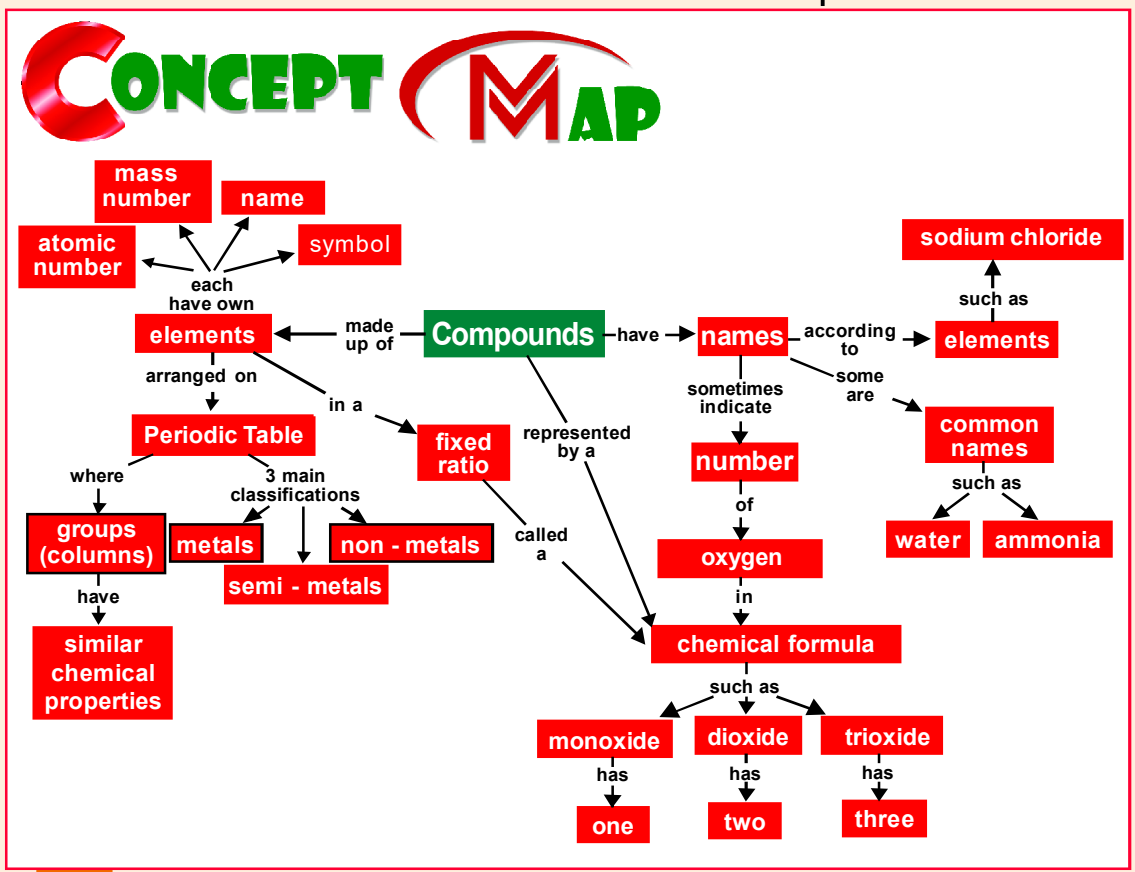
1 SYMBOLS AND FORMULAE

Baron Jons Jacob Berzelius, named by himself and contemporary society as Jacob Berzelius, was a Swedish chemist. Berzelius is considered, along with Robert Boyle, John Dalton, and Antoine Lavoisier, to be one of the founders of modern chemistry. Berzelius himself discovered and isolated several new elements, including cerium (1803) and thorium (1828). His system abbreviated the Latin names of the elements with one or two letters and applied superscripts to designate the number of atoms of each element present in both the acidic and basic ingredients.

CONCEPT MAP



Concept 1

Introduction:

Around 118 elements were discovered so far. Most of these elements have been found to occur in nature. Some of the elements are man-made. It is possible that scientists will continue to discover some more elements. The scientists who suggested a method of representing elements using the English letter (Capitals as well as small) is J.J.Berzelius.

Chemical symbols and formulae are introduced to represent the elements and compounds respectively. Chemical changes can be conveniently written using chemical symbols and formulae. The method of naming the substance is called chemical nomenclature. The representation of a substance with the help of symbol is called chemical notation.

A New Language - The Language of Chemistry:

Chemistry is like a new language. When we learn any new language, we start by learning the alphabet. Then we write words and finally words form sentences.

In the similar way elements combine to form molecule and these molecules combine with other molecules to undergo chemical reactions.

J.J. Berzelius suggested a method of representing elements using English capital letters.

Misconception:

Many chemical symbols are random letters, but they often represent ancient names or properties of the elements.

Symbol:

The short form representation of an element name is known as symbol.

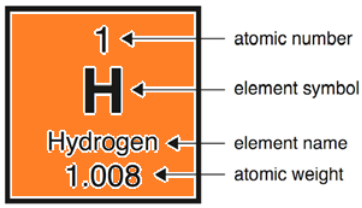
In General:

i) Each element has a unique symbol assigned to it.

ii) The symbol of an element is not used for any other element.

iii) We have seen that there are 118 known elements.

iv) Each of these elements has a symbol of its own.



Example: The symbol or short form representation of the element hydrogen is H. In chemical changes when you write H it means the element hydrogen.

Significance of a Symbol:

Qualitative Meaning:

A symbol represents a specific element. A symbol represents one atom of an element.

Example: O stands for oxygen, N stands for nitrogen.

Quantitative Meaning:

A symbol represents the mass of element, equal to its atomic mass of that element.

1. One atom of an element,

   Example: One atom of carbon

2. The number of parts by Atomic weight of an element,

   Example: 12 parts by weight of carbon.

3. One gram atom of an element,

   Example: One gram atom of carbon i.e., 12 grams.

Fun Facts

If Chemistry were a language, H_2O would be its most famous word!

Elements:

Definition: Substance, which cannot be broken further into any other substances by any physical or chemical means, is called **'*element*'.**

Example: Hydrogen, oxygen, nitrogen, sulphur, carbon etc.

Characteristics of an Element:

1. **Nature:** An element is a pure and homogeneous substance.
2. **Melting and boiling points:** It has characteristic melting and boiling points.
3. **Separation of substance:** An element cannot be broken down into simple substances, by any physical or chemical means.
4. **Nature of atoms:** An element is made up of same kind of atoms. Different elements are made up of different kinds of atoms.
5. **Chemical reaction:** An element may chemically react with other elements to form compounds.

   Example: Hydrogen combines with oxygen to form water.

   Hydrogen combines with chlorine to form hydrogen chloride.

CLASSROOM DISCUSSION QUESTIONS CDQ 01

1. Who suggested a method of representing elements using English capital letters?

(A) J.J. Thomson

(B) J.J. Berzelius

(C) Marie Curie

(D) Dmitri Mendeleev

2. What is the qualitative meaning of a chemical symbol?

(A) It represents the number of parts by atomic weight of an element

(B) It represents one gram atom of an element

(C) It represents the mass of an element, equal to its atomic mass

(D) It represents a specific element

3. How many known elements are there currently?

(A) 92 (B) 118

(C) 64 (D) 150

4. How is an element defined?

(A) A substance that can be broken down further into other substances

(B) A mixture of various compounds

(C) A pure and homogeneous substance that cannot be broken down further

(D) A substance made up of different kinds of atoms

5. What characteristic does not define an element?

(A) Nature

(B) Melting and boiling points

(C) Ability to be broken down into simpler substances

(D) Reactivity with other elements

6. What is the nature of atoms in an element?

(A) They are made up of the same kind of atoms

(B) They are made up of different kinds of atoms

(C) They have atoms with varying sizes

(D) They have atoms with different charges

7. How do elements interact with other elements?

(A) They cannot chemically react with other elements

(B) They chemically react with other elements to form compounds

(C) They physically combine with other elements

(D) They remain inert in the presence of other elements

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken ☐ Minutes

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Concept 2

Symbols with Elements:

- For some of the elements the first letter of its English name is used as symbol. To represent that element in short form only capital letters are used.

