Introduction

Chemical Aspects of Elements

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Chemical Aspects of Elements

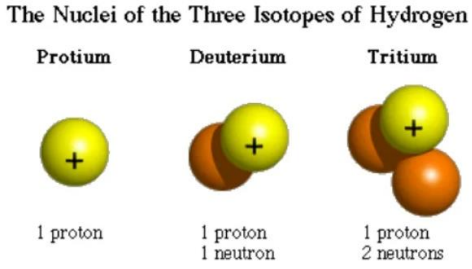
The following points highlight the five important chemical aspects of elements. The aspects are:

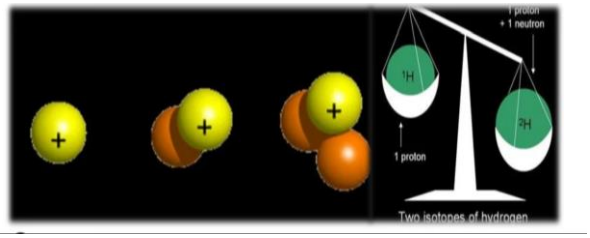
1. **Isotopes.**
2. **Radioactivity.**
3. **Acids and Bases.**
4. **Hydrogen Ion Concentration (pH Scale).**
5. **Redox reactions.**

1- ISOTOPES:-**Atoms with the same number of protons, but different numbers of neutrons** They are still the same element, but they have different weights because they have different numbers of neutrons. The **number of protons plus neutrons** in an atom is called the **mass number.**

Isotopes

- Atoms with the **same number of protons**, **but different number of neutrons**.
- Atoms of the same element (**same atomic number**) with **different mass number**.





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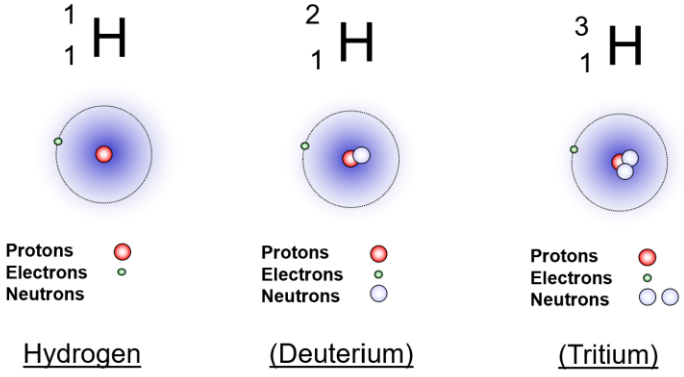
Hydrogen exists as 3 isotopes…
although Hydrogen-1 makes up the vast majority of the naturally occurring element.



All have a different mass, tritium is radioactive but all react with oxygen to form water

Isotopes can be indicated by:-

1. Element symbol followed by **a dash** and the **mass number**.
   Example :- Hydrogen -1, Hydrogen -2, Hydrogen -3.

2. Element symbol with the **mass number** in the **upper left** (similar to standard atomic notation).

   Example :- ^{1}**Hydrogen,** ^{2}**Hydrogen,** ^{3}**Hydrogen.**

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Interpreting Chemical Symbol

Mass=P+N

mass number (nucleon number) — 16

O — chemical symbol

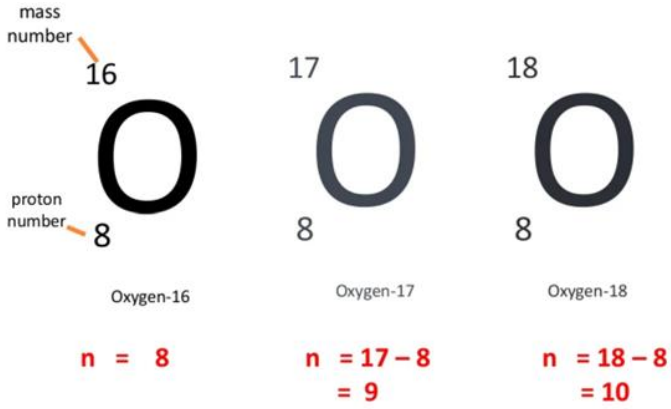
proton number (atomic number) — 8

mass number is the total number of protons and neutrons in an atom.
Number of neutrons in the oxygen atom is: 16 – 8 = 8.

P=E
No. of protons= no. of electrons

atomic number (proton number) is the number of protons in an atom.
Each oxygen atom has 8 protons.

As the number of electrons is equal to the number of protons in an atom, each oxygen atom contains 8 electrons.



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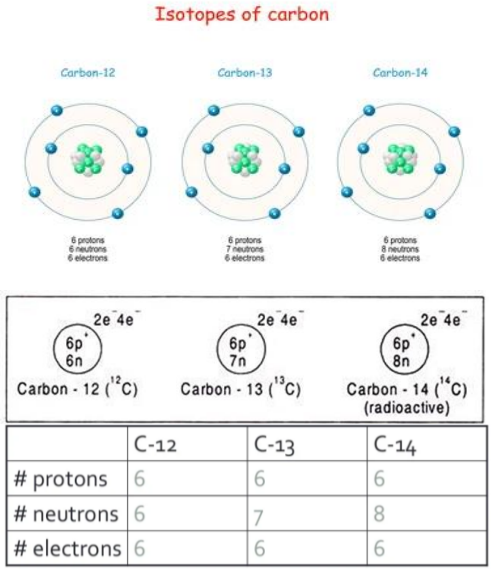

	C-12	C-13	C-14
# protons	6	6	6
# neutrons	6	7	8
# electrons	6	6	6

An atom of zinc has a mass number of 65.

