

**ASSIGNMENT No. 2**

**Q. 1 Discuss disaccharides and polysaccharides with suitable example.**

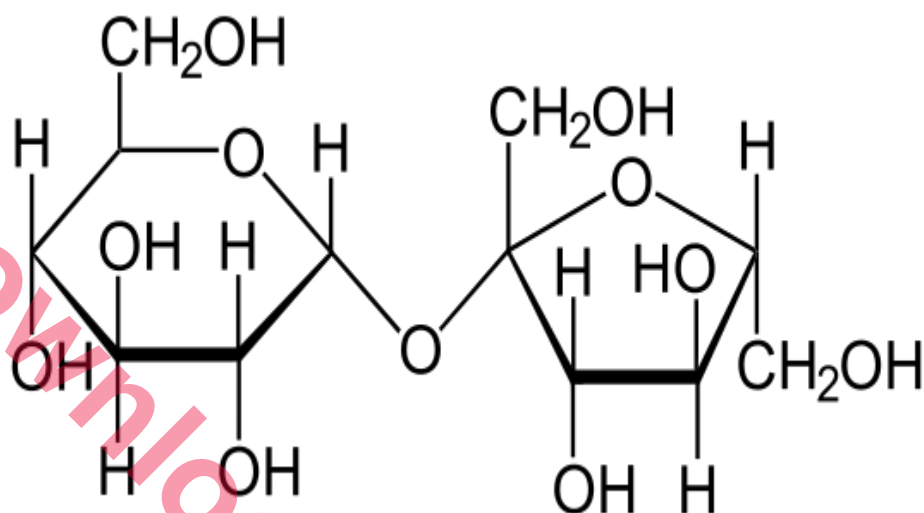
Polysaccharides are characterized by the following chemical properties: (1) not sweet in taste, (2) many of which are insoluble in water, (3) do not form crystals when desiccated, (4) compact and not osmotically active inside the cells, (5) can be extracted to form white powder, and (6) general chemical formula of  $C_x(H_2O)_y$ .

Polysaccharides consist of hydrogen, carbon, and oxygen, just as the other forms of carbohydrates. The ratio of hydrogen atoms to oxygen atoms is often 2:1, which is why they are also described as hydrates of carbon. The general chemical formula of polysaccharides is  $(C_6H_{10}O_5)_n$ . Because of the presence of carbon and C-C and C-H covalent bonds, they are considered as organic compounds similar to other carbohydrates.

Polysaccharides differ from oligosaccharides and disaccharides based on how many monosaccharide units are present. Disaccharides are made up of only two monosaccharides. Oligosaccharides have more than two monosaccharides. The term oligosaccharide is commonly used to describe relatively shorter chains than polysaccharides. Polysaccharides are a type of biological macromolecule comprised of multiple monosaccharide units.

There are diverse forms of polysaccharides. Their structure ranges from a simple linear to the more complex, highly branched forms. Many of them are heterogenous. Depending on their composition, they may be amorphous or water-insoluble. Polysaccharides may be a homopolysaccharide or a heteropolysaccharide depending on their monosaccharide components. A homopolysaccharide (also called homoglycan) is made up of only one type of monosaccharide whereas a heteropolysaccharide (also called heteroglycan) is composed of different types of monosaccharides. Based on their function, polysaccharides may be classified as storage or structural polysaccharides. Storage polysaccharides are those that are used for storage. For instance, plants store glucose in the form of starch. Animals store simple sugars in the form of glycogen. Structural polysaccharides are carbohydrates that have a structural role. Plants have celluloses, which are polymers of repeated glucose units that are joined by beta-linkages. Certain animals produce chitin that serves as a structural component, for example, of exoskeleton. Disaccharides are sugar molecules composed of two monosaccharides. Therefore every disaccharide is composed of two chemical rings. The bond between two monosaccharides is called a glycosidic bond. Disaccharides are also simple sugars. Disaccharides are classified into two groups according to their reducing strength.

- Reducing sugars – can act as a reducing agent
- Non-reducing sugars – cannot act as a reducing agent



Therefore, some disaccharides are reducing sugars and some are not. All disaccharides are water soluble and colorless when dissolved in water. Some disaccharides are sweet tasting but some are not.

