Chemical Reactions – Part 1

Reading:	Ch 6 sections 1 - 2	Homework:	5.3 questions 17, 18* 5.4 questions 20*,22* 6.1 questions 2, 4 6.2 questions 8, 10, 12*, 14, 16

* = 'important' homework question

Overview of Bonding Types

As we saw in previous work, **metals react with non-metals to form ionic compounds**:

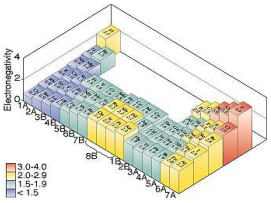
Example: $Na(s) + Cl_2(g) \rightarrow NaCl(s)$ (recall slide)

(i.e. sodium metal + chlorine gas → sodium chloride)

Ionic compounds are only formed between metals* (forming cations) and non-metals (forming anions)

Recall: Metals appear on the LEFT of the periodic table and non-metals on the RIGHT. Thus mixing a 'leftie' with a 'rightie' results in the formation of an ionic compound (see above example).

Discussion: When two non-metals are mixed (both from the right of the periodic table) would you expect an ionic bonded product? Explain*.



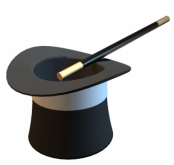
* Electronegativities: see slide at end of handout

Atoms close to one another in the P. table (two 'righties') have similar electronegativity values ⇒ they SHARE electrons and form COVALENTLY bonded MOLECULAR products

Example: $C(s) + O_2(g) \rightarrow CO_2(g)$ (molecular compound)

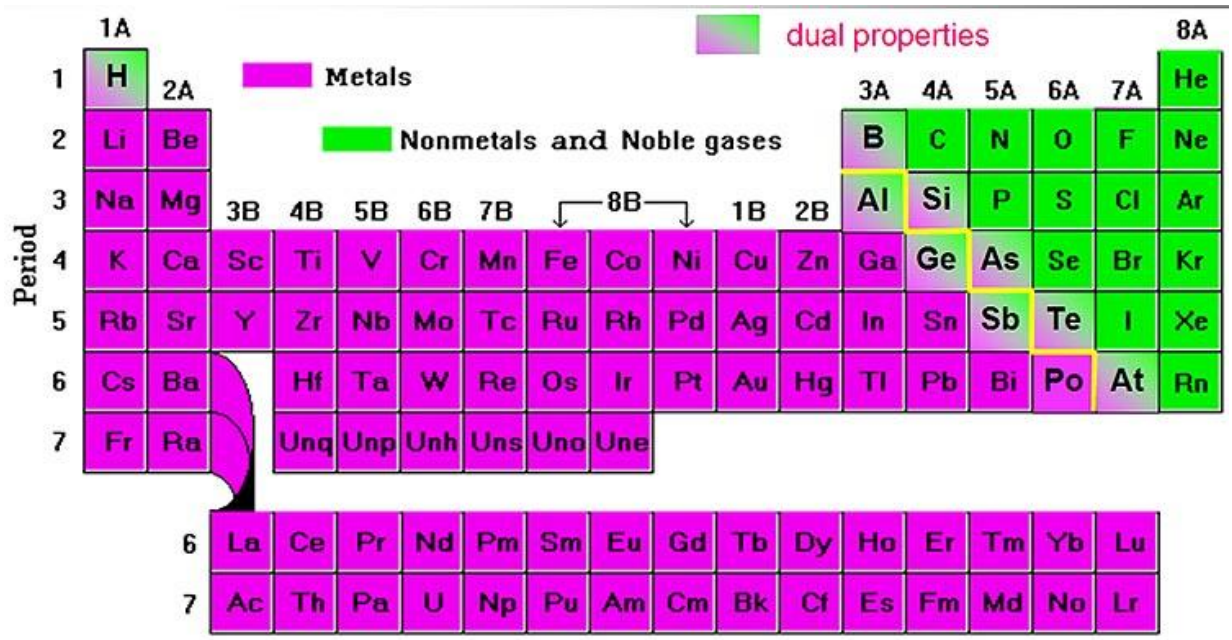
Atoms distant from to one another in the P. table ('leftie' and 'rightie') have dissimilar electronegativity values ⇒ they EXCHAGE electrons and have IONIC bonded GIANT products

Example: $Na(s) + Cl_2(g) \rightarrow NaCl(s)$ (giant ionic compound)



Location, Location, Location!