- A. Number of protons in the zinc atom
  1) 30 2) 35 3) 65
- B. Number of neutrons in the zinc atom
  1) 30 2) 35 3) 65
- C. What is the mass number of a zinc isotope with 37 neutrons?
  1) 37 2) 65 3) 67

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- A. Its atomic number is
  1) 14 2) 16 3) 34
- B. Its mass number is
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- C. The element is
  1) Si 2) Ca 3) Se

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Radioactivity

Radioactivity is the term used to describe **the natural process by which some atoms spontaneously disintegrate, emitting both particles and energy as they transform into different, more stable atoms**. This process, also called radioactive decay, occurs because unstable isotopes tend to transform into a more stable state.

There are different types of radioactivity depending on what particles or energy are released during the reaction. The three types are: **alpha particles, beta particles, and gamma rays**.

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So,

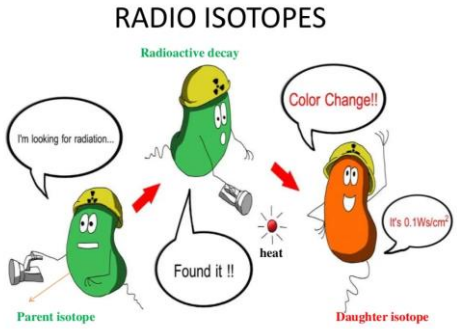
- Radiation is emitted when an unstable nucleus spontaneously changes, or disintegrates into more stable one.
- Every element in the periodic table has at least one radioactive isotope.
- Radioactivity is a form of nuclear reaction (nucleus) not chemical reaction (electron).
- A nuclear reaction involves changes in an atoms nucleus, usually producing a different element. Chemical reaction never changes the nucleus, it only rearranges the outer shell electrons.

[different isotopes of an element have essentially the same chemical reactivity (same electrons), but often have completely different behavior in nuclear reaction].

Radioactive decay

- Unstable atomic nucleus loses energy by emitting ionizing particles and radiation.
- This decay, or loss of energy , results in an atom of one type called parent nuclide transforming to an atom of different type, called the daughter nuclide.

- one element can change into another element via radioactive decay or transformation.



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Applications of isotopes

Radioactive isotopes have applications in **agriculture, food processing, pest control, archaeology, and medicine**.

Acids and Bases:

Substances which increase the hydrogen ion concentration in water are known as acids, and substances which increase the hydroxyl ion concentration in water are called bases. Therefore, an acid is a potential proton donor and a base is a potential proton acceptor.

Acid : $HA \rightleftharpoons H^+ + A^-$

$HCl \rightleftharpoons H^+ + Cl^-$

$CH_3COOH \rightleftharpoons H^+ + CH_3COO^-$

Base : $BOH \rightleftharpoons B^+ + OH^-$

$NaOH \rightleftharpoons Na^+ + OH^-$

Hydrogen Ion Concentration (pH Scale)

The term pH stands for potential of hydrogen and expresses the concentration of hydrogen ions (H^+) in a given solution. It is the negative logarithm of hydrogen ion concentration. In pure water the concentration of hydrogen ions is 1.0×10^{-7} moles/liter. The hydroxyl ion concentration of pure water is also the same. The actual degree of ionization of water is small and has a negative power.

Thus pH of pure water is:

$$\begin{aligned} pH &= -\log_{10} 10 \times 10^{-7} \\ &= -7 \times -\log_{10} 10 \\ &= -7 \times -1, \ [\text{as } \log_{10} 10 = 1] \\ &= 7.0 \end{aligned}$$

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5. Redox reactions

Redox reactions are chemical reactions that involve oxidation and reduction.

- Oxidation can be defined as a [**loss** of electrons **to another substance**].
- Reduction can be defined as an [**acceptance** of electrons **from another substance**].

redox reaction are those in which electrons are transferred from one reactant to another.

Like

- Photosynthesis.
- Respiration.
- Combustion of coal.
- Production and use of fertilizers.

Key terms

If electrons are transferred , it is a redox reaction.

1. A **loss** of electrons is called **oxidation** . A **gain** in electrons is called **reduction**.
2. Reduction and oxidation happen **simultaneously**, hence the name " redox".
3. An oxidizing agent (oxidant) **accepts electrons** and thus gets reduced.
4. A **reducing agent** (reductant) **donates electrons** and thus gets oxidized.

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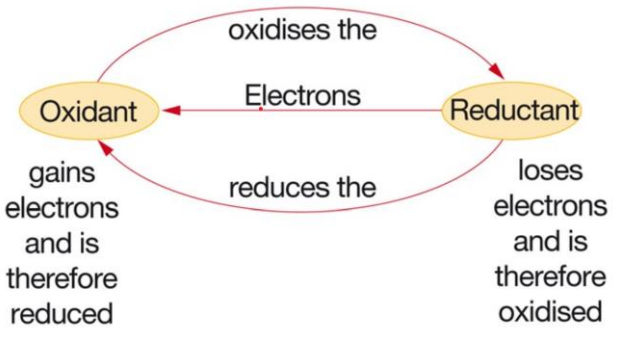

The **oxidant** is the species which *causes* oxidation and is itself reduced
The **reductant** is the species which *causes* reduction and is itself oxidised