Ministry of higher education
Higher institute for engineering
and Technology
New Damietta
Course title: petrochemicals

First Semester (Dec. 2017)
Final exam
Level five
Time allowed: 3 hours
Full Mark: 60 Marks

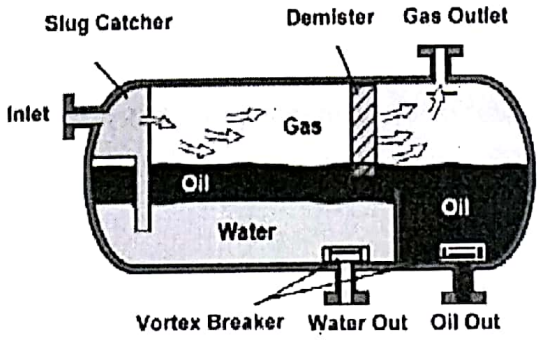
Model Answer

Question No. 1 **[20 marks]**

a) Draw a sketch for crude oil separator and list its type **[5 marks]**

The main separators shown here are gravity types. On the right, you see the main components around the first stage separator. As mentioned before, the production choke reduces well pressure to the HP manifold and first stage separator to about 3-5 MPa (30-50 times atmospheric pressure). Inlet temperature is often in the range of 100-150 ºC. On the example platform, the well stream is colder due to subsea wells and risers.The pressure is often reduced in several stages. In this instance, three stages are used to allow the controlled separation of volatile components. The idea is to achieve maximum liquid recovery and stabilized oil and gas, and to separate water. A large pressure reduction in a single separator will cause flash vaporization, leading to instability and safety hazards.

The retention period is typically 5 minutes, allowing gas to bubble out, water to settle at the bottom and oil to be taken out in the middle. In this platform the water cut (percentage water in the well flow) is almost 40%, which is quite high. In the first stage separator, the water content is typically reduced to less than 5%. At the crude entrance, there is a baffle **slug catcher** that will reduce the effect of slugs (large gas bubbles or liquid plugs). However, some turbulence is desirable as this will release gas bubbles faster than a laminar flow. At the end, there are barriers up to a certain level to keep back the separated oil and water. The main control loops are the oil level control loop (EV0101 20 above) controlling the oil flow out of the separator on the right, and the gas pressure loop at the top (FV0105 20, above). The loops are operated by the control system. Another important function is to prevent **gas blow-by,** which happens when a low oil level causes gas to exit via the oil output, causing high pressure downstream. There are generally many more instruments and control devices mounted on the separator. These will be discussed later. The liquid outlets from the separator will be equipped with **vortex breakers** to reduce disturbance on the liquid table inside. This is basically a flange trap to break any vortex formation and ensure that only separated liquid is tapped off and not mixed with oil or water drawn in through these vortices. Similarly, the gas outlets are equipped with **demisters**, essential filters that remove liquid droplets in the gas.



