Chapter 8

Industrial Chemistry

Time Allocation

Teaching periods	= 15
Assessment period	= 03
Weightage	= 15%

MAJOR CONCEPTS:

8.1 Preparation of soap
8.2 Preparation of sugar from sugar cane
8.3 Preparation of soft drinks
8.4 Petroleum Industry
8.5. Pharmaceutical Industry

STUDENTS LEARNING OUT COMES (SLO'S)

- Know different products prepared in industry. (Remembering)
- Know about saponification process (soap). (Remembering)
- Explain different materials required for soap preparation. (Understanding)
- Construct the flow chart diagram of full process of soap formation. (Applying)
- Describe the preparation of sugar from cane sugar. (Applying)
- Describe the various steps of sugar formation. (Understanding)
- Explain about the importance of pharmaceutical industries. (Creating)
- Define petroleum (Remembering)
- Describe the formation of petroleum and natural gas. (Understanding)
- Describe the composition of petroleum. (Remembering)
- Describe briefly the fractional distillation of petroleum. (Remembering)

Introduction

Almost everything used in human life for the human survival is made up of chemical products. In the modern world Chemical industries play an important role. In every industrial process chemical products are involved which play an essential vital role. The Chemical industry is the one responsible industry for converting raw materials like Petroleum, water, air, minerals, crops, metals and etc into more valuable products. There are several chemical products which have assumed the status of integral part of our daily life some of them are soaps, sugar, soft drinks, Medicines and several petroleum like Liquified Petroleum Gas (LPG), natural gas (stove gas) or compressed natural gas (CNG), polymers, petrol, diesel, lubricating oils and bitumen (damar).There are more than 70,000 different products that are manufactured through chemical industries. Here at this level we shall discuss only those which are mentioned above.

8.1 Preparation of soap

What is saponification?

Saponification is the reaction of triglycerides with sodium or potassium hydroxide to create glycerol and "soap," a fatty acid salt. Animal fats or vegetable oils are the most common sources of triglycerides. A hard soap is created when sodium hydroxide is used. The use of potassium hydroxide produces a soft soap.

When soap is dissolved in water, grime may be washed away. It may be used to treat skin lesions cleansing your body in some situations. However, we now use soap mostly for its aroma and as a cleaning.

Household uses for soaps include washing, bathing, and other types of houskeeping, where soaps act as surfactants, emulsifying oils to enable them to be carried away by water. In industry, they are used as thickeners, components of some lubricants, and precursors to catalysts.

8.1.1 Material needed for soap preparation

The raw material needed for the preparation of soap are as follows:

- Animal Fat
- Plant Oil
- Caustic Soda
- Potassium hydroxide
- Additives (color, texture, scent)
- Abrasives (silica, talc, marble)

Animal Fat

Animal fat tallows from cows, such as lard, are often used for soap making.

Plant oil

Soybean oil, like canola, safflower, and sunflower, is often used as a portion of a soap making recipe in combination with other "core" oils like coconut, olive, and palm. It's pretty unremarkable, but if you have it on hand, use it 5-15% of your soap recipe. It is mild, moisturizing and gives a low creamy lather.

Caustic soda / Potassium hydroxide (Alkali)

Caustic soda (NaOH) causes saponification and is an essential ingredient in soap-making. When flakes or beads of sodium hydroxide get added to a liquid, it forms a lye solution. This solution, when mixed with oils or fats, will lead to the chemical reaction called saponification.

Sodium hydroxide is employed as alkali for the saponification of soap now a days. Soap may also be manufactured with potassium hydroxide (caustic potash) as the alkali. Potassium soaps are more soluble in water than sodium soaps; in concentrated form, they are called soft soap. Although soft soaps are declining in importance, potassium soap is still produced in various liquid concentrations for use in combination with sodium soaps in shaving products and in the textile industry.

