Science 1206

Unit 2: Chemistry

Periodic Table Videos

Chemical Reactions

- **Chemistry:** the study of matter, its properties and its changes
- **Matter:** anything that has mass and takes up space (energy is **not** matter).
- The 3 states of mater:
  - Solid liquid gas

Pure Substances

Pure Substances:

have constant composition; all the particles that make up the substance are the same

1. **Elements:**
   - the simplest form of matter that can exist under normal conditions
   - composed of only *one kind of atom*
   - cannot be broken into simpler substances by chemical means (heat/electricity)
   - combine to form other substances

2. **Compounds:**
   substances composed of *two or more different kinds of atoms*
   can be broken down into simpler substances by chemical means

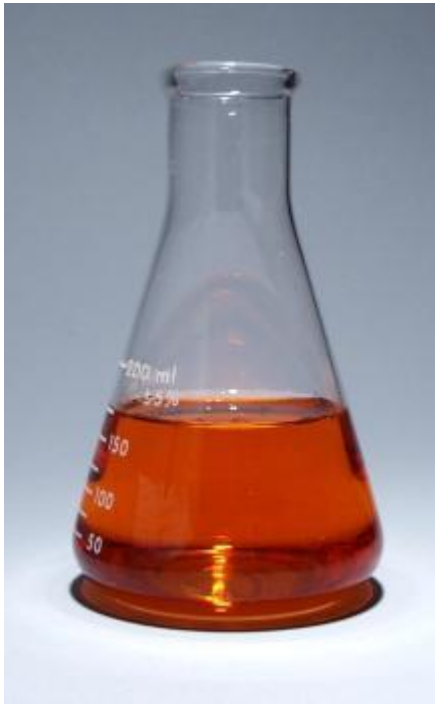
Mixtures

- Mixtures have variable compositions
  - Composed of 2 or more substances
- **Homogeneous Mixtures: solutions –** have only one visible component
- **Heterogeneous Mixtures: mechanical mixtures** – have 2 or more visible components
  - eg. sand in water, vegetable soup

Pure Substances: Elements and Compounds

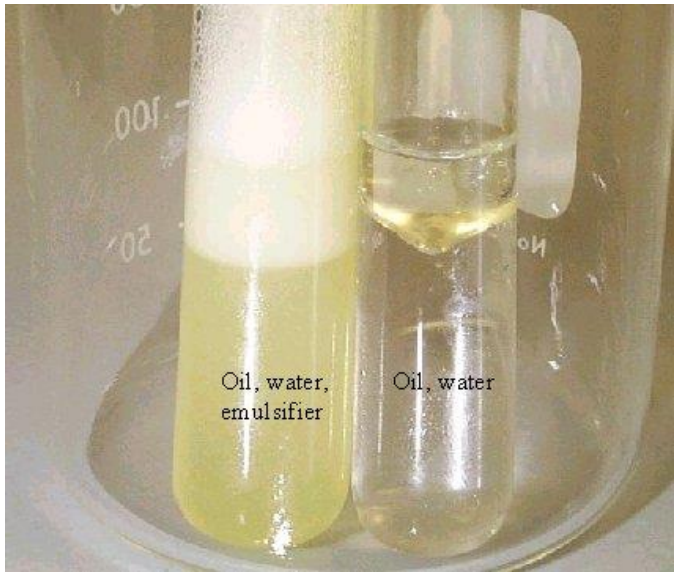
Mixtures

- Homogeneous – uniform look

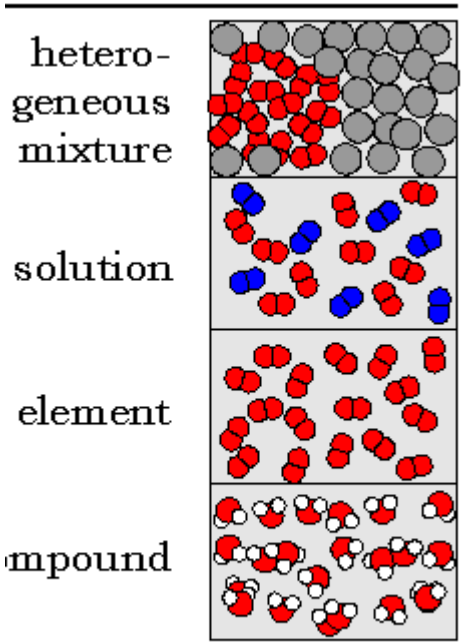


Mixtures

- Heterogeneous Mixtures



A closer look



Properties of Matter

- **Physical Property:**
  - characteristics of matter, used to identify substances
  - eg. state at room temperature, boiling and melting points, color, solubility, mass, electrical conductivity

Properties of Matter

- **Chemical Property:** characteristic of matter that can be observed when matter undergoes a change in composition (chemical reaction):
  - describes "how it reacts“
  - butane reacts with oxygen to produce carbon dioxide and water

Examples

Substance	Physical Property	Chemical Property
Iron		
Sodium		
Sugar		
Propane		

Changes in Matter

- **Physical Change:** a change in the size or form of a substance that does not change its composition
  - cutting, bending, changes in state: boiling, melting, condensing, and solidifying

Changes in Matter

- **Chemical Change:** a chemical reaction; a change in which at least one or more new substances
  - (**products**) are formed. The products have different properties from the starting substances (**reactants).**
  - $Fe_{(s)} + O_{2(g)} \rightarrow Fe_2O_{3(s)}$ The rust produced has completely different properties from iron and oxygen.

Change in Matter

- ***Evidence of Chemical Change:***
  - change in **color, odor, energy** (temperature change, light)
  - **bubbles = new gas produced**
  - **precipitate = new solid produced**
  - Hard to reverse

Precipitate Video

Homework

- Read pg. 172-174
- Questions: 1,2,4,7

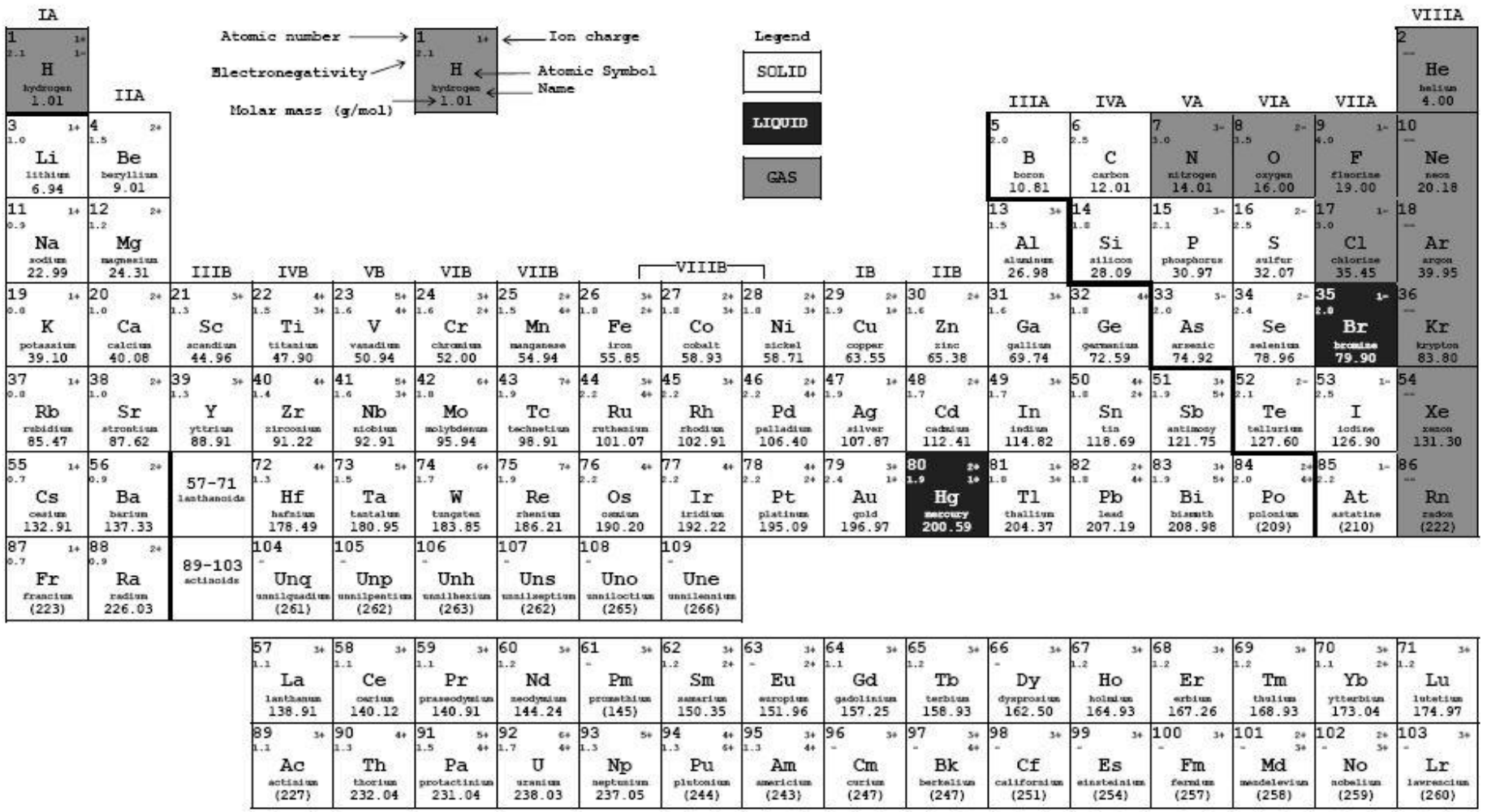
- Homework Check:

