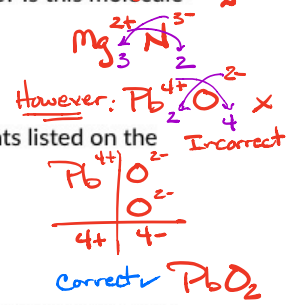
Exam 2 Review
Chapters 3 - 5

Study Guide Exam #2

1. Know how to use group number and period number in the periodic table; what information do these provide regarding number of valence electrons, location of valence electrons, and charge of the ion?
2. Compare covalent and ionic bonding with regard to electron transfer or sharing and type of elements involved (metals and non-metals). if metal = ionic all non metal = covalent
3. Write the correct formulas for the two products of this double-replacement reaction:

iron (II) chloride reacts with sodium oxide to form iron (II) oxide and sodium chloride.

4. Compare and contrast the naming rules for ionic vs. covalent compounds. Be able to correctly write the formula for an ionic compound given it's name (know how to "crisscross" charges.) → for odd & even only
5. Draw the Lewis dot structure for a molecule of H_2O. What is the shape of this molecule? Is this molecule polar or nonpolar? Do the same for BF_3 , CO_2 , NH_3 and PCl_3.
6. Explain electronegativity and how to determine if a bond is polar, nonpolar or ionic.
7. Understand the trend for electronegativity in the periodic table.