Additives

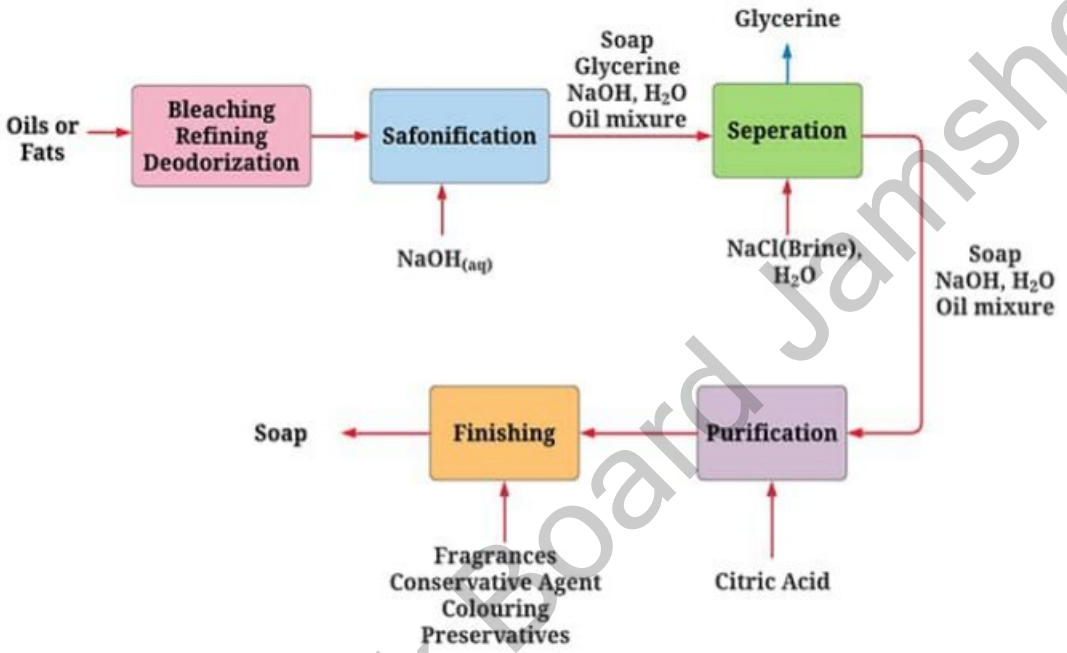
The major raw materials for soap manufacture are fat and alkali. Other substances, such as optical brighteners, colour, texture, scent, water softeners, are known as additives.

Abrasives

Water-insoluble minerals such as talc, diatomaceous earth, silica, marble, volcanic ash (pumice), chalk, feldspar, quartz, and sand are often powdered and added to soap or synthetic detergent formulations. Abrasives of an organic nature, such as sawdust, are also used. Abrasives help in removing grease and dirt from skin.

Figure 8.1 Abrasives

8.1.2 Flow sheet diagram of soap preparation



Flow Diagram for Soap Production

8.2 Preparation of sugar from sugar cane

The preparation of sugar from sugar cane composed of following steps.

- Harvesting and delivery
- Juice extraction
- Clarification
- Concentration
- Crystallization
- Crystal separation and drying

Harvesting and delivery of sugar cane

Sugarcane is generally harvested in the cooler months of the year, although it is harvested year-round in all over the Sindh. As much as two-thirds of the world's cane crop is harvested by hands but in some countries this process is also done by machines. Harvested cane is transported to the factory by many means and vehicles, such as oxcarts, trucks, railway cars, or barges.

Juice extraction of sugar cane

After weighing, sugarcane is loaded by hand or crane onto a moving table. The table carries the cane into one or two sets of revolving knives, which chop the cane into chips in order to expose the tissue and open the cell structure, thus readying the material for efficient extraction of the juice.

Clarification of extracted juice

Mixed juice from the extraction mills or diffuser is purified by addition of heat, lime, and flocculation aids. The lime is a suspension of calcium hydroxide, often in a sucrose solution, which forms a calcium saccharate compound. The heat and lime kill enzymes in the juice and increase pH from a natural acid level of 5.0–6.5 to a neutral pH. Control of pH is important throughout sugar manufacture.

This settling and separation process is known as defecation. Muds are pumped to rotary vacuum filters, where residual sucrose is washed out with a water spray on a rotating filter. Clarified juice, meanwhile, is pumped to a series of three to five multiple-effect evaporators.

Concentration of clarified juice

Steam is used to heat the first of a series of evaporators. The juice is boiled and drawn to the next evaporator, which is heated by vapour from the first evaporator. The process continues through the series until the clarified juice, which consists of 10–15 percent sucrose, is concentrated to evaporator syrup, consisting of 55–59 percent sucrose and 60–65 percent by weight total solids.

