SOLUTION & COLLIGATIVE PROPERTIES

NORMALITY

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Introduction of Equivalent Weight: -

Equivalent weight in chemistry is the most common term used and one of the basic concepts of chemistry in the physical chemistry part. An equivalent weight which is also known as gram equivalent can be defined as is the mass of one equivalent, that is the mass of a given substance that will combine with or displace a fixed quantity of another substance. Thus, in other words, gram equivalent or the equivalent weight of a substance is the mass of the substance that can displace 1.008 grams of hydrogen or 8.0 grams of oxygen or 35.5 grams of chlorine. Thus, to find out the equivalent weight, the atomic weight of the substance is divided by its valence. As an example, the equivalent weight of the oxygen will be equal to $16.0\ g / 2 = 8.0\ g$.

Equivalent Weight of an element: -

In the acid-base reaction, the equivalent mass of an acid or base is always equal to the amount of mass that supplies or reacts with the one mole of hydrogen ion (H^+). similarly, for the redox reaction, the equivalent weight of the substance is the mass that supplies or reacts with one gram mole of electrons (e^-) produced in the redox reaction. It has a dimension of the unit mass that is unlike that of the atomic mass that is dimensionless in nature. The equivalent weight can be determined by the experiment and it can be determined from the molar mass of the substance. In addition, the equivalent weight can be determined by dividing the molecular mass by the number of positive or negative electrical charges that result from the dissolution of the compound.

Here, we have covered the important topics related to the equivalent weight of metal. What is the equivalent weight definition in chemistry? The number of substances that completely react with each other in the reaction is called equivalent weight in chemistry. While answering the question, what is equivalent weight? you should keep in mind that its definition depends on the two factors; the molar mass and valency factor of the compound.

Equivalent Weight of Acid and base

Equivalent weight = molecular weight / X

In the above formula X represents the valency factor.

Equivalent Weight of Acid: -

For Acids: -

Taking an example of sulfuric acid as follows: -

$H_2SO_4 + 2OH^- \rightarrow 2H_2O + SO_4^{2-}$

The equivalent weight of the acid can be determined by determining the individual molecular weight of each of the elements from the periodic table and firstly adding them together. This will give us the molecular weight of the acid.

$2(1) + (32) + 4(16) = 98.0.$

The acid is seen to be donating two protons as the sulfate ion is seen to acquire negative charges.

Therefore, the equivalent weight of the acid would be

$98.0/2 = 49.0.$

In the case of hydrochloric acid (HCl)

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

The number of hydrogen ions or hydronium ions released by hydrochloric acid is one.

So, the valency factor will be one.

The molecular weight of hydrochloric acid = 36.45

As we know, Equivalent weight = molecular weight / X

The equivalent weight of hydrochloric acid = 36.45 / 1 = 36.45

Equivalent Weight of Base: -

For Bases: -

The reasoning for the base is the same. For example, ammonium hydroxide can accept a proton in solution to become an ammonium ion.

$NH_4OH + H^+ \rightarrow H_2O + NH_4^+$

The molecular weight of the hydroxide will be as follows.

$(14) + (4)(1) + (16) + 1 = 35.0.$

Here, since only one proton is accepted, thus the equivalent weight is equal to

$35.0/1 = 35.0.$

For the base, X (valency factor) is the acidity

Acidity- Acidity is the number of hydroxyl ions or hydroxide ions released by a base.

In the case of calcium hydroxide base $Ca(OH)_2$

$Ca(OH)_2 \rightarrow Ca^{+} + 2\ OH^{-}$

The number of hydroxyl ions released by the calcium hydroxide base is 2. Therefore, its valency factor or X value will be two.

The molecular weight of the calcium hydroxide base is 74.

As we know, Equivalent weight = molecular weight / X

The equivalent weight of calcium hydroxide base= 74 / 2 = 37

In the case of aluminium hydroxide base $Ca(OH)_2$

$Al(OH)_3 \rightarrow Al^{+3} + 3\ OH^{-}$

The number of hydroxyl ions released by the aluminium hydroxide base is 3. Therefore, its valency factor or X value will be three.

The molecular weight of the aluminium hydroxide base is 78 g/mol.

As we know, Equivalent weight = molecular weight / X

The equivalent weight of calcium hydroxide base= 78 / 3 = 26.

Equivalent Weight of Salt: -

Equivalent Weight of the Metal in Salt or Compounds

1. Aluminium Chloride

Step by Step Calculation for Finding the Equivalent Weight of Aluminium Salts

For the metals, X (valency factor) is the total positive charge on the positive ion (cation).

In the case of aluminium chloride salt $Al(Cl)_3$

$AlCl_3 \rightarrow Al^{3+} + 3Cl^{-}$

The number of positive charges on aluminium cation is three. Therefore, its valency factor or X value will be three.

The molecular weight of the aluminium chloride base is 133.34 g/mol.

As we know, Equivalent weight = molecular weight / X

The equivalent weight of aluminium chloride salt= 133.34 / 3 = 44.44.

2. Silver Carbonate (Ag_2CO_3)

Step by step calculation for finding the equivalent weight of silver salts for the salts, X (valency factor) is the total positive charge on the positive ion (cation).

In the case of silver carbonate salt Ag_2CO_3

$Ag_2CO_3 \rightarrow 2Ag^{+} + CO^{3-}$

The total positive charge of the silver cation is two. Therefore, its valency factor or X value will be two. The molecular weight of the silver carbonate salt is 275.75 g/mol.
As we know, Equivalent weight = molecular weight / X
The equivalent weight of silver carbonate salt= 275.75 / 2 = 137.87.

Did You Know?

Equivalent weight is used in the calculation of normality. The normality of a solution is defined as the number of gram equivalents of the solute present per litre of the solution. It is represented by the symbol, N.

Normality = gram equivalent of the solute/volume of the solution in litres the number of gram equivalents of the solute is calculated as follows:
No. of gram equivalents = mass of solute in grams / equivalent mass of the solute.

Summary

The equivalent masses of acids, bases, and salts are calculated as follows:
Equivalent mass of an acid = molecular mass of the acid/basicity.
Equivalent mass of a base = molecular mass of the base/acidity.
Equivalent mass of a salt = molecular mass of the salt/total positive valency of metal atoms.