

Oxidation states

Oxidation state of an atom is the charge of this atom after ionic approximation of its heteronuclear bonds. The oxidation state for an element in a chemical formula is calculated from the overall charge and postulated oxidation states for all the other atoms:

- 1.) An element in a free form has oxidation state = 0.
- 2.) In a compound or ion, the oxidation states' sum equals the total charge of the compound or ion.
- 3.) Fluorine in compounds has oxidation state = -1 ; this extends to chlorine and bromine only when not bonded to a lighter halogen, oxygen or nitrogen.
- 4.) Group 1 and group 2 metals in compounds have oxidation state = $+1$ and $+2$, respectively.
- 5.) Hydrogen has oxidation state = $+1$, but adopts -1 when bonded as a hydride to metals or metalloids.
- 6.) Oxygen in compounds has oxidation state = -2 .

Questions and problems:

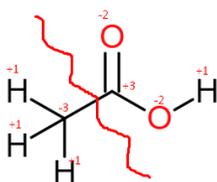
- 1.) What is the **oxidation number of the nitrogen atom** in each the following compounds and ions?

ammonia, NH_3 : -3
hydroxylamine, NH_2OH : -1
dinitrogen monoxide, N_2O : $+1$
dinitrogen pentoxide, N_2O_5 : $+5$
sodium nitrite, NaNO_2 : $+3$
sodium nitrate, NaNO_3 : $+5$
ammonium ion, NH_4^+ : -3
azanide (amide) ion: NH_2^- : -3
nitrite ion, NO_2^- : $+3$
nitrate ion, NO_3^- : $+5$

- 2.) Give the oxidation numbers of **all the atoms** in the following compounds:

$-4; +1$ $-2; +1; -2; +1$ $-3; +1; +3; -2; -2; +1$ $+2; -2$ $+4; -2$
 CH_4 ; $\text{C}_2\text{H}_5\text{OH}$; CH_3COOH ; CO ; CO_2 ;

Need help with organic molecules? Since the bond between two carbons is non-polar, sum of oxidation states of carbon and all other atoms bonded to it must remain 0.



Example: We can split acetic acid into two parts:
The two carbons in CH_3COOH have oxidation states of -3 and $+3$ respectively.

- 3.) What is the **oxidation number of sulfur** in each the following compounds?

hydrogen sulphide, H_2S :
sulfur, S :
sulfur dioxide SO_2 :
sulfur trioxide, SO_3 :
sodium sulphite, Na_2SO_3 :

sodium sulfate, Na_2SO_4 :

sulfid ion, S^{2-} :

bisulfide ion, HS^- :

sulfite ion, SO_3^{2-} :

sulfate ion, SO_4^{2-} :

thiosulfate ion, $\text{S}_2\text{O}_3^{2-}$:

disulfid ion, S_2^{2-} :

4.) What is the **oxidation number of manganese** in each the following compounds?

potassium permanganate, KMnO_4 :

manganese(II) sulfate, MnSO_4 :

manganese dioxide, MnO_2 :