- All elements can be split into two groups
- Metals and Nonmetals

Elements and Periodic Table

PROPERTY	**METALS**	**NONMETALS**
LUSTRE	shiny	dull
MALLEABILITY	malleable (bendable)	brittle
CONDUCTIVITY OF HEAT & ELECTRICITY	good conductors	poor or nonconductors
STATE AT ROOM TEMPERATURE	all solids except mercury, Hg = liquid	most are gases, some are solids and bromine, Br = liquid
REACTIVITY WITH ACID	mostly yes	no
LOCATION (PERIODIC TABLE)	**left** of staircase line	**right** of staircase line

Periodic Chart of the Elements



Metalliods

- **METALLOIDS (Semimetals)**
  - elements that have some properties of metals and some properties of nonmetals
  - includes all elements on either side of the staircase line **except Al and At**
  - also includes one form of Carbon, **graphite**, which is dull and brittle (nonmetal), but is a good conductor of electricity (metal)

CHEMICAL FAMILIES (GROUPS):

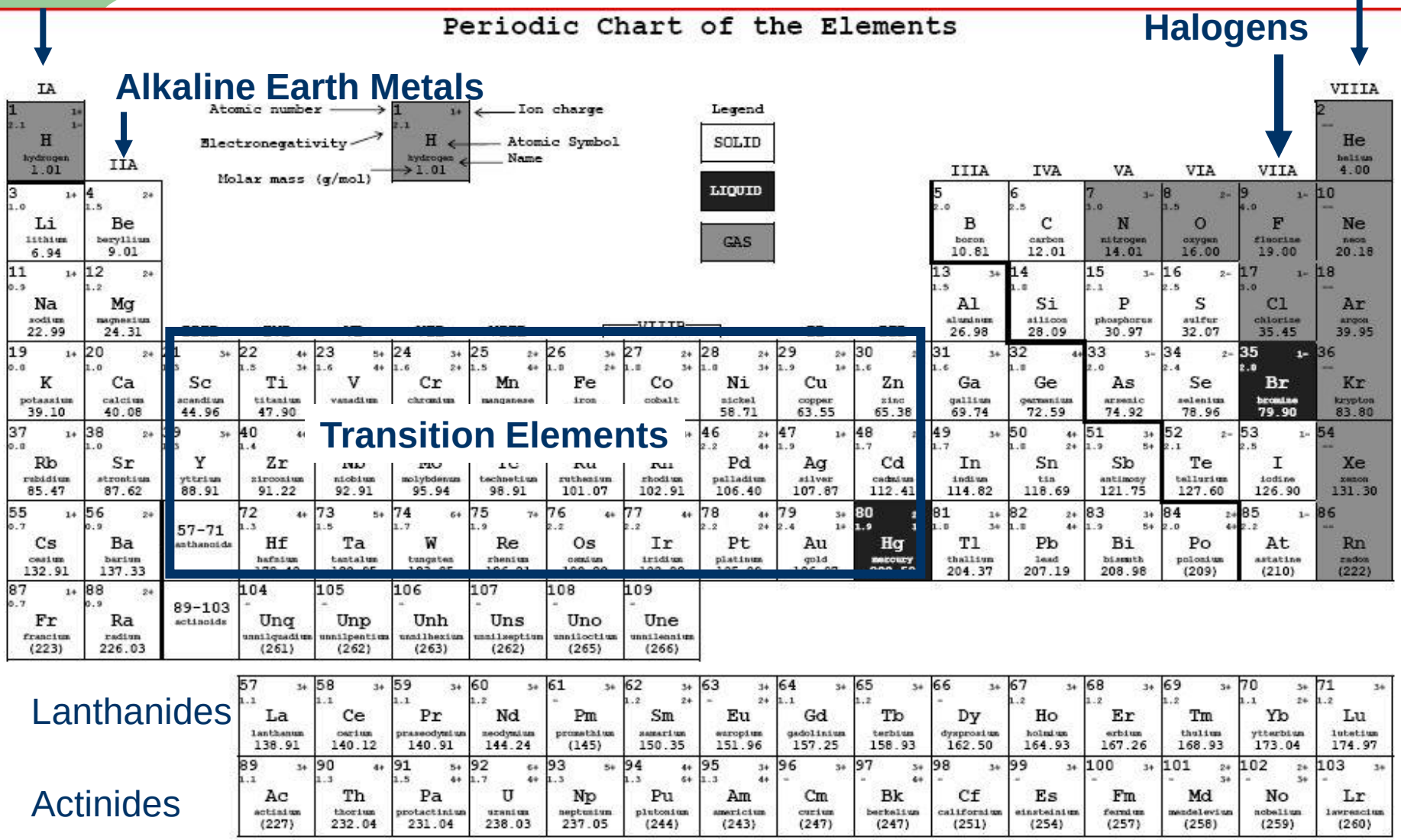
- Elements are grouped on the periodic table according to physical and chemical properties
- These are called Chemical Families or Groups

Alkali Metals

Noble Gases

Halogens

Alkaline Earth Metals

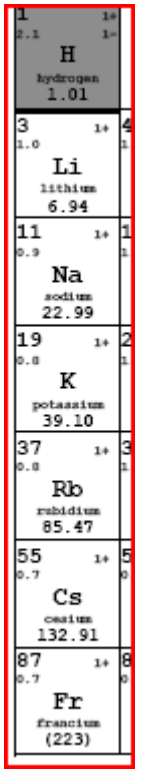


Hydrogen – Special Case

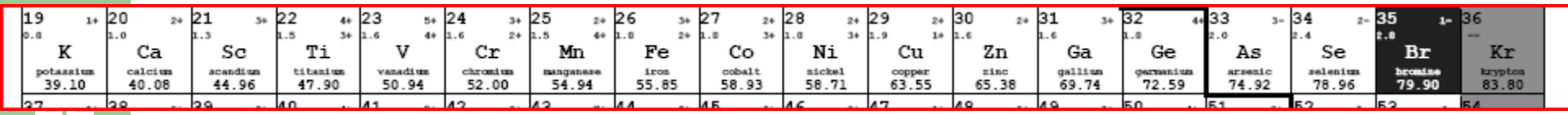
- **-** the lightest element and most abundant element in the universe
- - doesn't really belong to any group
- - it sometimes behaves like an alkali metal, sometimes like a halogen and at other times in
- its own unique way ie. as an acid

Groups and Periods

- Groups (Families) refer to the vertical columns
- Numbered on top



- Periods refer to the horizontal rows
  - (Think school periods)



The Atom

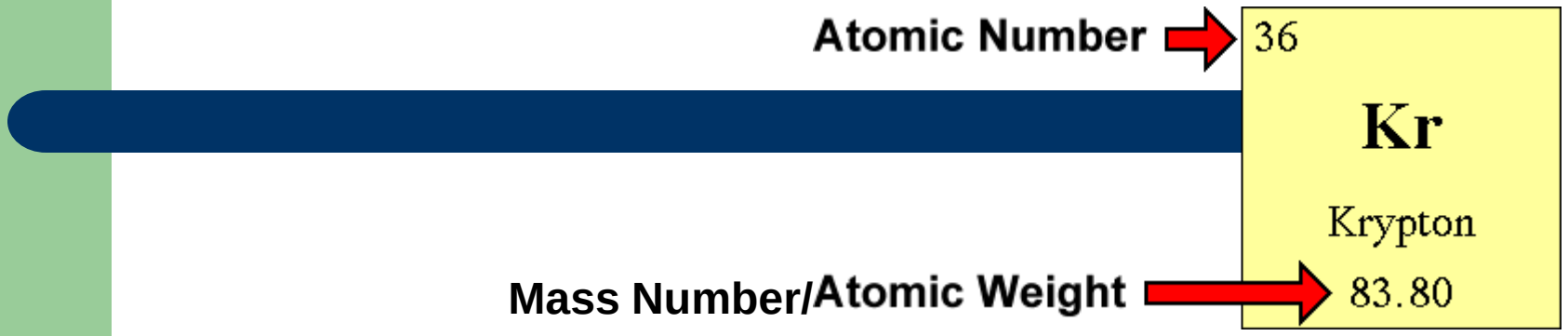
THE ATOM:

- The basic building block of all matter
- Electrically neutral: **# of positive charges = # of negative charges**
- composed of 3 types of subatomic particles:

PARTICLE	SYMBOL	RELATIVE CHARGE	ACTUAL MASS (g)	LOCATION
Proton	p^+	1^+	1.67×10^{-24}	nucleus
Neutron	n^o	0	1.67×10^{-24}	nucleus
Electron	e^-	1^-	9.11×10^{-28}	orbital

Finding the # of Protons

• The Atomic Number **IS** the # of Protons



Finding the # of Electrons

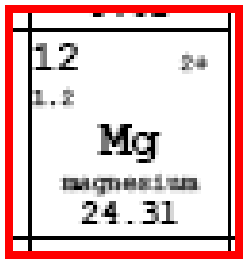
• If the element is NEUTRAL, then **# protons = # electrons**

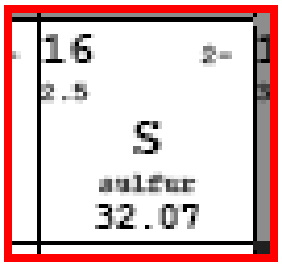
Finding the # of Neutrons

• Mass Number = # p + # n

• Therefore # n = Mass Number - # p

Examples





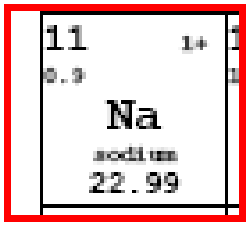
Quantum Mechanics

- According to this theory, an electron with a specific energy occupies a region in space (**orbital**) or electron energy level.

