Chemistry Revision Notes For Grade 12 Students

What is a Chemical Reaction?

Key Concepts:

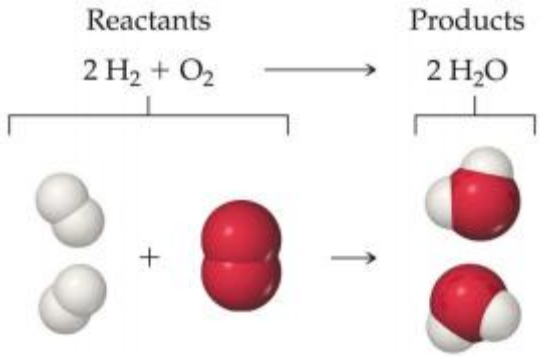
- A physical change, such as a state change or dissolving, does not create a new substance, but a chemical change does.
- In a chemical reaction, the atoms and molecules that interact with each other are called reactants.
- In a chemical reaction, the atoms and molecules produced by the reaction are called products.
- In a chemical reaction, only the atoms present in the reactants can end up in the products. No new atoms are created, and no atoms are destroyed.
- In a chemical reaction, reactants contact each other, bonds between atoms in the reactants are broken, and atoms rearrange and form new bonds to make the products.

Stoichiometry is a section of chemistry that involves using relationships between reactants and/or products in a chemical reaction to determine desired quantitative data.

Chemical Equations

A chemical equation is a shorthand notation to describe a chemical reaction.

- Just like a chemical formula, a chemical equation expresses quantitative relations
- Subscripts tell the number of atoms of each element in a molecule
- Coefficients tell the number of molecules



Fundamental Chemical Laws

I. Law of Conservation of mass: Mass cannot be created nor destroyed.

Learning Question: A 0.406 g sample of magnesium reacts with oxygen, producing 0.674 g magnesium oxide as the only product. What mass of oxygen was consumed in the reaction?

II. Law of Definite Proportion: A given compound always contains exactly the same proportion of elements by mass.

Example: 10.000 g of water gives 1.119 g of hydrogen gas and 8.881 g of oxygen gas. Also 27.000 g of water produces 3.021 g hydrogen and 23.979 g oxygen. How it shows the law of definite proportions?

Solution:

$$\frac{1.119\ g\ of\ Hydrogen}{10.000\ g\ of\ water} \times 100 = 11.19\ \%\ H$$

100 – 11.19 = 88.81% Oxygen

$$\frac{3.021\ g\ of\ Hydrogen}{27.000\ g\ of\ water} \times 100 = 11.19\ \%\ H$$

100 – 11.19 = 88.81% Oxygen

∴ **The results of two different measurements show same composition of water.**

Learning Question: 3.06 g of hydrogen react with oxygen where 27.35 g of water are obtained. In a second experiment, water is decomposed resulting in 1.45 g of hydrogen and 11.51 g of oxygen. Is this consistent with the law of definite proportions?

III. Law of multiple proportions: When two elements (A & B) form a series of compounds (AB_1, AB_2, AB_3...), the ratios of the masses of the second element (B) that combine with a fixed mass of the first element (A) can always be reduced to small whole numbers as: $\left(\frac{B_1}{B_2}, \frac{B_1}{B_3}, \frac{B_2}{B_3}, \cdots\right)$

Example: The nitrogen and oxygen forming three different compounds that contain different relative amounts of nitrogen and oxygen. One gram oxygen combines with the following mass of nitrogen:

Compound A	1.750	g Nitrogen
Compound B	0.8750	g Nitrogen
Compound C	0.4375	g Nitrogen

Solution:

$$\frac{A}{B} = \frac{1.750\ g}{0.8750\ g} = 2\ ;\quad \frac{B}{C} = \frac{0.8750\ g}{0.4375\ g} = 2\quad ;\quad \frac{A}{C} = \frac{1.750\ g}{0.4375\ g} = 4$$

∴ For the one gram oxygen, the ratios of the masses of nitrogen show small whole integer number.

Learning Question:

Which of the following pairs of compounds can be used to illustrate the "law of multiple proportions"?

CH_4 & CO_2

NH_4 & NH_4Cl

NO & NO_2

H_2O & HCl

ZnO_2 & $ZnCl_2$

CO & CO_2

What are the products of fractional distillation of petroleum?