Metallic vs Non metallic Elements in the Periodic Table



ONLY a non-metal (top RHS) bonded to metal (LHS) make *giant compounds with ionic bonds*. E.g. NaCl, CaO

THESE MATERIALS ARE NAMED IN ACCORDANCE WITH THE 'IONIC' RULES DISCUSSED PREVIOUSLY

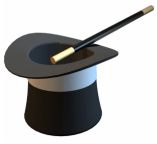
ONLY a non-metal bonded to another non-metal (top RHS p. table) make *molecular materials* with *covalent bonds*. E.g. CO, H_2O, SO_3

THESE MATERIALS ARE NAMED IN ACCORDANCE WITH THE (BELOW) 'MOLECULAR' RULES

Task: Based on the following materials' formulas, predict if each possesses *either* covalent *or* ionic bonding and if each has *either* a giant *or* molecular structure. Hint: recall the 'dividing line' in the p.table

Material	Bonding	Structure
Water (H_2O)		
Table salt (NaCl)		
Nitrogen gas		
Rust (Fe_2O_3)		

Question: What important relationship do you see between bonding and structure?



Naming Molecular Elements and Compounds

Task: Write the formula of *and* name as many molecular elements and compounds as you can

Formula	Name	Formula	Name

Discussion: What relationships do you see between the names and formulas of molecular compounds?



Prefix Table

Number of atoms	Prefix*	Example
1		
2		
3		
4		
5		
6		

*Prefixes are dropped for the first *single* atom in a formula. E.g. CO_2 is named 'Carbon dioxide', not 'Mono Carbon dioxide'.

Tasks:

Name the Following:

NF_3

Cl_2O

P_2O_5

Write formulas for the following:

Chlorine dioxide

Chlorine pentafluoride

Dihydrogen mono sulfide*

* If named using ionic nomenclature, also known as _____

Types of Chemical Reactions

Fact: There are FIVE general types of chemical reactions.

1. Combination Reactions - two or more types of material become one new material:

   Generic: A + Z → AZ

   Example: $C(s) + O_2(g) \rightarrow CO_2(g)$

   Note: All combustion (adding oxygen) reactions are classed as combination reactions.

2. Decomposition Reactions - a material becomes two or more new materials:

   Generic: AZ → A + Z

   Example: $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

   Note: Decomposition reactions may be considered the reverse of combination reactions.

3. Single Replacement ('Prom') reactions - a more reactive material replaces a less reactive one in a compound:

Random internet prom pic.

   Generic: A + BZ → AZ + B

   Example: $Sn(s) + 2HCl(aq) \rightarrow SnCl_2(aq) + H_2(g)$

   Note: The material replaced (B or H^+ above) is said to be LESS reactive than it's replacement (A or Sn above).

4. Double Replacement reactions - the respective ionic partners of a pair of dissolved ionic compounds are swapped, most often resulting in the formation of solid product(s):

gerr!

Generic: $AX + BZ \rightarrow AZ + BX$

Example: $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

Note: These types of reactions typically take place between dissolved ionic compounds, and typically result in one of the new materials forming a solid precipitate (ppt).

5. Neutralization reactions - very similar to double replacement, but ALWAYS between an acid and a base:

Generic: $HA + MOH \rightarrow MA + HOH$
(acid + base → salt + water, H_2O)

Example: $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

Note: These types of reactions are called neutralizations because acid (H^+) and basic (OH^-) ions react with each other to form water (H_2O). Such reactions typically liberate large amounts of heat (highly exothermic).