Electron Energy Diagrams

- The number of occupied energy levels in any atom is normally the same as the **period number** in which the atom appears
- for the first 3 energy levels, the maximum number of electrons that can be present are 2, 8 and 8 in order of increasing energy (increasing distance from nucleus)
- a lower energy level is filled with electrons to its maximum before the next level is started.
- the electrons in the highest (outermost) occupied energy level = **valence electrons,** which is the same as the **group number** (for group A elements)

Example



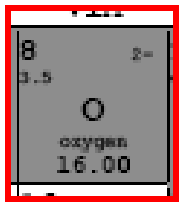
(max 8)

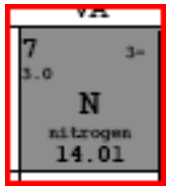
(max 8)

(max 2)

The electrons in the Outermost shell are called Valence Electrons

Examples





Worksheet

- Complete the worksheet # 1 on pg 12
- Checked as homework tomorrow

Worksheet 1

IA,1	IIA, 2	IIIA, 13	IVA, 14	VA, 15	VIA, 16	VIIA, 17	VIIIA, 18
1 1e- 1p+ H							2 2e- 2p+ He
3 1e- 2e- 3p+ Li	4 2e- 2e- 4p+ Be	5 3e- 2e- 5p+ B	6 4e- 2e- 6p+ C	7 5e- 2e- 7p+ N	8 6e- 2e- 8p+ O	9 7e- 2e- 9p+ F	10 8e- 2e- 10p+ Ne
11 1e- 8e- 2e- 11p+ Na	12 2e- 8e- 2e- 12p+ Mg	13 3e- 8e- 2e- 13p+ Al	14 4e- 8e- 2e- 14p+ Si	15 5e- 8e- 2e- 15p+ P	16 6e- 8e- 2e- 16p+ S	17 7e- 8e- 2e- 17p+ Cl	18 8e- 8e- 2e- 18p+ Ar
19 1e- 8e- 8e- 2e- 19p+ K	20 2e- 8e- 8e- 2e- 20p+ Ca						

How many VALENCE e-'s on each one??

STABLE ATOMS (pg. 4 – notes)
(pg 188 – Book)

- The noble gases are very stable (*unreactive*)
  - They all have 8 valence electrons
    - Valence electrons = electrons in the outermost shell

- Other elements are unstable (*reactive*)
  - They have to lose OR gain electrons to find stability

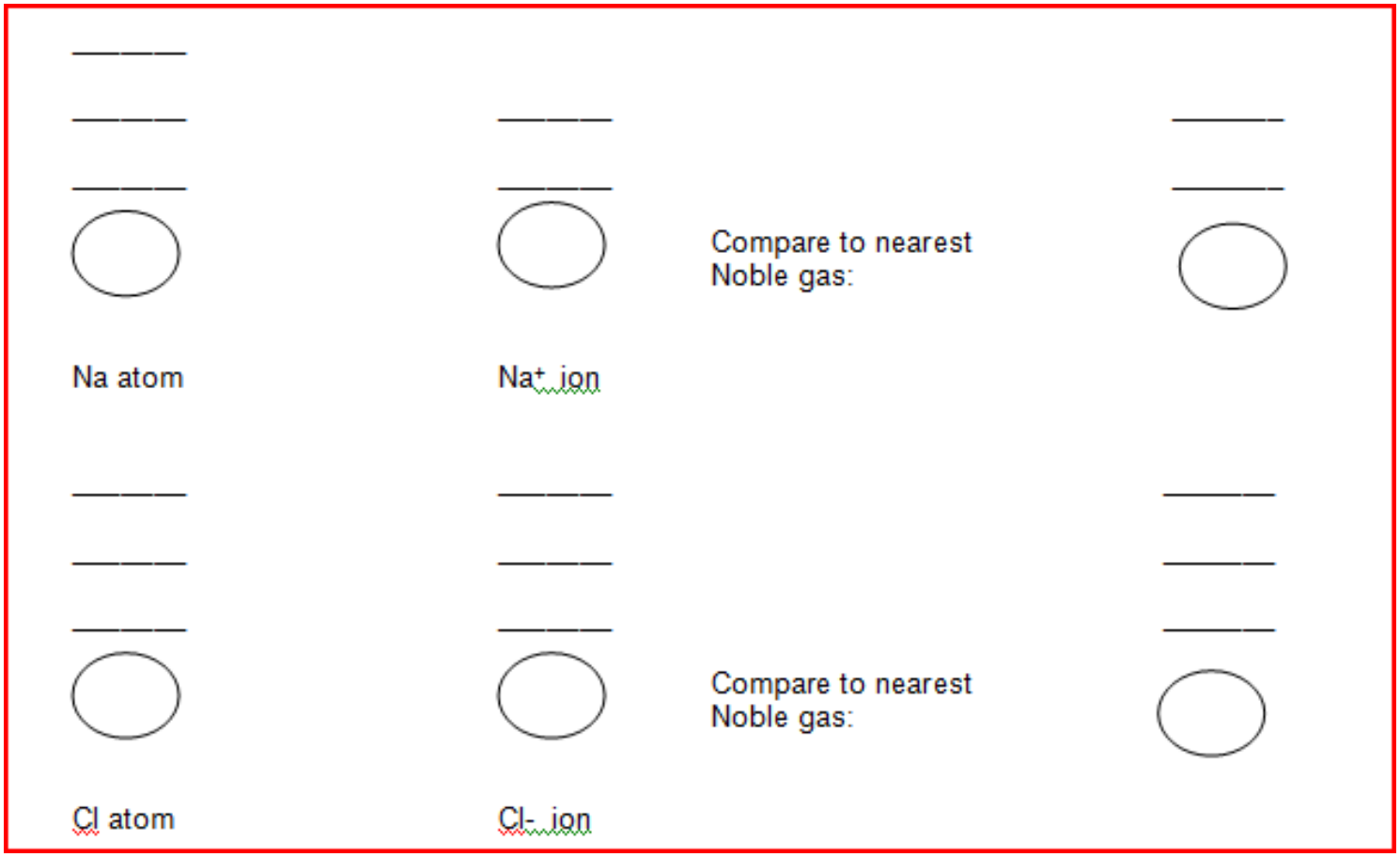
  - a) Octet Rule: - atoms attempt to obtain 8 valence electrons
  - b) Duet Rule: - atoms attempt to obtain 2 valence electrons
    - includes H, Li and Be

Ions

- When an element loses or gains electrons, they become ***charged***
  - Sngle atoms: form simple ions (*mon*atomic ions)
    - Na = sodium atom and Cl = chlorine atom become:
    - Na^+ = sodium ion and Cl^- = chloride ion
  - group of atoms: form complex ions (*poly*atomic ions)
    - Ex. N and O can form NO_3^- - nitrate ion

Atoms = No charge Ions = Charged

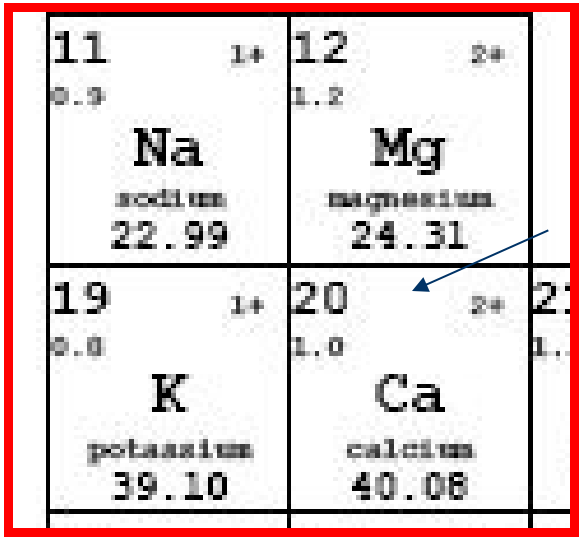
Sodium metal and chlorine gas react to produce NaCl, a very stable and unreactive substance, compared to Na (alkali metal) or Cl (halogen).
They do so by first forming ions.



