Name: _____ Date: _____ Block: _____

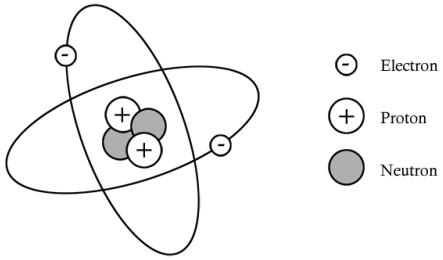
SECTION 1: REVIEW

Atom: _____

Proton: _____ charged particle in the _____ of an atom; has a mass of ___.

Neutron: _____ particle in the _____ of an atom; has a mass of _____.

Electron: _____ charged particle in _____ surrounding the nucleus of the atom; very _____ (mass of _____).



	Protons (p)	Neutrons (n)	Electrons (e)
Atom (neutral)			
Ion (charged)			

Ion: an atom or molecule with an _____; formed by _____ _____. Examples: _____

The Periodic Table tells you which ion(s) an atom can form.

Cation: _____ charged ion (e.g. _____); forms when electrons are _____ (Example: magnesium atom can _____)

Anion: _____ charged ion (e.g. _____); forms when electrons are _____ (Example: sulfur atom can _____)

Titanium is a _____ metal because: _____.

A **polyatomic ion** is a _____ of covalently bonded atoms with a charge. E.g. NH_4^+ is the ammonium ion.

Practice:

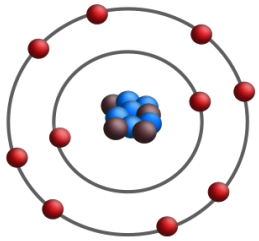
1) Why do atoms have the same number of protons and electrons?
2) Explain why you need to subtract atomic number from atomic mass to calculate the number of neutrons in an atom.
3) Why do atoms and ions have the same number of protons and neutrons, but different numbers of electrons?
4) Why do ions never have the same number of protons as electrons?
5) To form an anion, does an atom have to gain or lose electrons? Why?
6) When a calcium atom becomes an ion, does it have to gain or lose electrons? How many?
7) Is the chlorine ion a cation or an anion? Does it form by gaining or losing electrons?
8) Is Cr^{3+} a cation or anion?
9) Does arsenic form an ion by gaining or losing electrons? How many? How do you know?
10) Why do we call manganese a multivalent element? List 3 other multivalent elements.

	protons	neutrons	electrons
N			
Br^-			
Zn^{2+}			
Li			
argon			
calcium ion			
nickel(III) ion			
potassium			

SECTION 2: MODELLING ATOMS AND COMPOUNDS

Valence Shells and Compound Formation

- The **valence shell** is the _____.
  Electrons in this shell are called _____**.**
- A stable atom has a full valence shell.
- Atoms react to form _____ (groups of atoms bonded together) to become stable by having a _____.
  - Ionic compound: formed when atoms _____electrons.
  - Covalent compound: formed when atoms _____ electrons.



- Valence electrons can explain reactivity.
  - The _____ an atom is to a full valence shell, the more _____ it is.
  - Noble gases already have a _____; they do not react with other elements.

Practice: Identify the following as atoms (pure elements), ions, or compounds. BONUS: identify any cations, anions, and polyatomic ions.

1. Na
2. $TiCl_3$
3. CH_4
4. Cu
5. Fe^{3+}
6. H_2O
7. H_2
8. Fe
9. O^{2-}
10. I_2
11. $Ni(OH)_3$
12. Mg
13. $Ca(OH)_2$
14. Mn
15. HSO_4^-
16. Cu^+
17. VS_2
18. NO
19. MgO_2
20. Pt^{4+}
21. Be
22. ClO_2^-
23. CCl_4
24. Cl_2

Bohr Models of Atoms and Ions

	p	n	e		p	n	e
Na atom				**O atom**			
Na^+ ion				**O^{2-} ion**			
Mg atom				**Cl atom**			
Mg^{2+} ion				**Cl^- ion**			

1. Calculate the number of protons, neutrons, electrons.
2. In the nucleus:
   - _____
   - _____
3. Draw the electrons in energy shells:
   - Max electrons per shell from inside to outside: _____
   - (Except in first shell), electrons are filled ***starting at top***, going ***clockwise***, singly at first then paired
4. Ions only:
   - Add _____ and _____ from periodic table

Example: sodium atom	Example: oxygen ion

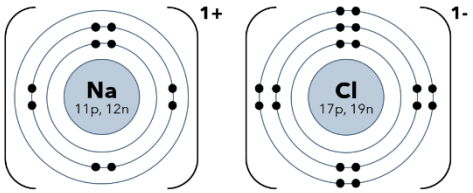
Ionic Compound Formation (Review)

- Atoms form ions to have a **full valence shell**, just like the noble gases have.
- Electrons are negatively charged. When electrons are added, atoms become negatively charged anions. When electrons are taken away, atoms become positively charged cations.
- Ionic compounds form when _____ and ions are formed. Usually involves a _____ and a _____.

