ALMUSTAQBAL UNIVERSITY

Department of Fuel and Energy Technologies Engineering

Analytical chemistry

First class / first term

Lecture Four

By

Asst. lect. SAFA FALLAH

Lecture Four

Oxidation state: In chemistry, the oxidation state, or oxidation number, is the hypothetical charge of an atom if all of its bonds to other atoms were fully ionic. It describes the degree of oxidation (loss of electrons) of an atom in a chemical compound. Conceptually, the oxidation state may be positive, negative or zero. While fully ionic bonds are not found in nature, many bonds exhibit strong ionicity, making oxidation state a useful predictor of charge.

hdrogen in the metal hydrides: Metal hydrides include compounds like sodium hydride, NaH. Here the hydrogen exists as a hydride ion, H-. The oxidation state of a simple ion like hydride is equal to the charge on the ion—in this case, -1.

Alternatively, the sum of the oxidation states in a neutral compound is zero. Because Group 1 metals always have an oxidation state of +1 in their compounds, it follows that the hydrogen must have an oxidation state of -1 (+1 -1 = 0).

Oxygen in peroxides: Peroxides include hydrogen peroxide, H2O2. This is an electrically neutral compound, so the sum of the oxidation states of the hydrogen and oxygen must be zero.

Because each hydrogen has an oxidation state of +1, each oxygen must have an oxidation state of -1 to balance it.

Oxygen in F2O: The deviation here stems from the fact that oxygen is less electronegative than fluorine; the fluorine takes priority with an oxidation state of -1. Because the compound is neutral, the oxygen has an oxidation state of +2.

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Chlorine in compounds with fluorine or oxygen: Because chlorine adopts such a wide variety of oxidation states in these compounds, it is safer to simply remember that its oxidation state is not -1, and work the correct state out using fluorine or oxygen as a reference. An example of this situation is given below.

Example 1: What is the oxidation state of chromium in Cr^{2+}?

Solution

For a simple ion such as this, the oxidation state equals the charge on the ion: +2 (by convention, the + sign is always included to avoid confusion)

What is the oxidation state of chromium in $CrCl_3$?

This is a neutral compound, so the sum of the oxidation states is zero. Chlorine has an oxidation state of -1 (no fluorine or oxygen atoms are present). Let n equal the oxidation state of chromium:

$n + 3(-1) = 0$

$n = +3$

The oxidation state of chromium is +3.

Example 2: What is the oxidation state of chromium in $Cr(H_2O)_6^{3+}$?

Solution

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This is an ion and so the sum of the oxidation states is equal to the charge on the ion. There is a short-cut for working out oxidation states in complex ions like this where the metal atom is surrounded by electrically neutral molecules like water or ammonia.

The sum of the oxidation states in the attached neutral molecule must be zero. That means that you can ignore them when you do the sum. This would be essentially the same as an unattached chromium ion, Cr^{3+}. The oxidation state is +3.

What is the oxidation state of chromium in the dichromate ion, $Cr_2O_7^{2-}$?

The oxidation state of the oxygen is -2, and the sum of the oxidation states is equal to the charge on the ion. Don't forget that there are 2 chromium atoms present.

$2n + 7(-2) = -2$

$n = +6$

Example 3: What is the oxidation state of copper in $CuSO_4$?

Solution

Unfortunately, it isn't always possible to work out oxidation states by a simple use of the rules above. The problem in this case is that the compound contains two elements (the copper and the sulfur) with variable oxidation states.

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In cases like these, some chemical intuition is useful. Here are two ways of approaching this problem:

Recognize $CuSO_4$ as an ionic compound containing a copper ion and a sulfate ion, SO_4^{2-}. To form an electrically neutral compound, the copper must be present as a Cu^{2+} ion. The oxidation state is therefore +2.

Recognize the formula as being copper(II) sulfate (the (II) designation indicates that copper is in a +2 oxidation state, as discussed below).

What Is Normality?

Normality in Chemistry is one of the expressions used to measure the concentration of a solution. It is abbreviated as 'N' and is sometimes referred to as the equivalent concentration of a solution. It is mainly used as a measure of reactive species in a solution and during titration reactions or particularly in situations involving acid-base chemistry.Normality

Although molarity is widely used in chemistry, some chemists use a unit of concentration in quantitative analysis called normality (N). A one-normal solution contains one equivalent per liter.