Finding the charge of an ions

1. Determine how many electrons an element must lose/gain

2. Use the periodic table of elements



Positive and Negative Ions

- Elements that lose electrons form positive ions called **Cations**

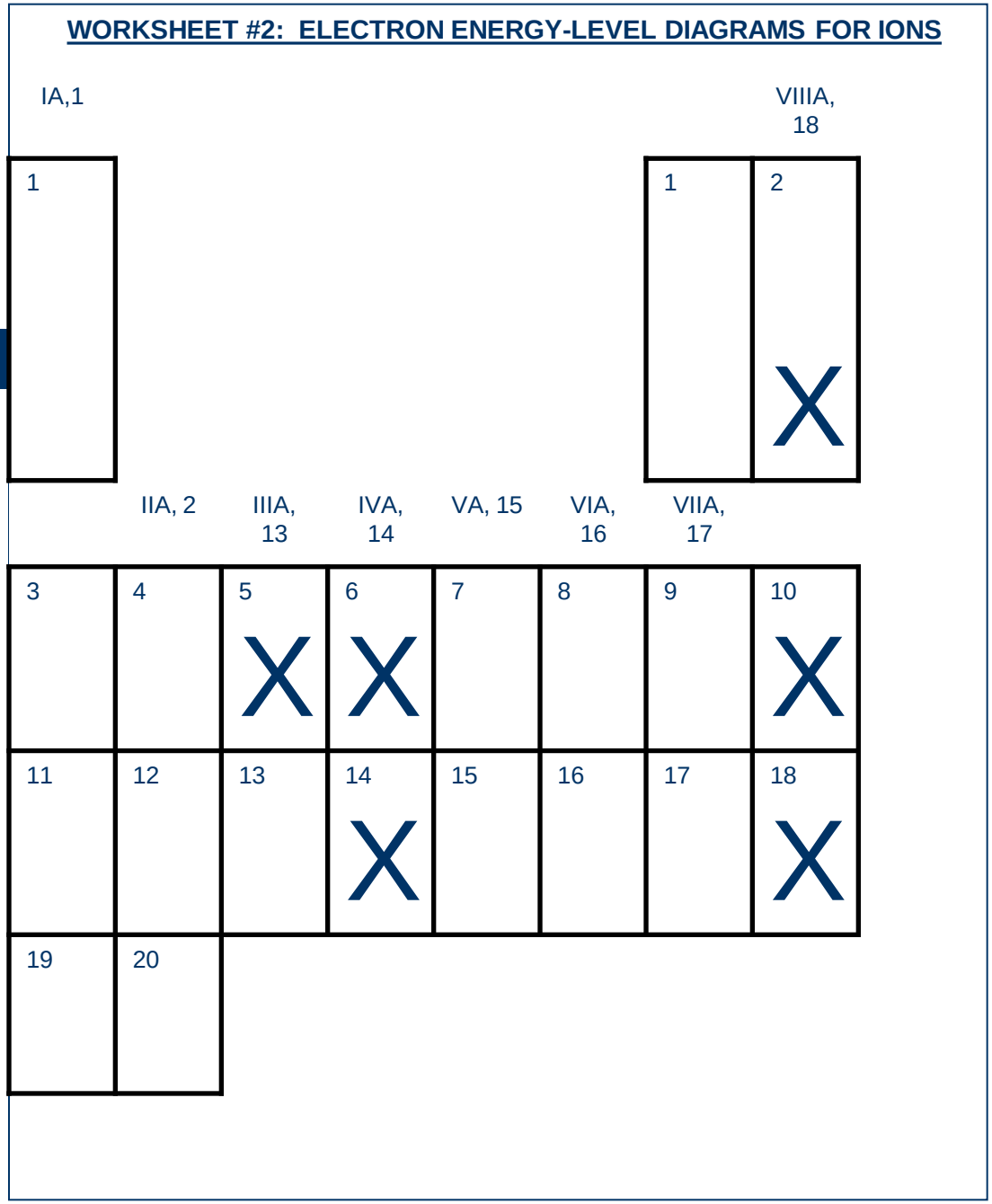
- Elements that gain electrons form negative ions called **Anions**

Homework

Complete energy diagrams for IONS

Write new symbol with charge

Try to find the charge by comparing p+ and e- totals



Homework Check

- Worksheet # 1 – Energy Diagrams of Atoms
- Worksheet # 2 – Energy Diagrams of Ions

- Today's Class
  - Quick recap
  - Naming Ions
  - Biomes Test

Worksheet 1

ATOMS

IA,1	IIA, 2	IIIA, 13	IVA, 14	VA, 15	VIA, 16	VIIA, 17	VIIIA, 18
1 **1e⁻** **1p⁺** **H**							2 **2e-** **2p+** **He**
3 **1e⁻** **2e⁻** **3p⁺** **Li**	4 **2e⁻** **2e⁻** **4p⁺** Be	5 **3e⁻** **2e⁻** **5p⁺** B	6 **4e⁻** **2e⁻** **6p⁺** C	7 **5e⁻** **2e⁻** **7p⁺** N	8 **6e⁻** **2e⁻** **8p⁺** O	9 **7e⁻** **2e⁻** **9p⁺** F	10 **8e⁻** **2e⁻** **10p⁺** Ne
11 **1e⁻** **8e⁻** **2e⁻** **11p⁺** **Na**	**12** **2e⁻** **8e⁻** **2e⁻** **12p⁺** **Mg**	**13** **3e⁻** **8e⁻** **2e⁻** **13p⁺** **Al**	**14** **4e⁻** **8e⁻** **2e⁻** **14p⁺** **Si**	**15** **5e⁻** **8e⁻** **2e⁻** **15p⁺** **P**	**16** **6e⁻** **8e⁻** **2e⁻** **16p⁺** **S**	**17** **7e⁻** **8e⁻** **2e⁻** **17p⁺** **Cl**	**18** **8e⁻** **8e⁻** **2e⁻** **18p⁺** **Ar**
19 **1e⁻** **8e⁻** **8e⁻** **2e⁻** **19p⁺** K	20 **2e⁻** **8e⁻** **8e⁻** **2e⁻** **20p⁺** Ca						

How many VALENCE e-'s on each one??

Worksheet 2

IONS

IA,1	IIA, 2	IIIA, 13	IVA, 14	VA, 15	VIA, 16	VIIA, 17	VIIIA, 18
1 **1p+** **H+**						2 **2e-** **1p+** **H-**	2 X
3 **2e-** **3p+** **Li+**	4 **2e-** **4p+** **Be2+**	5 X	6 X	**7** **5e-** **2e-** **7p+** **N3-**	**8** **6e-** **2e-** **8p+** **O2-**	**9** **7e-** **2e-** **9p+** **F-**	10 X
11 **8e-** **2e-** **11p+** **Na+**	**12** **8e-** **2e-** **12p+** **Mg2+**	**13** **8e-** **2e-** **13p+** **Al3+**	**14** X	**15** **8e-** **8e-** **2e-** **15p+** **P3-**	**16** **8e-** **8e-** **2e-** **16p+** **S2-**	**17** **8e-** **8e-** **2e-** **17p+** **Cl1-**	X
19 **8e-** **8e-** **2e-** **19p+** K+	20 **8e-** **8e-** **2e-** **20p+** Ca2+						

A quick review

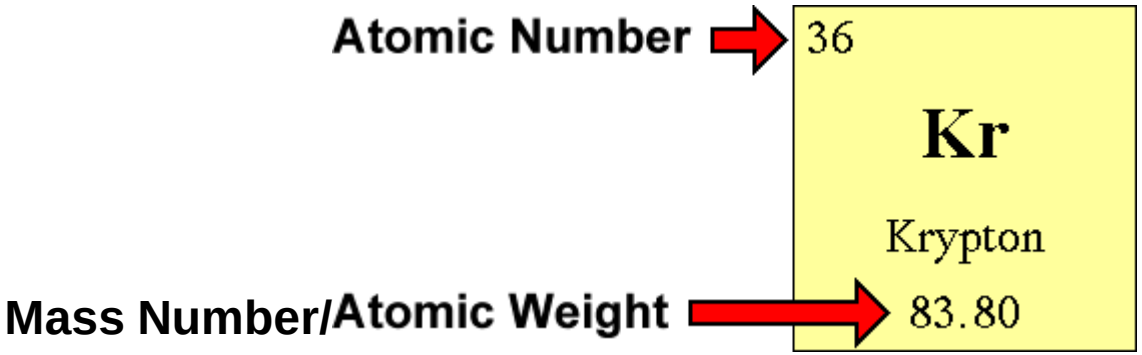
- Elements
  - Pure substances composed of 1 type of atom
  - Everything on the periodic table
- Compounds
  - Pure substances that have more then 1 type of atom
- Mixtures
  - Substances with made of more then one compound

A quick review

- Physical properties
- Chemical properties
- Physical Changes
- Chemical Changes

Previously

- The periodic table
  - Metals and Nonmetals
  - Groups/Families
  - Periods]
- The Atom
  - Protons
  - Electrons
  - Neutrons



Last Class

- Energy Levels (2, 8, 8 rules)

- Ions: elements that do not have the same number of protons and electrons
  - They have a charge
  - Ex:

$$Ca^{2+}$$

Ions

- Cations : Positive Ions
  - Formed when elements lose electrons
- Anions : Negative Ions
  - Formed with elements gain electrons

Naming Ions (Notes: pg 5)
Write this down!!

