

Chapter 7

Warm Up!



Radium was formerly used in self-luminous paints for watches, nuclear panels, aircraft switches, clocks, and instrument dials. This practice stopped because radium is treated the same as Ca in the body, and is deposited in bones where radioactivity degrades marrow and can mutate bone cells.

- Write the electron configuration for radium.
- What period and group is radium in?
- What ion will it form?
- Why does Ra react the same as Ca in the body?

Today's Agenda

- QOTD: How can we predict ions based on electron configurations and the periodic table?
- Review for Quiz!
- Define valence electrons and chemical bond.
- Predict the formation of ions.
- Relate ion formation to electron configuration

Chapter 6 Questions

- If **A is an ion** and **B is an atom**   of the same element is the ion positive or negative?
- If **A and B** are atomic radii of **two elements** in the same **period**, what is their order?
- If **A and B** are atomic radii of **two elements** in the same **group**, what is their order?

Chapter 6 Review

- What is the octet rule? Why do H and He break the octet rule?
- Of Mg, Ca and Ba, which forms an ion with the largest atomic radius? Why?
 - Is the Mg atom smaller or larger than the ion?
- How many valence electrons do elements in group 1 have? Group 18? Why?!

Warm Up!

Think about table salt, NaCl

- What ions do these elements like to form?
- Why do they work so well as a compound?

- Think of two possible rules for forming an ionic compound, like NaCl.

- Would Ca and F form an ionic compound?

Today's Agenda

- QOTD: What is an ionic compound and how do we name these compounds?
- Ch 6 Quiz!
- Ions and forming ionic compounds
- Naming Binary Ionic Compounds

Ion Formation (Ch 7)

- Where are the valence electrons?
- Why are we so interested in how many valence electrons an element has?
- A chemical bond is the force that holds two atoms together.

Bonds!

- Two types
- Covalent – forms because of the attraction between the positive nucleus of one atom and the negative electron cloud of another.
- Ionic – forms because of the positive ions of one element and negative ions of another.

Warm Up!

- What are the ions formed by

Na Cl O Mg Cs Br P K

- Make 3 ionic compounds with the above ions

Today's Agenda

- QOTD: How do ionic compounds form and how do we name them?
- Predict ions
- Forming and naming ionic compounds
- Naming and formula writing practice

NGC helps us Predict ion

- Elements react to complete their octet ... (what is the octet? **Stable arrangement of 8 valence electrons**)
- Elements react to attain the ideal NGC
- What ion does Na form?

$1s^2 2s^2 2p^6 3s^1$ **Na is a metal – metals are LOSERS**

If Na lost the $3s^1$ electron - 8 valence electrons! NGC!
Looks like Ne $1s^2 2s^2 2p^6$

Ions by Group

Group	Ion	Example
1	+1	Na ⁺¹ , Li ⁺¹
2	+2	Mg ⁺² , Ca ⁺²
13	+3	B ⁺³ , Al ⁺³
14	+4/-4	C ⁺⁴ , C ⁻⁴
15	-3	N ⁻³ , P ⁻³
16	-2	O ⁻² , S ⁻²
17	-1	Cl ⁻¹ , F ⁻¹