Crystallization of concentrated juice

Syrup from the evaporators is sent to vacuum pans, where it is further evaporated, under vacuum, to supersaturation. Fine seed crystals are added, and the sugar "mother liquor" yields a solid precipitate of about 50 percent by weight crystalline sugar. Crystallization is a serial process and named as A molasses, B molasses, C molasses and final molasses. which is 25% sucrose and 20% (Glucose and fructose).

Crystal separation and drying

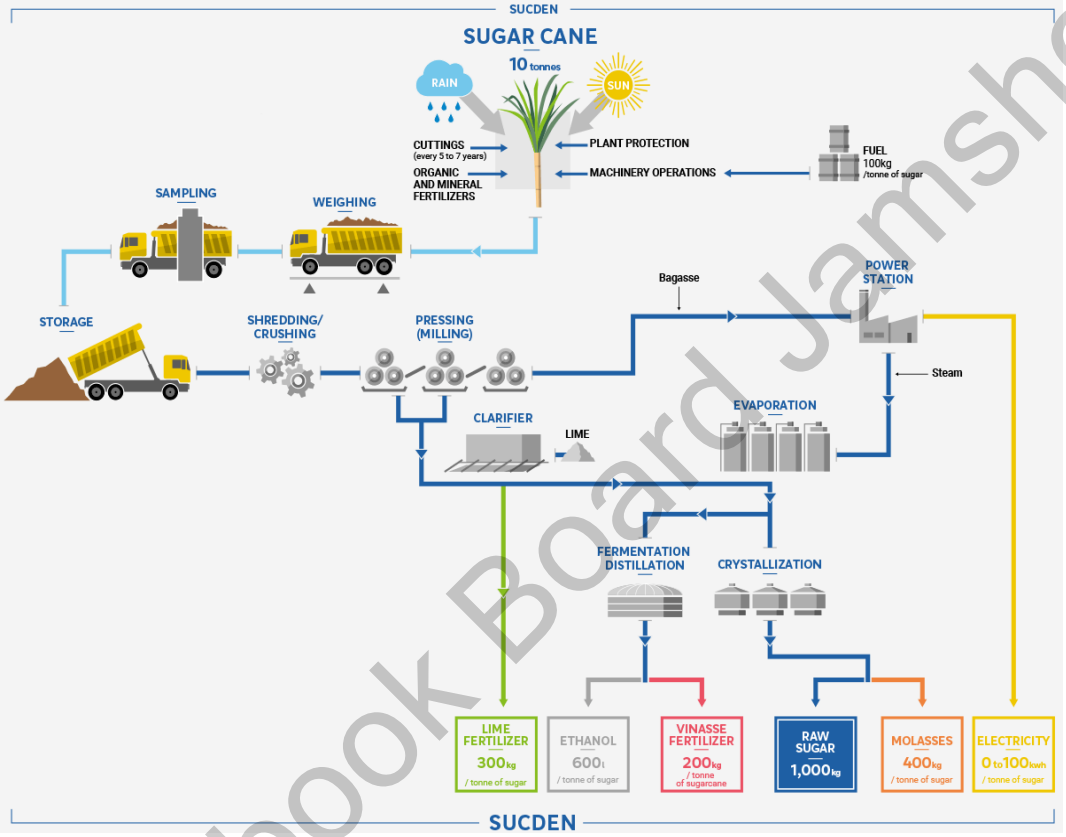
Crystals are separated in basket-type centrifuge machine. These machines continuously break the crystals through continuous centrifuge process and a fine jet of water is sprayed on the sugar pressed against the wall of the centrifugal basket, reducing the syrup coating on each crystal. In modern factories, the washing process is quite extensive in an effort to produce high-purity raw sugar.

8.2.1 Material needed for sugar preparation

The raw material needed for the preparation of sugar from sugar cane are as follows:

