrolyzed in a tubular high temp furnace with either SiO_2 or	4

		$Ca_3(PO_4)_2$ as the catalyst. Phenol from the hydrolyzer is washed with water, then extracted by benzene & finally purified by two stage distillation. HCl vapours from the high temp catalytic hydrolyzer is recycled to the hydrochlorination stage	
	c	**Difference between sulphate and sulphite process** **Sulphate Process** / **Sulphite Process** This process is alkaline in nature due to use of caustic and sodium carbonate / This process is acidic in nature due presence of sulfur dioxide. Cooking chemicals are recovered from black liquor / Sulfur dioxide is recovered. Pulp produced by the kraft process is stronger than that made by other pulping processes / Acidic sulfite processes degrade cellulose more than the kraft process, which leads to weaker fibers. Fiber yield is less. / Fiber yield is more. Comparatively difficult to bleach the pulp. / Can be bleached easily.	1 mark for each point in both processes. (any four)
	d	**Chemical reactions involved in the mfg. of alcohol from molasses** Invertase $C_{12}H_{22}O_{11}$ ----------> $C_6H_{12}O_6 + C_6H_{12}O_6$ sucrose yeast Glucose fructose zymase $C_6H_{12}O_6$ ---------→ $2\ C_2H_5OH + 2CO_2$ Glucose yeast alcohol **Chemical reactions involved in the mfg. of acetic acid** $CH_3CHO + ½\ O2 = CH_3COOH$	3 1
	e	**Varnish** Varnish is defined as homogeneous colloidal dispersion solution of natural or synthetic resins in oils or thinner or both. **Uses** For the protection of articles against corrosion	2 1 mark each for

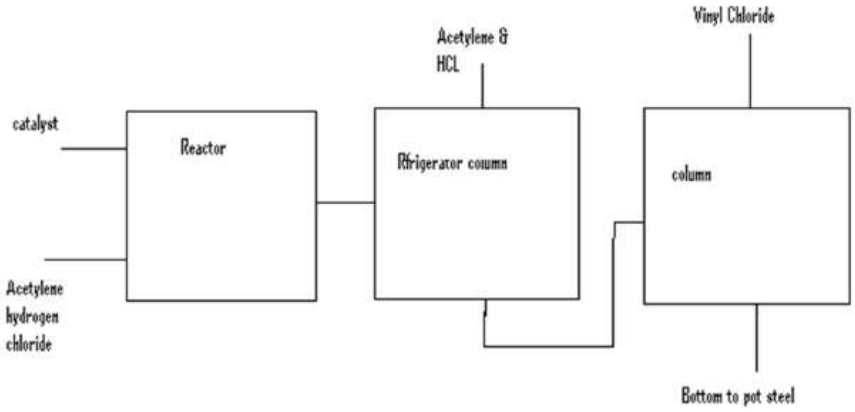
		As brightening coat to the painted surface Improving the appearance & intensifying the ornamental grains of wood surfaces.	any two
	f	**Manufacturing of vinyl chloride (thermal cracking)** When heated to 500 °C at 15–30 atm (1.5 to 3 MPa) pressure, EDC vapor decomposes to produce vinyl chloride and anhydrous HCl. $ClCH_2CH_2Cl \rightarrow CH_2=CHCl + HCl$  The thermal cracking reaction is highly endothermic, and is generally carried out in a fired heater. Even though residence time and temperature are carefully controlled, it produces significant quantities of chlorinated hydrocarbon side products. In practice, EDC conversion is relatively low (50 to 60 percent). The furnace effluent is immediately quenched with cold EDC to stop undesirable side reactions. The resulting vapor-liquid mixture then goes to a purification system. Some processes use an absorber-stripper system to separate HCl from the chlorinated hydrocarbons, while other processes use a refrigerated continuous distillation system.	4