Task: Identify the following reactions (some of which you may remember from lab) as either: *combination, decomposition, single replacement, double replacement* or *neutralization*. **Additionally, write the formula equivalent of each reaction below its word equation version**.

sulfur(s) + oxygen gas → sulfur dioxide gas

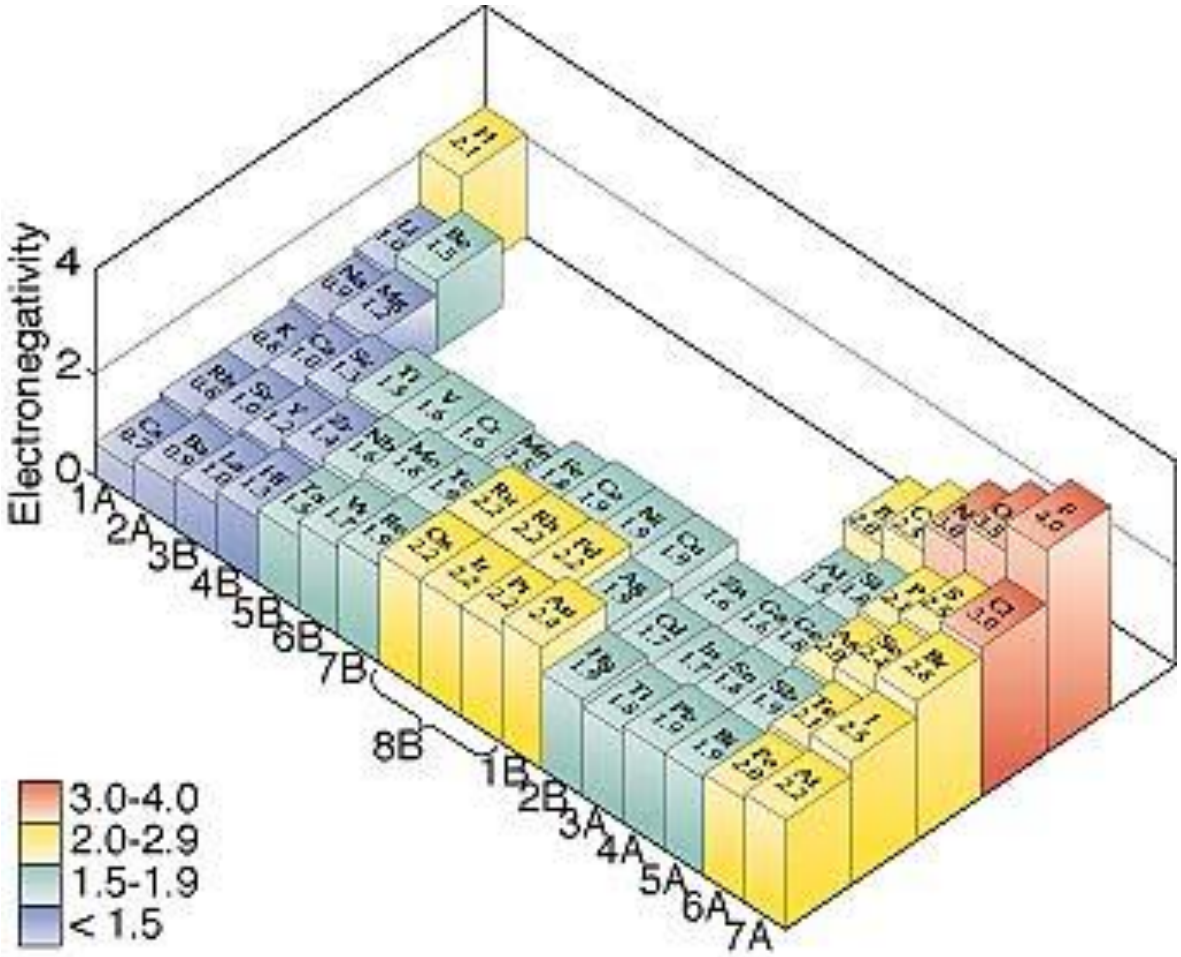
magnesium carbonate(s) → magnesium oxide(s) + carbon dioxide gas

zinc(s) + copper (II) nitrate sol^{n}. → metallic copper + zinc nitrate sol^{n}.

silver nitrate(aq) + sod. chloride(aq) → silver chloride(s) + sod. nitrate (aq)

sodium hydroxide solution + hydrochloric acid solution →

Electronegativity Values



Electronegativity 'map' of the periodic table – this and other periodic trends will be covered in more detail later in the course