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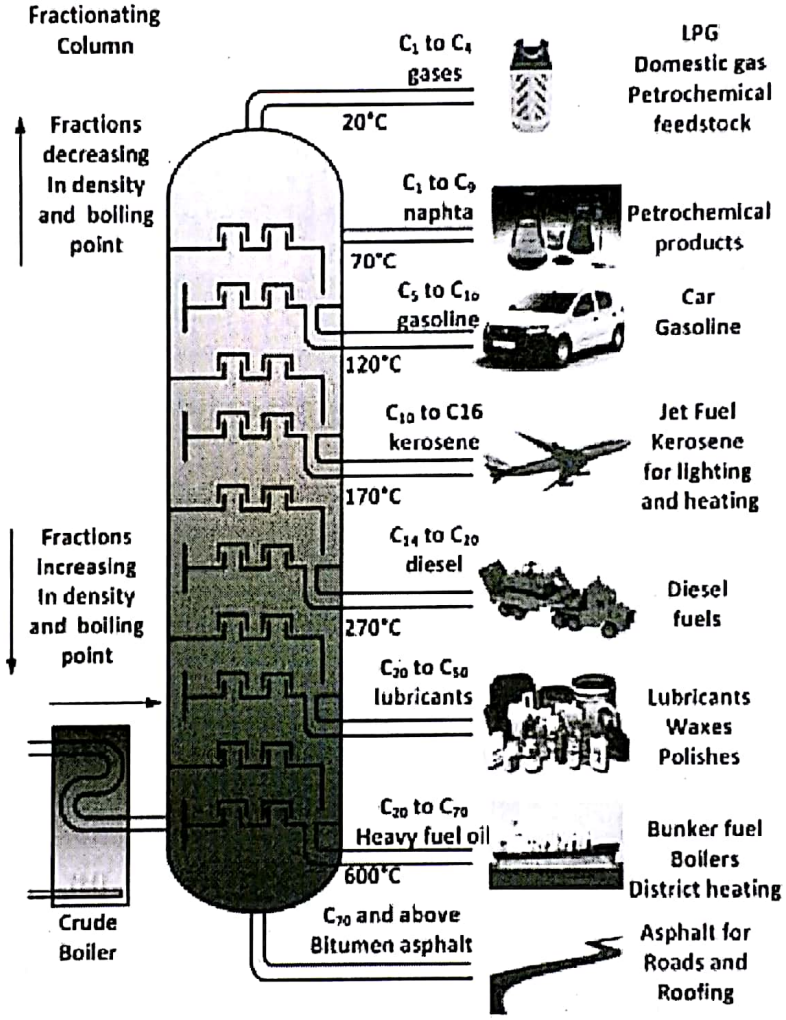
b) Show with drawing the basic products produced from crude oil fractional distillation

[5 marks]

The basic products from fractional distillation are:



Fractionating continuous distillation, overview

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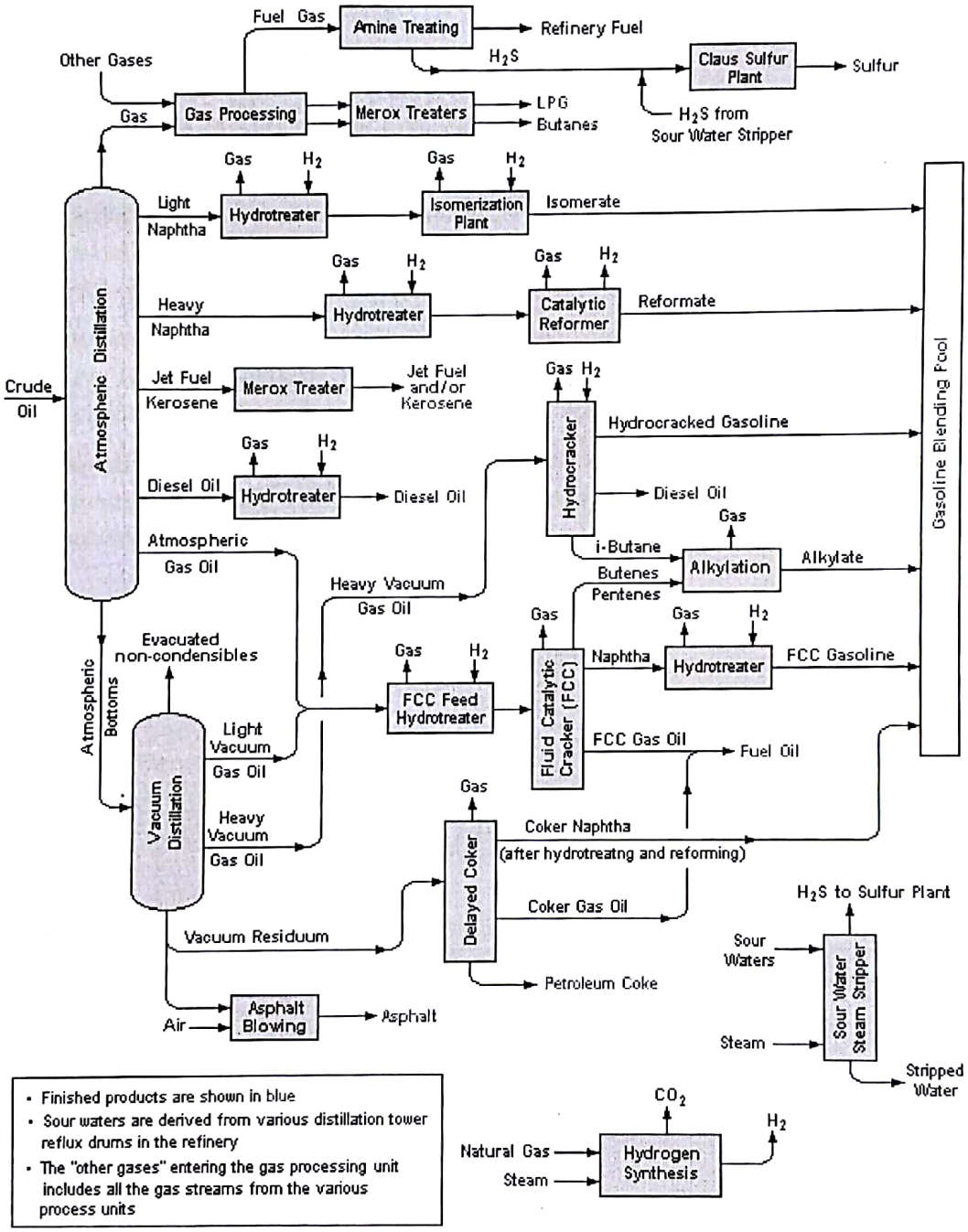
C) Draw a flow diagram for refining process [10dgree]