- To name ions:
  - Cations
    - element name + the word “ion”
    - Ex: Try:
      - Na = sodium atom Mg
      - Na^+ = sodium ion Mg^{2+}

Naming Ions (Notes: pg 5)

- To name ions:
  - Anions
    - **stem** of element name + “ide” + the word “ion”
    - Ex: Try:
      - Cl = chlorine atom F
      - Cl^- = chloride ion F^-

More Practice:

S O N P

Homework:

- Worksheet # 3 - Atoms and Ions

#	English Name	International Symbol	Number of Protons	Number of Electrons	Number of electrons lost or gained	Net Charge
Eg.	**Sodium ion**	**Na^+**	**11**	**10**	**Lost 1**	**1+**
1	Neon atom					
2	Lithium ion				Lost 1	
3			47			1+
4				18		2-

Homework Check and Review

- Worksheets # 1,2, and 3 should be done

- Today:
  - Review Worksheet #3 – step by step
  - Introduce Naming Ionic Compounds
  - Review Ecology Test #2

#	English Name	International Symbol	Number of Protons	Number of Electrons	Number of electrons lost or gained	Net Charge
Eg.	**Sodium ion**	**Na^+**	**11**	**10**	**Lost 1**	**1+**
1	Neon atom					
2	Lithium ion				Lost 1	
3			47			1+
4				18		2-
5		Si				
6			33	36		
7				54	Lost 1	
8			30	28		
9				1	0	
10		P				

	Name	Symbol	p+	e-	Loss or gain?	Charge
11		Ca^{2+}				
12	Selenide ion					
13			13			3+
14		Rb+				
15			18	18		
16			8	10		
17	Iodine atom					
18		Pu				
19				54	Gained 2	
20	Unnilseptium atom					

Ionic Compounds (Notes: pg. 5) (Text: pg 188-195)

- Ionic Compounds are composed of a cation and an anion
  - Cation
    - Usually a metal (Na^+, Mg^{2+}, Li^+, Ca^{2+}, Fe^{3+}, etc)
    - Exception - Ammonium, NH_4^+
  - Anion
    - Can be a nonmetal (Cl^-, N^{3-}, O^{2-})
    - Polyatomic Ions (NO_3^-, PO_4^{3-}, CH_3COO^-)

Ionic Compounds

- All are solids at SATP (Standard Ambient Temperature and Pressure) of 25oC and 100 kPa.
- When they dissolve in water, they form *aqueous* solutions that conduct electricity
  - they are **electrolytes**
- These compounds form after an electron transfer:

Ionic Compounds

- These compounds form after an electron transfer:
  - Ex: Calcium and Chlorine form Calcium Chloride

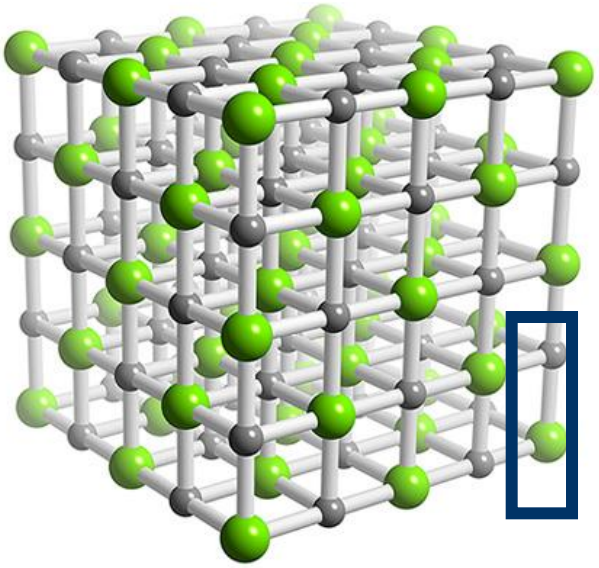
- Homework Check:
  - Read pg 188 – 189
  - Answer questions #1,2,3

Ionic Compounds (metals with nonmetals)

- the resulting ions (cations and anions) are attracted to each other (since they are oppositely charged) and they form **ionic bonds**

- Together all of the ions present form an **ionic crystal lattice** in which the net charge is zero
  - Eg: (1) in a sample of sodium chloride, NaCl, for every Na^+ ion there is one Cl^- ion
  - Eg: (2) in a sample of calclium chloride, $CaCl_2$, for every Ca^{2+} ion there are 2 Cl^- ions

Crystal Lattice



NaCl : A Formula Unit

expression of the simplest whole number ratio of cations to anions

Types of Ionic Compounds

- Monatomic Ions (Simple Ions)
  - Single atoms that have lost or gained one or more electrons
  - Form *Binary Ionic Compounds* (2 simple ions)
  - Eg. Na^+ Cl^-

- Polyatomic Ions (Complex Ions)
  - Cations or anions composed of a group of atoms with a net positive or negative charge
  - NH_4^+ NO_2^- NO_3^- CO_3^{2-}
  - Ammonium ion Nitrite ion Nitrate ion Carbonate ion

Types of Ions and Compounds

- Multivalent Ions
  - certain transition metals can form more than one type of ion, each with a different charge
  - Eg. Fe^{3+} Fe^{2+}
  - The more commonly occurring is listed on top, thus Fe^{3+} is more common than Fe^{2+}
  - Others:

- Hydrated Ionic Compounds
  - Water molecules are loosely held within the ionic compound
  - Eg. $ZnCl_2 \cdot 6H_2O$ $CuSO_4 \cdot 5H_2O$

Binary Ionic Compounds (Write this Down)

- Composed of two different ions

Name	Formula
sodium chloride	NaCl
magnesium oxide	MgO
lithium nitride	Li_2N
aluminum oxide	Al_2O_3

- Only two different types of elements!

Binary ionic formulas

- Given the name, write the formula:

Steps
1. Write the symbols for the ions
2. Balance the charges
3. Write the chemical formula

Remember:

$BaCl_2$ not $BaCl^2$

Ex: potassium iodide
1.

2.

3.

Ex: calcium iodide
1.

2.

3.

Example:

silver oxide

beryllium bromide

What about these?

aluminum oxide

zinc nitride

Nomenclature (Naming)

- Name the cation and anion and put them together

NaI

CaI_2

Al_2S_3

Worksheet #4 (Pass in tomorrow)

#	Chemical Formula	Name of Compound
Eg.	**$CaCl_2$**	**Calcium chloride**
1.		Potassium chloride
2.	MgO	
3.		Aluminum chloride

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Complex Ionic Compounds

Write this Down!!

Complex Ions

- More then one type of atom is in the ion
- Listed on the back of periodic table

Table of Some Common Polyatomic Ions

1 - Ions		2 - Ions		3 - Ions	
Formula	Name	Formula	Name	Formula	Name
$H_2PO_4^-$	dihydrogen phosphate	HPO_4^{2-}	hydrogen phosphate	PO_4^{3-}	phosphate
$H_2PO_3^-$	dihydrogen phosphite	HPO_3^{2-}	hydrogen phosphite	PO_3^{3-}	phosphite
HCO_3^-	hydrogen carbonate	CO_3^{2-}	carbonate	BO_3^{3-}	borate
HSO_4^-	hydrogen sulfate	SO_4^{2-}	sulfate		
HSO_3^-	hydrogen sulfite	SO_3^{2-}	sulfite		
BrO_3^-	bromate	$C_2O_4^{2-}$	oxalate		
CH_3COO^-	acetate	CrO_4^{2-}	chromate		
$C_6H_5COO^-$	benzoate	$Cr_2O_7^{2-}$	dichromate		
ClO^-	hypochlorite	$S_2O_3^{2-}$	thiosulfate		
ClO_2^-	chlorite	SiO_3^{2-}	silicate		
ClO_3^-	chlorate	1 + Ions			
ClO_4^-	perchlorate	Formula	Name		
CN^-	cyanide	NH_4^+	ammonium		
IO_3^-	iodate	H_3O^+	hydronium		
OH^-	hydroxide				
NO_3^-	nitrate				
NO_2^-	nitrite				
MnO_4^-	permanganate				
SCN^-	thiocyanate				

Write this Down!!

Give formulas for the following:

- potassium bromate
- silver nitrate
- aluminum cyanide

- ammonium carbonate (2 complex ions)

- calcium hydrogen carbonate

Name the following formulas

- Identify cation and anion first (Look at the tables)
  - $NaCH_3COO$
  - $KMnO_4$

Continued,,,

- Na_3BO_3
- NH_4NO_3

Man, this is COMPLEX !!!!

If you see ‘lots of letters’ --

Worksheets

- Worksheet # 4 – Binary Ionic Compounds
- Worksheet # 5 – Complex Ions

- Both due to be ***passed in*** on Tuesday

Science 1206

Multivalent Ions

Worksheets Due:

- Worksheet # 4 – Binary Ionic Compounds
- Worksheet # 5 – Complex Ions

- Both due to be ***passed in*** Today

Quick Review

- Binary Ionic Compounds
- Complex Ions

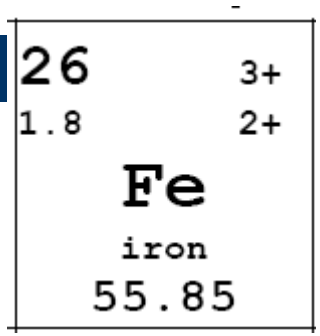
Write this Down!!

Multivalent Ions

- Some elements can form more then one ion

	IVB	VB	VIB	VIIB	VIIIB			IB
3+	22 4+ 3+ 1.5 **Ti** titanium 47.90	23 5+ 4+ 1.6 **V** vanadium 50.94	24 3+ 2+ 1.6 **Cr** chromium 52.00	25 2+ 4+ 1.5 **Mn** manganese 54.94	26 3+ 2+ 1.8 **Fe** iron 55.85	27 2+ 3+ 1.8 **Co** cobalt 58.93	28 2+ 3+ 1.8 **Ni** nickel 58.71	29 2+ 1+ 1.9 **Cu** copper 63.55
3+	40 4+ 1.4 **Zr** zirconium 91.22	41 5+ 3+ 1.6 **Nb** niobium 92.91	42 6+ 1.8 **Mo** molybdenum 95.94	43 7+ 1.9 **Tc** technetium 98.91	44 3+ 4+ 2.2 **Ru** ruthenium 101.07	45 3+ 2.2 **Rh** rhodium 102.91	46 2+ 4+ 2.2 **Pd** palladium 106.40	47 1+ 1.9 **Ag** silver 107.87
ds	72 4+ 1.3 **Hf** hafnium 178.49	73 5+ 1.5 **Ta** tantalum 180.95	74 6+ 1.7 **W** tungsten 183.85	75 7+ 1.9 **Re** rhenium 186.21	76 4+ 2.2 **Os** osmium 190.20	77 4+ 2.2 **Ir** iridium 192.22	78 4+ 2+ 2.2 **Pt** platinum 195.09	79 3+ 1+ 2.4 **Au** gold 196.97