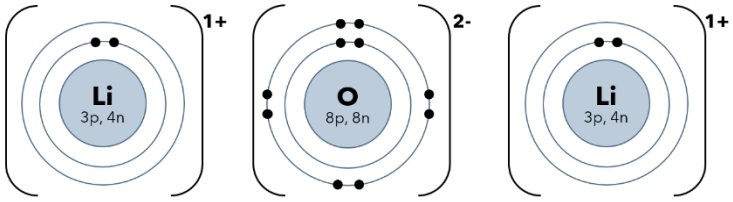
Bohr Models of Ionic Compounds

1. Determine how many of each ion is in the compound, from the subscripts.
2. Use the periodic table to find the ionic charge of each ion.
3. Draw the Bohr models of all the ions in the compound, side by side. (They should all have full valence shells.)

e.g. NaCl:



e.g. Li_2O:

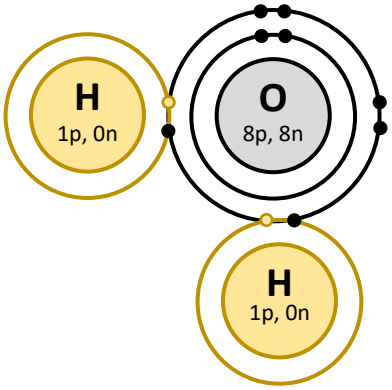


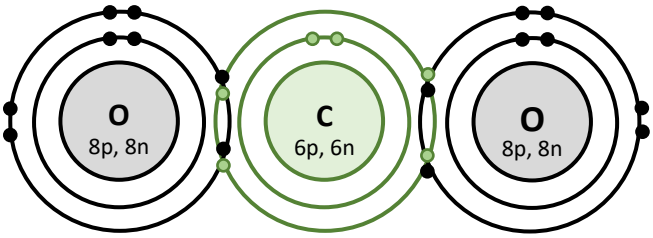
Practice: Draw the Bohr models of the following ionic compounds.

a) $MgCl_2$	b) Li_3N

Covalent Compound Formation

- Covalent compounds form when two (or more) _____ _____.
- **Lone pair**: pair of _____ that is _____ between atoms
- **Bonding pair**: _____ _____ in a covalent compound





Bohr Models of Covalent Compounds

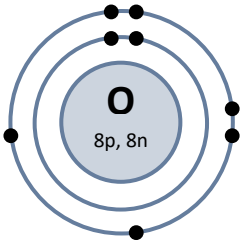
1. Determine how many of each atom is in the compound, from the subscripts.
2. Draw the Bohr models of the atoms. 'Guess and check' what covalent bonds between valence electrons will cause all atoms to have a full valence shell.
3. Redraw the Bohr model, showing the covalent bonds.

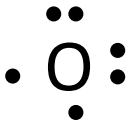
Practice: Draw the Bohr model of the following covalent compounds.

a) CH_4	b) N_2

Introducing Lewis Structures

Bohr Model	Lewis Structure
• All electrons • All energy shells • Shows protons and neutrons • Shows a lot of information, but is clunky and time-consuming	• Only _____ electrons (except cations) • Outermost shell only • Protons and neutrons ignored • Good at determining bonding in a _____ compound





How do you determine the number of valence electrons in an atom?

_____

Lewis Structures of Atoms

1. Write element symbol (capitalization matters!)
2. Draw valence electrons around, using the same positions as the Bohr model (i.e. clockwise, unpaired at first then paired)

Practice: Draw the Lewis structures of:

a) Mg atom	b) N atom	c) H atom	d) F atom

Lewis Structures of Ions and Ionic Compounds

Cation:

- Element symbol
- No electrons
- Square brackets and charge

Anion:

- Element symbol
- Full valence shell
- Square brackets and charge

Practice: Draw the Lewis structures for the following ionic compounds:

a) NaCl	b) $MgCl_2$	c) CaH_2	d) AlF_3

Lewis Structures of Covalent Compounds

Rule 1: All _____.

Rule 2: All atoms must have a _____.

1. Draw the Lewis structure of each atom.
2. Determine how many bonds each atom "needs" to complete its valence shell.
3. Guess and check with single, double, and triple bonds until your structure satisfies Rules 1 and 2.