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Refinery process flow diagram

Question No. 2 **[10 marks]**

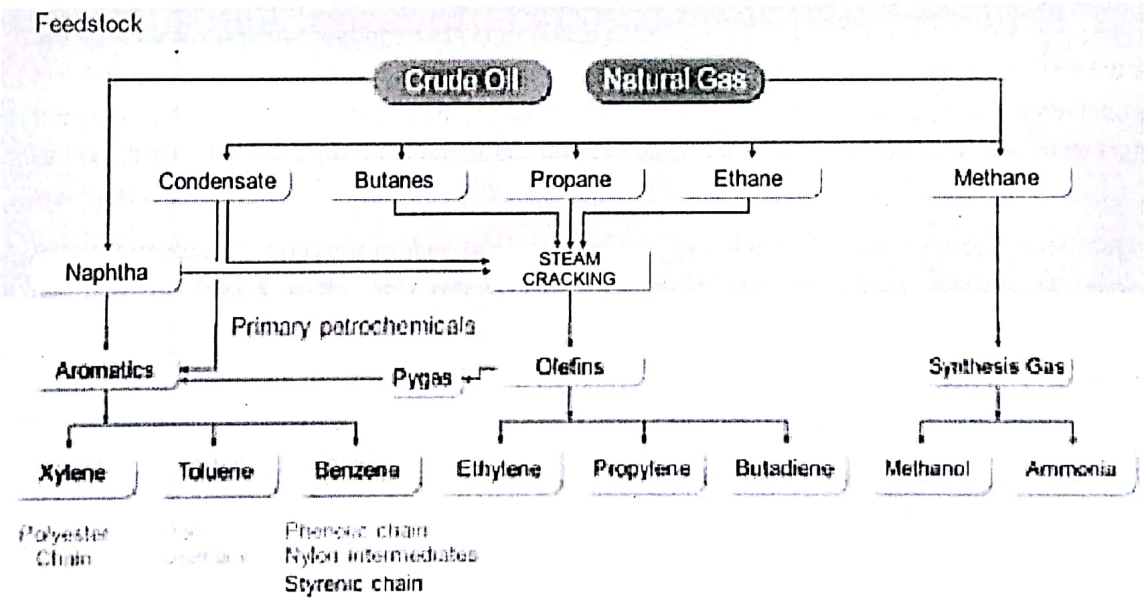
a) Define petrochemicals and its groups **[5 marks]**

Petrochemicals are chemicals made from petroleum or natural gas. Primary petrochemicals are divided into three groups, depending on their chemical structure:

Olefins include ethylene, propylene, and butadiene. Ethylene and propylene are important sources of industrial chemicals and plastics products. Butadiene is used in making synthetic rubber. Olefins are produced by cracking.

Aromatic petrochemicals include benzene, toluene, and xylenes. Benzene is used in the manufacture of dyes and synthetic detergents. Toluene is used in making explosives. Manufacturers use xylenes in making plastics and synthetic fibers. Aromatics are produced by reforming.