Example:

Name	Hydrogen	Carbon	Nitrogen	Oxygen	Fluorine	Sulphur
Symbol	H	C	N	O	F	S

- When the names of the two elements start with the same letter, the second letter or a prominent letter is added to the first letter. When two letters are used, the first letter is in capital and the second letter is always a small one.

Example:

Name	Calcium	Chlorine	Barium	Beryllium	Platinum	Bromine
Symbol	Ca	C*l*	Ba	Be	Pt	Br

- The symbols of some elements are derived from their latin names. They are given below.

Example:

S.no	Element	Latin Name	Symbol
1	Sodium	Natrium	Na
2	Potassium	Kalium	K
3	Iron	Ferrum	Fe
4	Copper	Cuprum	Cu
5	Silver	Argentum	Ag
6	Gold	Aurum	Au
7	Mercury	Hydrargyrum	Hg
8	Lead	Plumbum	Pb
9	Tin	Stannum	Sn
10	Antimony	Stibium	Sb
11	Tungsten	Wolfram	W

- Some elements are named after the names of the countries and laboratories.

***Example*:**

S.No	Element	Country or laboratory	Symbol
1	Berkelium	City of Berkley	Bk
2	Californium	University of California	Cf
3	Polonium	Poland	Po
4	Americium	America	Am
5	Ruthenium	Russia	Ru
6	Germanium	Germany	Ge

- Some elements are named after the names of the planets.

***Example*:**

S.No	Element	Name of the planet	Symbol
1	Uranium	Uranus	U
2	Neptunium	Neptune	Np
3	Plutonium	Pluto	Pu

- Some elements are named after the names of the scientists

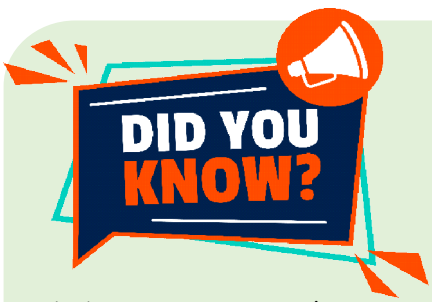
***Example*:**

S.No	Element	Name of the Scientists	Symbol
1	Curium	Madam curie	Cm
2	Einsteinium	Albert Einstein	Es
3	Fermium	Enrico Fermi	Fm
4	Nobelium	Alfred nobel	No
5	Mendelevium	Mendeleev	Md

Elements are Made up of Atoms:

Elements are pure substances that are made of small particles called atoms. An atom is the smallest unit of matter that may or may not exist independently but takes part in chemical reactions.

It has been found that atoms are made up of certain particles that are inside the atom as follows.



Carbon is a unique element that can react with other elements to produce 10 million different compounds.

1. The atoms have electrons, protons, neutrons in them.
   a) The electrons are negatively charged particles.
   b) The protons are positively charged particles.
   c) The neutrons are neutrally charged particles.

Riddle

I am so small you can't see me,
But I make up everything, literally!
What am I?

2. The number of electrons in an atom is equal to the number of protons in it. Since the negatively charged particles (electrons) are equal to the positively charged particles (protons), the atom is electrically neutral.
3. The protons and neutrons are present in a small central region within the atom called the **nucleus**. Since protons and neutrons are found inside the nucleus of the atom, they are called **nucleons**.
4. The number of protons in the nucleus of atom is called **atomic number**. As an atom is electrically neutral therefore the number of electrons revolving around the nucleus is equal to the atomic number. The atomic number is represented on left hand side of the symbol of the element in **subscript.**

   For example: ${}_{13}Al$, Atomic number of aluminium is 13.

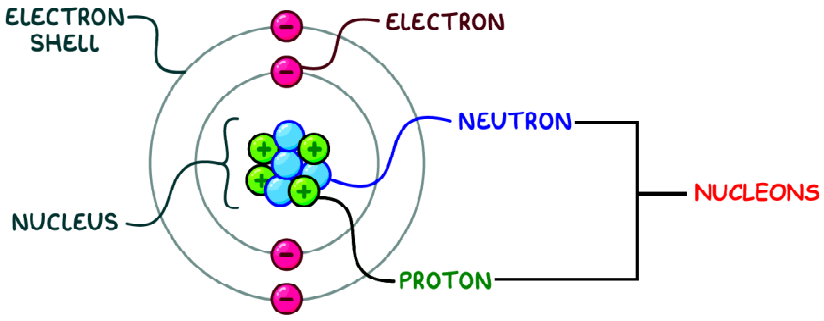
CHALLENGE

Explain why atoms of the same element have identical properties.

5. **The mass number** of an element gives the sum of the number of protons and neutrons in an atom.

   For example, mass number of sodium is 23. This means that the sum of the protons and neutrons in the nucleus of sodium atom is 23.
6. The difference between mass number and atomic number gives the number of neutrons in the atom of the element.

   For example, the difference between mass number of sodium (23) and its atomic number (11) is 23–11=12. There are 12 neutrons in sodium atom.



ATOM WITH SUBATOMIC PARTICLES

CLASSROOM DISCUSSION QUESTIONS CDQ 02

1. What is the symbol for the element nitrogen?

(A) N (B) Ni

(C) Na (D) Ng

2. Which element is named after the planet uranus?

(A) Uranium

(B) Neptunium

(C) Plutonium

(D) None of these

3. How is the atomic number represented in the symbol of an element?

(A) As a superscript to the symbol

(B) As a subscript to the symbol

(C) On the right side of the symbol

(D) On the left side of the symbol

4. What particles are found inside an atom?

(A) Electrons, protons, photons

(B) Electrons, neutrons, isotopes

(C) Electrons, protons, neutrons

(D) Electrons, positrons, neutrons

5. What is the symbol for the element gold?

(A) Au (B) Ag

(C) Fe (D) Sn

6. What is the atomic number of an atom?

(A) The number of electrons

(B) The number of protons

(C) The number of neutrons

(D) The sum of protons and neutrons

7. Who is the element Curium named after?

(A) Isaac Newton

(B) Marie Curie

(C) Albert Einstein

(D) Enrico Fermi

8. What does the mass number of an element represent?

(A) The number of protons

(B) The number of electrons

(C) The sum of protons and neutrons

(D) The number of neutrons

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken ☐ Minutes

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Concept 3

Valency:

The combining capacity of an element is called its valency. (or) The number of hydrogen atoms that combines with one atom of an element is known as its valency.

Example:

One atom of chlorine combines with one atom of hydrogen. Valency of chlorine is 1.

One atom of oxygen combines with two atoms of hydrogen. Valency of oxygen is 2.

