

SCH 4U

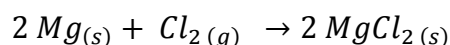
PART 1: OXIDATION-REDUCTION REACTIONS

- OXIDATION REACTIONS – Formally known as reactions involving oxygen.
- REDUCTION REACTIONS – Formally known as a chemical process of extracting metals from their ores, thus reducing the mass of the material from which they came.

RECENT DEFINITIONS:

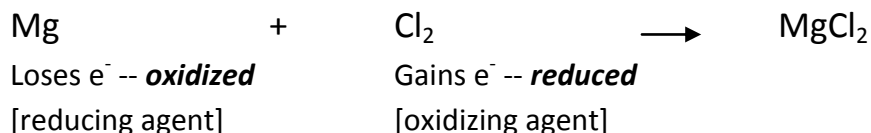
- OXIDATION: loss of electrons from one substance to another
- REDUCTION: substance that gains the electrons lost by another substance
- Oxidation and reduction must happen together – also known as **REDOX** reactions.

Consider the reaction of magnesium metal with chlorine gas:



- The substance that is oxidized is the reducing agent. A reducing agent causes reduction to occur in the other substance
- The substance that is reduced is the oxidizing agent.

In the reaction of magnesium and chlorine, since the magnesium loses electrons, it is being oxidized and is called the reducing agent as it causes the chlorine atom to be reduced. Each chlorine atom gains an electron, so it is being reduced and is called the oxidizing agent as it causes the sodium atom to be oxidized.



- A redox reaction is a chemical reaction in which changes in oxidation numbers (or oxidation states) occur.

Many REDOX reactions are already well-known to us.

- Organic reactions
- Synthesis and decomposition reactions
- Many double displacement reactions

NOT ALL reactions are REDOX reactions – increase/decrease of oxidation states do not always occur.

EXAMPLE: Identify the oxidizing and reducing agents in the reaction of iron and bromine, producing iron (III) bromide.

SPONTANEITY of a REDOX REACTION:

- Will a reaction occur? – associated with single displacement reactions

Recall the Metal Activity Series from Gr. 11 Chemistry:

The metal activity series arranges metals in a column from most to least reactive, so that if a metal in the chart is located above the cation of a compound, the reaction will occur.

In tables of the Metal Activity Series, metals are often arranged from least reactive (weakest reducing agent) to most reactive (strongest reducing agent). The stronger the reducing agent, the greater the metal's ability to lose electrons to the other substance and form a new compound, or in other words, the greater the metal's ability to cause reduction (gain electrons) in the other substance, a reaction will occur. So when predicting if a REDOX reaction will occur, if the pure metal is located below the cation of the compound, a reaction will be spontaneous.

EXAMPLE: Which of the following reactions will proceed spontaneously?
If a reaction occurs, identify the oxidizing and reducing agents.

1. solid iron and aqueous tin (II) chloride

2. aqueous aluminum nitrate and copper metal

PART 2: OXIDATION NUMBERS

RULES FOR ASSIGNING OXIDATION NUMBERS (O.N.):

- 1. Oxidation number of a free element is zero:**
- 2. Oxidation number of monoatomic ion is equal to the charge on the ion:**

In compounds/polyatomic ions AND in the following order:

- 3. fluorine has oxidation number -1.**
- 4. hydrogen has oxidation number of +1, with the exception of metal hydrides where it has O.N. of -1**
- 5. oxygen has oxidation number of -2.**
- 6. molecules not containing H or O → the more electronegative element is assigned an O.N. equal to the negative charge it usually has when in an ionic compound.**

In general,

- 7. Sum of oxidation numbers in a molecule is 0.
Sum of oxidation numbers in a polyatomic ion equals charge on particle.**

EXAMPLES: Determine the oxidation number of each element in the given substance.

- | | | |
|-------------------|--------------|--------------|
| 1. Cl_2O | 2. Cl_2O_7 | 3. $HOCl$ |
| 4. $Mg_3(PO_4)_2$ | 5. NCl_3 | 6. HSO_4^- |

Periodic Table of the Elements																		18 VIIIA 8A																													
1 IA 1A		2 IIA 2A												13 IIIA 3A		14 IVA 4A		15 VA 5A		16 VIA 6A		17 VIIA 7A		2 He Helium 4.003																							
1 H Hydrogen 1.008																						5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180																				
3 Li Lithium 6.941	4 Be Beryllium 9.012											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.065	17 Cl Chlorine 35.453	18 Ar Argon 39.948																														
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 9	10 VIII 10	11 IB 1B	12 IIB 2B																																				
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 84.80																														
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98.007	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.905	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.757	52 Te Tellurium 127.6	53 I Iodine 126.905	54 Xe Xenon 131.29																														
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71		72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [210]	86 Rn Radon [222]																													
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103		104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [277]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [271]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium [284]	114 Fl Flerovium [289]	115 Uup Ununpentium [288]	116 Lv Livermorium [293]	117 Uus Ununseptium [294]	118 Uuo Ununoctium [294]																													
Lanthanide Series																		57 La Lanthanum 138.905		58 Ce Cerium 140.115		59 Pr Praseodymium 140.908		60 Nd Neodymium 144.24		61 Pm Promethium [144.913]		62 Sm Samarium 150.36		63 Eu Europium 151.965		64 Gd Gadolinium 157.25		65 Tb Terbium 158.925		66 Dy Dysprosium 162.50		67 Ho Holmium 164.930		68 Er Erbium 167.26		69 Tm Thulium 168.934		70 Yb Ytterbium 173.04		71 Lu Lutetium 174.967	
Actinide Series																		89 Ac Actinium 227.028		90 Th Thorium 232.038		91 Pa Protactinium 231.036		92 U Uranium 238.029		93 Np Neptunium 237.048		94 Pu Plutonium 244.064		95 Am Americium 243.061		96 Cm Curium 247.070		97 Bk Berkelium 247.070		98 Cf Californium 251.080		99 Es Einsteinium 252.083		100 Fm Fermium 257.090		101 Md Mendelevium 258.10		102 No Nobelium 259.101		103 Lr Lawrencium [262]	