Synthesis gas (SynGas) is a mixture of carbon monoxide and hydrogen, and is used to make the petrochemicals ammonia and methanol. Ammonia is used in making fertilizers and explosives, where methanol serves as a source for other chemicals.



Petrochemical tree: feedstock and primary petrochemicals

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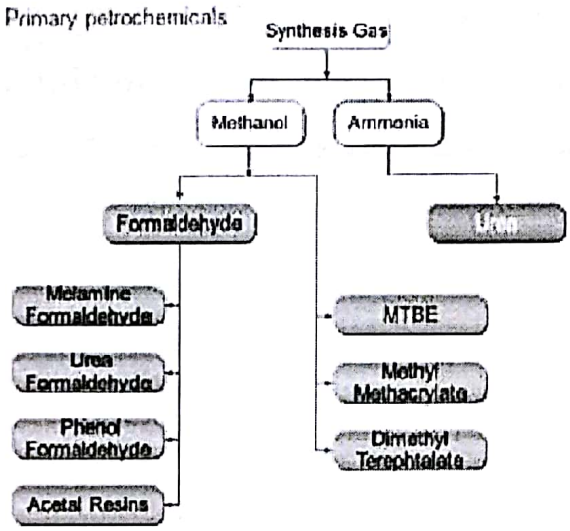
b) What are the synthesis gases and their applications? **[5 marks]**



Synthesis gas

methacrylate butadiene-styrene (MBS), used as a modifier for PVC. MMA polymers and copolymers are used for waterborne coatings, such latex house paint.

Polybutadiene is a synthetic rubber that is a polymer formed from the polymerization of the monomer 1,3-butadiene. It has a high resistance to wear and is used especially in the manufacture of tires. It has also been used to coat or encapsulate electronic assemblies offering extremely high electrical resistivity.

Polyisobutylene is a synthetic rubber, or elastomer. It is special because it is the only rubber that is gas impermeable; it is the only rubber which can hold air for long periods of time. Polyisobutylene, sometimes called butyl

Ammonia is a pungent, colorless, gaseous alkaline compound of nitrogen and hydrogen (NH_3) that is very soluble in water and can easily be condensed to a liquid by cold and pressure. It is manufactured by the direct combination of hydrogen and nitrogen under pressure over a catalyst. The main process is still the Haber-Bosch synthesis invented in 1915, operating at 15–25 MPa and between 300 and 550 °C in four reaction chambers with catalyst. Anhydrous ammonia is mainly used for the manufacture of nitrogenous fertilizers. It is also a building block for the synthesis of many pharmaceuticals, for explosives, and is used in many commercial cleaning products.

Urea $CO(NH_2)_2$ is synthesized from ammonia and carbon dioxide. It is named for its presence in human and most land animal urine (except fish and birds). Dissolved in water, it is neither acidic nor