Element	Valency	Element	Valency	Element	Valency
Sodium	1	Potassium	1	Fluorine	1
Magnesium	2	Calcium	2	Chlorine	1
Aluminium	3	Nitrogen	3	Hydrogen	1

On other hand, valency also can be defined as "The number of electrons lost, gained or shared by an atom of the element to acquire stable electronic configuration is called its valency".

Example: $Na - 1e^- \rightarrow Na^+$ $\quad Cl + 1e^- \rightarrow Cl^-$

$Ca - 2e^- \rightarrow Ca^{2+}$ $\quad O + 2e^- \rightarrow O^{2-}$

$Al - 3e^- \rightarrow Al^{3+}$ $\quad N + 3e^- \rightarrow N^{3-}$

Note: Noble gases like He, Ne, Ar, Kr, Xe, Rn have zero valency.

Concept of Variable Valency:

When an element exhibits more than one valency, it is said to exhibit variable valency. The reason for variable valency in certain metals is that, depending upon the experimental conditions, an atom of the metal loses one (or) more electrons that are present in its outermost shell (valence shell), i.e., it loses some electrons from the shell next to outermost shell. Thus, it exhibits variable valency.

Fun Facts

Carbon is a valency chameleon! It can form single, double and triple bonds with other atoms.

How to Name the Ions of an Element with Variable Valency?

If an element exhibits two different positive valencies, then suffix ***–ous*** is attached at the end of the name of the metal for ***lower valency*** and suffix ***–ic*** is attached at the end of the name of the metal for ***higher valency***.

Example: An atom of iron can lose 2 electrons from its outermost orbit to form iron ion (Fe^{2+}). However, under special experimental conditions, it can lose two electrons from the outermost orbit and one electron from the penultimate shell (last but one shell). Thus, it forms iron ion (Fe^{3+}). In such a situation, the element is said to exhibit variable valency.

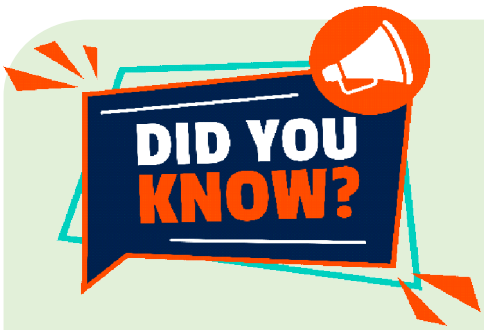
Some Examples:

Metal	Name and Lower valency	Name and Higher valency
Iron (Ferrum)	Ferrous Fe^{2+} or Fe(II)	Ferric Fe^{3+} or Fe(III)
Copper (Cuprum)	Cuprous Cu^{+} or Cu(I)	Cupric Cu^{2}+ or Cu(II)
Mercury (Hydrargyrum)	Mercurous Hg^{+} or Hg(I)	Mercuric Hg^{2+} or Hg(II)
Gold (Aurum)	Aurous Au^{+} or Au(I)	Auric Au^{+3} or Au (III)
Lead (Plumbum)	Plumbous Pb^{+2} or Pb(II)	Plumbic Pb^{+4} or Pb(IV)
Antimony	Antimonous Sb^{+3} or Sb(III)	Antimonic Sb^{+5} or Sb(V)
Arsenic	Arsenous As^{3+} or As(III)	Arsenic As^{5+} or As(V)

Atomicity:

The molecules of an element are constituted by the same type of atoms. Molecules of many elements, such as argon (Ar), helium (He) etc., are made up of only one atom of that element. But this is not the case with most of the nonmetals.

For example, a molecule of oxygen consists of two atoms of oxygen and hence it is known as a diatomic molecule (O_2). If three atoms of oxygen unite into a molecule, instead of the usual, we get ozone (O_3).



Hydrogen is the most abundant element in the universe. Stars including our Sun, are primarily composed of hydrogen gas.

The number of atoms constituting a molecule is known as its ***atomicity.***

Molecules of metals and some other elements, such as carbon, do not have a simple structure but consist of a very large and indefinite number of atoms bonded together.

Generally, elements exist as single atoms. However, sometimes two or more atoms of an element combine with one another to form a compound atom or molecule. Depending upon the number of atoms present in its molecules, the elements can be classified as under:

1. **Monoatomic elements:** The molecule of a monoatomic element contains only one atom(single atom per molecule).

   Example: Copper (Cu), silver (Ag), gold (Au) iron (Fe), sodium (Na) and noble gases such as helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), radon (Rn).

Amazing Fact

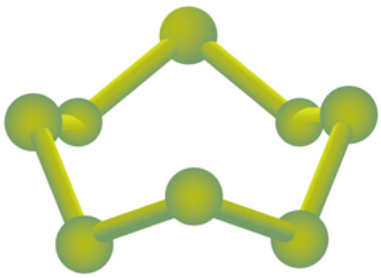
Helium is the coldest element on earth, with a boiling point of -452°F.

2. **Diatomic elements:** The molecule of a diatomic element contains two atoms(two atoms per molecule).

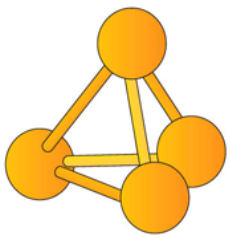
   Example: Hydrogen (H_2), oxygen (O_2), nitrogen (N_2), chlorine (Cl_2) etc.,

3. **Polyatomic elements:** The molecule of a poly atomic element contains more than two atoms(more than two atoms per molecule).

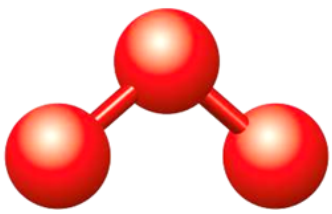
   Example: Ozone — Triatomic(O_3)
   Phosphorous — Tetra atomic (P_4)
   Sulphur — Octa atomic(S_8)
   Carbon — (C_{60})



Sulphur molecule (S_8)



Phosphorous molecule (P_4)



Ozone molecule (O_3)

Additional Information about Elements:

- 104 elements occur as solids, 11 elements occur as gases and 2 elements occur as liquids.
- 93 elements occur as metals, 11 elements occur as non-metals, 7 elements occur as metalloids and 6 elements occur as noble gases.

- The first man made elements is Technetium (Tc)
- The metal present in chlorophyll is Magnesium (Mg)
- The metal present in haemoglobin is Iron (Fe)

CLASSROOM DISCUSSION QUESTIONS CDQ 03

1. What is valency?

(A) The number of atoms in a molecule

(B) The combining capacity of an element

(C) The number of electrons in an atom

(D) The number of neutrons in an atom

2. Which element has a valency of 3?

(A) Sodium

(B) Magnesium

(C) Aluminium

(D) Potassium

3. What is the atomicity of ozone?

(A) Monoatomic

(B) Diatomic

(C) Triatomic

(D) Tetraatomic

4. Which of the following sets consists only of monoatomic elements?

(A) H_2, O_2, N_2

(B) Cu, He, Ar

(C) O_3, Fe, Ne

(D) Au, Cl_2, Xe

5. How many elements occur as liquids at room temperature?

(A) 2 (B) 6

(C) 11 (D) 104

6. Which of the following elements is diatomic?

(A) Copper

(B) Argon

(C) Hydrogen

(D) Phosphorus

7. What is the concept of variable valency?

(A) The ability of an element to exhibit different valencies

(B) The ability of an element to change its atomic number

(C) The ability of an element to exist in multiple states of matter

(D) The ability of an element to conduct electricity

8. What is the name for a molecule containing two atoms of the same element?

(A) Monoatomic

(B) Diatomic

(C) Polyatomic

(D) Triatomic

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken ☐ Minutes

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Concept 4

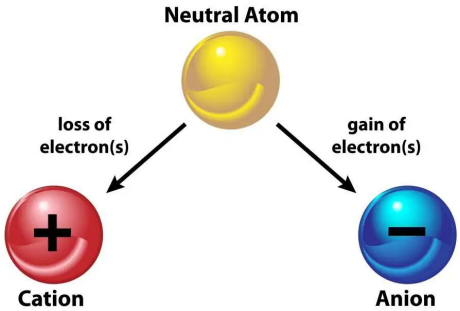
Ions:

When an atom loses or gains electrons, it gets a charge.