Crude oil is a fossil fuel, it was made naturally from decaying plants and animals living in ancient seas millions of years ago. Crude oil is processed or refined to produce useable products such as gasoline.

Crude Oil refinery process:

The oil refining process starts with a **fractional distillation column.** The various components of crude oil have different sizes, weights and boiling temperatures; so, the first step is to separate these components. Because they have different boiling temperatures, they can be separated easily by a process called fractional distillation. After going through the fractional distillation, crude oil is chemically processed to change one fraction into another. Finally, Distillated and chemically processed fractions are treated to remove impurities.

What are the major products (or fractions) of petroleum refining?

Give one use of each petroleum product.

The crude petroleum oil obtained from oil field, undergoes fractional distillation and a number of products are generated. These products of fractional distillation include, **petrol (or gasoline), naphtha, kerosene, diesel oil, lubricating oil, fuel oil, grease and wax**, and some residue.

The various fraction of petroleum and their uses

1. **Petroleum gas**: It is used as a fuel in homes and industry. It is used as a fuel as such or in the form of Liquefied petroleum gas (LPG)
2. **Petrol**: It is used a fuel in light motor vehicles. It is also used as a solvent for dry cleaning.
3. **Kerosene**: It is used as a fuel in wick stoves and pressure stoves to cook food. It is used in lanterns for a lightning purpose.
4. **Diesel**: It is used as a fuel in heavy motor vehicles. It is also used to run pump sets for irrigation in agriculture and in electric generators.
5. **Lubricating oil**: It is used for lubrication in machines and engines.
6. **Paraffin Wax**: It is used for making candles, Vaseline, ointments, wax paper, and grease.
7. **Bitumen**: It is used for road surfacing. It is also used for water-proofing the roofs of the building. It is used in making black paints.

Study the Following Table

	Fraction	Number of Carbon	Temperature range
(1)	Gases	C_1 to C_4	298K
(2)	Petrol	C_5 to C_{10}	303K to 393K
(3)	Naphtha	C_8 to C_{10}	393K to 453 K
(4)	Kerosene	C_{12} to C_{15}	453K to 533K
(5)	Diesel	C_{15} to C_{18}	533K to 613 K
(6)	Lubricating oil	C_{16} to C_{20}	Above 613K

The table shows the products obtained by fractional distillation of petroleum and temperature range. From this give the right order of the product obtained?

- **Petrol** is obtained in the temperature range of 303K to 393K.

- **Naphtha** is obtained in the temperature range 393K to 453 K.
- **Kerosene** is obtained in the temperature range of 453K to 533K.
- **Diesel** is obtained in the temperature range 533K to 613 K.

Questions:

1. In the refining of petroleum, in a fractionating column, the principle used is _____.

   Ans: difference in boiling points

2. Which component obtained from the refining of petroleum is used as a solvent in petrochemicals?

   A. Tar B. Kerosene C. Naphthalene D. Petroleum coke

   Ans. The correct option is **C** Naphthalene. Naphthalene (an aromatic hydrocarbon) is obtained from the refining of petroleum. It is used as a solvent in petrochemicals. Naphthalene is a nonpolar solvent and is used to dissolve nonpolar compounds. Option C is correct.

3. Arrange the products obtained in fractional distillation column from top to bottom during petroleum refining:

   A. Petroleum gas B. Petrol C. Kerosene D. Lubricating oil

   Ans. Crude oil is separated into fractions by fractional distillation. The fractions at the top of the fractionating column have lower boiling points than the fractions at the bottom. Hence, the correct order is:

   Petroleum gas
   ↓
   Petrol
   ↓
   Kerosene
   ↓
   Lubricating oil

4. The correct order of products in which they are extracted from crude oil in fractional distillation column from top to bottom is:

A Natural gas, Petrol, Diesel, Paraffin

B Natural gas, Diesel, Petrol, Paraffin

C Natural gas, Parafin , Diesel, Petrol

D Parafin , Natural gas, Petrol, Diesel

Solution

The correct option is C. Natural gas, Petrol, Diesel, Paraffin.

Fractional distillation is different from the distillation process. In fractional distillation process separates a mixture into the number of different parts, called fractions.