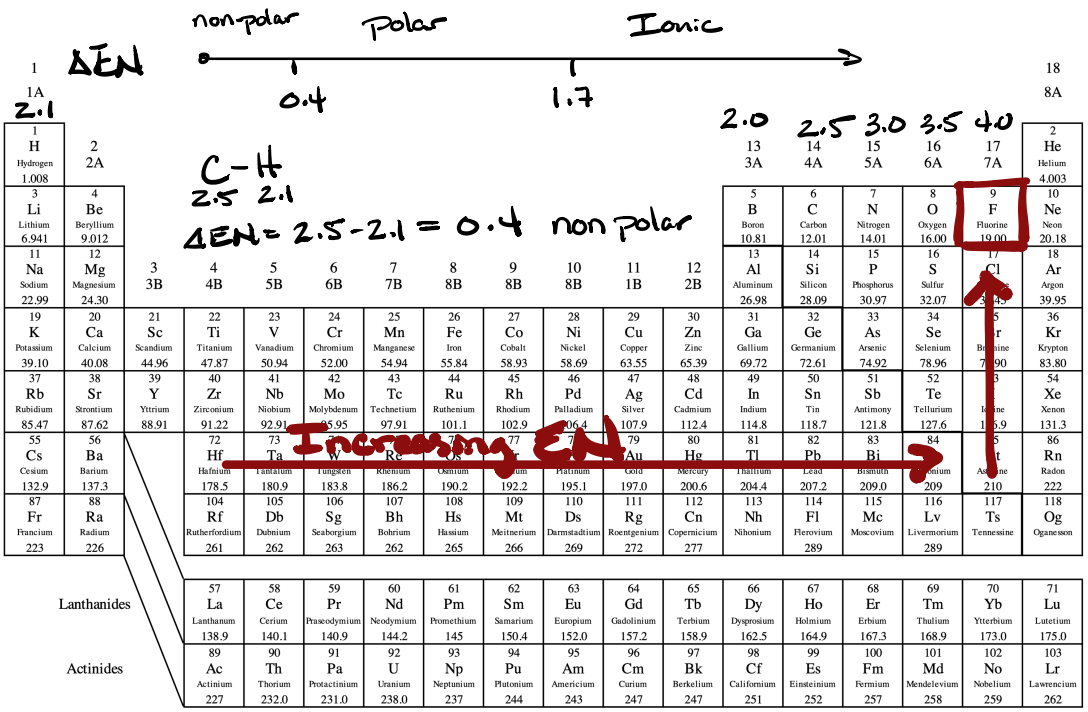


Stoichiometry

8. What is the definition of a mole? What is the relation between moles and atomic weights listed on the periodic table?
9. What is Avogadro's number? Know how to use this number on your calculator!
10. Calculate how many atoms are present in 10g of carbon. How many moles is this?
11. 5.5×10^{23} atoms of sulfur is how many moles of sulfur? How many grams is this?
12. Review sample problems from lecture notes and homework, and be able to convert between number of atoms/molecules, grams and moles.
13. Know how (and why) to balance equations (see lab activity #12 and chp 4 hw for practice)
14. Briefly define redox reactions; be able to identify oxidation and reduction reactions, as well as oxidizing and reducing agents in an equation.
15. What is meant by the term theoretical yield? Be able to solve calculations involving actual, theoretical and percent yield.
16. Given a balanced equation and available moles of a reactant, predict amount of product made or other reactants required.

$\Delta EN = |EN_1 - EN_2|$

$0 \geq 0.4$ non-polar $\quad 0.4 \leq 1.7$ polar $\quad > 1.7$ Ionic



1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
2.1																	
1 H Hydrogen 1.008	2 2A																2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.30	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl [illegible]	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.84	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 [illegible] Bromine [illegible]	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.95	43 Tc Technetium 97.91	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 [illegible] Iodine [illegible]	54 Xe Xenon 131.3
55 Cs Cesium 132.9	56 Ba Barium 137.3		72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 [illegible] [illegible] 192.2	78 [illegible] Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 [illegible] [illegible] 209	85 [illegible] Astatine 210	86 Rn Radon 222
87 Fr Francium 223	88 Ra Radium 226		104 Rf Rutherfordium 261	105 Db Dubnium 262	106 Sg Seaborgium 263	107 Bh Bohrium 262	108 Hs Hassium 265	109 Mt Meitnerium 266	110 Ds Darmstadtium 269	111 Rg Roentgenium 272	112 Cn Copernicium 277	113 Nh Nihonium	114 Fl Flerovium 289	115 Mc Moscovium	116 Lv Livermorium 289	117 Ts Tennessine	118 Og Oganesson
Lanthanides			57 La Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium 145	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.2	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
Actinides			89 Ac Actinium 227	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium 237	94 Pu Plutonium 244	95 Am Americium 243	96 Cm Curium 247	97 Bk Berkelium 247	98 Cf Californium 251	99 Es Einsteinium 252	100 Fm Fermium 257	101 Md Mendelevium 258	102 No Nobelium 259	103 Lr Lawrencium 262

Molecular Polarity

Does the molecule Contain Polar Bonds $\Delta EN > 0.4$

NO — nonpolar

Yes

Is the molecule Symmetrical Such that the dipoles all Cancel (AX_2, AX_3, AX_4 | X are all same element)

Yes — nonpolar

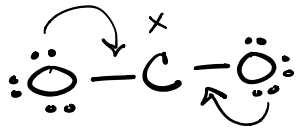
NO — polar

AX_2E_2, AX_2E, AX_3E

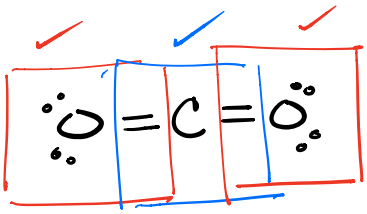
CO_2

e^- Count

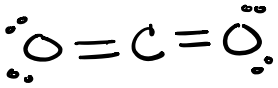
		e^-
IVA	C 1 × 4 =	4
VIA	O 2 × 6 =	12
		16 ✓