On losing electrons, the positive charge becomes more than the negative charge in an atom. Thus, the atom acquires positive charge.

On gaining electrons, the negative charge becomes more than the positive charge. Thus, the atom acquires negative charge.

An atom that acquires an electrical charge either positive (on losing electrons) or negative (on gaining electrons) is called an ***ion***.



Types of Ions:

1. Electro positive ions or Cations:

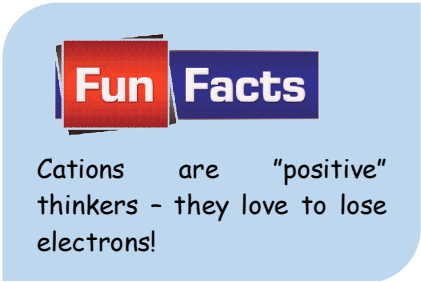
If an atom (generally metallic atom) loses electrons, the atom gets positive charge. Such 'positively charged atom is called an ***electro positive ion*** or ***cation***'.

Examples: H^{+}, Be^{+2}, Al^{+3}, Pb^{+4}, Sb^{+5}

i) Monovalent electro positive ion:

The metallic ion formed by the donation of one electron from its outer most orbit is called monovalent electro positive ion.

Examples: H^{+}, Na^{+}, Rb^{+}, NH^{+}_{4}



ii) Divalent electro positive ion:

The metallic ion formed by the donation of two electrons from its outer most orbit is called divalent electro positive ion.

Examples: Be^{+2}, Mg^{+2}, Ca^{+2}, Sr^{+2}

iii) Trivalent electro positive ion:

The metallic ion formed by the donation of three electrons from its outer most orbit is called trivalent electro positive ion.

Examples: Al^{+3}, Fe^{+3}, Co^{+3}, Sb^{+3}

iv) Tetravalent electro positive ion:

The metallic ion formed by the donation of four electrons from its outer most orbit is called tetravalent electro positive ion.

Examples: Pb^{+4}, Sn^{+4}

2. Electronegative ions or Anions:

If an atom (generally non-metallic atom) gains electrons, the atom gets negative charge. Such 'negatively charged atom is called an ***electronegative ion*** or ***anion***'.

Examples: Cl^-, O^{-2}, N^{-3}, C^{-4}

i) Monovalent electronegative ion.

An ion (or) radical formed by the acceptance of only one electron is called as monovalent electronegative ion

Examples: Cl^-, OH^-, NO^-

ii) Divalent electronegative ion.

An ion (or) radical formed by the acceptance of two electrons is called as divalent electronegative ion.

Examples: O^{-2}, S^{-2}, SO_4^{-2}

iii) Trivalent electronegative ion.

An ion (or) radical formed by the acceptance of three electrons is called as trivalent electronegative ion.

Examples: N^{-3}, B^{-3}, PO_4^{-3}

Radicals:

A radical is a group of atoms that carries a charge (positive or negative) and behaves as unit in chemical reactions.

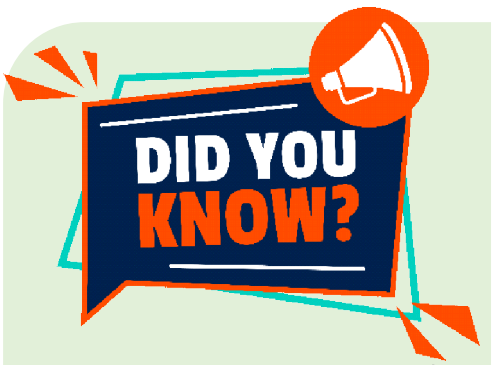
Example: The symbol of sulphate ion is SO_4^{-2}. Sulphate ion is a radical.

Sulphate ion is present in sulphuric acid. Sulphuric acid reacts with sodium chloride as follows.

$$H_2SO_4 + 2NaCl \rightarrow Na_2SO_4 + 2HCl$$

Sulphate radical moves as unit to replace chloride ion in sodiumn chloride and combines with sodium

The sulphate part in H_2SO_4 moves as a unit and combines with sodium.



Radicals are like the *rebels* of the molecular world! They will be super active and always looking to stabilize themselves.

CLASSROOM DISCUSSION QUESTIONS CDQ 04

1. What is an ion?

(A) An atom with a positive or negative electrical charge

(B) An atom with an even number of protons

(C) An atom with a balanced number of electrons and neutrons

(D) An atom with a single electron in its outermost shell

2. Which type of ion is formed when an atom loses electrons?

(A) Electropositive ion

(B) Electronegative ion

(C) Monovalent ion

(D) Divalent ion

3. Which type of ion is generally formed by metallic atoms?

(A) Neutral (B) Cation

(C) Anion (D) Radical

4. What is the charge on a monovalent electronegative ion?

(A) +1 (B) –1

(C) +2 (D) –2

5. What is the name for a group of atoms that carries a charge and behaves as a unit in chemical reactions?

(A) Isotopes (B) Radicals

(C) Elements (D) Compounds

6. An atom that gains electron(s) becomes:

(A) A cation

B) A radical

C) An anion

D) A neutral atom

7. Which element forms a tetravalent electropositive ion?

(A) Aluminium (Al)

(B) Iron (Fe)

(C) Lead (Pb)

(D) Sodium (Na)

8. The sulphate ion (SO_4^{2-}) is an example of:

(A) A monovalent anion

(B) A tetravalent cation

(C) A divalent electropositive ion

(D) A divalent electronegative radical

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken ☐ Minutes

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Concept 5

Formula of the Compound:

A symbolic representation of one molecule of a compound representing the number of atoms of various elements present in it, is called formula of the compound

(or)

The short form representation of the name of a compound is known as formula.

Example: The formula of calcium carbonate is $CaCO_3$.

Introduction:

- You know that English alphabet has 26 letters. By combining these 26 letters we can make millions of English words.
- Much the same way by combining elements in different combinations, we can make an endless number of compounds.
- Each compound is represented by a formula.

Following Information is given by the Formula of a Compound:

- It tells which elements are present in a compound.
- It tells the number of atoms of each element present in a compound.

How to Read Information in the Formula of a Compound?

The symbols in a formula can be prefixed or suffixed by a numeral.

Following Examples Will Make it Clear:

- When the numeral is written on the left-hand side before the formula, it represents number of molecules of the compound, and hence, the number of atoms present in each molecule.
- When we write 2S, 3C*l* or 4A*l*, it means two atoms of sulphur, three atoms of chlorine or four atoms of aluminium respectively.
- When we write 2NaC*l*, 4ZnO, etc., it means two molecules of sodium chloride (which contains two atoms of sodium and two atoms of chlorine), four molecules of zinc oxide (which contains four atoms of zinc and four atoms of oxygen).

Note: Compound is refers to a pure substance made up of two or more elements chemically combined in a fixed ratio by weight.