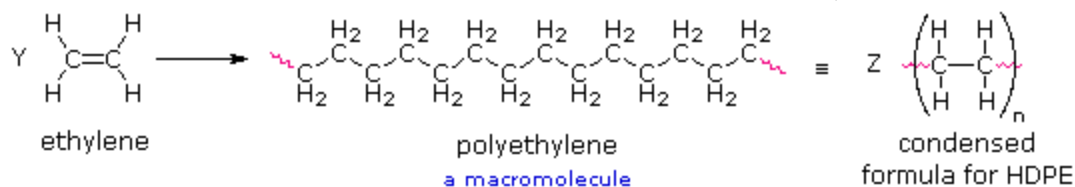
**Q. 2 How can the repeated units of particular polymers and their specific isomeric structure be identified which can exist for those repeat units.**

Prior to the early 1920's, chemists doubted the existence of molecules having molecular weights greater than a few thousand. This limiting view was challenged by [Hermann Staudinger](#), a German chemist with experience in studying natural compounds such as rubber and cellulose. In contrast to the prevailing rationalization of these substances as aggregates of small molecules, Staudinger proposed they were made up of **macromolecules** composed of 10,000 or more atoms. He formulated a **polymeric** structure for [rubber](#), based on a repeating isoprene unit (referred to as a monomer). For his contributions to chemistry, Staudinger received the 1953 Nobel Prize. The terms **polymer** and **monomer** were derived from the Greek roots poly (many), mono (one) and meros (part).

Recognition that polymeric macromolecules make up many important natural materials was followed by the creation of synthetic analogs having a variety of properties. Indeed, applications of these materials as fibers, flexible films, adhesives, resistant paints and tough but light solids have transformed modern society. Some important examples of these substances are discussed in the following sections.

**2. Writing Formulas for Polymeric Macromolecules**

The repeating structural unit of most simple polymers not only reflects the monomer(s) from which the polymers are constructed, but also provides a concise means for drawing structures to represent these macromolecules. For polyethylene, arguably the simplest polymer, this is demonstrated by the following equation. Here ethylene (ethene) is the monomer, and the corresponding linear polymer is called high-density polyethylene (HDPE). HDPE is composed of macromolecules in which n ranges from 10,000 to 100,000 (molecular weight  $2 \times 10^5$  to  $3 \times 10^6$ ).

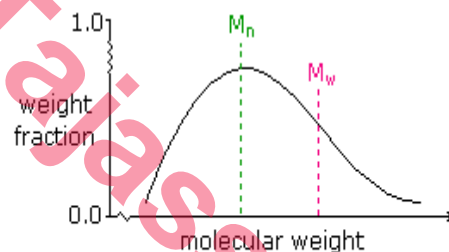


If Y and Z represent moles of monomer and polymer respectively, Z is approximately  $10^{-5}$  Y. This polymer is called polyethylene rather than polymethylene,  $(-\text{CH}_2-)_n$ , because ethylene is a stable compound (methylene is not), and it also serves as the synthetic precursor of the polymer. The two open bonds remaining at the ends of the long chain of carbons (colored magenta) are normally not specified, because the atoms or groups found there depend on the chemical process used for polymerization. The synthetic methods used to prepare this and other polymers will be described later in this chapter. Unlike simpler pure compounds, most polymers are not composed of identical molecules. The HDPE molecules, for example, are all long carbon chains, but the lengths may vary by thousands of monomer units. Because of this, polymer molecular weights are usually given as averages. Two experimentally determined values are common:  $M_n$ , the number average molecular weight, is calculated from the mole fraction distribution of different sized molecules in a sample, and  $M_w$ , the weight average molecular weight, is calculated from the weight fraction distribution of different sized molecules. These are defined below. Since larger molecules in a sample weigh more than smaller molecules, the weight average  $M_w$  is necessarily skewed to higher values, and is always greater than  $M_n$ . As the weight dispersion of molecules in a sample narrows,  $M_w$  approaches  $M_n$ , and in the unlikely case that all the polymer molecules have identical weights (a pure monodisperse sample), the ratio  $M_w / M_n$  becomes unity.

$$M_n = \sum n_i M_i \quad n_i = \text{mole fraction of chains with molecular weight } M_i$$

$$M_w = \sum w_i M_i \quad w_i = \text{weight fraction of chains with molecular weight } M_i$$

note  $w_i = \frac{n_i M_i}{M_n}$



$M_n$  and  $M_w$  in a typical sample of polydispersed macromolecules

Many polymeric materials having chain-like structures similar to polyethylene are known. Polymers formed by a straightforward linking together of monomer units, with no loss or gain of material, are called **addition polymers** or **chain-growth polymers**. A listing of some important addition polymers and their monomer precursors is presented in the following table.