Check e^- count ✓
Check octets ✗



Check e^- count ✓
Check octets ✓



$\Delta EN = EN_{oxy} - EN_{carbon}$

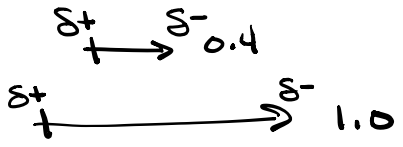
$= 3.5 - 2.5$

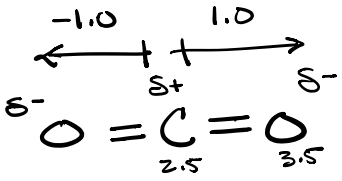
$= 1.0 > 0.4$ ✓ polar

O = 3.5
C = 2.5

ΔEN is a vector ⟶

vector has direction & magnetude

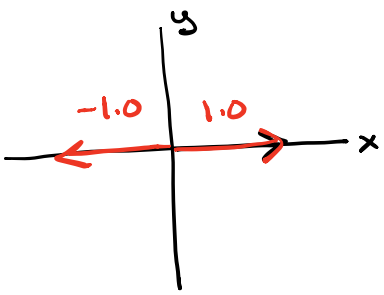




AX_2

A = central

X = atom bound to central

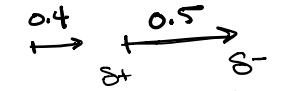


net vector = 1.0 − 1.0 = 0

no net vector

nonpolar

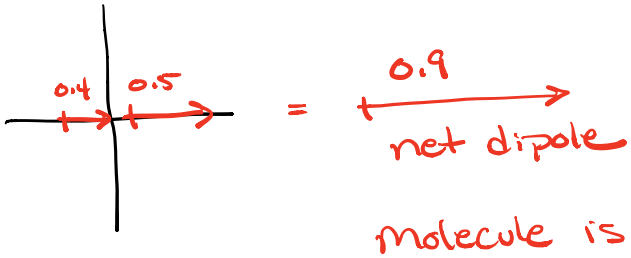
Lets look at HCN



H − C ≡ N:

C − H ΔEN = C 2.5 − H 2.1 = 0.4 nonpolar

C − N ΔEN = N 3.0 − C 2.5 = 0.5 polar



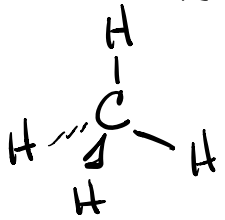
molecule is polar

AX_2 but x's not the same

Is the molecule polar or non-polar

ΔEN C-H = 0.4 Polar or nonpolar

CH_4



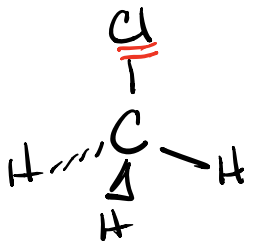
AX_4 non-polar

Tetrahedral

C-H 0.4 nonpolar

C-Cl 0.5 polar ✓ Polar

CH_3Cl

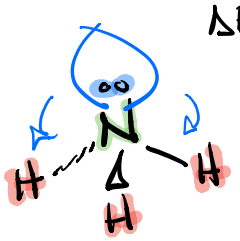


AX_4

Tetrahedral

ΔEN $^{N}3.0 - ^{H}2.1 = 0.9$ polar ✓

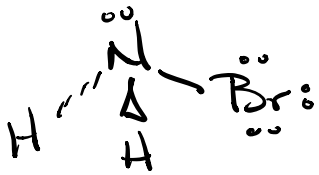
NH_3



AX_3E Polar

Trigonal pyramidal

NH_2Br



AX_3E Polar

Trigonal pyramidal

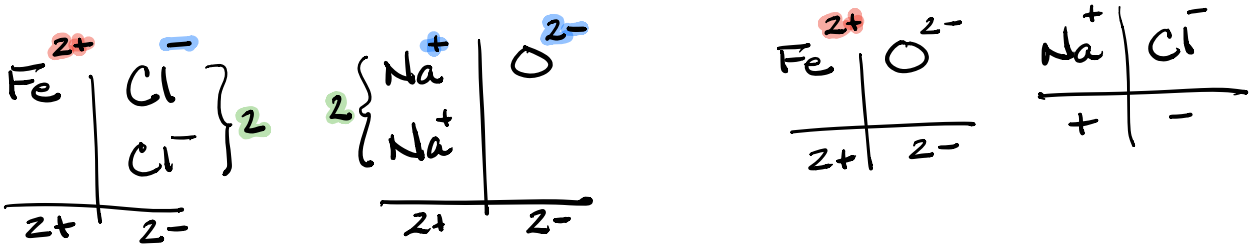
Not AX_3

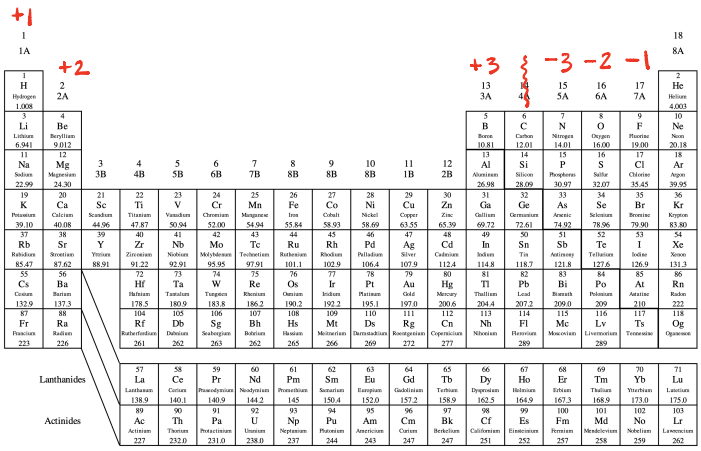
yes polar bonds

① writing the formula

$$FeCl_2 + Na_2O \longrightarrow FeO + NaCl$$

Iron(II) Chloride + Sodium Oxide → Iron(II) Oxide + Sodium Chloride





② Balance the formula ✓

$$FeCl_2 + Na_2O \longrightarrow FeO + 2NaCl$$

Fe	1
Cl	2
Na	2
O	1

Fe	1	✓
Cl	~~1~~ 2	✓
Na	~~1~~ 2	✓
O	1	✓

Ionic Nomenclature

Cation 1st Anion 2nd

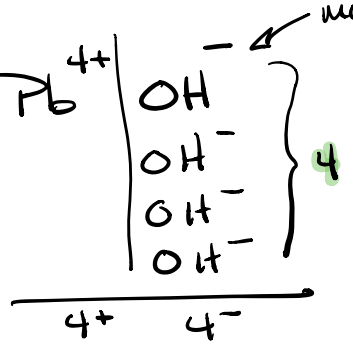
Metal — non-metal or polyatomic

memorized

Lead(IV) hydroxide

$Pb(OH)_4$ ✓

$PbOH_4$ ✗



Covalent nomenclature (Binary Covalent)

2 non-metals

CO_2	Carbon	dioxide
CO	Carbon	monoxide
BCl_3	Boron	trichloride

1 mon
2 di
3 tri
4 tetra
5 penta
6 hexa
7 hepta
8 octa
9 nona
10 deca

⟹ Because there are no charges in covalent we need the prefixes.

Redox Oxidation & Reduction

e^- Bookkeeping

Oxidation is the loss of e^- OIL

Reduction is the gain of e^- RIG

Set of Rules for assigning oxidation #'s

- Elements in elemental state are zero

  $\overset{0}{Fe}$ $\overset{0}{Na}$ $\overset{0}{O_2}$ $\overset{0}{H_2}$ $\overset{0}{Cl_2}$ $\overset{0}{Ar}$ $\overset{0}{He}$

