# Atoms, Molecules and Radicals

**Points to Remember :**

1. Atoms of the most elements are composed of still smaller particles known as fundamental particles or subatomic particles. They are **protons, electrons** and **neutrons.**
2. Protons are the positively charged particles present in an atom.
3. Electrons are the negatively charged particles present in an atom and its mass is 1/1837 the mass of one hydrogen atom.
4. Neutrons are particles with no electrical charge. Its mass is equal to one atomic mass unit.
5. The central part of an atom is called nucleus, which contains both protons and neutrons.
6. Shells or orbits around the nucleus.
7. **Atomic number** refers to the number of protons present in an atom. It is denoted by the alphabet Z.
8. **Mass number**— Mass number is the sum of number of protons and neutrons present in the nucleus of an atom. Mass number (A) = Number of protons + Number of neutrons.
9. **Atomic mass—** The mass of an atom is known as its atomic mass.
10. Relative atomic mass ip the mass of an atom of an element as a multiple of the standard atomic mass unit.
11. Atoms of different elements combine to form molecules so as to attain chemical stability.
12. A positively charged ion is called a **cation** and a negatively charged ion is called **anion.**
13. The valency of an element is the number of electrons donated or accepted by its 'atom' during chemical combination.
14. There are some elements with more than one valency e.g., iron, copper, tin, lead.
15. Two or more different non-metals that collectively accept or donate one or more electrons and become negatively or positively charged in the process are called **radicals.**

## EXERCISE

**Question 1.**
Define the following terms :
**Answer:**

1. **Atom :** An atom is the smallest indivisible unit of an
   OR
   Atom is the smallest unit of matter.
2. **Molecule :** Molecule is the smallest unit of a compound (or an element) which always has an independent existance.
3. **Radicals :** A radical is an atom of an element or a group of atoms of different elements that behaves as a single unit with a positive or negative charge on it.
4. **Valency :** It is the number of electrons donated or accepted by the valence shell of an atom during chemical combination.
5. Periodic table represents the tabular arrangment of elements in horizontal rows called periods and vertical columns called groups in order to classify the elements and their systematic study.



**Question 2.**
Write the names of the elements present in the following compounds.
**Answer:**

1. **Common salt :** Sodium, chlorine.
2. **Ammonia :** Nitrogen, hydrogen.
3. **Sulphuric acid :** Hydrogen, sulphur, oxygen.
4. **Glucose :** Carbon, hydrogen, oxygen.
5. **Sodium hydroxide :** Sodium, oxygen, hydrogen.
6. **Acetic acid :** Carbon, hydrogen, oxygen.

**Question 3.**
What does each of the following represent ?
**Answer:**

1. **$2C0_2$** = 2 molecules of carbon dioxide.
2. **$2H_2S$** = 2 molecules of hydrogen sulphide.
3. **$5H_2S0_4$** = 5 molecules of sulphuric acid.
4. **$6NaNO_3$** = 6 molecules of sodium nitrate.

**Question 4.**
Write the symbols and valencies of the following radicals:
**Answer:**

| | Element | Symbol | Valencies |
|---|---|---|---|
| (a) | Magnesium ion | $Mg^{2+}$ | 2 |
| (b) | Ammonium | $NH^{+}_{4}$ | 1 |
| (c) | Carbonate | $CO^{2-}_{3}$ | 2 |
| (d) | Nitrate | $NO^{-}_{3}$ | 1 |
| (e) | Oxide | $O^{2-}$ | 2 |
| (f) | Bisulphate | $HSO^{-}_{3}$ | 1 |
| (g) | Aluminium ion | $Al^{3+}$ | 3 |

**Question 5.**
Name the following radicals :
**Answer:**

1. **$SO_4^{2-}$** = Sulphate
2. **$HC0_3^{-}$** = Bicarbonate
3. **OH-** = Hydroxide
4. **$Cr_20_7^{2-}$** = Dichromate



**Question 6.**

1. Name one ion for each of the valencies +1, +2 and +3.
2. Name one ion for each of the valencies-1, -2 and -3.

**Answer:**

1. +1 = Sodium Na+
   +2 = Calcium Ca+2
   +3 = Aluminium Al+3
2. -1 = Chlorine Cl-
   -2 = Oxygen 0-2
   -3 = Nitrogen N3_