OR

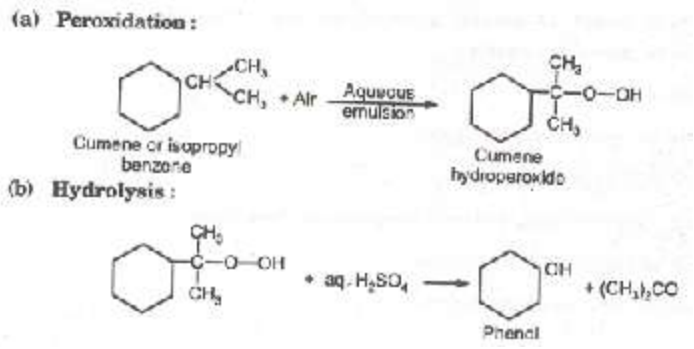
Manufacturing of vinyl chloride (acetylene process)

The vapor phase reaction between acetylene and hydrogen chloride in presence of mercuric chloride catalyst gives vinyl chloride. Anhydrous HCL gas and pure dry acetylene are mixed and fed to reactor. The reaction is exothermic so coolant is circulated to keep temperature 160-250^{o}C the gases are condensed the acid free monomer is further fractionated in second refrigerated column where vinyl chloride is obtained which is stabilized with phenol.