In crude oil, fractional distillation oil is evaporated and its vapour condenses at different temperatures in the fractionating column.

5. Mark the correct sequence of substances obtained during fractional distillation of petroleum in ascending order of their boiling points.

A Petroleum gas, Kerosene Petrol, Diesel, Paraffin wax

B Petrol, Petroleum gas, Kerosene, Light oil, Diesel

C Petroleum gas, Petrol, Kerosene, Diesel, Lubricating oil

D Petroleum gas, Petrol, Lubricating oil, Diesel, Kerosene

Solution

The correct option is D. Petroleum gas, Petrol, Kerosene, Diesel, Lubricating oil

Fractional distillation is the separation of a mixture into its component parts or fractions such as in separating chemical compounds by their boiling point by heating them to a temperature at which one or more fractions of the compound will vaporize.

Petroleum gas< Petrol< Kerosene<Diesel< Lubricating oil

6. State one use each of the following products of petroleum :
   A. Petroleum gas
   B. Petrol
   C. Diesel
   D. Lubricating oil
   E. Bitumen

   Solution

   Various fraction of petroleum and their uses:

   I. **Petroleum gas:** It is used as a fuel in homes and industry. It is used as a fuel as such or in the form of Liquefied petroleum gas(LPG)

   II. **Petrol:** It is used a fuel in light motor vehicles. It is also used as a solvent for dry cleaning.

   III. **Diesel:** It is used as a fuel in heavy motor vehicles. It is also used to run pump sets for irrigation in agriculture and in electric generators.

   IV. **Lubricating oil:** It is used for lubrication in machines and engines.

   V. **Bitumen** is used in road construction (for surfacing the roads).

7. Which of the following is not obtained as a fraction during the refining of petroleum?
   A. Kerosene B. Natural gas C. Lubricating oil D. Bitumen
8. Which of these fractions of petroleum has the lowest boiling point?
   A. Heavy oil B. Gasoline C. Kerosene D. Petroleum gas

   Ans: Petroleum gas has the lowest boiling point i.e. below 40^{o}C whereas heavy oil has the highest boiling point.

9. The product of petroleum used to drive heavy vehicles like trucks is:
   A. Petrol B. Kerosene C. Diesel D. petroleum gas

   Ans: Diesel is used to drive heavy vehicles.

10. Which of the following is the most environment friendly fuel to be used in automobiles?
    A. Petrol B. diesel C. natural gas D. petroleum gas

    Ans; natural gas

11. During fractional distillation of petroleum, different fractions are obtained. Their name, number of carbon atoms, temperature range at which it is obtained and their use are given. There is an error in one of the alternatives. In which alternative there is an error?

A Petrol, C_5 to C_{10}, 303K to 393K, fuel in vehicles

B Diesel, C_{15} to C_{18} 533K to 613K, fuel in vehicles and generators

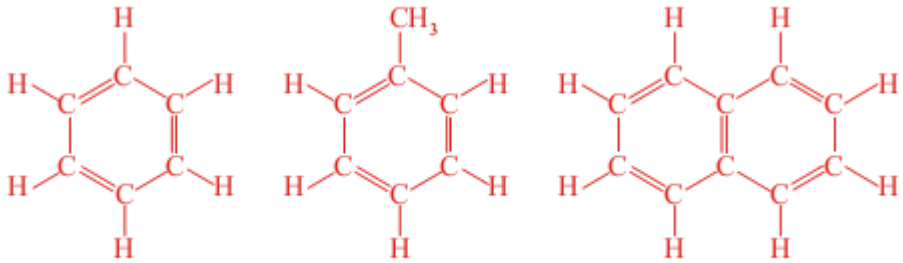
C Neptha, C_8 to C_{10} 393K to 453K, solvent in petrochemicals

D Lubricating oil, C_8 to C_{12}, 400K, fuel in high speed vehicles

Ans: Lubricating oil, C_8 to C_{12}, 400K, fuel in high speed vehicles. Lubricating oil, C_{20} to C_{30}, above 613K, is used as lubrication oil in machine and to prepare grease, Vaseline, wax etc.