- Sugar cane beads
- Lime
- Water

8.2.2 Flow sheet diagram of sugar preparation



8.3 Preparation of soft drinks

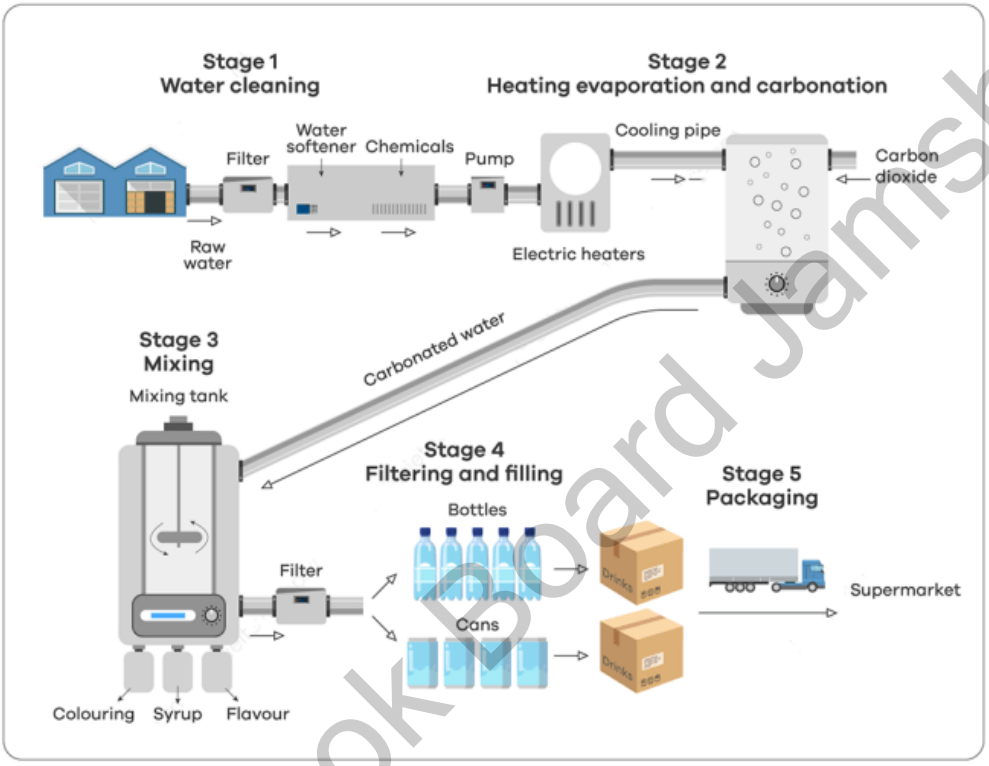
The basis of soft drinks, the syrup, is made up of water, sugar, acid, coloring and flavoring agents. This syrup is prepared by dissolving these ingredients into water to 65^{0} Brix.

8.3.1 Material required for preparation of soft drink

The preparation of sugar from soft drinks compose of following steps.

- Water
- Calcium and other minerals
- Coloring and flavoring agent
- Sugar for microbial growth.
- Citric acid for sour taste.

8.3.2 Flow sheet diagram of soft drinks



8.4 Petroleum Industry

8.4.1 Petroleum

Petroleum is a natural substance trapped in rocks beneath the Earth's crust. The term "petroleum" refers to rock oil. Water, salts, and earth particles are all present in this complex combination of gaseous, liquid, and solid hydrocarbons. It is a liquid that is lighter than water yet insoluble in it.

Formation of petroleum and natural gas

Oil and gas are made up of organic material that is deposited on the seafloor as sediments, then broken down and altered over millions of years. The presence of an appropriate mix of source rock, reservoir rock, cap rock, and a trap in a given location may lead to the discovery of viable oil and gas resources.

The majority of the oil and gas resources on the Norwegian shelf are formed by a thick layer of black clay that lies thousands of meters beneath the seabed.

The black clay is a source rock, which indicates it came from a deposit with a lot of organic waste.

Composition of petroleum

Petroleum is mostly made up of hydrogen and carbon, but it also includes trace amounts of oxygen, nitrogen, sulfur, and metals including vanadium, cobalt, and nickel. Alkanes (paraffins), naphthenes, aromatics, and heterocompounds are some of the most prevalent organic substances.

The exact molecular composition of crude oil varies widely from formation to formation but the proportion of chemical elements varies over fairly narrow limits as follows:

Composition by weight	
Element	**Percent range**
Carbon	83 to 85%
Hydrogen	10 to 14%
Nitrogen	0.1 to 2%
Oxygen	0.05 to 1.5%
Sulfur	0.05 to 6.0%
Metals	< 0.1%

8.4.4 Fractional distillation of petrolium

This is done in oil refineries with the use of massive fractionating columns (also known as fractionating towers). These are frequently found near to the crude oil source.The industrial fractionating column is intended to be cold at the top and hot at the bottom, allowing it to cool and condense crude oil vapour at distinctively different temperature ranges defined by the column's temperature gradient.

Do You Know?

Fractional Distillation

The process of separating the constituents of a liquid mixture by heating it and separating the components according to their different boiling points.