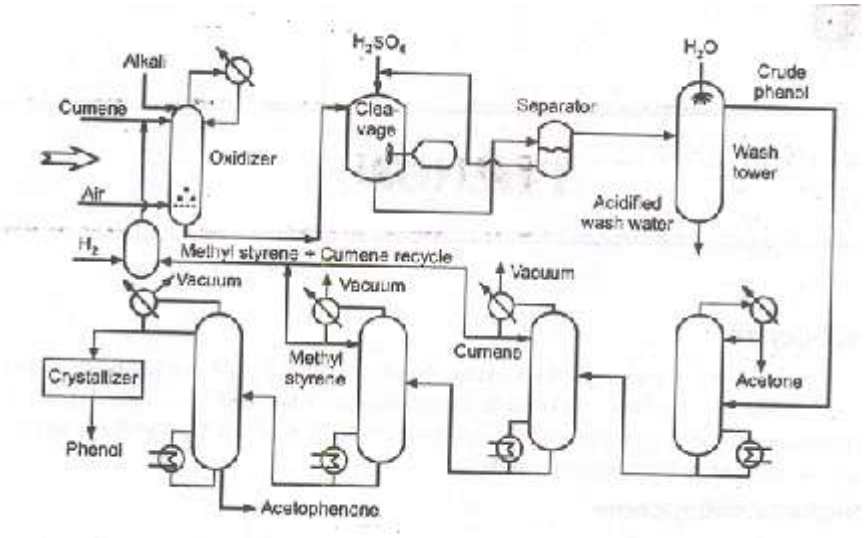
$C_2H_2 + HCl \rightarrow CH_2=CHCl$

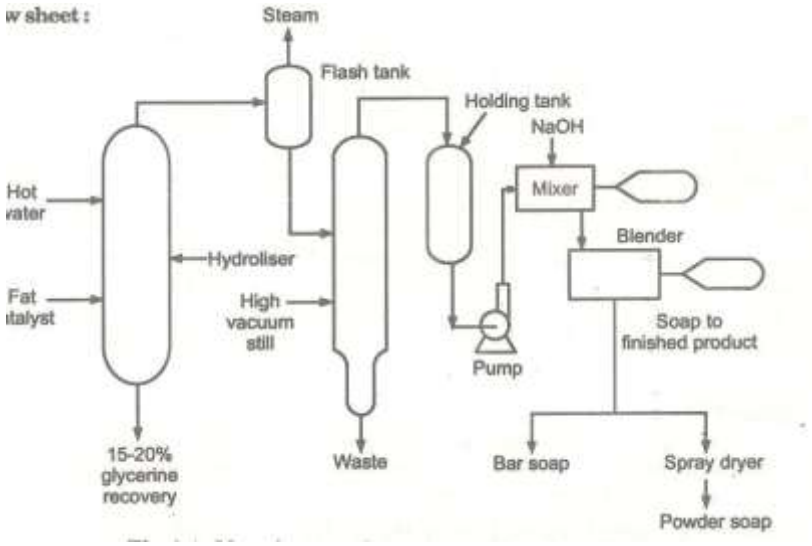


5		**Attempt any two**	**16**
	a	**Manufacturing of Phenol from Cumene**	2

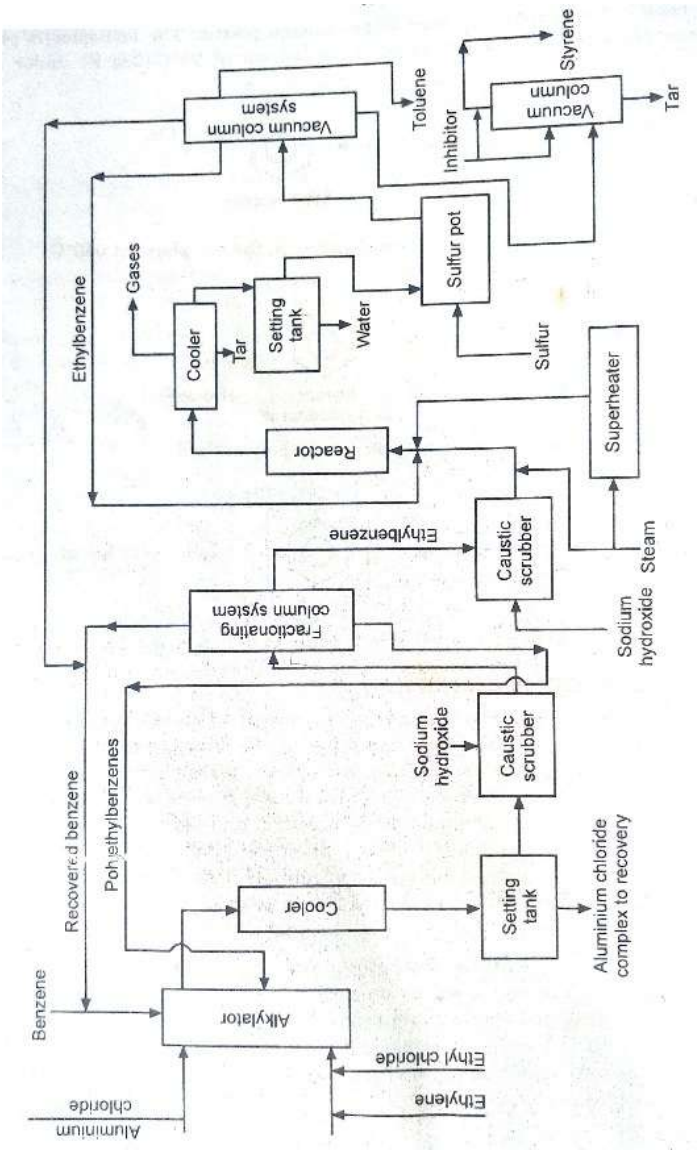


Process description: Cumene is mixed with recycle cumene & send to the hydrogenerator. Unsaturated compounds are converted to saturated materials to avoid undesirable

		decomposition of the peroxide during the oxidation step.H2 over nickel catalyst at 1000c in a batch reactor is used for purification. Oxidation is carried out in the presence of air in an aqueous emulsion stabilized by an alkali such as sodium carbonate in the 8.5-10.5 pH range. Vent gases are passed through a condenser to recover hydrocarbon. The cumene peroxide thus formed is cleaved in an acidifier containing 10-25% H_2SO_4 . This is an agitated vessel at 55-650C . The reaction products are separated into an aqueous acid layer for recycle to the cleavage vessel and an oil layer containing 76 wt % cumene,14% phenol,8% acetone % 1-2% α- methyl styrene & acetophenone. This mix is separated in a series of four distillation steps, that last three of which are under vacuum. Phenol is the overhead of the last vacuum fractionator.  	2 4
	b	**Soap by continuous process** **Process** Glycerides plus catalyst are added at the bottom of the hydrolysis tower where high pressure water at 230-250oC is passed countercurrently to the glycerides. And triglycerides are brake into fatty acid and glycerin with a 15-20% glycerin solution being removed from bottom of the tower. The fatty acid is passed overhead to a flash tank to remove excess steam. The crude fatty acid are vacuum distilled and the condensate in the distillate receiver is either available as a marketable product or for soap mfg.	4