**Question 7.**
The valency of calcium is 2. Write the valencies of other radical in the following :

1. CaO
2. $Ca(OH)_2$

3. $CaC0_3$
4. $CaCl_2$

**Answer:**

1. O= 2
2. OH = 1
3. $CO_3$ = 2
4. Cl = I

**Question 8.**

Write the names of the following compounds :

**Answer:**

| | Compound | Name |
|---|---|---|
| (a) | $(NH_4)_2SO_4$ | Ammonium Sulphate |
| (b) | $Ca(NO_3)_2$ | Calcium Nitrate |
| (c) | FeS | Iron Sulphide |
| (d) | $Na_3PO_4$ | Sodium Phosphate |
| (e) | $NH_4OH$ | Ammonium Hydroxide |
| (f) | $CuCO_3$ | Copper Carbonate |
| (g) | HgO | Mercuric Oxide |
| (h) | $ZnCl_2$ | Zinc Chloride |
| (i) | ZnS | Zinc Sulphide |
| (j) | $H_2S$ | Hydrogen Sulphide |



**Question 9.**

Write the molecular formulae of:

**Answer:**

| | Compound | Molecular Formula |
|---|---|---|
| (a) | Sodium sulphide | $Na_2S$ |
| (b) | Magnesium oxide | MgO |
| (c) | Calcium hydroxide | $Ca(OH)_2$ |
| (d) | Hydrogen chloride | HCl |
| (e) | Sulphuric acid | $H_2SO_4$ |
| (f) | Iron (II) sulphide | FeS |
| (g) | Iron (III) sulphate | $Fe_2(SO_4)_3$ |
| (h) | Nitric acid | $HNO_3$ |
| (i) | Calcium phosphate | $Ca_3(PO_4)_2$ |
| (j) | Aluminium sulphate | $AlSO_4$ |
| (k) | Magnesium nitride | $Mg_3N_2$ |

**Question 10.**
The valency of sodium is one, write the molecular formula for the following compounds of sodium.

1. **sodium oxide :** $Na_20$
2. **sodium sulphate :** $Na_2S0_4$
3. **sodium carbonate :** $Na_2CO_3$
4. **sodium hydroxide :** NaOH
5. **sodium nitrate :** $NaN0_3$

**Question 11.**
What is variable valency ? Give two examples of elements showing variable valency.
**Answer:**
There are some elements with more than one valency. They are said to have variable valency, e.g. Iron, copper.

**Question 12.**
Give the group number of following elements present in periodic table

1. **Magnesium :** IIA
2. **Carbon :** IVA
3. **Sulphur :** VIA
4. **Neon :** Zero



**Question 13.**
An element belongs to group VA. What would be its valency? Name two such elements.
**Answer:**
Elements of group VA has valency 3.
Two elements : Nitrogen and phosphorus.

**Question 14.**
An element belongs to group II. What would be its valency? Write the formula of molcules of compounds it will form with elements in VA, VIA and VIIA groups.
**Answer:**
Valency 2.

VA $Mg^{2+}$ $Mg^{-3}$

$Mg_3$ $N_2$

VIA

| Symbols | | Valencies | |
|---|---|---|---|
| Magnesium | Oxide | Magnesium | Oxide |
| Mg | O | $2^+$ | $2^-$ |

(*i*) Write the symbols

| On the left hand side | On the right hand side |
|---|---|
| Calcium | Chloride |
| Ca | Cl |

(*ii*) Write the valency of the symbols

| At the top right corner | At the top right corner |
|---|---|
| Positive ion | Negative ion |
| $Ca^{2+}$ | $Cl^{1-}$ |

(*iii*) Interchange the valency number
(Ignore the (+) and (–) signs)

$Ca^{2+}$ $Cl^{1-}$


(*iv*) Write the interchanged numbers at the base
But ignore the + and the – signs

$Ca_1$ $Cl_2$



## OBJECTIVE TYPE QUESTIONS

**1. Fill in the blanks:**
**Answer:**

1. Atoms are **neutral.**
2. An ion with positive charge is called **cation.**
3. An ion with negative charge is called **anion.**
4. $2H_2$ means two **atoms** of hydrogen.
5. **Ozone** is a triatomic molecule.
6. Metals have **variable** valency.
7. Chemical name of caustic soda is **sodium hydroxide NaOH.**

**2. Tick (√) the correct answer.**

(a) The valency of iron in Fe203 is

1. 1

2. 2
3. **3**
4. 6

(b) Which of the following has valency 4 ?