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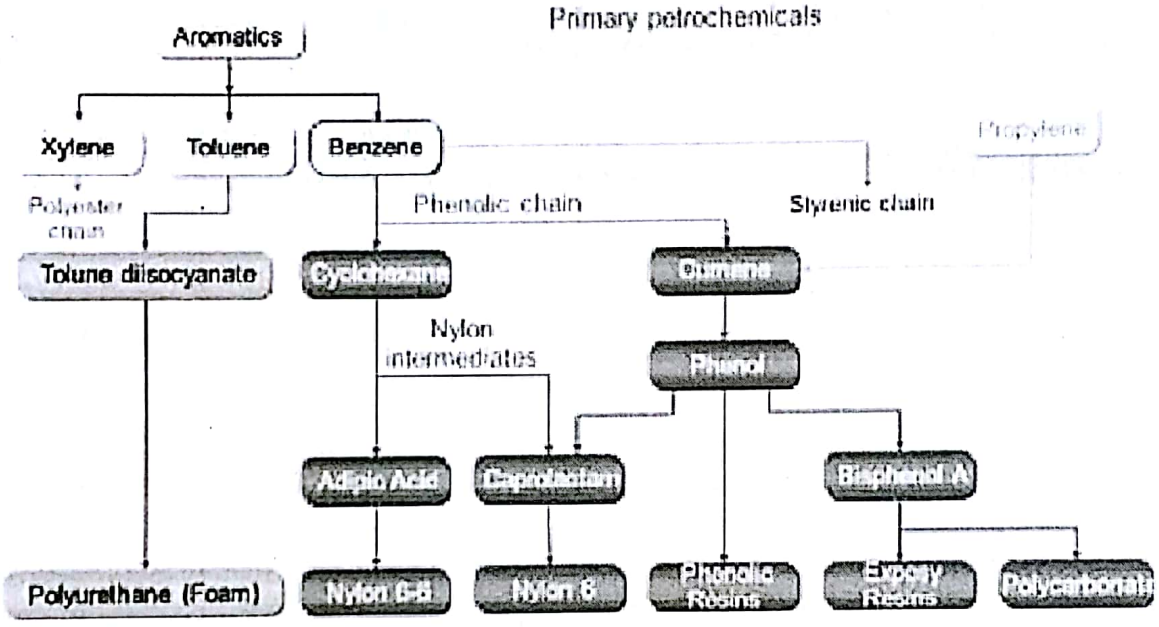
alkaline. Urea is widely used in fertilizers as a convenient source of nitrogen. Urea is also an important raw material for the chemical industry in animal feed, plastics and resins.

Question No. 3 **[30 marks]**

a) aromatic derivatives and its applications **[10 marks]**



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Aromatics – toluene and benzene, polyurethane and phenolic chain

Tolune diisocyanate (TDI) is an isocyanate used in the production of polyurethanes for flexible foam applications, ranging from furniture, bedding, and carpet underlay to transportation and packaging. TDI is also used in the manufacture of coatings, sealants, adhesives and elastomers.

Nylon is a generic designation for a family of synthetic polymers known generically as aliphatic polyamides derived from benzene, first produced in 1935 by DuPont. Nylon can be used to form fibers, filaments, bristles, or sheets to be manufactured into yarn, fabric, and cordage

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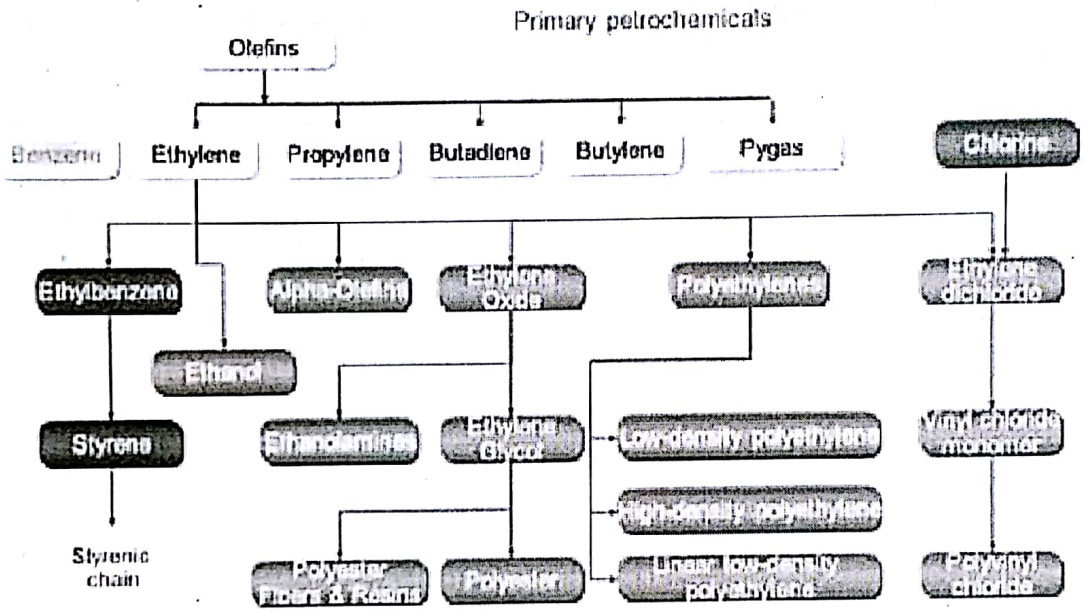
b) Olefins derivatives and its applications **[10 marks]**

Ethylene, derivatives



Olefins – ethylene, derivatives

Polyester and polyester resins is described under the Aromatics chain.