		Caustic soda is added to fatty acid in a continuous high speed mixture and the saponification is completed in a slow speed blender where other ingredients are added if desired. Soap from the blender may be pumped through heated lines to bar soap or flake or spray drying equipments followed by packing operations.  **Chemical Reaction -:** **a) Fat splitting-:** $(R.COO)3.\ C3H5 + 3H2O \rightarrow 3R.COO.H + C3H5(OH)3$ **b) Saponification**-: $R.COO.H + M\ .\ OH \rightarrow R.COO.M + H2O$ Where M is usually an alkali metal such as **Na** or **K**	2 2
	c	**Manufacturing of Polystyrene** Benzene is alkylated with ethylene in the presence of aluminum chloride. Dry benzene and ethylene are continuously fed to an alkylating tower operating at atm pressure. Small amount of ethylene chloride is added as a catalyst promoter .Granulated $AlCl_3$ is used as a catalyst. The crude ethyl benzene from settling tank is washed with 50% caustic solution to neutralize it. Purified ethyl benzene is heated with steam Sulfur is continuously mixed in the reactor. Crude styrene stream contains 37% styrene and 61% ethyl benzene. Styrene is obtained by	3

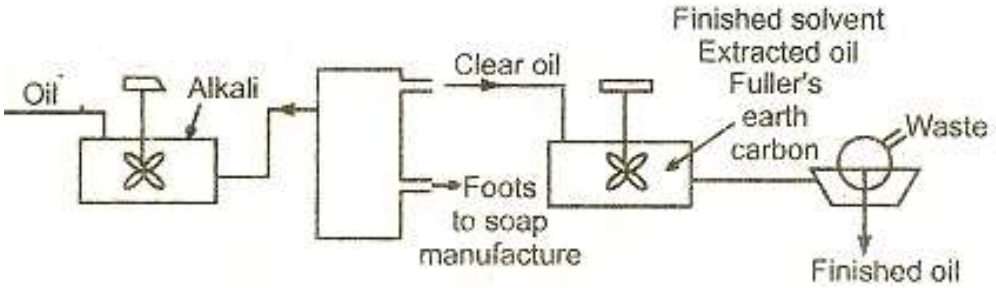
distillation of this stream.