Symbols Used in Lewis Structures	
Lone pair	:
Single bond (1 bonding pair; 2 electrons)	–
Double bond (2 bonding pairs; 4 electrons)	=
Triple bond (3 bonding pairs; 6 electrons)	≡

Example: H_2O	Example: NH_3	Example: CO_2

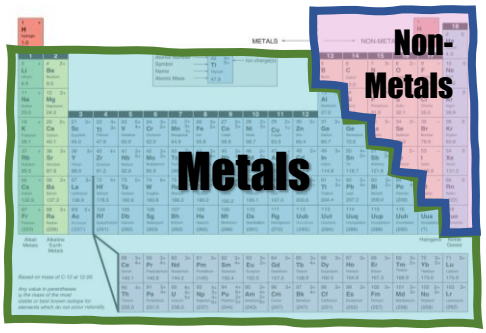
Practice: Try drawing the Lewis structures of the following covalent compounds.

HF	PF_3	CH_2O
N_2 *	CH_4	CO_2H_4 *(challenge)*

SECTION 3: IUPAC NOMENCLATURE

Ionic vs Covalent Compounds

- Ionic compounds form when **electrons are** _____ and ions are formed. Usually involves a _____ **and a** _____.
- Covalent compounds form when two (or more) _____ atoms _____ **electrons**.



Draw a diagram to help you identify elements, ionic compounds, and covalent compounds based on its formula.

Practice: Identify the following as elements (E), ionic compounds (IC), or covalent compounds (CC).

Chemical	What is it?	Chemical	What is it?	Chemical	What is it?
PF_3		NO_2		NaOH	
$CaCl_2$		Br_2		CCl_4	
Cl_2		Mg		$MgBr_2$	

Naming Elements

An element is a pure substance containing _____.
Examples:

- Mg (_____)
- _____ (calcium)
- _____ (hydrogen)
- Cl_2 (_____)

Names of elements are found on the _____. Ignore subscripts when naming.

Diatomic Elements: When in their elemental form, exist as diatomic molecules: two atoms bonding covalently to fill their valence shells.

List: _____ Memory Aid: _____

Reference

Non-metal	"-ide" Ending	Non-metal	"-ide" Ending	Non-metal	"-ide" Ending
N, nitrogen		**Cl**, chlorine		**As**, arsenic *	
O, oxygen		**Se**, selenium		**Te**, tellurium *	
F, fluorine		**Br**, bromine		**At**, astatine *	
P, phosphorus		**I**, iodine			
S, sulfur		**H**, hydrogen			

Naming Ions

	What is it?	Naming	Examples	
			Ion Name	*Ion Symbol*
Monovalent Ion	Can only make one ion (see periodic table)	Cations: write name of element	sodium	Na^{+}
			yttrium	Y^{3+}
		Anions: write name of element with "-ide" ending	bromide	Br^{-}
			oxide	O^{2-}
Multivalent Metal Ion	Can make multiple ions (see periodic table)	Must specify charge with Roman numerals	manganese(III)	Mn^{3+}
			manganese(IV)	Mn^{4+}
			copper(I)	Cu^{+}
			vanadium(V)	V^{5+}
Polyatomic Ion	Group of non-metal atoms covalently bonded with an ionic charge	Spelling counts!!!! (Copy from table)	ammonium	NH_4^{+}
			phosphate	PO_4^{3-}
			phosphite	PO_3^{3-}

Practice: Complete the table with the names and chemical formulas (including charges) of the following ions. Identify as non-metal (NM), monovalent metal (M), multivalent metal (MM), or polyatomic (P).

Ion Formula	Ion Name	Type
Mn^{4+}		
K^{+}		
CO_3^{2-}		
HSO_4^{-}		
Se^{2-}		
NO_3^{-}		
Br^{-}		
OH^{-}		
Ti^{3+}		
NH_4^{+}		
Mg^{2+}		
	hypochlorite	
	sulfide	
	iodide	
	perchlorate	
	nickel(II)	
	chromium(III)	
	hydride	
	hydroxide	
	cyanide	
	gold(I)	

Naming Ionic Compounds

1) Write the _____, first.
   - For monovalent ions, do not write the ion charge.
   - For multivalent metals, determine the ion charge through _____.

     Then, put the ion charge in _____ _____, in brackets.
   - If the cation is polyatomic, write it exactly the way it is written in the table.
2) Write the anion with _____ (unless it is polyatomic.)

Charge Balancing (to find the charge of a _____ metal ion)

1) Write out all the ions you have. Leave the charge blank on the multivalent metal.
2) *Rule: The total number of* _____ *charges in an ionic compound must equal the total number of* _____ *charges.* Determine the charge on the metal ion.
3) Write the compound name. Specify the ion charge on the multivalent metal using brackets and Roman numerals.

