* closed system* → one in which nothing can enter or leave (ie. sealed glass tube)

Name:_____
Blk:_____ Date:_____

Chemistry 11
CONSERVATION LAWS + BALANCING EQUATIONS

A CONSERVATION LAW- an experimentally observed law that states what is "conserved" (unchanged) in a chemical reaction

THERE ARE FOUR CONSERVATION LAWS that you must familiarize yourself with:

Sc. 8 → 1. Law of Conservation of ENERGY- the total energy in a closed system does not change.

Sc. 9 → 2. Law of Conservation of MASS- the total mass in a closed system does not change.

Sc. 10 → 3. Law of Conservation of ATOMS- the number and types of atoms in a closed system does not change.

Chem 12 → 4. Law of Conservation of ELECTRICAL CHARGE- the total electrical charge in a closed system does not change.

When a Chemical Equation is BALANCED, then __mass__, __atoms__ and __electrical__ __charge__ are CONSERVED!!!

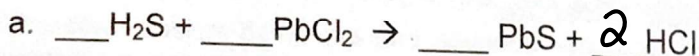**Example 1**. Balance the following chemical equations:
RECALL THE (MI-NOH CHEMISTRY) TECHNIQUE
Step 1. Balance the METALS
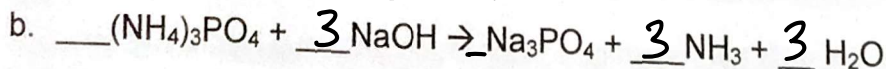Step 2. Balance the UNCHANGED POLYATOMIC IONS
Step 3. Balance the NON-METALS
Step 4. Balance Hydrogen's and Oxygen's last

a. ___ H_2S + ___ $PbCl_2$ → ___ PbS + __2__ HCl

$$1 = Pb = 1$$
$$2 = Cl = 2$$
$$1 = S = 1 \quad \checkmark$$

b. ___ $(NH_4)_3PO_4$ + __3__ $NaOH$ → ___ Na_3PO_4 + __3__ NH_3 + __3__ H_2O

$$3 = Na = 3$$
$$1 = PO_4^{3-} = 1$$
$$3 = N = 3 \quad \checkmark$$
$$15 = H = 15$$
$$3 = O = 3$$
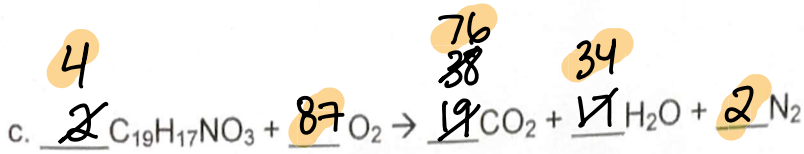
c. $\underset{2}{\cancel{2}}\,C_{19}H_{17}NO_3 + \underset{87}{87}\,O_2 \rightarrow \underset{19}{19}\,CO_2 + \underset{17}{17}\,H_2O + \underset{2}{2}\,N_2$

4 $\underset{38}{76}$ 34

$76\ 38\ 19 = C = 19\ 38\ 76$
$4\ \cancel{8}\ X = N = \cancel{2}\ 4$
$6B\ 34 = H = \cancel{2}\ 34\ 6B$
$87\ \cancel{5} = O = 93\ 186$

$186 - 12 = \dfrac{174}{2}$

d. $\underline{}\,Cr_2(SO_4)_3 + \underline{5}\,KI + \underline{}\,KIO_3 + \underline{3}\,H_2O \rightarrow \underline{2}\,Cr(OH)_3 + \underline{3}\,K_2SO_4 + \underline{3}\,I_2$

$6\ \cancel{2} = K = \cancel{2}\ 6$
$2 = Cr = 2$
$3 = SO_4^{2-} = 3$
$6 = I = 6$
$6\ \cancel{2} = H = \cancel{2}\ 66$
$6 = O = 6$

e. $\underset{4}{4}\,MoCl_3 + \underline{}\,O_2 + \underset{2}{\cancel{2}}\,AgCl \rightarrow \underset{4}{4}\,MoCl_4 + \underline{2}\,Ag_2O$

4

$4\ X = Mo = X\ 4$
$4\ \cancel{2} = Ag = 24$
$16\ \cancel{7} = Cl = 4\ 16$
$2 = O = 2$
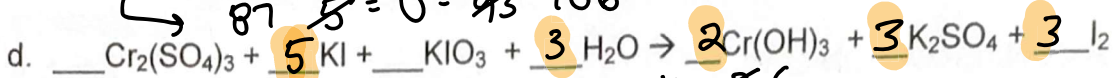
Including PHASES in Chemical Equations:

Recall that the following lower case letters represent a different PHASE for the species in a chemical reaction:

(s)= Solid   (l)= liquid   (g)= gas   (aq)= aqueous

Recall the DIATOMIC elements- H_2 O_2 F_2 Br_2 I_2 N_2 Cl_2
(g) (g) (g) (l) (s) (g) (g)
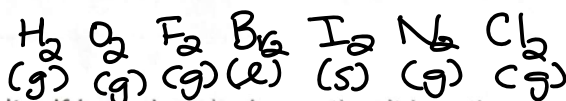
IMPT: When SULFUR appears by itself in a chemical equation it has the chemical formula of S_8 (s)

The words _crystals_ , _powder_ and _precipitate_ all refer to a SOLID substance. A _precipitate_ is used to refer to a situation when a solid is produced when TWO ~~IONIES~~ are mixed.
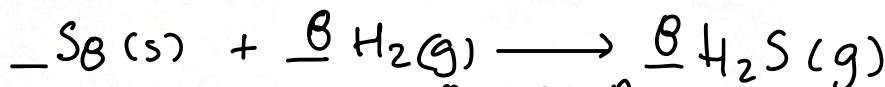_SOLUTIONS_

Example 2. Translate the following word equations into chemical equations with phases and then balance the result.

a. (Aqueous) phosphoric acid reacts with (aqueous) barium hydroxide to produce water and a precipitate of barium phospate:

$\underset{2}{2}\,H_3PO_4\ (aq) + \underset{3}{3}\,Ba(OH)_2\ (aq) \longrightarrow \underset{6}{6}\,H_2O\ (l) + \underline{}\,Ba_3(PO_4)_2\ (s)$
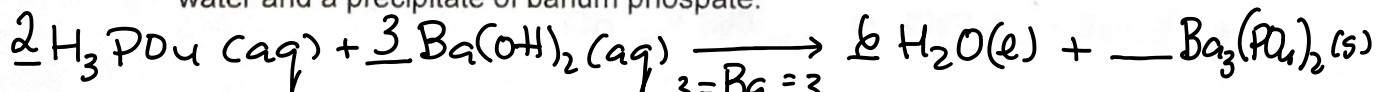
$3 = Ba = 3$
$2 = PO_4^{3-} = 2$
$12 = H = 12$
$6 = O = 6$

b. Solid Sulphur reacts with hydrogen gas to produce (gaseous) Hydrosulphic acid:

$\underline{}\,S_8\ (s) + \underset{8}{8}\,H_2(g) \longrightarrow \underset{8}{8}\,H_2S\ (g)$

$8 = S = 8$
$16 = H = 16$

Ex: 1 + 2