Rules For Assigning Oxidation States

1. For free elements the oxidation state is zero.
   e.g. Fe(s), O_2(g), O_3(g), H_2(g), Hg(l), Hg(g), S(s) etc.

2. For monoatomic ions, the oxidation state is given by the charge on the ion.
   e.g. Cl^- (**-1**), Fe^{2+} (**+2**), Fe^{3+} (**+3**), S^{2-} (**-2**), Ca^{2+} (**+2**), H^+ (**+1**) etc

3. Certain elements when present in compounds have common oxidation states.

   a) alkali metals (Li^+, Na^+, K^+) are always **+1**

   b) alkali earth metals (Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}) are always **+2**

   c) hydrogen is **+1** (except in metal hydride compounds such as LiH)

   d) oxygen is **-2** (except in peroxides such as H_2O_2)

   e) halogens (F^-, Cl^-, Br^-, I^-) are usually **-1** (exceptions include interhalogen compounds e.g., in Cl_2F_7, chlorine is **+7** and fluorine is **-1** and oxyanions e.g., in ClO_3^- chlorine is **+5**)

4. The sum of the oxidation states in a molecule is zero.
   e.g. H_2O (**+1**) + (**+1**) + (**-2**) = 0 $Fe(OH)_2$ (**+2**) + 2(**-2**) + 2(**+1**) = 0

5. The sum of the oxidation states in an ion is equal to the charge on the ion.
   e.g. OH^- (**-2**) + (**+1**) = -1 SO_4^{2-} (**+6**) + 4(**-2**) = -2

Note: Oxidation corresponds to an increase in the oxidation state and reduction corresponds to a a decrease in the oxidation state.

Sample Exercises:

1. Determine the oxidation states for all of the atoms in each of the following:

a) NO_3^-, NH_3, NH_4^+, N_2
b) Na_2S, Na_2SO_3, $Na_2S_2O_3$, Na_2SO_4
c) ClO_4^-, ClO_3^-, ClO_2^-, ClO^-
d) CO_2, H_2CO_3, C_2H_5OH, CH_3CHO

2. Indicate whether the following processes involve oxidation or reduction

a) SO_4^{2-} ---> H_2S
b) NH_4^+ ---> NO_3
c) NaClO -----> Cl^-
d) 2 Cu^+ -----> Cu^{2+} + Cu

3. In the following reactions identify the species that is oxidised and that being reduced.

a) IO_4^- + I^- + H^+ ---> I_2 + H_2O
b) NO_3^- + H^+ + Cl^- ---> NO + Cl_2 + H_2O
c) NO_3^- + Cu + H^+ ---> NO_2 + Cu^{2+} + H_2O

Solutions

1.

a) (+V), (-III), (-III), (0)
b) (-II), (+IV), (+II), (+VI) on sulfur
c) (+VII), (+V), (+III), (+I)
d) (+IV), (+IV), (-III and –I), (-III and +I)

2.
a) reduction
b) oxidation
c) reduction
b) both (disproportionation)

3.	oxidized	reduced
a)	I^-	IO_4^-
b)	Cl^-	NO_3^-
c)	Cu	NO_3^-