1. aluminium
2. oxygen
3. carbon
4. **phosphorus**

(c) The sulphate radical is written as $SO_4^{2-}$. What is the formula of calcium sulphate ?

1. $Ca(SO_4)_2$
2. $Ca_2(SO_4)$
3. $Ca(SO_4)_3$
4. **$CaSO_4$**

(d) Which of the following exhibit variable valency ?

1. calcium
2. **copper**
3. carbon
4. chlorine



**3. State the term for the following:**

1. The number of atoms present in a molecule of an element **atomicity.**
2. The symbolic representation of a molecule **molecular formula.**
3. A group of atoms that react as a single unit **molecule.**
4. The combining capacity of an element **valency.**
5. The tabular arrangement of elements in horizontal rows and vertical columns **periodic table.**

## ADDITIONAL QUESTIONS

**1. Define the following terms:**

1. **Ions—** An atom which becomes charged by losing or gaining electrons is called an ion.
2. **Chemical bond—** A chemical bond is the binding force between two or more atoms of a molecule.
3. **Atomic number**— Atomic number refers to the number of protons present in an atom. It is denoted by Z.

4. **Mass number**— Mass number is the sum of the number of protons and neutrons present in the nucleus of an atom. It is denoted by A.
5. **Relative atomic mass—** Relative atomic mass is the mass of an atom of an element as a multiple of the standard atomic mass unit.

**2. Answer the following questions.**

**1. What does an atom consist of ? Explain.**
An atom consists protons, electrons and neutrons. Protons are positively charged, electrons have negative charge while neutrons have no charge.

**2. Give the charge and the mass of an electron, proton and neutron present in an atom.**

| Particle | charge | Mass |
|---|---|---|
| (*i*) Proton | Positive | One atomic mass unit. (amu) |
| (*ii*) Electron | Negative | 1/1837 times the mass of one hydrogen atom. |
| (*iii*) Neutron | No charge | One atomic mass unit, equal to mass of proton. |



**3. Name two particles found inside the nucleus. What are they collectively called ?**
Protons and Neutrons. Mass number.

**4. (a) Name the particles which revolve around the nucleus.**
**(b) What are orbits or shells ?**
**(c) What is the maximum number of electrons present in:**
**1. first shell**
**2. second shell**
**3. third shell and**
**4. fourth shell**
**(d) The maximum number of electrons, an atom can have in the outermost shell.**
(a) Electron.
(b) The fixed circular paths along which electrons revolve round the nucleus.
(c) First Shell (K) = 2, Second Shell (L) = 8, Third Shell (M) = 18, Fourth (d) = 8, Shell (N) = 32

**5. Elements X and Y have 1 and 7 electrons in their outermost shell respectively.**

1. Which element will lose electron ? **X**
2. Which element will gain electron ? **Y**
3. Which will form positive ion ? **X**

4. Which will form negative ion ? **Y**
5. What will be the charge present of the molecule XY after chemical combination ? **electrically neutral**

**6. (a) What is the number of electrons donated by a magnesium atom and number of electrons accepted by a sulphur atom during their chemical combination?**
**(b) How many units of charge are developed on each atom ?**
**(c) What is the number of electrons after the transfer of electrons in magnesium and sulphur atoms.**
**(d) Diagrammatically represent the transfer of electrons.**

(a) Two, Two (b) Two
(c) Eight

(d)


(Mg)



**3. What do you understand by the following terms valency, valence electrons and valence shell ?**

1. **Valency—** The capacity of the atom of an element to form chemical bonds.
2. **Valence electrons—** The electrons present in the valence shell are called valence electrons.
3. **Valence shell—** The outer most shell of an atom is known as its valence shell.