- The oxidation state of an ion is the same as the charge state

  Ox # → +2 +3 +1 -2 -1 +3

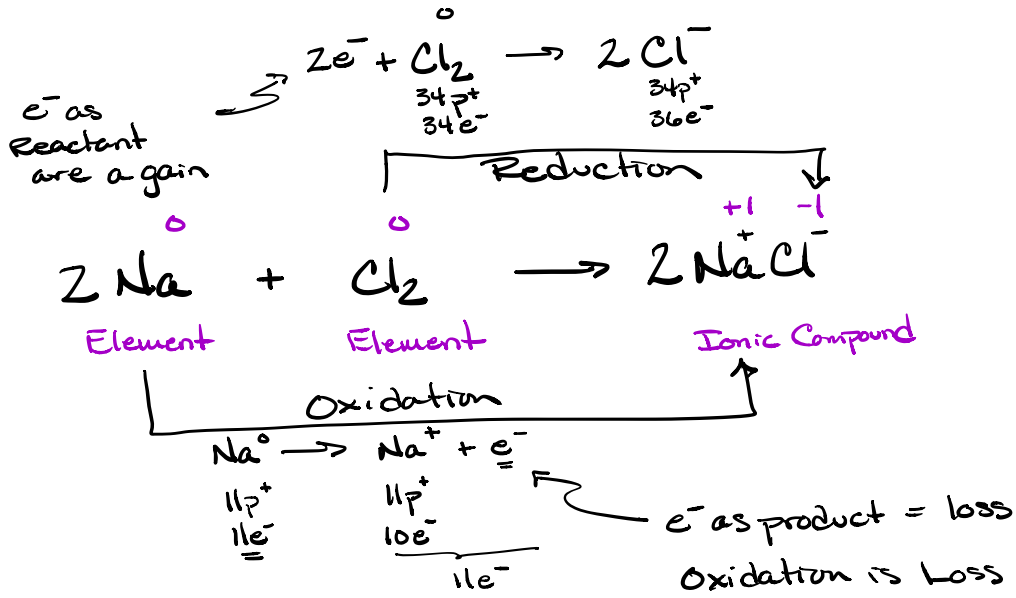
  Charge state → $2+$ $3+$ $+$ $2-$ $-$ $3+$

  Fe Fe^{3+} Na^{+} O^{2-} Cl^{-} Al^{3+}

- Combined oxygen is -2
- Combined Hydrogen is +1
- Combined Fluorine is -1

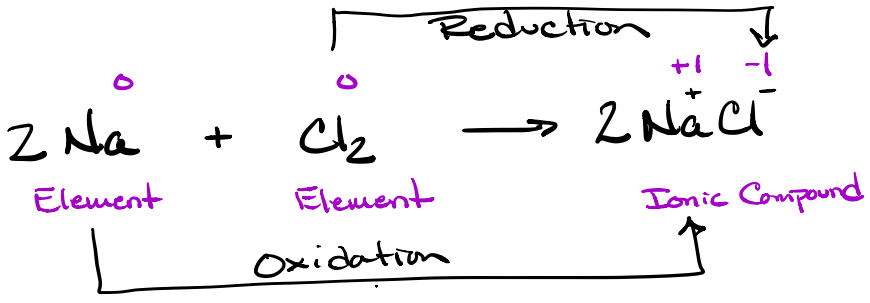
} Combined = Covalent

- For a molecule the sum of the oxidation numbers must = Zero
- For a polyatomic ion the sum of the oxidation numbers must = Charge on ion



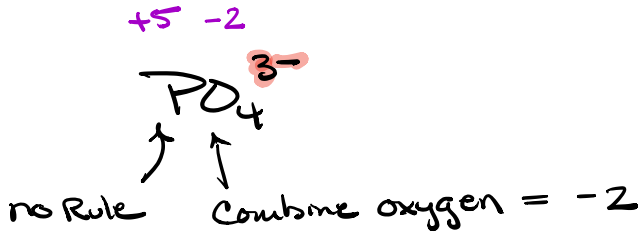
Oxidizing Agent ⇒ The (Reactant) species that was reduced & caused oxidation

