Quantities in Chemical Reactions: Review

Date: ______________________________

Balancing Equations

Basic concepts:

- Matter cannot be created nor destroyed (Law of Conservation of Matter)
- Balanced equations use COEFFICIENTS to show exactly how much reactant and product are involved in a reaction
- Never change SUBSCRIPTS of chemical formulas in order to balance an equation

Practice 1

a) ___ S_8 + ___ O_2 → ___ SO_3

b) ___ Al + ___ FeO → ___ Al_2O_3 + ___ Fe

c) ___ $SiCl_4$ + ____ H_2O → ____ H_4SiO_4 + ____ HCl

d) ___ $Fe_2(SO_4)_3$ + ___ KOH → ____ K_2SO_4 + ____ $Fe(OH)_3$

e) ___ Si_2H_3 + ___ O_2 → ____ SiO_2 + ____ H_2O_3

[ans: a) 1, 12, 8; b) 2, 3, 1, 3; c) 1, 4, 1, 4; d) 1, 6, 3, 2; e) 4, 17, 8, 6]

The Mole

Basic concepts:

- One mole is an amount equivalent to 6.02×10^{23} entities (atoms, molecules, or ANYTHING)
- The value 6.02×10^{23} is also known as Avogadro's number
- The mass of one mole of a substance is called its **MOLAR MASS**, and is expressed in grams/mole (g/mol). It is different for each element, and can be obtained from the atomic mass on the periodic table.
- Molar mass of a compound can be obtained by adding up the individual molar masses of its component atoms.

Practice 2

	Number of atoms	Atomic mass (with units)	Molar mass (with units)
a) H_2O	H=2 O=1	18.02 amu	18.02 g/mol
b) KNO_3	K=1 N =1 O=3	101.10 amu	101.10 g/mol
c) C_3H_7OH	C=3 H=8 O=1	60.09 amu	60.09 g/mol

Basic concepts:

- A molecule's molar mass can be used to convert between molar amounts and gram masses.

Conversion factor:
Molar mass (g/mol)

AMOUNT (moles) → MASS (grams)

Practice 3

	Molar mass	Mass	Amount
a) PCl_5	208.24 g/mol	135 g	0.650 mol
b) $Al_2(SO_4)_3$	342.15 g/mol	344.5 g	1.007 mol
c) NaOH	40.00 g/mol	15.0 g	0.375 mol
d) Br_2	159.81 g/mol	2.20×10^2 g	1.38 mol
e) $MgCl_2$	95.21 g/mol	745 mg	7.82×10^{-5} mol

Molar Solutions

Basic concepts:

- Solute concentrations are usually expressed in moles of solute per litre of solution (mol/L = M)
- The molar concentration of a solution can be used to convert between molar amounts, and millilitre volumes.

Conversion factor:
concentration (mol/L)

AMOUNT (moles) → VOLUME (L)

Practice 4

	Concentration	Volume	Amount of solute	Mass of solute
a) $Mg(OH)_{2\ (aq)}$	1.58 mol/L	0.375 L	0.593 mol	34.6 g
b) $H_2CO_{3\ (aq)}$	2.00 mol/L	0.0885 L	0.177 mol	11.0 g
c) $NaF_{\ (aq)}$	0.42 mol/L	220 mL	0.093 mol	3.90 g
d) $H_2O_{2\ (aq)}$	0.23 mol/L	375 mL	85 mmol	2.9 g

Stoichiometry

Basic concepts:

- Coefficients in balanced equations reflect not only the molecular ratios between reactants and products, but also the **MOLAR RATIOS**.

Practice 5

a) $2\ Fe_2O_3 + 3C \rightarrow 4\ Fe + 3\ CO_2$

	Fe_2O_3	C	Fe	CO_2
Moles	8	12	16	12
Mass	1277.52 g	144.00 g	893.44 g	528.12 g

b) $2\ Na_3PO_4 + 3\ MgCl_2 \rightarrow 6\ NaCl + Mg_3(PO_4)_2$

	Na_3PO_4	$MgCl_2$	NaCl	$Mg_3(PO_4)_2$
Moles	1	1.5	3	0.5
Mass	163.94 g	142.82 g	175.32 g	131.43 g

c) $N_2 + 3\ H_2 \rightarrow 2\ NH_3$

	N_2	H_2	NH_3
Moles	1.67	5.00	3.33
Mass	46.8 g	10.1 g	56.7 g

d) $2\ HNO_{3\ (aq)} + Ca(OH)_{2\ (aq)} \rightarrow Ca(NO_3)_{2\ (aq)} + 2\ H_2O_{\ (l)}$

	$HNO_{3\ (aq)}$	$Ca(OH)_{2\ (aq)}$	$Ca(NO_3)_{2\ (aq)}$	$H_2O_{\ (l)}$
Moles of solute	0.626 mol	0.313 mol	0.313 mol	0.626 mol
Solution concentration	1.50 mol/L	1.25 mol/L	0.470 mol/L	N/A
Solution volume	0.417 L	0.250 L	0.667 L	N/A