#### Some Common Addition Polymers

Name(s)	Formula	Monomer	Properties	Uses
Polyethylene	$-(\text{CH}_2-\text{CH}_2)_n-$	ethylene	soft, waxy solid	film wrap, plastic

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low density (LDPE)		$\text{CH}_2=\text{CH}_2$		bags
<b>Polyethylene</b>		ethylene		electrical insulation
high density (HDPE)	$-(\text{CH}_2-\text{CH}_2)_n-$	$\text{CH}_2=\text{CH}_2$	rigid, translucent solid	bottles, toys
<b>Polypropylene</b>	$-(\text{CH}_2-$	propylene	atactic: soft, elastic solid	similar to LDPE
(PP) different grades	$\text{CH}(\text{CH}_3)]_n-$	$\text{CH}_2=\text{CHCH}_3$	isotactic: hard, strong solid	carpet, upholstery
<b>Poly(vinyl chloride)</b>	$-(\text{CH}_2-\text{CHCl})_n-$	vinyl chloride	strong rigid solid	pipes, siding, flooring
(PVC)		$\text{CH}_2=\text{CHCl}$		
<b>Poly(vinylidene chloride)</b>	$-(\text{CH}_2-\text{CCl}_2)_n-$	vinylidene chloride	dense, high-melting solid	seat covers, films
(Saran A)		$\text{CH}_2=\text{CCl}_2$		
<b>Polystyrene</b>	$-(\text{CH}_2-$	styrene	hard, rigid, clear solid	toys, cabinets
(PS)	$\text{CH}(\text{C}_6\text{H}_5)]_n-$	$\text{CH}_2=\text{CHC}_6\text{H}_5$	soluble in organic solvents	packaging (foamed)
<b>Polyacrylonitrile</b>	$-(\text{CH}_2-\text{CHCN})_n-$	acrylonitrile	high-melting solid	rugs, blankets
(PAN, Orlon, Acrilan)		$\text{CH}_2=\text{CHCN}$	soluble in organic solvents	clothing
<b>Polytetrafluoroethylene</b>	$-(\text{CF}_2-\text{CF}_2)_n-$	tetrafluoroethylene	resistant, smooth solid	non-stick surfaces
(PTFE, Teflon)		$\text{CF}_2=\text{CF}_2$		electrical insulation
<b>Poly(methyl methacrylate)</b>	$-(\text{CH}_2-$	methyl methacrylate	hard, transparent solid	lighting covers, signs
(PMMA, Lucite, Plexiglas)	$\text{C}(\text{CH}_3)\text{CO}_2\text{CH}_3]_n-$	$\text{CH}_2=\text{C}(\text{CH}_3)\text{CO}_2\text{C}$		skylights
		$\text{H}_3$		
<b>Poly(vinyl acetate)</b>	$-(\text{CH}_2-$	vinyl acetate	soft, sticky solid	latex paints, adhesives
(PVAc)	$\text{CHOCOCH}_3)_n-$	$\text{CH}_2=\text{CHOCOCH}_3$		
<b>cis-Polyisoprene</b>	$-(\text{CH}_2-$	isoprene		requires
natural rubber	$\text{CH}=\text{C}(\text{CH}_3)-$	$\text{CH}_2=\text{CH}-$	soft, sticky solid	vulcanization
	$\text{CH}_2]_n-$	$\text{C}(\text{CH}_3)=\text{CH}_2$		for practical use
<b>Polychloroprene</b> (cis + trans)	$-(\text{CH}_2-\text{CH}=\text{CCl}-$	chloroprene	tough, rubbery solid	synthetic rubber
	$\text{CH}_2)_n-$	$\text{CH}_2=\text{CH}-\text{CCl}=\text{CH}_2$		oil resistant

(Neoprene)

**Q. 3 What are ceramics? Discuss different types and uses of ceramics.**

Ceramics are classified as nonmetallic and inorganic components which are vital to daily living or lifestyle. Materials and ceramic engineers are those who style and design the processes wherein these products can be manufactured, make new kinds of ceramic products, and look for diverse applications for ceramic products in daily living.