- When the numeral is written on the right bottom side of the symbol, it represents the number of atoms in one molecule of a compound.
- When we write H_2, O_2 etc. it means that one molecule of hydrogen has two atoms in it. Similarly, one molecule of oxygen has two atoms in it.
- When we write SO_2 it means one molecule of sulphur dioxide has one atom of sulphur and two atoms of oxygen.

Fun Facts

Every breath you take involves a chemical formula! The oxygen you breathe is O_2, and the carbon dioxide you exhale is CO_2.

- When we write $Al_2(SO_4)_3$, it means a molecule of aluminium sulphate has two atoms of aluminium, three atoms of sulphur and twelve atoms of oxygen.
- When we write $3KNO_3$, it means there are three molecules of potassium nitrate. Furthermore, total number of various atoms in three molecules are: three atoms of potassium; three atoms of nitrogen and nine atoms of oxygen.

Formulae of Some Common Compounds:

Name of the Compound	Formula	Name of the Compound	Formula
Ammonia	NH_3	Potassium chloride	KCl
Ammonium bicarbonate	NH_4HCO_3	Ferrous sulphide	FeS
Barium chloride	$BaCl_2$	Potassium chlorate	$KClO_3$
Calcium nitrate	$Ca(NO_3)_2$	Sodium nitrate	$NaNO_3$
Carbon tetra chloride	CCl_4	Aluminium chloride	$AlCl_3$
Copper carbonate	$CuCO_3$	Silver nitrate	$AgNO_3$
Magnesium hydroxide	$Mg(OH)_2$	Copper sulphate (Blue vitriol)	$CuSO_4.5H_2O$

Significance of a Formula:

1. Qualitative significance: Qualitatively, it represents the type of elements present in it

***Example*:** Calcium carbonate ($CaCO_3$) contains calcium, carbon and oxygen as the elements.

2. Quantitative significance: Quantitatively, it represents the number of atoms each element presents in one molecule of the compound.

***Example*:** One molecule of calcium carbonate ($CaCO_3$) represents one molecule of calcium carbonate is made up of one atom of calcium, one atom of carbon and three atoms of oxygen.

Writing the Formula of the Compound:

To write a formula, follow the steps given below. This method of writing formula is called ***criss-cross method***.

Step - 1: Write the symbol of positive ion or the radical to the left and the negative ion or radical to the right.

Step - 2: Put the valency number of each radical or the ion on its top right. Divide the valency numbers by highest common factor, if any, to get simple ratio. Now ignore the (+) and (–) symbols. Interchange the valency numbers of radicals or ions.

Step - 3: Shift the valency numbers to lower right side of radical or ion. If the radical receives a number more than 1, enclose it within brackets. Do not enclose ions within brackets.

Examples:

1. **Writing the formula of Aluminium chloride.**

Step-1 : $Al^{+3}Cl^{-1}$

Step-2 : $Al^{3}Cl^{1}$

Step-3 : $Al^{3}\times Cl^{1} \Rightarrow AlCl_3$

2. **Writing the formula of Magnesium sulphate.**

Step-1 : $Mg^{+2}SO_4^{-2}$

Step-2 : $Mg^{2}\ SO_4^{2}$

Step-3 : $Mg^{1}\times SO_4^{1} \Rightarrow MgSO_4$

3. **Writing the formula of Calcium bicarbonate**

Step-1 : $Ca^{2+}\ HCO_3^{-1}$

Step-2 : $Ca^{2}\ HCO_3^{1}$

Step-3 : $Ca^{2}\times HCO_3^{1} \Rightarrow Ca(HCO_3)_2$

CLASSROOM DISCUSSION QUESTIONS CDQ 05

1. What does "2NaCl" represent?

(A) Two atoms of sodium and two atoms of chlorine

(B) Two molecules of sodium chloride

(C) Two atoms of sodium and one atom of chlorine

(D) Two molecules of chlorine

2. What does "H_2" represent?

(A) Two molecules of hydrogen

(B) Two atoms of hydrogen in one molecule

(C) Two atoms of hydrogen in separate molecules

(D) Two molecules of oxygen

3. In the compound "$Al_2(SO_4)_3$", how many atoms of oxygen are present?

(A) 3 (B) 6 (C) 9 (D) 12

4. What is the formula for sodium bicarbonate?

(A) $NaHCO_3$ (B) Na_2CO_3

(C) NaCl (D) NaOH

5. What is the formula for calcium carbonate?

(A) CaO (B) $CaCO_3$

(C) $CaSO_4$ (D) $CaHCO_3$

6. What does the formula "$CuSO_4.5H_2O$" indicate?

(A) Five molecules of water

(B) One molecule of copper sulphate and five molecules of water

(C) Five atoms of copper and one atom of sulphur

(D) One molecule of copper sulphate containing five water molecules

7. What does the formula "$AgNO_3$" represent?

(A) Silver nitrate

(B) Nitric acid

(C) Silver nitrite

(D) Silver nitride

8. What is the qualitative significance of a formula?

(A) It represents the number of atoms of each element in a molecule

(B) It indicates the type of elements present in the compound

(C) It shows the total number of molecules in the compound

(D) It specifies the ratio of positive to negative ions in the compound

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken ☐ Minutes

1 Ⓐ Ⓑ Ⓒ Ⓓ	2 Ⓐ Ⓑ Ⓒ Ⓓ	3 Ⓐ Ⓑ Ⓒ Ⓓ	4 Ⓐ Ⓑ Ⓒ Ⓓ	5 Ⓐ Ⓑ Ⓒ Ⓓ
6 Ⓐ Ⓑ Ⓒ Ⓓ	7 Ⓐ Ⓑ Ⓒ Ⓓ	8 Ⓐ Ⓑ Ⓒ Ⓓ	9 Ⓐ Ⓑ Ⓒ Ⓓ	10 Ⓐ Ⓑ Ⓒ Ⓓ

Concept 6

Naming Chemical Compounds from their Formula:

Usually, the elements present in a compound are named in order of symbols appearing in formula. Following rules are applied in naming a compound.

Rule 1: If a compound contains only two elements (binary compounds) such that one of them is metal, the metal is named first. Non-metallic part is given a suffix '***ide***' at the end.

***Examples*:**

i) Compound of potassium and chlorine is potassium chloride (KCl).

ii) Compound of magnesium and nitrogen is magnesium nitride (Mg_3N_2).

iii) Compound of sodium and chlorine is sodium chloride ($NaCl$)

Rule 2 : The compound containing two non-metals are named by using Greek prefix like mono, di, tri, tetra, penta, which denotes the number of atoms present in the compound.

***Examples*:**

i) NO stands for nitrogen monoxide.

ii) NO_2 stands for nitrogen dioxide.

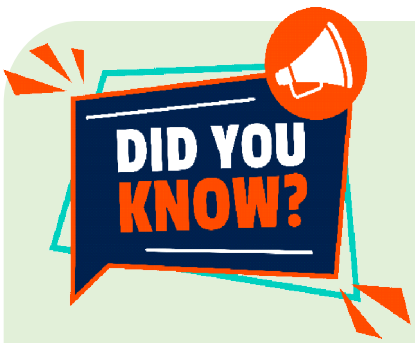
iii) SO_2 stands for sulphur dioxide.

iv) SO_3 stands for sulphur trioxide.

v) CO_2 stands for carbon dioxide.

vi) NH_3 stands for nitrogen trihydride.

vii) PCl_5 stands for phosphorous pentachloride.