Ethanol, also known as ethyl alcohol (common alcohol), is manufactured by synthesis from ethylene. It is an oxygenated hydrocarbon used in a wide variety of high performance solvent applications (toiletries and cosmetics, paints, lacquer thinners, printing inks, dyes, detergents, disinfectants and pharmaceuticals), as a chemical raw material for the production of a range of monomers and solvents, and is essential in pharmaceutical purification. In transportation, ethanol is used as a vehicle fuel by itself, blended with gasoline, or as a gasoline octane enhancer and oxygenate.

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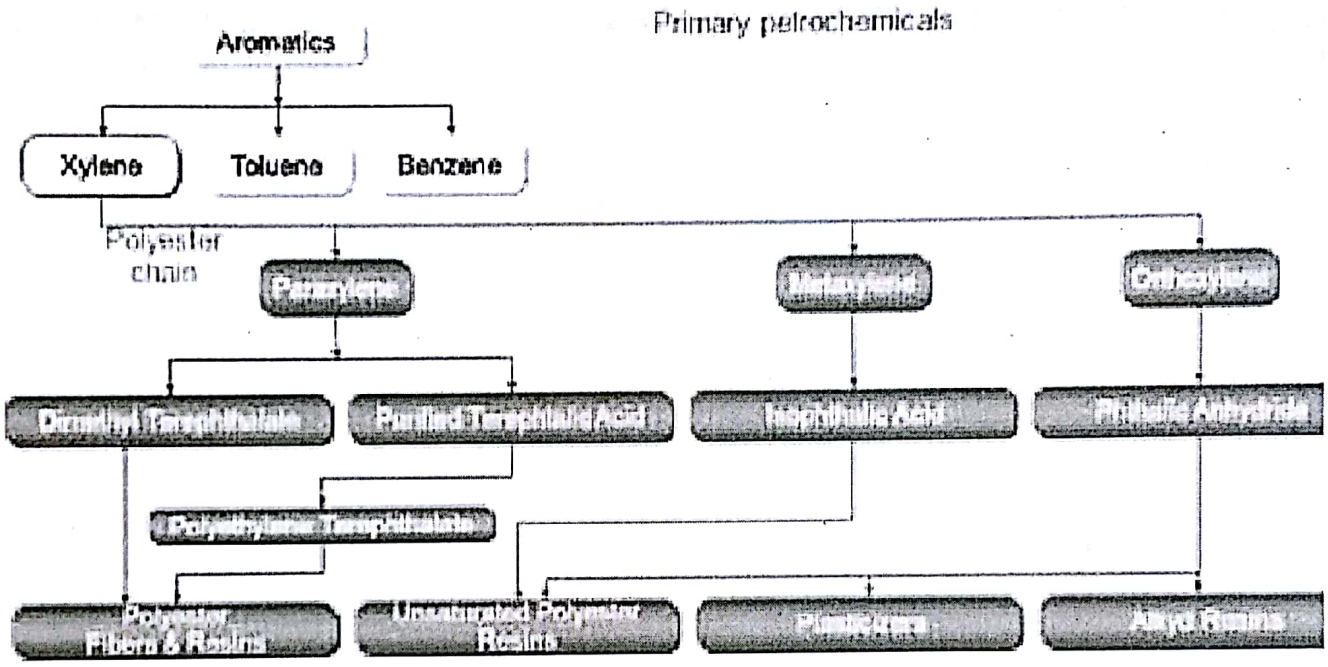
Ethanolamines are prepared by the reaction of ammonia and ethylene oxide. They include monoethanolamine (MEA), diethanolamine (DEA) and triethanolamine (TEA). The three are widely used in industry, principally as absorbents for acidic components of natural gas and of petroleum-refinery

c) xylene derivatives and its applications **[10 marks]**

Xylene and polyester chain



Aromatics – xylene and polyester chain, derivatives

Metaxylene is an isomer of mixed xylene. It is used as an intermediate in the manufacture of polyesters for coatings, inks, reinforced plastics and packaging applications.