Multivalent Ions



- Ex: Iron
  - Can form Fe^{3+} and Fe^{2+}
  - the most common ion is listed on top
  - Fe^{3+} and Cl^- Fe^{2+} and Cl^-

Naming Rules

- Named the same as other ionic compounds, but we specify the charge using Roman Numerals
- Ex:
  - Iron (III) chloride
  - Iron (II) chloride

1 = I

2 = II

3 = III

4 = IV

5 = V

6 = VI

7 = VII

8 = VIII

Names → Formulas

Ex: copper (I) nitrate

Ex: copper (II) nitrate

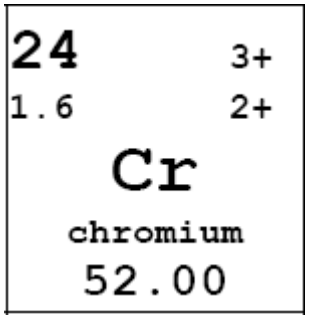
Names → Formulas continued

Ex: ruthenium (IV) oxide

Ex: bismuth (V) carbonate

Formulas → Names

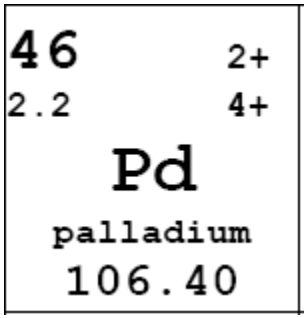
- Need to identify which ion is present
- Use the anion (-) to find the charge of the cation (+)



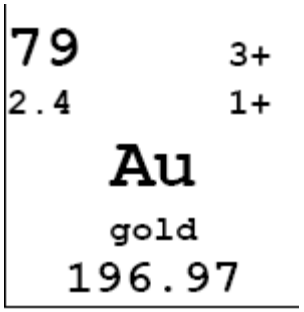
- Ex:
  - 1. CrF_3
  - 2. CrS

Cntd…

3. $Pd(CO_3)_2$



4. Au_2O_3



Worksheets

- Worksheet # 6 - Multivalent Ions

- Test: Next week

Science 1206

Hydrated Compounds

Homework Check

- Worksheet #6 – Multivalent Ions

- Return Worksheets #4 & #5
  - Fix mistakes are return to me for ½ marks!!

#	Chemical Formula		Name of Compound
Eg.	**Cu_2S**	**$2\ Cu^+$ S^{2-}**	**Copper(I) sulfide**
1.	$AuCl_3$		
2.			Mercury(II) oxide
3.	Sb_2S_3		
4.	V_2O_5		
5.			Iron(III) iodide
6.			Copper(II) sulfide
7.	FeS		
8.			Tin(II) fluoride

10.			Lead(IV) oxide
11.			Chromium(III) oxide
12.	HgS		
13.			Uranium(VI) fluoride
14.	SnO_2		
15.			Uranium(IV) oxide
16.	Fe_2O_3		
17.			Cobalt(II) chloride
18.	TiO_2		
19.	$NiBr_2$		
20.			Copper(II) chloride

Write this Down!!!

Hydrated Compounds (pg. 6 notes, not in textbook)

- Ionic compounds sometime have water molecules held loosely

Ex:

Copper(II) sulfate pentahydrate

Cobalt chloride dihydrate

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

Name → Formula

1. Give the formula as usual
2. Add “ • #H_2O ” on the end

Ex. Zinc chloride hexahydrate

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

continued…

Ex: copper(II) sulfate pentahydrate

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

Formula → Name

- 1. Name the ionic compound
- 2. Add *prefix***hydrate** on the end

- Ex: $Ba(OH)_2 \cdot 8H_2O$

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

Continued…

Ex:

$$NiCl_2 \cdot H_2O$$

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

Don’t forget to check if the cation is MULTIVALENT!!!

Homework

- Worksheet #7
- Fix/Finish Worksheets 4 & 5

- Remember:
  - Lunchtime tutorial today
  - Friday @ 3:00pm

Test Outline

- Classifications of Matter
  - Pure substances
  - Compounds
  - Mixtures
- Properties and Changes of Matter
- Elements and the Periodic Table
  - Groups/Families
  - Periods

- The Atom
  - # of protons, electrons, neutrons
  - Energy diagrams
  - Ions
- Naming and Formula Writing
  - Binary Ionic Compounds
  - Complex Ions
  - Multivalent cations
  - Hydrated compounds

Test

- 25 Multiple Choice
- Short Answer
- Naming
- Formula Writing

Homework Check

- Worksheet #6 – Multivalent Ions
- Worksheet #7 – Hydrated Compounds

- Return Worksheets #4 & #5
  - Fix mistakes are return to me for ½ marks!!

Worksheet #6

1.	$AuCl_3$	Au^{3+} $3\ Cl^-$	**Gold (III) chloride**
2.	**HgO**	Hg^{2+} O^{2-}	Mercury(II)oxide
3.	Sb_2S_3	$2\ Sb^{3+}$ $3\ S^{2-}$	**Antimony (III) sulfide**
4.	V_2O_5	$2\ V^{5+}$ $5\ O^{2-}$	**Vanadium (V) oxide**
5.	**FeI_3**	Fe^{3+} $3\ I^-$	Iron (III) iodide
6.	**CuS**	Cu^{2+} S^{2-}	Copper (II) sulfide
7.	FeS	Fe^{2+} S^{2-}	**Iron (II) Sulfide**
8.	**SnF_2**	Sn^{2+} $2\ F^-$	Tin (II) fluoride
9.	MnO_2	Mn^{4+} $2\ O^{2-}$	**Manganese (IV) oxide**
10.	**PbO_2**	Pb^{2+} $2\ O^{2-}$	Lead (IV) oxide
11.	**Cr_2O_3**	$2\ Cr^{3+}$ $3\ O^{2-}$	Chromium (III) oxide
12.	HgS	Hg^{2+} S^{2-}	**Mercury (II) sulfide**
13.	**UF_6**	U^{6+} $6\ F^-$	Uranium (VI) fluoride
14.	SnO_2	Sn^{2+} $2\ O^{2-}$	**Tin (II) oxide**
15.	**UO_2**	U^{4+} $2\ O^{2-}$	Uranium (IV) oxide
16.	Fe_2O_3	$2\ Fe^{3+}$ $3\ O^{2-}$	**Iron (III) oxide**
17.	**$CoCl_2$**	Co^{2+} $2\ Cl^-$	Cobalt (II) chloride
18.	TiO_2	Ti^{4+} $2\ O^{2-}$	**Titanium (IV) dioxide**
19.	$NiBr_2$	Ni^{2+} $2\ Br^-$	**Nickel (II) bromide**
20.	**$CuCl_2$**	Cu^{2+} $2\ Cl^-$	Copper (II) chloride

Worksheet #7

#	Name of Hydrate	Chemical Formula
Eg.	**Copper (II) sulfate pentahydrate**	**$CuSO_4 \cdot 5H_2O$**
1	**Magnesium sulfate heptahydrate**	$MgSO_4\ 7H_2O$
2	Sodium carbonate decahydrate	**$Na_2CO_3 \cdot 10H_2O$**
3	**Magnesium chloride hexahydrate**	$MgCl_2 \cdot 6H_2O$
4	Barium chloride dihydrate	**$BaCl_2 \cdot 2H_2O$**
5	**Cadmium nitrate tetrahydrate**	$Cd(NO_3)_2 \cdot 4H_2O$
6	**Zinc chloride hexahydrate**	$ZnCl_2 \cdot 6H_2O$
7	Zinc sulphate heptahydrate	**$ZnSO_4 \cdot 7H_2O$**
8	Lithium chloride tetrahydrate	**$LiCl \cdot 4H_2O$**
9	**Sodium thiosulfate pentahydrate**	$Na_2S_2O_3 \cdot 5H_2O$
10	Cobalt(II)chloride hexahydrate	**$CoCl_2 \cdot 6H_2O$**
11	**Aluminum chloride hexahydrate**	$AlCl_3 \cdot 6H_2O$
12	**Calclium chloride dihydrate**	$CaCl_2 \cdot 2H_2O$
13	Barium hydroxide octahydrate	**$Ba(OH)_2 \cdot 8H_2O$**
14	Nickel(II)chloride hexahydrate	**$NiCl_2 \cdot 6H_2O$**
15	**Sodium sulfate decahydrate**	$Na_2SO_4 \cdot 10H_2O$
16	Iron(III)phosphate tetrahydrate	**$FePO_4 \cdot 4H_2O$**
17	**Iron (III) sulfate heptahydrate**	$FeSO_4 \cdot 7H_2O$
18	Calcium sulphate dihydrate	**$CaSO_4 \cdot 2H_2O$**
19	**Tin (IV) chloride pentahydrate**	$SnCl_4 \cdot 5H_2O$
20	Barium bromide tetrahydrate	**$BaBr_2 \cdot 4H_2O$**

Review:

- Worksheets

Science 1206

Molecular Compounds

Molecular Compounds (Handouts pg 8, Text pg 201)

- **<u>MOLECULAR SUBSTANCES:</u>**
- are solids, liquids or gases at SATP
- if soluble, dissolve in water to form **colorless** aqueous solutions that **do not conduct** electricity
  - they are ***non-electrolytes***
- they contain only **nonmetal atoms**