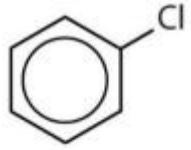
AROMATIC HYDROCARBONS

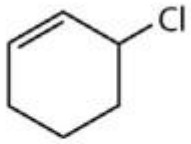
Aromatic hydrocarbons are generally obtained from petroleum and coal tar. They are a group of hydrocarbons characterized by the presence of a benzene ring or related structures. Some examples of aromatic hydrocarbon structures are given below:

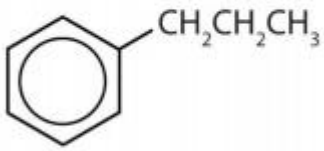


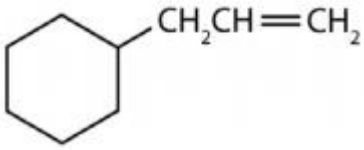
Aromatic hydrocarbons are compounds that contain a benzene ring structure. The simplest aromatic compound is benzene (C_6H_6) and it is of great commercial importance, but it also has noteworthy deleterious health effects.

Example 1: Which compounds are aromatic?

1. 

2. 

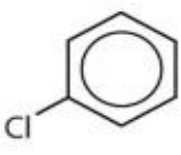
3. 

4. 

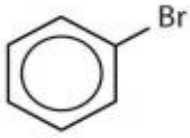
Solution:

1. The compound has a benzene ring (with a chlorine atom substituted for one of the hydrogen atoms); it is aromatic.
2. The compound is cyclic, but it does not have a benzene ring; it is not aromatic.
3. The compound has a benzene ring (with a propyl group substituted for one of the hydrogen atoms); it is aromatic.
4. The compound is cyclic, but it does not have a benzene ring; it is not aromatic

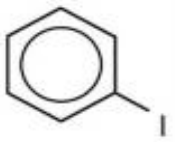
In the International Union of Pure and Applied Chemistry (IUPAC) system, aromatic hydrocarbons are named as derivatives of benzene. Five examples are shown below. In these structures, it is immaterial whether the single substituent is written at the top, side, or bottom of the ring: a hexagon is symmetrical, and therefore all positions are equivalent.



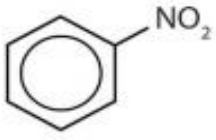
Chlorobenzene



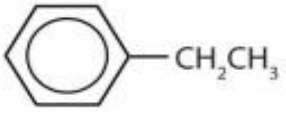
Bromobenzene



Iodobenzene

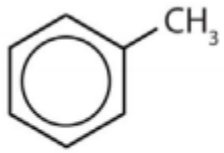


Nitrobenzene

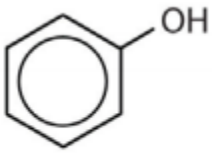


Ethylbenzene

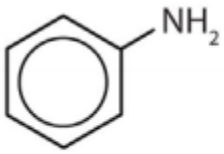
Although some compounds are referred to exclusively by IUPAC names, some are more frequently denoted by common names, as is indicated below.



Toluene



Phenol

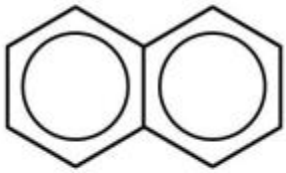


Aniline

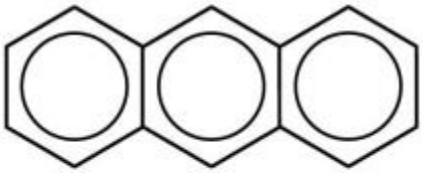
Aromatic hydrocarbons appear to be unsaturated, but they have a special type of bonding and do not undergo addition reactions.

Polycyclic Aromatic Hydrocarbons

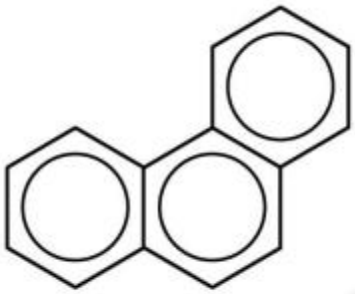
Some common aromatic hydrocarbons consist of fused benzene rings—rings that share a common side. These compounds are called polycyclic aromatic hydrocarbons (PAHs). An aromatic hydrocarbon consisting of fused benzene rings sharing a common side.



Naphthalene



Anthracene



Phenanthrene