Ceramic is everywhere. This type of material takes account of bricks, tile, toilets, glass as well as plates. This material can also be found in various products such as watches, snow skis, cars as well as phone lines. Ceramics are also used on appliances like enamel coatings, shuttles, as well as airplanes like nose cones. It depends on the method of configuration; ceramics can be lightweight or dense. Usually, they will show superb toughness and strength properties.

On the other hand, this ceramic is brittle in nature. Ceramics can also be made to serve as electrically conductive materials or insulators. There is also a type of ceramics like superconductors that show magnetic properties.

In general, ceramics are made by taking a combination of clay, powders, earthen elements as well as water and forming them into desired shapes. Once this material is formed or shaped, it is a fire in an extreme heat oven, also called kiln. Most of the time, ceramics are wrapped or coated in a waterproof, decorative, paint-like substance called glazes.

There are four basic types of pottery, porcelain, stoneware, earthenware, and Bone China. Those four vary in accordance to the clay used to create them, as well as the heat required to fire them.

**Earthenware**

Earthenware are considered the longest established form of pottery, way back in the Stone Age. Even if the composition of this pottery can differ significantly, a usual composition of this is 25% ball clay, 32% quartz, 28% kaolin as well as 15% feldspar. Earthenware is considered the softest form of pottery, being fired at the lowest heat. It absorbs water, porous as well as scratched easily.

The classification of this kind of pottery takes account of all ancient pottery, terracotta objects, sixteenth century and later Chinese and Japanese pottery, and also pottery from Europe made up to the seventeenth century. In particular, it takes account of delft or faience in a tin-glazed type of earthenware. The best examples of fine art earthenware are Chinese clay warriors, also called the Terracotta Army.

To make it waterproof, they wrapped it in a glass-like liquid known as vitreous, and then they re-fired it in the kiln. Clay has iron that used for the making of earthenware that provides a shade that ranges from buff to cream, dark red, black, or grey, in accordance to the amount available as well as the oxygen content in the kiln during the process of firing. This type of pottery can be as thin as porcelain and less tough, strong, but more porous than stoneware. In general, this type of pottery is fired at high temperatures of 1000 to 1200 degree Celsius.

### Stoneware

This type of pottery is dense and has a character that resembles stone after being heated; this is why it called stoneware. This pottery is impermeable or waterproof and normally opaque. In the natural condition, it is grey; however, it turns brown due to the firing process, and different colors might be then used in the type of glazes.

In general, this type of pottery is fired at high temperatures of 1000 to 1300 degrees Celsius. This is utilized in the making of commercial ware. On the other hand, it is also preferred by renowned artists in the making of fine art pottery. The first stoneware was made during the time of the Shang Dynasty in China. First, it appeared in Germany in the fifteenth century. Afterward, in the seventeenth century, a ceramicist in English first started making a salt-glazed type of stoneware. The development followed in the eighteenth century when the man called Josiah Wedgwood made black stoneware or basalts and the Jasperware or white stoneware.

### Porcelain

The disparity between stoneware and porcelain is vague. Ceramists from china define porcelain as a pottery item that provides a ringing tone once tapped. On the other hand, in the west, porcelain is set apart from stoneware by its translucent feature once held to the light. Stoneware varies from porcelain as it opaque and usually just partially vitrified. It is fired at high temperatures.

China is the main origin of porcelain. It appears in the Han Dynasty, or perhaps later in the time of the Tang Dynasty, with the use of white china clay or kaolin and feldspathic rock or ground petuntse. Conversely, developments were done during the time of the Song Dynasty as well as the Yuan Dynasty and Ming Dynasty. 16-century ceramicists tried to remake its exceptional translucence by means of putting in glass to clay, making a form called soft porcelain. However, the formulation of the hard and true form of Chinese porcelain wasn't discovered until in Germany, especially in Dresden and Meissen in the 1700s, when Ehrenfried Walter Von renowned ceramists and Johan Friedrich Bottger an alchemist started utilizing feldspathic rock rather than glass.

Porcelain is broken down into various classifications such as:

Hard-paste or also known as true porcelain: It has added mineral materials to the clay, normally mica. It is fired at high temp and results to tougher and harder objects.