**4. Name the following radicals and give their valencies :**

1.
    1. SQ4
    2. CO3
    3. OH
    4. Cr207

| Radicals | Valency |
|---|---|
| (*i*) Sulphate $SO_4$ | 2 |
| (*ii*) Carbonate $CO_3$ | 2 |
| (*iii*) Hydroxide OH | 1 |
| (*iv*) Dichromate $Cr_2O_7$ | 2 |

**5. (i) What is variable valency ?**
**(ii) Give three examples of elements having variable valency.**
**ans :**
(i) **Variable valency—** There are some elements with more than one valency. They are said to have variable valency.
(ii) e.g., iron, copper, tin, lead

**6. (i) Name three elements each whose ions have valency +1, +2 and +3 respectively.**
**(ii) Name three non-metals/radicals which have valency -1, -2, and -3.**

1. +1 = Hydrogen, Sodium, Potassium.
   +2 = Calcium, Magnesium, Zinc.
   +3 = Aluminium, Chromium, Ferric [Fe (III)]
2. -1 = Chlorine, Bromine, Iodine.
   -2 = Oxide, Sulphide, Sulphate.
   -3 = Nitrogen, Nitride Phosphate.

**7. Define:**
**(a) Ionic bond (b) Covalent bond**
Ans. **(a) Ionic bond—** A bond formed by transfer of electrons between atoms is called ionic bond.
**(b) Covalent bond—** When atoms of different non-metals neither donate nor accept electrons and hence no ions are formed, such a bond is called covalent bond.

**8. Give two examples for each of ionic and covalent bond.**
Ans. **Example of ionic bonds**— Sodium chloride and calcium oxide.
**Example of covalent bond—** Water, carbon dioxide.

**9. Write electronic configuration of oxygen, fluorine, sodium, silicon, argon.**

| | Element | At. Number | Electronic configuration | | | |
|---|---|---|---|---|---|---|
| | | | K | L | M | N |
| 1. | Oxygen | 8 | 2 | 6 | | |
| 2. | Fluorine | 9 | 2 | 7 | | |
| 3. | Sodium | 11 | 2 | 8 | 1 | |
| 4. | Silicon | 14 | 2 | 8 | 4 | |
| 5. | Argon | 18 | 2 | 8 | 8 | |

**10. Who originated the word 'atom' ?**
Ans. Democritus

**11. What does the word 'atom' mean ?**
Ans. "atom" means'indivisible"

**12. State Dalton's atomic theory.**

1. Matter is made up of tiny particles called atoms
2. Atoms are indivisible.
3. Atom can be neither be created nor destroyed.
4. Atoms of same element are identical in mass and properties
5. Atoms of different elements differ in mass and properties

**13. How did Neils Bohr visualise the atom ?**
Ans. Niels Bohr explained that atom is like a solar system with an empty space with a minute central nucleus, like Sun and electrons life planets revolve around it.

**14. Name the particle or particles you would expect to find in :**

1. **The orbit of an atom :** electrons
2. **The nucleus of an atom :** protons and neutrons

**15. An atom has 13 protons and 14 neutrons.**

1. What is the atomic number of the atom ? **13**
2. How many electrons would be present in this atom ? **13**
3. What is the atomic mass of the atom ? **27**

**16. Define :**

1. **An Atom:** Smallest particle of an element that can exist and have properties of an element.
2. **Atomic number :** Number of protons present in the nucleus of an atom.
3. **Mass number :** Numbr of protons and neutrons present in the nucleus of an atom.
4. **Atomic weight :** It is the ratio that tells how many times an atom of an element is heavier than atom of Hydrogen.

**17. A certain particle 'X' has 17 protons, 18 electrons and 20 neutrons.**

1. What is such a particle called **anion**
2. What is the mass number of X **35**
3. What is the atomic numebr of X **17**
4. Does the particle have an excess of electrons or a deficiency of electrons **excess of electrons**
5. What is the charge on the particle **– 1 (negative)**



**18. Fill in the blanks :**

1. If an atom gains an electron, it is called an **anion**
2. If an atom loses an electron, it acquires **positive** a charge.
3. A charged particle is called an **ion**
4. An **atom** is electrically neutral.
5. An excess of electrons produces a **negative** charge.
6. A deficiency of electrons produces a **positive** charge.