Fraction distilled from crude oil	Boiling point range (°C)	Carbon chain length	Hydrocarbons present	Uses
Refinery Gas	-160 to -5	1-4	Methane CH_4 Ethane C_2H_6 Propane C_3H_8 Butane C_4H_{10}	Home heating and cooking, camping fuel
Gasoline(petrol)	40-110	5-8	Octane C_8H_{18}	Car fuel
Naphtha	110-180	8-10	Decane $C_{10}H_{22}$	Plastics
Kerosene (paraffin)	180-260	10-16	Dodecane $C_{12}H_{26}$	Jet aircraft fuel
Diesel	260-320	16-20	Hexadecane $C_{16}H_{34}$	Fuel for buses and lorries
Fuel Oil	320-400	20-50	Icosane $C_{20}H_{42}$	Industrial heating systems
Bitumen/ Residue	400-600	>50		Surfacing roads

8.5 Pharmaceutical Industry

8.5.1 Origin of pharma

Pharmacy as a separate science dates back to the first third of the nineteenth century. Pharmacy had been as a part of medicine since antiquity. Although the history of pharmacy and the history of medicine are closely related, it is vital to distinguish between the two subjects. Every country's healthcare system is dependent on the pharmaceutical sector. Companies authorised to study, manufacture, sell, and distribute drugs for the prevention, treatment, and cure of illnesses and other health issues make up the pharmaceutical sector. The pharmaceutical industry develops, manufactures, and markets pharmaceuticals that are administered (or self-administered) to patients with the goal of curing, vaccinating, or alleviating symptoms.

8.5.1 Importance of Pharmaceutical Industry

Pakistan's pharmaceutical business has risen significantly in recent decades. Pharmaceutical firms are always working on novel therapies that will help people live longer, healthier lives. Here are some of the industry's most important contributions, as well as why pharmaceutical firms are so vital to patients, society, and the life sciences industry:

1. Treatments increase life expectancy

The pharmaceutical business has made a significant contribution to the global increase in life expectancy for men and women. Pharmaceutical improvements are said to have responsible for 73% of the entire increase in life expectancy between 2000 and 2009 in 30 developing and high-income nations.

2. The industry strives to eradicate and eliminate diseases

When it comes to creating remedies, the ultimate objective is disease elimination, as this helps ecosystems on a worldwide scale. Smallpox is the first – and so far only – human illness to be declared eliminated globally, according to the World Health Organization (WHO).

3. Reduced pain and suffering

According to a research conducted by the World Health Organization, people who live with chronic pain are four times more likely to have melancholy, anxiety, and difficulties working than those who do not.

4. Vaccines save money

Vaccines not only serve to save millions of lives, but they also help to save money. Vaccines are commonly regarded as a cost-effective public health intervention that reduces healthcare costs and prevents lost productivity, hence limiting the economy's overall impact.

5. Hospital stays are shorter

Many illnesses that used to necessitate invasive procedures and surgery can now be addressed with medications. Patients' ability to be discharged more quickly has relieved pressure on the healthcare system and personnel.

6. The industry employees millions of people

Pharmaceutical firms employ millions of people across the world. Who labor in fields as diverse as scientific research, technological support, and manufacturing. Pharmaceutical enterprises demand highly trained and educated employees, with positions ranging from administrative to Ph.D. scientists.

7. Pharmaceutical companies boost the global economy

The pharmaceutical business is a vital asset to the global economy, as well as driving medical development by researching, developing, and providing innovative medications to people throughout the world that enhance their health and quality of life.

Pharmaceutical businesses, on the whole, play an important role in assisting patients and communities. They supply more than just possible cures and life-saving treatments;

Pharmaceutical businesses, on the whole, play an important role in assisting patients and communities. They supply more than just possible cures and life-saving treatments; they also give rewarding jobs and help to power the global economy. Looking ahead, the

