Oxidation Number Exercise

Do not hand in this work sheet. When you are ready, you will be given an examination over this material. Complete the examination by yourself and hand it in to receive credit.

Purpose: This exercise is designed to teach the student how to assign oxidation numbers. Oxidation numbers are very important and are used for 1) naming compounds, 2) balancing oxidation-reduction reactions, 3) calculations in electrochemistry and other areas of chemistry.

Rule 0  The following rules are in the form of a hierarchy; that is, the first stated rule takes precedence over subsequent rules if a conflict arises.

Rule 1  The oxidation numbers for all the atoms in a neutral molecule must add up to 0. Similarly, the oxidation numbers for all the atoms of an ion must add up to the charge of the ion. (You are expected to recognize polyions. For the common polyions, know their charges and their names. A summary of the common polyions appears on page xiv. The first step is, always, to determine what polyions are present.)

Rule 1a  The oxidation number of elements in the elemental form is 0. (Note - this rule is a direct consequence of rule 1. How so?)

Rule 1b  The oxidation number of any monatomic ion is the same as its charge. (See comment in 1a.)

Exercises - Give the oxidation number for the following atoms:

- $O_2$: $O = \underline{\hspace{2cm}}$
- $F_2$: $F = \underline{\hspace{2cm}}$
- $S_8$: $S = \underline{\hspace{2cm}}$
- $Cl_2$: $Cl = \underline{\hspace{2cm}}$
- $N_2$: $N = \underline{\hspace{2cm}}$
- $Al$: $Al = \underline{\hspace{2cm}}$
- $Co^{2+}$: $Co = \underline{\hspace{2cm}}$
- $Mn^{2+}$: $Mn = \underline{\hspace{2cm}}$
- $Cl^{-}$: $Cl = \underline{\hspace{2cm}}$
- $Cr^{3+}$: $Cr = \underline{\hspace{2cm}}$
- $I_3^{-}$: $I = \underline{\hspace{2cm}}$
- $Hg_2^{2+}$: $Hg = \underline{\hspace{2cm}}$
**Rule 2** Fluorine has an oxidation number of -1.

**Exercises - Give the oxidation number for the following atoms:**

NaF, Na = _____ \( \text{IF}_3 \), I = _____ \( \text{ClF}_2^- \), Cl = _____  
SF\(_4\), S = _____ \( \text{PF}_3 \), P = _____ \( \text{SF}_6^{2-} \), S = _____  
PF\(_5\), P = _____ \( \text{PF}_6^{3-} \), P = _____ \( \text{W}_2\text{F}_9^{3-} \), W = _____  
OF\(_2\), O = _____ \( \text{NF}_3 \), N = _____ \( \text{F}_2 \), F = _____

**Rule 3** The metals of group 1 (old CAS IA) have an oxidation number of +1  
The metals of group 2 (old CAS IIA) have an oxidation number of +2  
Sc, Y and Al have an oxidation number of +3.

**Exercises - Give the oxidation number for the following atoms:**

Na\(_2\)O, Na = _____ \( \text{Na}_2\text{O}_2 \), O = _____ \( \text{KO}_2 \), O = _____  
NaOH, Na = _____ \( \text{ScH}_3 \), H = _____ \( \text{LiH} \), H = _____  
CaC\(_2\), C = _____ \( \text{CaMgO}_2 \), O = _____ \( \text{MgH}_2 \), H = _____  
MgF\(_2\), Mg = _____ \( \text{RbO}_2 \), O = _____ \( \text{MgSF}_6 \), S = _____  
NaPF\(_6\), P = _____ \( \text{LiBF}_4 \), B = _____

**Rule 4** Hydrogen has an oxidation number of +1 when combined with elements on the right side of the periodic chart (non-metals) and a -1 when combined with elements on the left side of the periodic chart (metals).