Soft-paste: This is the least or low type of porcelain. This was discovered by European who fired at lower temps. It is regarded as a fragile or low type of porcelain. The best thing about it in spite of being low quality is that it does not require a fixed mineral to be made. Kaolin is combined with bone quartz, ash, soapstone as well as glass to yield this kind, with ball clay added into the mixture. It is also created under high temperatures.

### Bone China

This replaces true porcelain in today's time. It is considered the toughest type of porcelain. It is also very resistant to chip damage. It has remarkable physical strength and normally generates a white and translucent result. It has bone ash, kaolin, phosphates as well as feldspar.

Later, ceramicists such as Josiah Spode tweaked the usual formula by putting in powdered bone ash to create bone china- a typical form of porcelain that is less prone to damage like chipping. What is more, it comes with an ivory-white appearance.

Still, Europe loved the German form of porcelain, while Bone China is common in the USA as well as Britain. The hue of porcelain clay that is not unfired can be something from cream to white, while bone china is clear or white. When done firing, they are both white and usually fired at a high temperature of 1200 – 1450 degrees Celsius, which is a bit higher compared to stoneware.

#### Q. 4 Discuss the properties and different types of semi-conductors.

Semiconductors are the materials which have a **conductivity between conductors** (generally metals) and non-conductors or **insulators** (such as ceramics). Semiconductors can be compounds such as gallium arsenide or pure elements, such as germanium or silicon. Physics explains the theories, properties and mathematical approach governing semiconductors.

Examples of Semiconductors:

Gallium arsenide, germanium, and silicon are some of the most **commonly used semiconductors**. Silicon is used in electronic circuit fabrication and gallium arsenide is used in solar cells, [laser diodes](#), etc.

Holes and Electrons in Semiconductors

**Holes and electrons** are the types of charge carriers accountable for the flow of current in semiconductors. **Holes** (valence electrons) are the positively charged electric charge carrier whereas **electrons** are the negatively charged particles. Both electrons and holes are equal in magnitude but opposite in polarity.

Mobility of Electrons and Holes

In a semiconductor, the **mobility of electrons is higher than that of the holes**. It is mainly because of their different band structures and scattering mechanisms.

Electrons travel in the conduction band whereas holes travel in the valence band. When an electric field is applied, holes cannot move as freely as electrons due to their restricted movement. The elevation of electrons from their inner shells to higher shells results in the creation of holes in semiconductors. Since the holes experience stronger atomic force by the nucleus than electrons, holes have lower mobility.

The mobility of a particle in a semiconductor is more if;

- Effective mass of particles is lesser
- Time between scattering events is more

For intrinsic silicon at 300 K, the mobility of electrons is  $1500 \text{ cm}^2(\text{V}\cdot\text{s})^{-1}$  and the mobility of holes is  $475 \text{ cm}^2(\text{V}\cdot\text{s})^{-1}$ .

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The **bond model** of electrons in silicon of valency 4 is shown below. Here, when one of the free electrons (blue dots) leaves the lattice position, it creates a hole (grey dots). This hole thus created takes the opposite charge of the electron and can be imagined as positive charge carriers moving in the lattice.

### Band Theory of Semiconductors

The introduction of band theory happened during the quantum revolution in science. Walter Heitler and Fritz London discovered the energy bands.

We know that the electrons in an atom are present in different energy levels. When we try to assemble a lattice of a solid with  $N$  atoms, then each level of an atom must split up into  $N$  levels in the solid. This splitting up of sharp and tightly packed energy levels forms **Energy Bands**. The gap between adjacent bands representing a range of energies that possess no electron is called a **Band Gap**.

### Conduction Band and Valence Band in Semiconductors

#### Valence Band:

The energy band involving the energy levels of valence electrons is known as the valence band. It is the highest occupied energy band. When compared with insulators, the bandgap in semiconductors is smaller. It allows the electrons in the valence band to jump into the conduction band on receiving any external energy.

#### Conduction Band:

It is the lowest unoccupied band that includes the energy levels of positive (holes) or negative (free electrons) charge carriers. It has conducting electrons resulting in the flow of current. The conduction band possess high energy level and are generally empty. The conduction band in semiconductors accepts the electrons from the valence band.

Fermi level (denoted by  $E_F$ ) is present between the valence and conduction bands. It is the highest occupied molecular orbital at absolute zero. The charge carriers in this state have their own quantum states and generally do not interact with each other. When the temperature rises above absolute zero, these charge carriers will begin to occupy states above Fermi level.