Society, Technology and Science

Different types of fire require different methods to extinguish.
Extinguishing different sorts of fires necessitates different approaches.
The following items are required to start and maintain a fire:
Wood, oil, and electricity are examples of fuels that burn in the combustion process.
Heat is the energy component of a fire that supplies the energy required for ignition and the continuation of the combustion process when it comes into contact with fuel.
Air (oxygen) is a key component in the combustion process.
A self-sustaining chemical chain reaction is a complicated reaction that necessitates the precise combination of fuel, oxygen, and heat energy.
Any of the above-mentioned components can be removed to put out a fire. Various fuels necessitate different strategies for extinguishment.
Water can be thrown on a wood fire to put it out. Water absorbs a lot of heat during the evaporation process, therefore it absorbs a lot of heat and deprives the wood fire of heat, making it impossible to keep the fire going.Oil and water do not mix, hence water will not put out an oil fire. Because oil is lighter than water, it floats and spreads across it. Water aids in the propagation of the fire. To put out an oil fire, the oxygen supply must be shut off. Throwing sand, table salt, or baking soda on the flames will help contain this.
Because its source of heat is electrical energy, an electric fire is far more powerful than ordinary flames. To put it out, the oxygen supply must be shut off. Fire extinguishers can be used to regulate oxygen delivery.

Chemistry as a career in industry
A professional chemist can be obtained through studying chemistry. He researches the chemical composition and characteristics that are now accessible. Then he devises procedures for mass-producing novel compounds on a commercial scale to fulfill societal demands. He also creates and improves tools and processes to make production more cost-effective.
Chemists can work in practically any industry, depending on their areas of specialty.
Organic chemists work in a variety of sectors, including pharmaceuticals, petroleum, petrochemicals, cosmetics, polymers, and plastics.
Inorganic chemists operate in metallurgical industries, textile, cement, sugar, and chemical manufacturing facilities, and fertilizer, acids, and caustic soda making plants.
Work prospects for physical chemists exist in the energy transformation industry. They

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Summary

- The Chemical industry is the one responsible industry for converting raw valuable products.
- Soap is the term for a salts of a fatty acid or for a variety of cleansing and lubricating products produced from such a substance
- Petroleum is a complex mixture of hydrocarbons that can be refined into several chemical compounds.
- Petroleum is formed by decomposition of dead animals and plants buried under the earth crust.
- Petroleum (crude oil) can be separated into several useful products by fractional distillation.
- The pharmaceutical industry plays a significant role in developing medications and vaccines to reduce the incidence of diseases, to treat diseases and enhance the quality of life of people.
- The pharmaceutical industry is the part of the healthcare sector that deals with medications.
- The industry comprises different subfields pertaining to the development, production and marketing of medications.
- These more or less interdependent subfields consist of drug manufacturers, drug marketers and biotechnology companies.

Exercise

SECTION- A: MULTIPLE CHOICE QUESTIONS

1. Soap is the term for a salts of a:

(a) Carboxylic acid (b) citric acid (c) Sulphuric acid (d) fatty acid

2. Surfactants reduce the _____ of water.

(a) Viscosity (b) Surface tension (c) Boiling point (d) Melting Point

3. The carboxylate end of the soap molecule that is attracted to water is called __.

(a) hydrophobic end (b) end point (c) hydrophilic end (d) n.o.t

4. The use of potassium hydroxide produced a:

(a) Hard soap (b) Soft soap (c) Moderate soap (d) All of these

5. The citric acid is used in preparation of cold drinks for:

(a) Sweet taste (b) Bitter taste (c) Sour taste (d) Salty taste

6. The centrifuge machine used for separation of:

(a) Juice (b) pH (c)Mud (d)Crystal

7. The abrasives are:

(a) Water soluble minerals
(b) Water insoluble minerals
(c) Water semi soluble minerals
(d) Water absorving minerals

8. The harvesting is most important step of:

(a) Preparation of soap
(b) Preparation of coldrinks
(c) Preparation of sugar
(d) Preparation of medicines

9. Which of the following is used as jet fuel:

(a) Kerosene oil (b) Diesel oil (c) fuel oil (d) petrol

10. Which one of the following is not a fraction of crude oil?

(a) paraffin wax (b) ammonia (c) fuel oil (d) petroleum coke

SECTION- B: SHORT QUESTIONS:

1. Define saponification process.
2. Describe that NaOH or KOH are used in preparation of soap.
3. List down the raw material needed for sugar preparation.
4. Explain components of soft drinks.
5. Define petroleum
6. Justify the petroleum is "Black Gold".

SECTION- C: DETAILED QUESTIONS:

1. Describe fractions of petroleum in detail.
2. Explain the process of preparation of sugar from sugar cane.
3. Write down the importance of pharma industry.
4. Describe the soap preparation with the help of flow sheet diagram.
5. Draw stepwise preparation of soft drinks in flow sheet diagram.