Reducing Agent ⇒ The species (Reactant) that was oxidized & caused Reduction



Na oxidized ⇒ Na Reducing agent

Cl_2 Reduced ⇒ Cl_2 Oxidizing agent



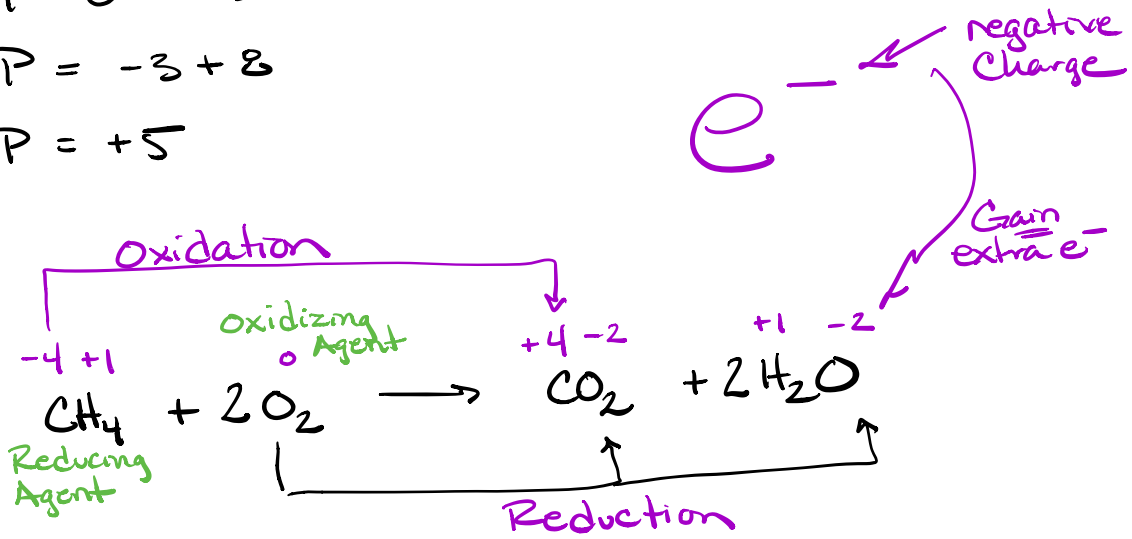
$P + 4\,Oxy = 3-$

$P + 4(-2) = 3-$

$P - 8 = -3$

$P = -3 + 8$

$P = +5$



Combined H = +1
Elements = 0
Combined oxygen = -2

HOFBrINCl

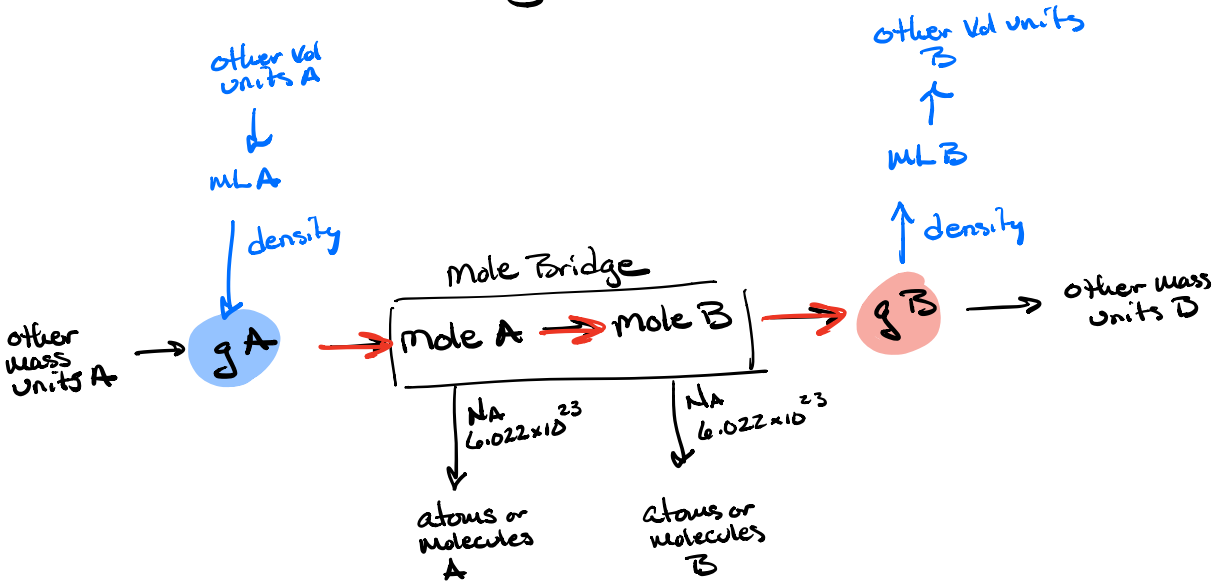
CH_4

$C + 4H = 0$
$C + 4(+1) = 0$
$C + 4 = 0$
$C = -4$

CO_2

$C + 2O = 0$
$C + 2(-2) = 0$
$C - 4 = 0$
$C = +4$

Stoichiometry Road Map



How much carbon dioxide is formed from the complete combustion of 10.6 g of methane gas with excess oxygen?