In a **p-type semiconductor**, there is an increase in the density of unfilled states. Thus, accommodating more electrons at the lower energy levels. However, in an **n-type semiconductor**, the density of states increases, therefore, accommodating more electrons at higher energy levels.

### Properties of Semiconductors

Semiconductors can conduct electricity under preferable conditions or circumstances. This unique property makes it an excellent material to conduct electricity in a controlled manner as required.

Unlike conductors, the charge carriers in semiconductors arise only because of external energy (thermal agitation). It causes a certain number of valence electrons to cross the energy gap and jump into the conduction band, leaving an equal amount of unoccupied energy states, i.e. holes. Conduction due to electrons and holes are equally important.



- **Resistivity:**  $10^{-5}$  to  $10^6$   $\Omega\text{m}$
- **Conductivity:**  $10^5$  to  $10^{-6}$  mho/m
- **Temperature coefficient of resistance:** Negative
- **Current Flow:** Due to electrons and holes

**Q.5 Analyze the effect of industrial pollution on environment and elucidate the responsibilities of industrialists in this regard.**

With the coming of the [Industrial Revolution](#), humans were able to advance further into the 21st century. Technology developed rapidly, science became advanced, and the manufacturing age came into view. With all of these came one more effect, industrial pollution. Earlier, industries were small factories that produced smoke as the primary pollutant.

However, since the number of factories were limited and worked only a certain number of hours a day, the [levels of pollution](#) did not grow significantly. But when these factories became full-scale industries and manufacturing units, the issue of industrial pollution started to take on more importance.

Any [form of pollution](#) that can trace its immediate source to industrial practices is known as industrial pollution. Most of the pollution on the planet can be traced back to industries of some kind.

In fact, the issue of industrial pollution has taken on grave importance for agencies trying to fight against [environmental degradation](#).

Countries facing sudden and rapid growth of such industries are finding it to be a serious problem that has to be brought under control immediately.

Industrial pollution takes on many faces. It contaminates several sources of drinking water, releases unwanted toxins into the air and [reduces the quality of soil](#) all over the world.

[Major environmental disasters](#) have been caused due to industrial mishaps, which have yet to be brought under control. Below are a few of the causes of industrial pollution that have resulted in [environmental degradation](#).

Industrial pollution is wreaking havoc on Earth. Every nation is affected, and there are people who are working tirelessly to increase awareness and advocate for change. The activities causing pollution include:

- Burning coal
- Burning fossil fuels like oil, natural gas, and petroleum
- Chemical solvents used in dyeing and tanning industries
- Untreated gas and liquid waste being released into the environment
- Improper disposal of radioactive material

#### Causes of Industrial Pollution

##### 1. Lack of Policies to Control Pollution

Lack of effective policies and poor enforcement drive allowed many industries to bypass laws made by the pollution control board, which resulted in mass-scale pollution that affected the lives of many people.

## 2. Unplanned Industrial Growth

In most industrial townships, unplanned growth took place wherein those companies flouted rules and norms and polluted the environment with both air and water pollution.

## 3. Use of Outdated Technologies

Most industries still rely on old technologies to produce products that generate a large amount of waste. To avoid high cost and expenditure, many companies still make use of traditional technologies to produce high-end products.

## 4. Presence of a Large Number of Small Scale Industries

Many small scale industries and factories that don't have enough capital and rely on government grants to run their day-to-day businesses often escape environment regulations and release a large number of toxic gases in the atmosphere.

## 5. Inefficient Waste Disposal

Water pollution and soil pollution are often caused directly due to inefficiency in the disposal of waste. Long term exposure to polluted air and water causes chronic health problems, making the issue of industrial pollution into a severe one. It also lowers the air quality in surrounding areas, which causes many respiratory disorders.

## 6. Leaching of Resources From Our Natural World

Industries do require a large amount of raw material to make them into finished products. This requires the extraction of minerals from beneath the earth. The extracted minerals can cause soil pollution when spilled on the earth. Leaks from vessels can cause oil spills that may prove harmful to marine life.

## 7. Natural Resource Use

Raw material is a must for industries, which often requires them even pulling out underground elements. One of the most common forms of leaching from natural resources is fracking for oil.

When industries extract minerals, the process causes soil pollution and also causes oil leaks and spills that are harmful and even deadly to people and animals.