Chemists have synthesized over 60 million different chemical compounds to date, with new compounds being discovered and created regularly

Rule 3: Compounds containing three elements (tertiary compounds), one of which is oxygen, are named with suffix '-***ate'*** at the end, provided there is only one such compound. If there are two compounds, the one with more number of oxygen atoms is named with suffix ***'ate'*** ending and one with less number of oxygen atoms is named with ***'ite'*** ending.

Examples:

i) (a) Sodium nitrate ($NaNO_3$)

(b) Sodium nitrite ($NaNO_2$)

ii) (a) Magnesium sulphate ($MgSO_4$)

(b) Magnesium sulphite ($MgSO_3$)

iii) (a) Calcium phosphate $[Ca_3(PO_4)_2]$

(b) Calcium phosphite $[Ca_3(PO_3)_2]$

Knowledge Box

Hydrogen is the most abundant element in the universe, and the sun is made up of 75% hydrogen and 25% helium.

Rule 4: If a compound has fewer oxygen atoms than one ending in ***'-ite'***, it is given the prefix ***'hypo-'***. If a compound has more oxygen atoms than one ending in ***'-ate'***, it is given the prefix ***'per-'***.

Examples:

i) $KClO$ is named potassium hypochlorite as it contains less oxygen atoms than potassium chlorite ($KClO_2$).

ii) $KClO_4$ is named potassium perchlorate as it contains more oxygen atoms than potassium chlorate ($KClO_3$).

Naming of Acids:

(i) Binary Acids(Hydracids):

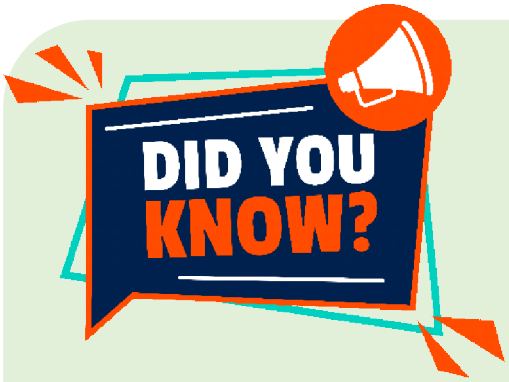
1. The names of binary acids (acids containing hydrogen and one more element) are given by adding prefix ***'hydro-'*** and suffix ***'-ic'*** to the name of second element.

Examples:

i) Acid of hydrogen and chlorine is hydrochloric acid(HCl)

ii) Acid of hydrogen and fluorine is hydrofluoric acid(HF).

iii) Acid of hydrogen and bromine is hydrobromic acid(HBr).



You might know N_2O as **nitrous oxide**, following the standard naming rules. This gas is also known as **laughing gas**. When inhaled, it causes euphoria and uncontrollable laughter!

(ii) Oxy Acids:

Oxy acid is a compound that contains hydrogen, oxygen and at least one other element.

The number of oxygen atoms in an acid determines whether it is named with the suffix "-ic" or "-ous" because the number of oxygen atoms effects the acids acidity.

"-ic":- Acids with more oxygen atoms are named with the suffix "-ic".

"-ous":- Acids with fewer oxygen atoms are named with the suffix "-ous".

In case of oxyacids prefix hydro is not used.

The names of acids containing radicals or polyatomic groups are given on the basis of second element.

Examples:

i) Sulphuric acid (H_2SO_4), Sulphurous acid (H_2SO_3)

ii) Phosphoric acid (H_3PO_4), Phosphorous acid (H_3PO_3)

iii) Nitric acid (HNO_3), Nitrous acid (HNO_2)

Naming of Bases:

Bases containing -OH radical are named as hydroxides, after the name of metal.

Examples:

i) Sodium hydroxide (NaOH)

ii) Calcium hydroxide [$Ca(OH)_2$]

iii) Ammonium hydroxide (NH_4OH)

Trivial Names or Common Names:

There are certain names of compounds which do not follow any systematic rule. Such names are called trivial names or common names. Chemists have not considered wise to replace these names by systematic names as they are widely understood by the common man.

Fun Facts

Trivial names can be older than Chemistry itself! They come from ancient languages or historical uses long before modern chemistry even existed.

Examples:

i) Common name for Nitrogen hydride is **Ammonia** (NH_3)

ii) Common name for Sodium chloride is **Table salt** ($NaCl$)

iii) Common name for Hydrogen oxide is **Water** (H_2O)

iv) Common name for Potassium nitrate is **Nitre** (KNO_3)

v) Common name for Magnesium carbonate is **Magnesite** ($MgCO_3$)

Names of Some Compounds and their Formulae:

Name of the compound	Common name	Formula
Nitric acid	Aqua fortis	HNO_3
Sulphuric acid (King of chemical)	Oil of vitriol	H_2SO_4
Sodium hydroxide	Caustic soda	NaOH
Calcium oxide	Quick lime	CaO
Sodium carbonate	Soda ash	Na_2CO_3
Calcium carbonate	Marble stone/ limestone	$CaCO_3$
Sodium bicarbonate	Baking soda	$NaHCO_3$
Sodium chloride	Common salt/ Table salt	$NaCl$
Potassium nitrate	Nitre	KNO_3
Silver nitrate	Lunar caustic	$AgNO_3$
Hydrated copper sulphate	Blue vitriol	$CuSO_4.5H_2O$
Hydrated ferrous sulphate	Green vitriol	$FeSO_4.7H_2O$
Hydrated zinc sulphate	White vitriol	$ZnSO_4.7H_2O$
Hydrated sodium carbonate	Washing soda	$Na_2CO_3.10H_2O$

The scientific name for water is dihydrogen monoxide (H_2O), but almost every culture on Earth has a simple, unique word for it. Here's the cool part: even though the words are different, they all have short sounds because water is so essential that languages evolved to make it easy to say!

English: Water Spanish: Agua

French: Eau German: Wasser

Japanese: Mizu Hindi: Pani

Imagine trying to order "dihydrogen monoxide" at a restaurant - it just wouldn't work!

Fun Facts

"Water" Isn't Its Scientific Name - But It's Universal!

Atomic Numbers and Mass Numbers of First 30 Elements:

Name of the Element	Symbol	Atomic Number (Z)	Mass Number (A)	No. of electrons	No. of protons	No. of Neutrons (n=A-Z)
Hydrogen	H	1	1	1	1	0
Helium	He	2	4	2	2	2
Lithium	Li	3	7	3	3	4
Beryllium	Be	4	9	4	4	5
Boron	B	5	11	5	5	6
Carbon	C	6	12	6	6	6
Nitrogen	N	7	14	7	7	7
Oxygen	O	8	16	8	8	8
Fluorine	F	9	19	9	9	10
Neon	Ne	10	20	10	10	10
Sodium	Na	11	23	11	11	12
Magnesium	Mg	12	24	12	12	12
Aluminium	A*l*	13	27	13	13	14
Silicon	Si	14	28	14	14	14
Phosphorus	P	15	31	15	15	16
Sulphur	S	16	32	16	16	16
Chlorine	C*l*	17	35	17	17	18
Argon	Ar	18	40	18	18	22
Potassium	K	19	39	19	19	20
Calcium	Ca	20	40	20	20	20
Scandium	Sc	21	45	21	21	24
Titanium	Ti	22	48	22	22	26
Vanadium	V	23	51	23	23	28
Chromium	Cr	24	52	24	24	28
Manganese	Mn	25	55	25	25	30
Iron	Fe	26	56	26	26	30
Cobalt	Co	27	59	27	27	32
Nickel	Ni	28	58	28	28	30
Copper	Cu	29	63	29	29	34
Zinc	Zn	30	65	30	30	35

