Cosmo School

Chemistry

Class-9

Chapter-7

Chemical reactions

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Lecture sheet with worksheet-4

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Unit-1:Oxidation number or oxidation state

Oxidation number is a number assigned to an element in chemical combination which represents the number of electrons lost (if the number is positive) or gained (if the number is negative), by an atom of that element in the compound. The oxidation number, sometimes referred to as oxidation state.

There are the rules that areused to figure out oxidation numbers.

- The first rule is this, an element by itself always has an oxidation number of 0. It means that there are a lot of chemical substances that have just one element that element is not combined with any other elements.Sothe oxidation state of any pure element is always zero. So the oxidation state of oxygen gas(O_2) as a pure element is zero, fluorine gas(F_2) as the pureelement is zero, evenphosphorus(P or P_4) as a pure element is zero. So, there is no charges and it's only onepure element and it is not a compound. the oxidation state will always be zero.
- The other rule is about monatomic ions. These are ions that are made of only one and so like this for monatomic ions their oxidation number is the same as their ion charge.So for K^+ here it's oxidation number is going to be +1.For N^{3-} ion, it will have an oxidation number of -3 and for Mg^{2+}, here is going to have an oxidation number of +2.
- When we write oxidation numbers, we write this the sign first so plus(+) minus (-) and then the number after. This is the opposite of how we write ionic charges. So just keep that in mind the charge might be 2+ on magnesium but the oxidation number is +2.
- There is another example this isthe peroxide ion(O_2^{2-}) to find the oxidationstate of each oxygen atom.In this ionyou can write an equation is two oxygenatoms with the total charge of -2.So individually each oxygen atom hasa charge of -1.So that is theoxidation state of oxygen individuallyin the peroxide ion.In the superoxide ion(O_2^-) if youwant to find the oxidation state, youneed to divide the total charge by 2.So each oxygen atom has a net charge of-½. So two of them combinedwill have a net charge of -1. Wheneveryou have fluorine inside a compound whenit's not a pure element fluorine isalways going to have a negative 1(-1)oxidation state.Fluorine is the mostelectronegative element.

For O_2^{2-}, $2O = -2$ $\quad\quad$ $O = -1$

For O_2^-, $2O = -1$ $\quad\quad$ $O = -1/2$ or 0.5

- When oxygen isin a compound, it's going to have a-2oxidation state unless it'sbonded to fluorine or unless you hearthe name peroxide or superoxide.Wheneveryou hear the name peroxide oxygen has a-1oxidation state if you hear the word superoxide it has a -1/2 oxidation state if you hear the word oxide then the oxidation state is -2.
- Now hydrogen will have an oxidation state of +1 when bonded to a nonmetal. When bonded to a metal, hydrogen willhave an oxidation state of -1 and really the key is electronegativity. Hydrogen is more electronegative thanmost metals.That's why it bears anegative charge but hydrogen is usuallyless electronegative than mostnonmetals and so that's why there's apositive charge.So typically, the elementthat is more electronegative is the onethat usually carries the negative charge.
- Now let's work on some examples.
  What is the oxidation state of magnesiumand chlorine in $MgCl_2$compound?By the waymost halogens are usually -1, Chlorine technically has a -1 charge like fluorine.If we write anequation,
  Mg+ 2 Cl = 0
  This whole compound is neutral sotherefore the total charge is zero. Now if chlorine has a -1 oxidation state that means magnesium hasto have a +2 oxidation state.Youcan literally solve it and it makessense magnesium is an alkaline earthmetal which typically has a +2charge.
- You could solve another example, find the oxidationstate of vanadium and oxygen in a compound, V_2O_5.This is called vanadium oxide.
  So whenever you hear the word oxide, oxygen has a ……. charge.So wegot two vanadium atoms with…… oxygenatoms with a net charge of zero.So each oxygen atom has an oxidation state of -2.
- Some examples containing polyatomic ions, considersulfate(SO_4^{2-}).

What is the oxidation state ofsulfurinsulfate?

We know oxygen isusually -2.So let's write anequationsulfur plus 4 oxygen atoms hasa net charge of -2.

$$S + 4O = -2$$

Suppose, the oxidation no. of S = x

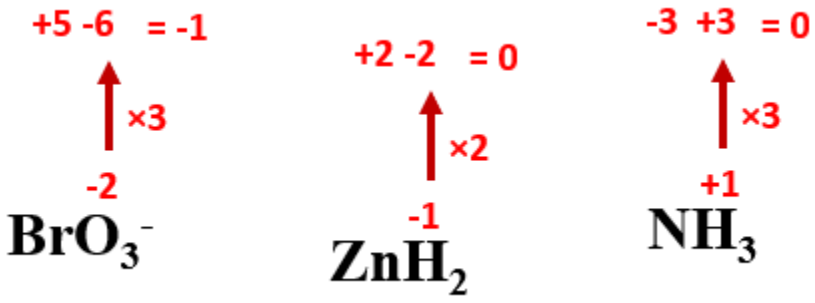
The oxidationstate of sulfurinsulfate will be …….

- Now two more examples,$BrCl_3$ and IBr_5.Findthe oxidation state of every element inthese examples.
  So most halogens like fluorine, chlorine,bromine and iodine, they typically have a-1 charge.But in $BrCl_3$, both bromine andchlorine can't be negative.So which oneis negative and which one is positive? Keep in mind bromine has anelectronegativity value of 2.8, chlorineis 3.0 and iodine is 2.5.So in this examplechlorine bears the partialcharge and

bromine is partially positive.So, therefore, chlorine is going to have its natural oxidation state of -1 and for bromine we need to calculate it.
So it'sgoing to be Br+ 3 Cl and that'sequal to 0.So this is going to be 3times -1 and so we can see thatbromine has an oxidation state of +3.

- Now in the second example, IBr_5,bromine is going to carry the partial……..charge and iodine carries the partial ……..charge. In any compound, usually the electropositive element iswritten firstthe electronegative element is there insecond.So the one that you see on theright side is usually the one thatcarries the natural charge. So in thiscase bromine is going to have itsnatural oxidation state of …….
  So iodine is going to have anoxidation state of …….inIBr_5.

Exercise:



1. Explain the three processes used to calculate the oxidation number shown in figure above.
2. What is oxidation number (oxidation state)?
3. Mention the differences between valency and oxidation number.
4. Could the oxidation number of any element be a whole number or fraction? Explain according to the compounds $K_2Cr_2O_7$ and $Na_2S_4O_6$.
5. Determine the oxidation number of central atoms in the following compounds.
6. $Na_2S_2O_3$, H_2SO_4, $KMnO_4$, H_3PO_4, HNO_3 and Na_2CO_3