$N = (wt.(g) \times 1000)/(eq.wt. \times V\ ml)$

Eq. wt. is explained in lecture one (General principles to calculate the equivalent weight) page : 7

Or

$N = (\rho \times \% \times 10)/(eq.wt.)$

ρ : density of solution

% : concentration of subtenant

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Example 1: In the following reaction, calculate and find the normality when it is 1.0 M H3PO4

$H_3AsO_4 + 2NaOH \rightarrow Na_2HAsO_4 + 2H_2O$

Solution:

If we look at the given reaction, we can identify that only two of the H^+ ions of H_3AsO_4 react with NaOH to form the product. Therefore, the two ions are 2 equivalents. In order to find the normality, we will apply the given formula.

N = Molarity (M) × Number of equivalents

N = 1.0 × 2 (replacing the values)

Therefore, the normality of the solution = 2.0

Example 2: Calculate the normality of acid if 21.18 mL is used to titrate 0.1369 g Na_2CO_3.

Solution:

0.1369 g Na_2CO_3 × (1 mol/105.99 g) × (2 eq/1 mol) × (1 eq acid/1 eq base):

= 2.583×10^{-3} eq acid/0.02118 L = 0.1212 N

Normality of the acid = 0.1212 N.

Molarity (*M*) : is the amount of a substance in a certain volume of solution. Molarity is defined as the moles of a solute per liters of a solution. Molarity is also known as the molar concentration of a solution.

Example1: A solution was prepared using 20 g of sodium hydroxide. Calculate the molarity of the given solution of sodium hydroxide if the volume of the solution is 125 ml.
Solution:
Mass of sodium hydroxide (NaOH) in the given solution = 20 g
The volume of the solution = 125 ml = 125/1000 = 0.125 L

The molar mass of sodium hydroxide = 40g/mol
Number of moles of sodium hydroxide (n) = Mass of NaOH/Molar mass of NaOH
= 20/40 = 0.5 moles We know that,
Molarity (M) = Moles of NaOH/Volume of the solution
M = 0.5/0.125 = 4
Hence, the molarity of the solution is 4M.

Example2: A solution is prepared by bubbling 1.825 grams of hydrochloric acid in water. Calculate the molarity of the given solution if the volume of the solution is 12.8 ml.

Solution: The volume of the solution (V) = 12.8 ml = 12.8/1000 = 0.0128 L
The mass of HCl in the given solution = 1.825 g
The molecular weight of HCl = 36.5 g/mol
Number of moles of hydrochloric acid (n) = 7.3 g/36.5 g/mol
= 0.05 moles
We know that,
Molarity (M) = n/V
M = 0.05/0.0128 = 3.91 M
Hence, the molarity of the solution is 3.91M.

Differences between Normality and Molarity

Here are some key differences between normality and molarity.

Normality	Molarity
Also known as equivalent concentration.	Known as molar concentration.
It is defined as the number of gram equivalent per litre of solution.	It is defined as the number of moles per litre of solution.
It is used in measuring the gram equivalent in relation to the total volume of the solution.	It is used in measuring the ratio between the number of moles in the total volume of the solution.
The units of normality are N or eq L^{-1}	The unit of molarity is M or Moles L^{-1}

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Home work:1): A solution is prepared by mixing 10 grams of calcium chloride. Calculate the molarity of the calcium chloride solution if the volume of the solution is 200 ml?

What is Mole Fraction?

There are several ways to indicate the concentration of a solution, and **mole fraction** is one of them. A mole fraction is a unit of concentration. In the solution, the relative amount of solute and solvents are measured by the mole fraction, and it is represented by “X.”

EXAMPLE1:grams of formaldehyde (CH2O) is dissolved in 3.25 moles of carbon tetrachloride (CCl4); calculate the mole fractions of formaldehyde**.**

Answer: The mole fraction of formaldehyde is 0.208.

Solution:

The molecular weight of formaldehyde = 30.03 grams

The number= 0.856 moles

Total number of moles in the solution = 0.856 moles + 3.25 moles

= 4.106 moles

Mole fraction of formaldehyde

=0.856 /4.106

= 0.208 moles.

What Is volume fraction ?

in chemistry , the **volume fraction** is defined as the volume of a constituent V_i divided by the volume of all constituents of the mixture V prior to mixing.

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Example 1:Calculate the volume fraction V/V % solution by made combing 25 ml of ethanol ehith water to produce of 200 ml of solution ?

V/V = 25Mml/200ml x100%=12.5\