Molecular Compounds

- ***Molecule*:**
  - a particle of a molecular substance that contains a fixed number of covalently-bonded nonmetal atoms
- ***Covalent Bond:***
  - formed from the sharing of valence electrons between nonmetal atoms, which results in an electron structure that is the same as a noble gas, for each atom in the molecule

Covalent Bonding

- Hydrogen
- Chlorine
- Carbon dioxide

Note: Ionic vs Molecular

Ionic Compounds	Molecular Compounds
Cation (+) and Anion (-)	Only nonmetals
Electrons exchanged	Electrons shared
Ionic bonds	Covalent bonds
Solids at Room Temp	Gas, liquids, and solids
Electrolytes	Nonelectrolytes

1. Molecular Elements

- Only contain 1 type of nonmetal

Type	Molecular Elements
Monatomic – one atom	Noble gases: $He_{(g)}$ $Ne_{(g)}$ $Ar_{(g)}$ $Kr_{(g)}$ $Xe_{(g)}$ $Rn_{(g)}$
Diatomic – two atoms/molecule	Hydrogen, Oxygen, Nitrogen and the Halogens **The "HONorable Halogens"** $H_{2(g)}$ $O_{2(g)}$ $N_{2(g)}$ $F_{2(g)}$ $Cl_{2(g)}$ $Br_{2(l)}$ $I_{2(s)}$ $At_{2(s)}$
Polyatomic – more than 2 atoms/molecule	ozone = $O_{3(g)}$ Phosphorus = $P_{4(s)}$ Sulfur (Sulphur) = $S_{8(s)}$

2. Molecular Compounds

Molecular Compounds

- a) Common (**to memorize**):

  $H_2O_{(l)}$ = water

  $CH_{4(g)}$ = methane

  $CH_3OH_{(l)}$ = methanol

  $H_2O_{2(l)}$ = hydrogen peroxide

  $C_3H_{8(g)}$ = propane

  $C_2H_5OH_{(l)}$ = ethanol

  $NH_{3(g)}$ = ammonia

  $C_6H_{12}O_{6(s)}$ = glucose

  $C_{12}H_{22}O_{11(s)}$ = sucrose

2. Molecular Compounds

- B. Binary Molecular Compounds
  - 2 different nonmetals
  - CO CO_2 CCl_4

Writing Molecular Formulas

- ***General Rules***

1. Write each atom symbol.
2. Each prefix indicates the subscript for the nonmetal atom that precedes it (# of atoms present).
3. If no prefix is present, then there is only one atom of that nonmetal present. Monoxide = one oxygen atom present.

Examples: ***C***arbon monoxide
Carbon dioxide
Carbon tetrachloride
Suphur trioxide
Dinitrogen monoxide

Naming Binary Molecular Compounds

Naming Molecular Substances

General Rules

1. First element is named in full.
2. Second element name is shortened and given an **ide** ending.
3. Use prefixes (same as for hydrates) to indicate the number of each kind of atom.
   - The prefix mono is usually only used for molecules with 1 atom of oxygen (monoxides).
   - Certain Hydrogen compounds (those with H first in the formula) do not use prefixes.
   - $H_2S(g)$ = hydrogen sulfide, **not** dihydrogen sulfide

Examples

- ***Examples:***

  $NO_{(g)}$

  $P_4O_{6(s)}$

  $SO_{2(g)}$

  $SO_{3(g)}$

  $N_2O_{(g)}$

  $PCl_{3(s)}$

  $NI_{3(s)}$

Homework

- Worksheet #8

Science 1206

Acids and Bases

Homework Check

- Worksheet 8 – Molecular compounds

Eg.	CCl_4	Carbon tetrachloride
1		Nitrogen
2	O_2	
3		Argon
4	CO_2	
5		The other noble gases (besides Argon)
6	NO	
7	NO_2	
8		Sulphur dioxide

9	SO_3	
10		Carbon monoxide
11		Ozone
12		Ethanol
13		Sucrose
14		Sulphur (sulfur)
15	P_4O_{10}	
16	P_4O_6	
17		Chlorine dioxide
18		Methanol

19	P_4	
20		Ammonia
21	CH_4	
22	H_2O	
23		Dinitrogen monoxide

Acids (p. 10 notes)

- **ACIDS**
  - Molecules that ionize in water to produce hydrogen ions, H+(aq), ions which give acids their properties
- *Properties of acids:*
  - Conduct electricity
  - Turn blue litmus paper red
  - Taste sour
  - React with many metals to produce hydrogen gas, H2(g)
  - Have a pH value of less than 7
  - Neutralize or partially neutralize bases

Acids

- General Formula:

  H____ $_{(aq)}$ or ____COOH $_{(aq)}$

- *Note:* not all hydrogen containing compounds are acids
  - Eg: NH_3 CH_4 CH_3OH C_2H_5OH

Naming Acids

- ***General Rules***

1. Name the hydrogen compound like an ionic compound
2. Then convert the ionic name to the acid name

hydrogen _____ide becomes **hydro_____ic acid**

hydrogen_____ite becomes **_____ous acid**

hydrogen_____ate becomes **_____ic acid**

Naming Acids

hydrogen _____ide becomes **hydro_____ic acid**
hydrogen_____ite becomes **_____ous acid**
hydrogen_____ate becomes **_____ic acid**

Acid Formula	Ionic Name	Acid Name
$HCl_{(aq)}$		
$HCN_{(aq)}$		
$HNO_{2(aq)}$		
$H_2SO_{3(aq)}$		
$HNO_{3(aq)}$		
$H_2SO_{4(aq)}$		
$H_3PO_{4(aq)}$		
$CH_3COOH_{(aq)}$		

Writing Acid Formulas

General Rules:

1. Translate acid name into ionic name:

   hydro___ic acid → hydrogen ___ide

   ___ous acid → hydrogen ___ite

   ___ic acid → hydrogen ___ate

2. Write chemical formulas for each ion, using rules for writing formulas for ionic compounds.
3. Hydrogen symbol is written first (cation), except for carboxylic acids (those with COO group), in which case hydrogen is placed at the end eg: CH3COOH
4. Give the state as aqueous = (aq).

hydro___ic acid → hydrogen ___ide
___ous acid → hydrogen ___ite
___ic acid → hydrogen ___ate

Examples

Acid Name	Ionic Name	Formula
Hydroiodic acid		
Chlorous acid		
Chloric acid		
Boric acid		
Benzoic acid		

Homework

- Worksheet #9

hydrogen _____ide becomes **hydro_____ic acid**
hydrogen_____ite becomes **_____ous acid**
hydrogen_____ate becomes **_____ic acid**

Eg.	**$HCl_{(aq)}$**	**H^+ Cl^- hydrogen chloride**	**Hydrochloric acid**
1	$HBr_{(aq)}$	Hydrogen bromide	Hydrobromic acid
2	$H_2CO_{3(aq)}$	Hydrogen carbonate	Carbonic acid
3			Hypochlorous acid
4	$H_2CrO_{4(aq)}$	Hydrogen chromate	Chromic acid
5			Chlorous acid
6	$H_2S_{(aq)}$	Hydrogen sulfide	Hydrosulfuric acid
7	$H_3BO_{3(aq)}$	Hydrogen bromate	bromic acid
8	$HI_{(aq)}$	Hydrogen iodide	Hydroiodic acid
9			Oxalic acid
10	$HClO_{4(aq)}$	Hydrogen chlorate	Chlroic acid

hydrogen _____ide becomes **hydro_____ic acid**
hydrogen_____ite becomes **_____ous acid**
hydrogen_____ate becomes **_____ic acid**

11			Nitrous acid
12			Benzoic acid
13	$H_2SO_{3(aq)}$	Hydrogen sufite	Sulfurous acid
14			Chloric acid
15	$H_2S_2O_{3(aq)}$	Hydrogen thiosulfate	Thiosulfuric acid
16			Permanganic acid
17			Hydrofluoric acid
18	$HCN_{(aq)}$	Hydrogen cyanide	Hydrocyanic acid
19			Thiocyanic acid
20			Sulphuric acid

Base

- Most are ionic compounds with OH^- and (aq)
- *Properties of bases:*
  - Conduct electricity
  - Turn red litmus paper blue
  - Taste bitter
  - Feel slippery
  - Have a pH value greater than 7
  - Neutralize or partially neutralize acids

Bases

- **Naming Bases**
  - Follow the general rules given for ionic compounds

$NaOH_{(aq)}$

$NH_4OH_{(aq)}$

- **Writing Base Formulas**
  - follow the general rules given for ionic compounds

lithium hydroxide

Calcium hydroxide

WHMIS

- Workplace and Hazardous Materials Information System

MSDS

- Material Safety Data Sheet

Homework

- WHMIS and MSDS Worksheet
  - Passed in on Monday
  - Very short assignment
- Naming and Formula Review Sheet

Science 1206

Chemical Equations

Pass in Assignments

- WHMIS and MSDS Worksheet
  - Passed in on Monday
  - Very short assignment
- Naming and Formula Review Sheet
- Get Homework Checklist

Chemical Equations

- Show how chemicals react to form new compounds and molecules

$$2\ Mg_{(s)} + O_{2(g)} \rightarrow 2\ MgO_{(s)}$$

Reactants $\rightarrow$ Products

- The number of atoms must be conserved!!!
- We use Coefficients to balance

Before we start:

- Learn to count the atoms:

- $Ca(NO_3)_2$

  Ca =
  N =
  O =

  $(NH_4)_2SO_4$

  N =
  H =
  S =
  O =

Balancing Chemical Equations

Start by balancing the atom with the highest numbers:

$$Mg + O_2 \rightarrow MgO$$

Note: Sometimes easier to balance the IONS instead of the atoms!!!

$$Cu + AgNO_3 \rightarrow Ag + Cu(NO_3)_2$$

$$Pb(NO_3)_2 + KI \rightarrow PbI_2 + KNO_3$$

$$NH_3 \rightarrow N_2 + H_2$$

$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

Try These:

1. $Fe + O_2 \rightarrow Fe_2O_3$

2. $Na + Cl_2 \rightarrow NaCl$

3. $AsCl_3 + H_2S \rightarrow As_2S_3 + HCl$

4. $H_2SO_4 + NaHCO_3 \rightarrow Na_2SO_4 + CO_2 + H_2O$

5. $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

Homework

- Worksheet #10 Balancing
  - We will correct this at the beginning of next class
  - Have it done!!!!