Examples:	
NaCl	$Mg(OH)_2$
Cr_2O_3	$Ti_2(CrO_4)_3$

Writing Formulas of Ionic Compounds

	Version 1 1. Write down each ion with its charge. 2. Add more of the ions to balance the charges: the total number of positive and negative charges must be equal. 3. Write your formula with subscripts.	Version 2 1. Write down each ion with its charge. 2. Write the chemical formula by writing the cation first and the anion second. Then, "criss-cross" the charges to become the subscripts. 3. Reduce the subscripts if both divisible by the same number.
calcium phosphide		
chromium(II) hydroxide		

Naming Covalent Compounds

1. Write the first element.
2. Write the second element with "–ide" ending.
3. Add **prefixes** to show how many of each element there is.
    - *Do not add "mono-" to first element.*
    - *If adding "mono-" to "-oxide", write "monoxide" instead.*

Prefixes Reference

Arabic numeral	Prefix	Arabic numeral	Prefix
1		6	
2		7	
3		8	
4		9	
5		10	

Covalent Compounds with Special Names (memorize):

NH_3 = ammonia
H_2O = water
CH_4 = methane

Examples:
O_2F_2
PF_3
N_2O

Chemical Formulas of Binary Covalent Compounds

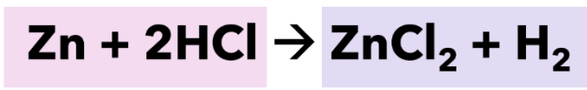
1. Identify the elements involved. Write their symbols.
2. Use the prefixes to determine the number of each element in the compound. Write as subscripts.

Examples:
tetraphosphorus pentaoxide
nitrogen triiodide
xenon hexafluoride

SECTION 4: BALANCING CHEMICAL EQUATIONS

Chemical Equation Vocabulary

Reactants: what _____ the reaction; on the _____ side of the reaction arrow
Products: what _____ the reaction; on the _____ side of the reaction arrow



	Definition and Example	Example
Word Equation	uses _____ to describe reactants and products	zinc + hydrogen chloride → zinc chloride + hydrogen
Skeleton Equation	uses _____ to describe reactants and products	$Zn + HCl \rightarrow ZnCl_2 + H_2$
Balanced Chemical Equation	uses _____ and chemical formulas to describe reactants and products in their correct _____	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

Why Balance?

- Chemical "recipes": how much do you put in? how much do you expect to yield?
- **Law of Conservation of Mass**: no atoms are ever created or destroyed
- Balancing chemical formulas involves adding _____ in front of elements and compounds until _____ _____.

Tips for Balancing

- **Goal: the number of atoms of each element in the reactants equals the products.**
- Change coefficients only. Never add or change subscripts.
- Balance atoms in compounds first. Save elements for last.
- If the same _____ appears in the reactants *and* products, you can often treat it as a _____ instead of splitting it up.
- At the end, reduce all coefficients to lowest whole-number terms.
- Note: _____ if there is only "____" of that element or compound.

Trick for Combustion Reactions (e.g. #10-12 below)

1. Balance every atom except oxygen.	___C_6H_{14} + ___ O_2 → ___ CO_2 + ___ H_2O
2. Find out how many oxygen atoms you need the __O_2 to contribute. Divide that number by 2. This is your *temporary* coefficient for O_2.	___C_6H_{14} + ___ O_2 → ___ CO_2 + ___ H_2O
3. You are not allowed to have fractional coefficients in your final answer. Multiply all the coefficients by 2.	___C_6H_{14} + ___ O_2 → ___ CO_2 + ___ H_2O

Practice: Balance the following chemical reactions.

1. ___ N_2 + ___ H_2 → ___ NH_3
2. ___ NaCl + ___ F_2 → ___ NaF + ___ Cl_2
3. ___ Ag_2O → ___ Ag + ___ O_2
4. ___ P + ___ O_2 → ___ P_2O_5
5. ___ NaBr + ___ CaF_2 → ___ NaF + ___ $CaBr_2$
6. ___ $FeCl_3$ + ___ NaOH → ___ $Fe(OH)_3$ + ___ NaCl
7. ___ H_2SO_4 + ___ $NaNO_2$ → ___ HNO_2 + ___ Na_2SO_4
8. ___ CO_2 + ___ H_2O → ___ $C_6H_{12}O_6$ + ___ O_2
9. ___ HCl + ___ $CaCO_3$ → ___ $CaCl_2$ + ___ H_2O + ___ CO_2
10. ___ C_3H_8 + ___ O_2 → ___ CO_2 + ___ H_2O
11. ___C_6H_{14} + ___ O_2 → ___ CO_2 + ___ H_2O
12. ___ C_8H_{18} + ___ O_2 → ___ CO_2 + ___ H_2O