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

10.6 g — ? g

g CH_4 → mole CH_4 → mole CO_2 → g CO_2

molar mass CH_4 | coefficients in eq | molar mass CO_2

CH_4 C = 12.01 g/mole
H = 1.008 g/mole

$1 \times 12.01 = 12.01$
$4 \times 1.008 = +\ 4.032$
16.042

$CH_4 = 16.04$ g/mol

CO_2 C = 12.01 g/mol
O = 16.00 g/mol

C $1 \times 12.01 = 12.01$
$2 \times 16.00 = 32.00$
44.01 g/mole

$CO_2 = 44.01$ g/mole

g CH_4 → (molar mass CH_4) mole CH_4 → (coefficients in eq) mole CO_2 → (molar mass CO_2) g CO_2

$$10.6\ g\ CH_4 \times \frac{1\ mole\ CH_4}{16.04\ g\ CH_4} \times \frac{1\ mole\ CO_2}{1\ mole\ CH_4} \times \frac{44.01\ g\ CO_2}{1\ mole\ CO_2}$$

3 (sig figs for 10.6 g) → 4 (sig figs for 16.04 g)

4 (sig figs for 44.01 g)

29.083 915 22 g

29.1 g CO_2 produced

Activity 14

Question # 8

Cobalt Chloride exists as hydrate w/ mw 237.93 g/mole.
Prolonged heating can drive off the H_2O.
A 54.8 g sample heated for 15 min, cooled & reweighed.
The residual mass was found to be 33.2 g.
Calc # H_2O molecules in hydrate

$$\underset{54.8\,g}{CoCl \cdot X\,H_2O} \xrightarrow{\Delta} \underset{33.2\,g}{CoCl_2} + \underset{?\,g}{X\,H_2O_{(g)}}$$

- find mass of H_2O lost
- Cacilate moles of H_2O from mass lost

Mass H_2O lost = $54.8\,g - 33.2\,g = 21.3\,g\ H_2O$ lost

H_2O H = 1.008 g/mole
O = 16.00 g/mole

$2 \times 1.008 = 2.016$
$1 \times 16.00 = 16.00$
18.02 g/mole

# of moles H_2O lost = $21.3\,g\ H_2O \times \frac{1\ mole\ H_2O}{18.02\,g\ H_2O} = 1.182019977$

(3 sig figs) (4 sig figs)

$= 1.18$ moles H_2O

moles $CoCl_2$

Co = 58.93 g/mol

Cl = 35.45 g/mol

$1 \times 58.93 = 58.93$

$2 \times 35.45 = 70.90$

129.83 g/mole

moles $CoCl_2$

$$33.2\ g\ CoCl_2 \times \frac{1\ mole\ CoCl_2}{129.83\ g\ CoCl_2} = 0.2557190 17$$

$$= 0.256\ mole\ CoCl_2$$

$$\frac{x\ mole\ H_2O}{1\ mole\ CoCl_2} = \frac{1.18\ mole\ H_2O}{0.256\ mole\ CoCl} = 4.609$$

$$\approx 5\ H_2O$$

$CoCl_2 \cdot x\ H_2O$

$1 : x$

New approach

$CoCl_2 \cdot x H_2O = 237.93$ g/mole

$-CoCl_2 = 129.83$ g/mole

$x H_2O = 108.1$ g/mole

$H_2O = 18.02$ g/mole

$x(18.02 \text{ g/mole}) = 108.1$ g/mole

$x = \frac{108.1 \text{ g/mole}}{18.02 \text{ g/mole}} = 5.998890$

= 6 molecules of H_2O

$C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

Carbon dioxide

C
H
O

C
H
O

HOFBrINCl

H_2 O_2 F_2 Br_2 I_2 N_2 Cl_2