CLASSROOM DISCUSSION QUESTIONS CDQ 06

1. There are certain names of compounds which do not follow any systematic rule. Such names are called:

(A) Chemical name

(B) Trivial name

(C) Common name

(D) Both B & C

2. The chemical name of caustic soda is:

(A) Sodium hydroxide

(B) Calcium hydroxide

(C) Magnesium hydroxide

(D) None of these

3. Sulphuric acid is a / an:

(A) Hydracid

(B) Oxyacid

(C) Radical

(D) None of these

4. While naming the binary acids suffix "-ic" is added to the name of:

(A) Hydrogen

(B) Second element

(C) Both A & B

(D) None

5. The common name of silver nitrate is:

(A) Lunar caustic

(B) Caustic soda

(C) Nitre

(D) Aqua fortis

6. The chemical formula of potassium perchlorate is:

(A) $KClO_3$

(B) $KClO_2$

(C) $KClO_4$

(D) $KClO$

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken ☐ Minutes

1 Ⓐ Ⓑ Ⓒ Ⓓ	2 Ⓐ Ⓑ Ⓒ Ⓓ	3 Ⓐ Ⓑ Ⓒ Ⓓ	4 Ⓐ Ⓑ Ⓒ Ⓓ	5 Ⓐ Ⓑ Ⓒ Ⓓ
6 Ⓐ Ⓑ Ⓒ Ⓓ	7 Ⓐ Ⓑ Ⓒ Ⓓ	8 Ⓐ Ⓑ Ⓒ Ⓓ	9 Ⓐ Ⓑ Ⓒ Ⓓ	10 Ⓐ Ⓑ Ⓒ Ⓓ

C.D.F. (Concepts, Definitions and Formulae)

1. The representation of a substance with the help of symbol is called chemical notation.
2. A **symbol** represents short form of an element's name. J.J. Berzelius suggested a method of representing elements using English capital letters.
3. Symbol of a chemical element denotes one atom of that element.
4. The number of atoms constituting a molecule is known as its ***atomicity.***
5. The number of protons in the nucleus of atom is called ***atomic number.***
6. The protons and neutrons are present in a small central region within the atom is called the ***nucleus.***
7. The ***mass number*** of an element gives the sum of the number of protons and neutrons in an atom.
8. The difference between mass number and atomic number gives the number of neutrons in the atom of the element.
9. The number of hydrogen atoms which combine directly or indirectly with one atom of an element, so as to form a compound is called **valency**.
10. When an element exhibits more than one valency, it is said to exhibit variable valency.
11. If an atom (generally metallic atom) loses electrons, the atom gets positive charge. Such 'positively charged atom is called an ***electro positive ion*** or ***cation***'.
12. If an atom (generally non-metallic atom) gains electrons, the atom gets negative charge. Such 'negatively charged atom is called an ***electronegative ion*** or ***anion***'.
13. A **radical** is a group of atoms that carries a charge (positive or negative) and behaves as unit in chemical reactions.
14. The representation of a molecule of a substance (element or compound) in terms of symbols and subscript numbers is known as the **formula**.
15. A **molecule** is the basic unit of a substance that can be an element or a compound.
16. There are certain names of compounds which do not follow any systematic rule. Such names are called **trivial names** or **common names**.

Advanced Worksheet

LEVEL 1

Single Correct Answer Type (S.C.A.T.):

1. Iron shows two valencies: +2 and +3. What is the correct name of the ion Fe^{3+}?

(A) Ferric ion

(B) Ferrous ion

(C) Iron(II) ion

(D) None of these

2. Which of the following pairs is correctly classified?

(A) Carbon – Diatomic

(B) Sulphur – Octoatomic

(C) Nitrogen – Polyatomic

(D) Phosphorus – Monoatomic

3. The formula of aluminium sulphate is $Al_2(SO_4)_3$. How many oxygen atoms are present in one molecule of aluminium sulphate?

(A) 3 (B) 4

(C) 12 (D) 6

4. What does the numeral written on the left side of a formula indicate?

(A) Number of atoms

(B) Number of molecules

(C) Valency of the element

(D) Charge on the molecule

5. Which of the following correctly represents four atoms of chlorine?

(A) $2Cl_2$ (B) $4Cl$

(C) Cl_4 (D) $4Cl_2$

6. What is the name of $KClO_3$?

(A) Potassium hypochlorite

(B) Potassium chlorite

(C) Potassium chlorate

(D) Potassium perchlorate

7. The Latin name of copper is:

(A) Natrium

(B) Argentum

(C) Stannum

(D) Cuprum

8. The combining capacity of an element is called:

(A) Atom

(B) Molecule

(C) Compound

(D) Valency

9. The valency of chlorine is:

(A) One

(B) Zero

(C) Three

(D) Two

10. The name of the ion of a variable valent element with lower valency in a compound ends with:

(A) Ous (B) Ic

(C) Ene (D) Yne

11. The name of the ion of a variable valent element with higher valency in a compound ends with:

(A) Ene (B) Ous

(C) Ic (D) Yne

12. Valency is always:

(A) Whole number

(B) Fractional number

(C) Decimal number

(D) All of these

13. The Latin name for tungsten is:

(A) Kalium

(B) Ferrum

(C) Stibium

(D) Wolfram

14. The charged particle formed by either gaining or loosing of electrons by an atom is called:

(A) Ion

(B) Atom

(C) Element

(D) Compound

15. A positively charged ion is called:

(A) Anion (B) Cation

(C) Electron (D) Neutron

16. The representation of a molecule of a substance in terms of symbols and subscript number is:

(A) Compound

(B) Atom

(C) Formula

(D) Radical

17. The metallic ion formed by the donation of one electron is called:

(A) Monovalent electropositive

(B) Divalent electropositive

(C) Trivalent electropositive

(D) All of these

18. Which of the following is an element?

(A) Sodium chloride

(B) Hydrargyrum

(C) Carbon dioxide

(D) Ammonia

19. An atom (or) a group of atoms which can exist independently with charge is called:

(A) Ion

(B) Molecule

(C) Compound

(D) Substance

20. The valency of nitrogen in NH_3 is:

(A) 3 (B) 2

(C) 1 (D) 4

21. The molecular formula is a short form representation of:

(A) A compound

(B) A solution

(C) A mixture

(D) An alloy

22. The atomic number of sulphur is:

(A) 15 (B) 18

(C) 16 (D) 14

23. Which of the following element exhibits diatomicity?

(A) Sodium

(B) Magnesium

(C) Phosphorus

(D) Nitrogen

24. The number of electrons accepted by an atom of an element is called:

(A) Electropositive valency

(B) Electronegative valency

(C) Outermost valency

(D) None

25. The chloride ion is formed by the gain of _____electron(s).

(A) One (B) Two

(C) Three (D) Four

26. The chemical formula of mercury oxide or mercury(II) oxide is:

(A) HgO_2 (B) HgO_3

(C) Hg_2O_4 (D) HgO

27. The common (or) trivial name of sodium chloride is:

(A) Table salt

(B) Chile salt

(C) Rock salt

(D) Both A & C

28. The common name of copper sulphate is:

(A) Blue vitriol

(B) White vitriol

(C) Green vitriol

(D) Rock vitriol

29. Which of the following is a radical?

(A) Potassium nitrate

(B) Sulphate

(C) Sodium chloride

(D) Hydrogen peroxide

30. F^-, P^{-3}, O^{-2} are respectively called as _____ valent ions.

(A) Mono, Di, Tetra

(B) Di, Mono, Tri

(C) Mono, Di, Tri

(D) Mono, Tri, Di

LEVEL 2

Multi Correct Answer Type (M.C.A.T.):