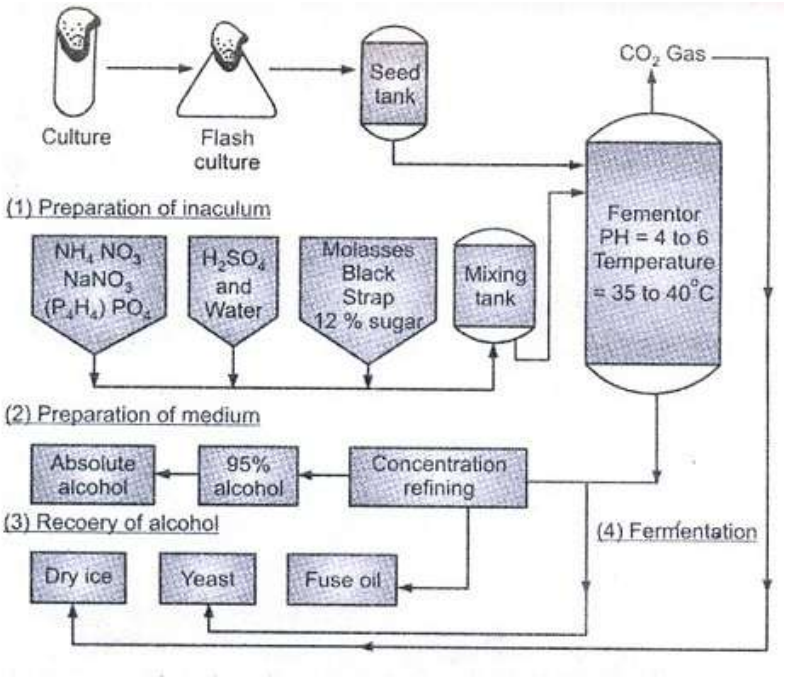
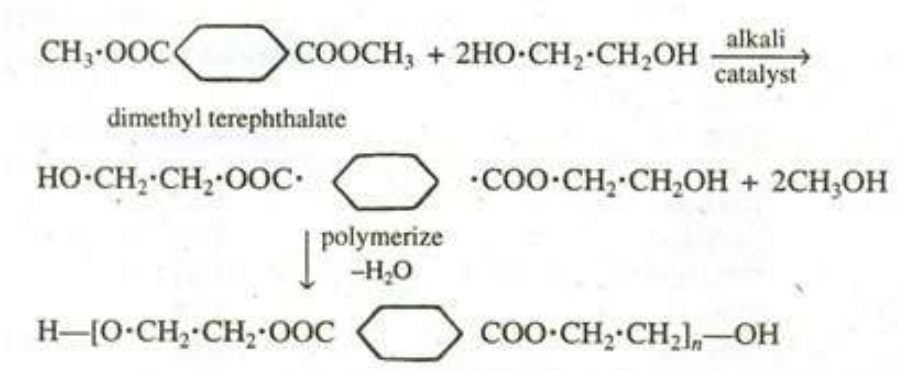
3

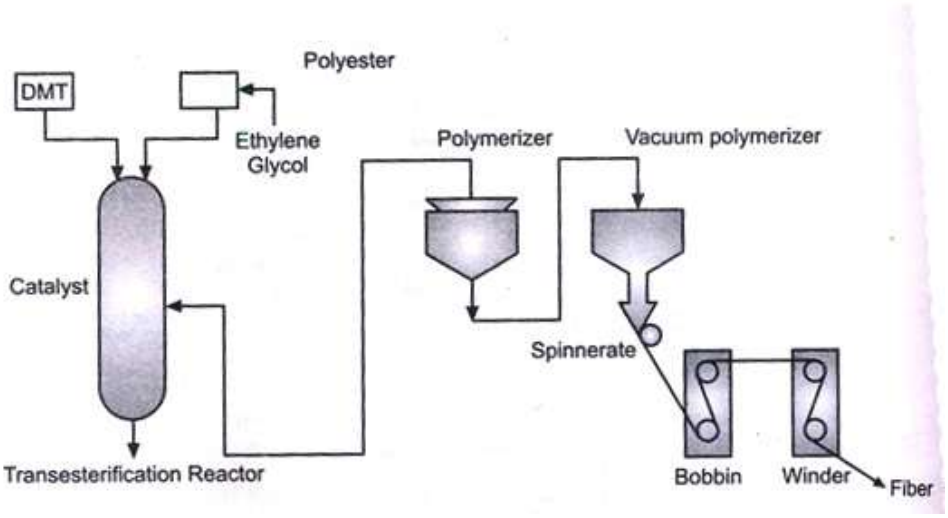
Polystyrene production is carried out by free radical initiation or by coordinated catalyst. Bulk suspension and emulsion polymerizations are in use. In emulsion polymerization initiators are per-sulphates and emulsifiers are soap. Polymerisation is accomplished 3-5 m^3 enameled reactors fitted with water jacket stirrer and reflux condenser.

