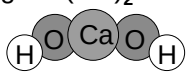
Balancing Equations: Chemical and Nuclear

How molecules are symbolized

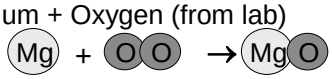
Cl_2 2Cl $2Cl_2$

- Molecules may also have brackets to indicate numbers of atoms. E.g. $Ca(OH)_2$
- Notice that the OH is a group
- The 2 refers to both H and O
- How many of each atom are in the following?
  a) NaOH Na = , O = , H =
  b) $Ca(OH)_2$ Ca = , O = , H =
  c) $3Ca(OH)_2$ Ca = , O = , H =



Balancing equations: MgO

- The law of conservation of mass states that matter can neither be created or destroyed
- Thus, atoms are neither created or destroyed, only rearranged in a chemical reaction
- Thus, the number of a particular atom is the same on both sides of a chemical equation
- Example: Magnesium + Oxygen (from lab)
- $Mg + O_2 \rightarrow MgO$



- However, this is not balanced
- Left: Mg = 1, O = 2
- Right: Mg = 1, O = 1

Balance equations by "inspection"

From $Mg + O_2 \rightarrow MgO$
$2Mg + O_2 \rightarrow 2MgO$ is correct
$Mg + \frac{1}{2}O_2 \rightarrow MgO$ is incorrect
$Mg_2 + O_2 \rightarrow 2MgO$ is incorrect
$4Mg + 2O_2 \rightarrow 4MgO$ is incorrect

Hints: start with elements that occur in one compound on each side. Treat polyatomic ions that repeat as if they were a single entity

a) $P_4 + O_2 \rightarrow P_4O_{10}$
b) $Li + H_2O \rightarrow H_2 + LiOH$
c) $Bi(NO_3)_3 + K_2S \rightarrow Bi_2S_3 + KNO_3$
d) $C_2H_6 + O_2 \rightarrow CO_2 + H_2O$

Balance these skeleton equations:

a) $Mg + HCl \rightarrow MgCl_2 + H_2$
b) $Ca + N_2 \rightarrow Ca_3N_2$
c) $NH_4NO_3 \rightarrow N_2O + H_2O$
d) $BiCl_3 + H_2S \rightarrow Bi_2S_3 + HCl$
e) $C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$
f) $O_2 + C_6H_{12}O_6 \rightarrow CO_2 + H_2O$
g) $NO_2 + H_2O \rightarrow HNO_3 + NO$
h) $Cr_2(SO_4)_3 + NaOH \rightarrow Cr(OH)_3 + Na_2SO_4$
i) $Al_4C_3 + H_2O \rightarrow CH_4 + Al(OH)_3$

Returning to reaction types

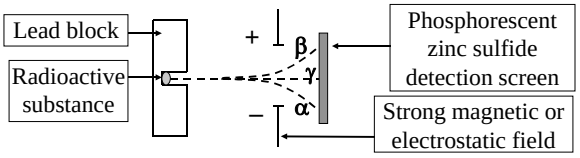
- We have looked at several types of reactions without worrying about balancing
- However, all equations should be balanced
- Predict the products and balance these: (recall, metals above replace metals below, reactions with water yield metal hydroxides)

$Fe + CuSO_4 \rightarrow$
$Ni + NaCl \rightarrow$
$Al + CuCl_2 \rightarrow$
$Li + ZnCO_3 \rightarrow$
$Li + H_2O \rightarrow$
$Al + O_2 \rightarrow$

K
Na
Li
Ca
Mg
Al
Zn
Fe
Ni
Sn
Pb
H
Cu
Hg
Ag
Au

Discovery of Radioactivity

- Radioactivity is the release of energy or particles when an atom disintegrates (demo)
- Radioactivity was discovered when minerals were exposed to film through an opaque cover
- The 3 types of radioactivity can be shown by passing emissions through an electrical field:



Types of Radioactivity

Types of radiation: 1) α, 2) β, 3) γ

1. Alpha (α) particles are symbolized as ^4_2He
2. Beta (β) particles (essentially electrons) are $^0_{-1}e$
3. Gamma (γ) rays are symbolized as $^0_0\gamma$

- You can determine the composition of each: α: mass of 4 u, charge of +2 (2 p^+, 2 n^0, 0 e^-)
- Other symbols: proton = ^1_1p, neutron = ^1_0n
- There are different terms to describe the different types of nuclear reactions
- "alpha decay" means an α particle is given off.
- Other: beta decay, fusion (meaning to bring together), fission (meaning to break apart)

Nuclear equations

Q. Write the beta decay for C-14

Q. Write the alpha decay for ^{209}Po

Q. Complete this fission reaction

$$^{235}_{92}U + {}^1_0n \rightarrow 3\,{}^1_0n + {}^{139}_{56}Ba +$$

In all cases, charge and mass must be balanced

- Practice: pg. 222-3, Q6, Q3