Test Review:

1. ___$C_{10}H_{20(s)}$ + ___$O_{2(g)}$ → ___$CO_{2(g)}$ + ___$H_2O_{(g)}$

2. ___$Al(OH)_{3(s)}$ + ___$HCl_{(aq)}$ → ___$AlCl_{3(aq)}$ + ___$HOH_{(l)}$

3. ___$C_4H_{8(g)}$ + ___$O_{2(g)}$ → ___$CO_{2(g)}$ + ___$H_2O_{(g)}$

4. ___$C_{(s)}$ + ___$O_{2(g)}$ → ___$CO_{(g)}$

5. ___$C_5H_{12(l)}$ + ___$O_{2(g)}$ → ___$CO_{2(g)}$ + ___$H_2O_{(g)}$

6. ___$Li_{(s)}$ + ___$AlBr_{3(aq)}$ → ___$LiBr_{(aq)}$ + ___$Al_{(s)}$

7. ___$C_2H_{6(g)}$ + ___$O_{2(g)}$ → ___$CO_{2(g)}$ + ___$H_2O_{(g)}$

8. ___$NH_4OH_{(aq)}$ + ___$H_3PO_{4(aq)}$ → ___$(NH_4)_3PO_{4(aq)}$ + ___$HOH_{(l)}$

9. ___$Li_{(s)}$ + ___$P_{4(s)}$ → ___$Li_3P_{(s)}$

10. ___$CH_{4(g)}$ + ___$O_{2(g)}$ → ___$CO_{2(g)}$ + ___$H_2O_{(g)}$

11. ___$Al(OH)_{3(s)}$ + ___$H_2SO_{3(aq)}$ → ___$Al_2(SO_3)_{3(s)}$ + ___$HOH_{(l)}$

12. ___$Ca(NO_3)_{2(aq)}$ + ___$Na_3PO_{4(aq)}$ → ___$Ca_3(PO_4)_{2(s)}$ + ___$NaNO_{3(aq)}$

WRITING BALANCED CHEMICAL EQUATIONS (pg. 2, Part II notes)

- To write a balanced chemical equation from a statement or word equation:
  1. Write the chemical formulas for all reactants and products involved
  2. Arrange as Reactants → Products

Example

Hydrogen and chlorine react to produce hydrogen chloride gas.

1. Word Equation:

2. Chemical Equation:

Example 2 (pg. 6, Balancing Worksheet)

Solid potassium and aqueous magnesium chloride react to produce solid magnesium and aqueous potassium chloride.

1. Word Equation:

2. Chemical Equation:

Remainder of Class (Homework)

- Worksheet #11 – Balancing Chemical Reactions
  - Don't forget: WHMIS Worksheet and Formula Review

Science 1206

Reaction Types

Homework

- Worksheet #11 – Balancing Chemical Reactions
  - Don't forget: WHMIS Worksheet and Formula Review
    - Both have to be passed in today
- Quiz on Monday – Balancing and Reaction Types

Worksheet #11

2. Solid aluminum combines with oxygen gas to produce solid aluminum oxide.

Aluminum + oxygen → aluminum oxide

$Al + O_2 \rightarrow Al_2O_3$

3. Hydrogen peroxide decomposes (breaks down) into water and oxygen gas.

Hydrogen peroxide → water + oxygen

$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$

4. The combustion (burning) of ethyne gas, $C_2H_{2(g)}$ in the presence of oxygen gas produces carbon dioxide gas and water vapor.

ethyne + oxygen → carbon dioxide + water

$2\ C_2H_2 + 5\ O_2 \rightarrow 4\ CO_2 + 2\ H_2O$

Types of Chemical Reactions (pg 2-4 notes)

- There are 5 types of reactions that you need to recognize:
  - Simple Composition
  - Simple Decomposition
  - Single Replacement
  - Double Replacement
  - Hydrocarbon Combustion

1. Formation (Simple Composition)

2 elements or compounds react to form 1 new compound

Example: $2\ Mg_{(s)} + O_{2(g)} \rightarrow 2\ MgO$

General: $A + B \rightarrow AB$

Word: element + element → compound

Formation: A + B → AB

- magnesium reacts with oxygen from the air
- Magnesium + oxygen →
- Mg + O_2 →

Formation: A + B → AB

- hydrogen and oxygen react to produce water
- Hydrogen + oxygen → water
- $2\ H_2 + O_2 \rightarrow 2\ H_2O$

2. Decomposition

1 compound breaks down into 2 elements or compounds

General: $AB \rightarrow A + B$

Word: compound → element + element OR
compound → compound + compound

Example: $2\ Cu_2O_{(s)} \rightarrow 4\ Cu_{(s)} + O_{2(g)}$

AB → A + B

water is broken down into its elements

Water →

H_2O →

AB → A + B

mercury(II) oxide decomposes

Mercury(II) oxide →

HgO →

3. Single Replacement (Single Displacement)

- A element replaces the cation/anion in a compound

General: $A + BC \rightarrow B + AC$

Word: element + compound → element + compound

Example: $Zn_{(s)} + Pb(NO_3)_{2(aq)} \rightarrow Pb_{(s)} + Zn(NO_3)_{2(aq)}$

A + BC → B + AC

- Barium and zinc chloride react
- Barium + zinc chloride →
- Ba + $ZnCl_2$ →

A + BC → B + AC

- chlorine reacts with sodium bromide solution
- Chlorine + sodium bromide →
- Cl_2 + NaBr →

4. Double Replacement (Double Displacement)

- Two compounds react and switch ions

General: $AB + CD \rightarrow AD + CB$

Word: compound + compound → compound + compound

Example: $BaCl_{2(aq)} + AgNO_{3(aq)} \rightarrow Ba(NO_3)_{2(aq)} + AgCl_{(s)}$

- solutions of barium chloride and potassium carbonate react
- barium chloride + potassium carbonate
- $BaCl_2 + K_2CO_3 \rightarrow$

5. Hydrocarbon Combustion (Not on midterm)

- A hydrocarbon (C_xH_y) reacts with oxygen to produce CO_2 and H_2O

General: $C_xH_y + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)}$

Word: hydrocarbon + oxygen → carbon dioxide + water

Example: $C_3H_{8(g)} + 5\ O_{2(g)} \rightarrow 3\ CO_{2(g)} + 4\ H_2O_{(g)}$

- Butane, $C_4H_{10(g)}$ is burned as fuel in a lighter

- Butane + oxygen →

Formation Decomposition

Single Replacement Double Replacement

Hydrocarbon Combustion

1. ___$C_{10}H_{20(s)}$ + ___$O_{2(g)}$ → ___$CO_{2(g)}$ + ___$H_2O_{(g)}$

2. ___$Al(OH)_{3(s)}$ + ___$HCl_{(aq)}$ → ___$AlCl_{3(aq)}$ + ___$HOH_{(l)}$

3. ___$C_4H_{8(g)}$ + ___$O_{2(g)}$ → ___$CO_{2(g)}$ + ___$H_2O_{(g)}$

4. ___$C_{(s)}$ + ___$O_{2(g)}$ → ___$CO_{(g)}$

5. ___$C_5H_{12(l)}$ + ___$O_{2(g)}$ → ___$CO_{2(g)}$ + ___$H_2O_{(g)}$

6. ___$Li_{(s)}$ + ___$AlBr_{3(aq)}$ → ___$LiBr_{(aq)}$ + ___$Al_{(s)}$

Formation Decomposition

Single Replacement Double Replacement

Hydrocarbon Combustion

7. ___$C_2H_{6(g)}$ + ___$O_{2(g)}$ → ___$CO_{2(g)}$ + ___$H_2O_{(g)}$

8. ___$NH_4OH_{(aq)}$ + ___$H_3PO_{4(aq)}$ → ___$(NH_4)_3PO_{4(aq)}$ + ___$HOH_{(l)}$

9. ___$Li_{(s)}$ + ___$P_{4(s)}$ → ___$Li_3P_{(s)}$

10. ___$CH_{4(g)}$ + ___$O_{2(g)}$ → ___$CO_{2(g)}$ + ___$H_2O_{(g)}$

11. ___$Al(OH)_{3(s)}$ + ___$H_2SO_{3(aq)}$ → ___$Al_2(SO_3)_{3(s)}$ + ___$HOH_{(l)}$

12. ___$Ca(NO_3)_{2(aq)}$ + ___$Na_3PO_{4(aq)}$ → ___$Ca_3(PO_4)_{2(s)}$ + ___$NaNO_{3(aq)}$

Homework

- Worksheets
  - 12
  - 13
  - 14 (Not Combustion)

- Monday – Short Quiz
  - Balancing
  - Give equations from names
  - Identify reaction types