**Exercises - Give the oxidation number for the following atoms:**

HCl, Cl = _____ \( \text{HF} \), F = _____ (why) \( \text{NaOH} \), O = _____  
HI, I = _____ \( \text{UH}_3 \), U = _____ \( \text{NH}_4^+ \), N = _____  
PH\(_3\), P = _____ \( \text{H}_2\text{SF}_6 \), S = _____ \( \text{NH}_3 \), N = _____  
AsH\(_3\), As = _____ \( \text{ScH}_3 \), Sc = _____ \( \text{HPF}_4 \), P = _____  
H\(_3\)O\(^+\), O = _____ \( \text{OH}^- \), O = _____
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**Rule 5** Oxygen has an oxidation number of -2. (Note: Your knowledge of the polyions is now needed. The polyions you are responsible for knowing are on xiv.  **Turn to xiv now and become familiar with this chart.** Notice that for the polyions on xiv, the oxidation number for oxygen is -2)

Cautionary Note: Review Rule 0.

**Exercises** - Give the oxidation number for the following atoms:

- Co(ClO)₂: Co = _____, Cl = _____, Na₂O₂: Na = _____, O = _____
- CoCrO₄: Cr = _____, Co = _____, AgNO₃: Ag = _____, N = _____
- Mg(OH)₂: Mg = _____, O = _____, H₂SO₄: S = _____
- RbO₂: Rb = _____, O = _____, ClO₄⁻: Cl = _____
- KMnO₄: Mn = _____, K = _____, NH₄OH: N = _____
- OF₂: F = _____, O = _____, IO₃⁻: I = _____
- KO₂: K = _____, O = _____, K₂Cr₂O₇: Cr = _____
- IO₂⁻: I = _____, BrO₂⁻: Br = _____
- Zn(NO₂)₂: Zn = _____, O = _____

Cautionary Note: Review Rule 0 again

**Rule 6** Group 17 (old CAS VIIA) atoms have an oxidation number of -1.

**Rule 7** Group 16 (old CAS VIA) atoms have an oxidation number of -2.

**Rule 8** Group 15 (old CAS VA) atoms have an oxidation number of -3.

**Exercises** - Give the oxidation number for the following atoms:

- PH₃: P = _____, CH₃NH₂: C = _____, CN⁻: C = _____
- BF₃NH₃: B = _____, MnCl₄: Mn = _____, W₂Cl₉³⁻: W = _____
- Co₃N₂: Co = _____, NCl₃: N = _____, KSCN: C = _____
- HCN: C = _____, POCl₃: P = _____, V₃N₄: V = _____
Additional (Optional) Exercises:

NH₃  N = _______  As₂O₅  As = _______  SiF₄  Si = _______
HNO₃  N = _______  N₂H₄  N = _______  PCl₆⁻  P = _______
MnO₂  Mn = _______  CrCl₃  Cr = _______  Cr₂O₇²⁻  Cr = _______
AgCH₃COO  Ag = _____  N₂O  N = _______  N₂O₅  N = _______
Au₂O  Au = _______  AuO  Au = _______  CuSO₄  Cu = _______
Os₂O₅  Os = _______  Fe₃O₄  Fe = _______  Fe₂O₃  Fe = _______
FeO  Fe = _______  FePO₄  Fe = _______  SiO₂  Si = _______
H₂S  S = _______  FeS  S = _______  NaHCO₃  C = _______
AuHCO₃  Au = _______  ScAsO₄  As = _______  NH₄OH  N = _______
SO₃  S = _______  H₂CrO₄  Cr = _______  H₄P₂O₇  P = _______
Cl₂  Cl = _______  S₂O₃²⁻  S = _______  MgC₂  C = _______
S₂Cl₂  S = _______  Cr₂(CO₃)₃  Cr = _______  K₃FeO₄  Fe = _______
S₈  S = _______  BO₂⁻  B = _______  Al₂O₃  Al = _______
Ag₂CrO₄  Ag = _______  RbO₂  O = _______  I₃⁻  I = _______
RbH  H = _______  Th₄H₁₁  Th = _______  NaHSO₄  S = _______
Na₂HPO₄  P = _______  Eu₃(PO₃)₂  P = _______  B₄O₇²⁻  B = _______
P₄O₁₀  P = _______  BeF₂  Be = _______  P₄O₁₀  P = _______
OF₂  F = _________  O = _________
Ce(ClO₃)₂  Ce = _________  Cl = _________
Fe(MnO₄)₂  Mn = _________  Fe = _________
NaSCN  S = _________  C = _________  N = _________