The monomer is Suspended in aqueous phase using a stabilizer, sodium sulphate is added to control pH A thorough agitation keeps the monomer suspended in medium. The aqueous phase emulsified and mixed with monomer. The emulsion is sent into reactor which is kept &

		heated at 60 ^{o}C. The polymerization is carried out in nitrogen atm. Catalyst is added into the reactor. The reaction takes place for 3-6 hrs, after which sent into coagulator. The polymer formed the latex is separated by centrifugation. The polymer is washed & sent to drier. **Reactions** $C_6H_6 + H_2C=CH_2 \rightarrow C_6H_5CH_2CH_3$ $C_6H_5CH_2CH_3 \rightarrow C_6H_5CH=CH_2 + H_2$ $C_6H_5CH=CH_2 + H_2 \rightarrow [C_6H_5\text{-}CH_2\text{-}CH_2\text{-}]n$	2
6		**Attempt any two**	**16**
	a	**Refining of Oil** The colour and flavor to fats of edible and non-edible oils is mainly due to presence of non-glyceride components. Free fatty acids, waves, coloured bodies, mucilaginous materials, gossypol compounds (found only in cottonseed oil) and phosphatides are responsible for the undesirable properties of fat or oil used for edible purposes and industrial applications. Most of those compounds are removed by treatment with aqueous solution of caustic soda at 40^{o} -85^{o}C . It reduces fatty acid contents to 0.01%. This process of refining is carried out in a tank called batch. The aquous emulsion of soaps formed from fatty acids along with the other impurities (soap-stock) settles to the bottom and is taken out. Then refined oil is washed with water to remove traces of alkali and soap stock. Oils which are refined with soda ash or ammonia generally require a treatment with caustic soda. After water-washing., the oil is dried by heating in a vaccum or by filtering through dry filter and material. This refined oil is used for industrial purposes or may be processed further to achieve food value.  	5 3

	b	**Manufacture of Alcohol from Molasses :** **i) Raw materials :** **1. Molasses (Black strap) :** Molasses is considered as the mother liquor left after the removal of sugar crystals. Hence, it is a by-product of the sugar industry. It contains about 55% sugar (2/3 sucrose and 1/3 invert sugar. **2. Yeast :** **i. Selected strains of saccharomyces cerevisiae :**are commonly employed for fermentation. It produces a large amount of alcohol. Yeast is a source of different enzymes. **ii. Preparation of inoculum :**From the selected strains of yeast, the inoculum is prepared. The starter containing yeast is in its log phase. The yeast developed in a seed tank should be pure and free from contamination and mutation. **iii. Preparation of medium :**The molasses is difuted with water to 10 to 18%. These molasses can be used directly as fermentation medium. Nutrients such as ammonium sulphates or ammonium phosphate may be added to improve the quality of fermentation. The pH value of the medium is adjusted to 4 or 5 by adding sulphuric or lactic acid. Lactic acid is particularly beneficial as it inhabits the growth of butyric acid bacteria. pH below 5 inhibits lactic acid bacteria. Other possible microbial contaminants are inhibited by high sugar and alcohol concentration and the anaerobic condition of the fermentation. /as a result of these considerations, the molasses medium is not sterilized. iv. **Fermentation** : Alcoholic fermentation is an example of anaerobic fermentation. Fermentation has therefore to be carried out in the absence of oxygen. In alcoholic fermentation, the carbon dioxide produced pushes out air and automatically creates an anaerobic atmosphere. The fermentation reaction being exothermic, the fermenter get heated and no temperature control is needed. The fermentation is carried out for 50 hours at 30 to 40^{o}C in fermenter, after mixing yeast starter and medium. v. **Recovery** : The fermented mesh (beer) is distilled to obtain pure ethyl alcohol. The fractions containing 60% alcohol are known as high wine. These fractions are then	3 marks for raw materials and process

		distilled to get 95% alcohol (raw spirit). Because of the lability of alcohol to form an azeotropic mixture containing 5% water ever after successive distillation only 95% alcohol is obtained. To prepare absolute ethanol, the 5% water is removed by forming aazeotropic mixture of benzene, water and ethanol which is then distilled with increasing temperature.  **Factors affecting** :- Temperature, C/N ration, substrate concentration	4 1
	c	**(ii)Reactions involved in polyester manufacturing**  	4

		(i)PFD for manufacturing of polyester  	4