31. Which of the following are binary acids?

(A) HCl (B) H_2SO_4

(C) HF (D) HBr

32. Identify compounds with "hypo–" and "per–" naming.

(A) $KClO$ (B) $KClO_2$

(C) $KClO_3$ (D) $KClO_4$

33. Which of the following compounds of metals have same valency?

(A) $Al_2(SO_4)_3$ (B) Fe_2O_3

(C) $MgSO_4$ (D) $NaCl$

34. Which of the following elements can form both monovalent and divalent electropositive ions?

(A) Cu (B) Hg

(C) Fe (D) Pb

35. Which of the following elements exhibit mono atomicity?

(A) Calcium

(B) Copper

(C) Mercury

(D) Ozone

36. In which of the following compounds of metals have same valency?

(A) MgH_2 (B) BaH_2

(C) CaH_2 (D) NaH

37. Which of the following is/are the Latin names of elements?

(A) Plumbum

(B) Aurum

(C) Kalium

(D) Mercury

38. Which of the following metals exhibit variable valency?

(A) Sodium (B) Copper

(C) Iron (D) Mercury

39. Which of the following is/are di (or) bivalent electronegative ion?

(A) Oxide

(B) Sulphide

(C) Nitride

(D) Bromide

40. Which of the following elements can exhibit monovalent electropositive ion?

(A) Hydrogen

(B) Silver

(C) Oxygen

(D) Magnesium

Comprehension Passage Type (C.P.T.):

A symbol represents short form of an element. A symbol represents a specific element and one atom of an element.

41. The symbols for the elements nickel and scandium respectively are:

(A) Nk and Se

(B) N and Sd

(C) Ni and Sc

(D) Ne and S

42. The scientist who suggested a method of representing elements using the English letters is:

(A) Lavoisier

(B) J.J.Berzelius

(C) Robert Boyle

(D) Rutherford

43. Identify the correct symbols for the following elements respectively.

i) Calcium ii) Chlorine

iii) Beryllium

(A) Ca, Ch, Br

(B) Ca, CL, Be

(C) Ca, C*l*, Be

(D) Ca, Ce, By

LEVEL 3

Matrix Matching Type (M.M.T.):

SET - I

COLUMN - I

(Element)

44. Iron

45. Lead

46. Silver

47. Potassium

COLUMN - II

(Symbol)

(A) K

(B) Ag

(C) Fe

(D) Pb

SET - II

COLUMN-I	COLUMN-II
48. Metal oxide	**(A)** $CaCl_2$
49. Metal sulphide	**(B)** SO_2
50. Metal chloride	**(C)** MgO
51. Non–metallic oxide	**(D)** HgS

Assertion Reason Type (A.R.T.):

(A) Both assertion and reason are true and reason is the correct explanation of assertion

(B) Both assertion and reason are true but reason is not the correct explanation of assertion

(C) Assertion is true but reason is false

(D) Assertion is false but reason is true

52. Assertion (A): Variable valencies are used to indicate ions with more than one valency.

Reason (R): Some elements have more than one valency because they can achieve a stable state by losing different number of electrons. This ability to lose a different number of electrons resuslts in the formation of ions with different positive charges or valencies.

53. Assertion (A): The formula for hydrogen is H_2.

Reason (R): H_2 represents one molecule of hydrogen, it constitutes two atoms of hydrogen.

Statement Type (S.T.):

(A) Both statements are correct

(B) Both statements are incorrect

(C) Statement I is correct statement II is incorrect

(D) Statement I is incorrect statement II is correct

54. Statement-I: The Latin name of mercury is hydrargyrum.

Statement-II: Shorthand representation of an element is called symbol.

55. Statement-I: Formula of the compound tells the elements present in a compound.

Statement-II: A pure chemical compound is homogeneous.

Integer Type Questions (I.T.Q.):

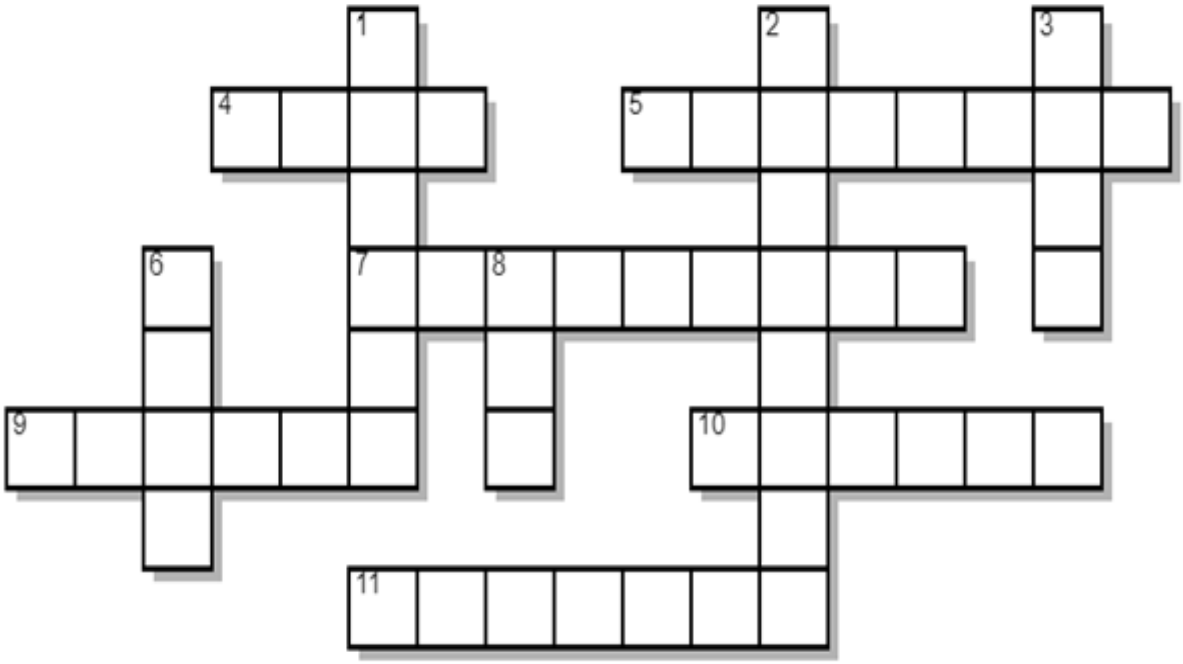
56. The number of divalent elements from the given list is ____.

Be, *Al*, Mg, Na, *Cl*, N, O, Ca, Rb & C

57. The electropositive ion Co^{3+} is formed due to the loss of ____electrons.

58. Ozone is represented as O_3. What is its atomicity?

Find the common names for the elements for which latin names are given below:



***Across*: (→)**

4. Ferrum _____.
5. Wolfram _____.
7. Kalium _____.
9. Argentum _____.
10. Natrium _____.
11. Hydrargyrum _____.

***Down*: (↓)**

1. Cuprum _____.
2. Stibium _____.
3. Plumbum _____.
6. Aurum _____.
8. Stannum _____.