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5.7 HONORS CLASS WORKSHEET – INTRODUCING OXIDATION NUMBERS

The **oxidation number** (or **oxidation state**) of an atom is the charge that would exist on an atom if the bonding were completely ionic.

Oxidation numbers are very useful for identifying oxidation and reduction processes in more complex situations.

Fill in the blanks in the tables below:

1. If an atom has a charge, the oxidation number of the atom is just the charge on that atom:

Formula	Ca^{2+}	Fe^{3+}	N^{3-}	Na^{+}	S^{2-}	Br^{-}	$MgCl_2$	CaO	Na_2S	Al_2O_3
O. N.	+2	+3	-3	+1	-2	-1	+2, -1	+2, -2	+1, -2	+3, -2

2. In elements and free atoms, all atoms have an oxidation number of zero:

Formula	Na	Cl_2	O_2	Al	S_8
O. N.	0	0	0	0	0

3. In compounds, the sum of the oxidation numbers on the atoms is always zero, but the most electropositive atom will always have a positive oxidation number and the most electronegative atom will always have a negative oxidation number; a few atoms always have the same oxidation number and this can be used to predict the others:
   - Group 1 atoms always have an oxidation number of +1; Group 2 atoms always have an oxidation number of +2; Al always has an oxidation number of +3; F always has an oxidation number of -1
   - O usually has an oxidation number of -2
   - H usually has an oxidation number of +1

Formula	H_2O	CO_2	NH_3	SO_2	SO_3	CH_4	H_2S	SiF_4	C_2H_6	CO
O. N.	+1, -2	+4, -2	-3, +1	+4, -2	+6, -2	-4, +1	+1, -2	+4, -1	-3, +1	+2, -2

Formula	$CaCO_3$	NaOH	H_2SO_4	HNO_3	$KMnO_4$	$Na_2S_2O_3$	NaClO	HCN
O. N.	+2, +4, -2	+1, -2, +1	+1, +6, -2	+1, +5, -2	+1, +7, -2	+1, +2, -2	+1, +1, -2	+1, +2, -3

4. In polyatomic ions, the rules are the same as for compounds, except that the sum of the oxidation numbers is equal to the overall charge on the ion:

Formula	CO_3^{2-}	OH^{-}	CO_3^{2-}	SO_4^{2-}	NO_3^{-}	PO_4^{3-}	NH_4^{+}	$Cr_2O_7^{2-}$
O. N.	+4, -2	-2, +1	+4, -2	+6, -2	+5, -2	+5, -2	-3, +1	+6, -2

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5. There are some important exceptions (but not many) to the rules for hydrogen and oxygen:

Formula	Oxidation Numbers	Name
H_2O_2	+1, -1	hydrogen peroxide
Na_2O_2	+1, -1	sodium peroxide
NaH	+1, -1	sodium hydride
AlH_3	+3, -1	aluminium hydride
OF_2	+2, -2	oxygen (di)fluoride

6. Identify the following processes as oxidation or reduction:

Process	Change in Oxidation Number	Oxidation or Reduction
PbO_2 to PbO	Pb changes from +4 to +2	reduction
H_2O_2 to O_2	O changes from -1 to 0	oxidation
ClO^- to Cl^-	Cl changes from +1 to -1	reduction
$S_2O_3^{2-}$ to $S_4O_6^{2-}$	S changes from +2 to +2.5	oxidation
NO_3^- to NO	N changes from +5 to +2	reduction