Ions by Electron Configuration

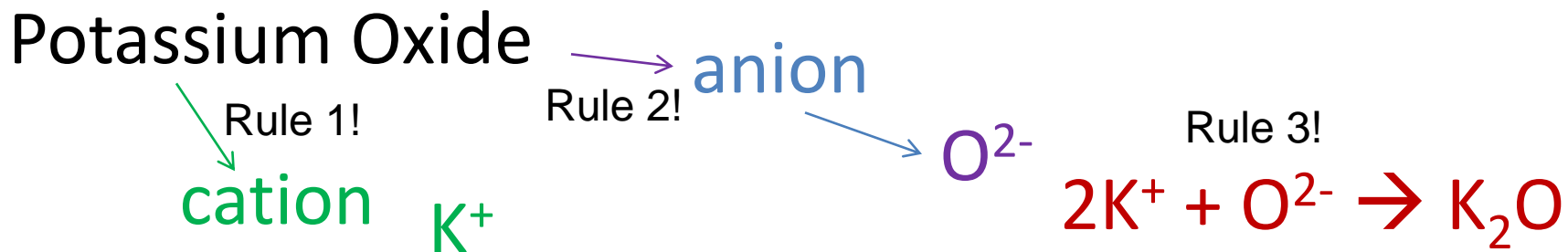
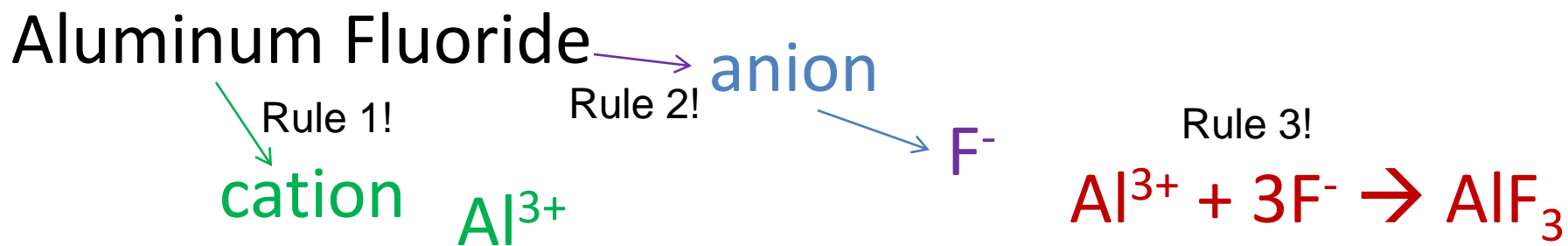
- Na [Ne]~~3s~~¹ Lose 1 Na⁺¹ [Ne]
- Mg [Ne]~~3s~~² Lose 2 Mg⁺² [Ne]
- Al [Ne]~~3s~~²~~3p~~¹ Lose 3 Al⁺³ [Ne]
- Si [Ne]~~3s~~¹~~3p~~² Lose/Gain 4 Si^{+4/-4} [Ne], [Ar]
- P [Ne]3s¹3p³ Gain 3 P⁻³ [Ne]3s²3p⁶
- S [Ne]3s¹3p⁴ Gain 2 S²⁻ [Ne]3s²3p⁶
- Cl [Ne]3s¹3p⁵ Gain 1 Cl⁻¹ [Ne]3s²3p⁶

Naming and Writing Formulas for Representative Element Binary Ionic Compounds

- Binary Ionic Compounds are compounds containing 2 ions of opposite charge.
- Metals **LOSE** all valence electrons, become **cations**.
- Nonmetals **GAIN** enough electrons to fill valence, become **anions**.

Formula Writing Rules

1. Identify the cation symbol and charge.
2. Identify the anion symbol and charge.
3. Balance the cation and anion charge so resultant formula is ZERO.



Try These!

Write the formulas for these:

1. Sodium Iodide:
2. Calcium Fluoride:
3. Potassium Sulfide:

Write the charges of ions and names of compounds:

1. NaF
2. SrBr₂
3. Cs₂O

Warm Up!!

- Write Formulas for:
- Rubidium Phosphide
- Barium Fluoride
- Indium Oxide

- Write names for :
- BaS
- Al_2O_3
- Na_2Te

Agenda for Today

- Question of the Day: How do we name and write formulas for multi atom ions (a.k.a. polyatomics)?
- Review Binary Ionic formulas and naming
- Recognizing polyatomic ions
- Practice writing formulas and naming polyatomic ion containing compounds.

Balancing!

- What about a formula for aluminum selenide?

Ion	Common Multiple	Charge	Needed for Neutrality	Final Charges
Al^{3+}	6	+3	2	+6
Se^{2-}	6	-2	3	-6

- Magnesium phosphide?

Ion	Common Multiple	Charge	Needed for Neutrality	Final Charges
Mg^{2+}	6	+2	3	+6
P^{3-}	6	-3	2	-6

Names and Formulas for Compounds of Polyatomic Ions

- What's a polyatomic ion?

Poly – many Atomic – atoms Ion – charged species

You will have to make a 3x5 polyatomic ion card.

This card will be TURNED IN TO ME next
Wednesday, 12/14.

Late cards NOT accepted, lost cards may NOT be
replaced.

You can use this card for the rest of the year on
tests/quizzes

Naming Compounds of Polyatomic Ions

- Treat all representative element metals and non-metals the same as before.
- Metals loses all valence e⁻'s, forms cation
- Non-metal gains enough electrons to fill their valence shell, form anion

- Polyatomic ions
- Made from more than one atom.
- Most are anions (except ammonium)
- Names are cation first then anion

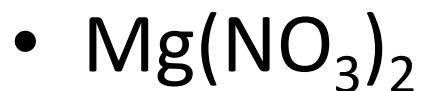
Naming Practice



ID cation – Sodium

ID anion – (polyatomic) – Phosphate

Sodium Phosphate



ID cation – Magnesium

ID anion – (polyatomic) - Nitrate

Magnesium Nitrate

Polyatomic Ion Formula Writing Rules

1. ID the cation symbol and charge
2. ID the anion symbol and charge
3. Balance the cation and anion charge so the resultant formula is neutral.
4. If more than one of the polyatomic ion is required to balance charges, parenthesis are required.

Formula Writing Practice

- Aluminum Phosphate

ID cation – Al^{+3}

ID anion – (polyatomic) PO_4^{-3}

Balance ions to be neutral



- Strontium Bromate

ID cation – Sr^{2+}

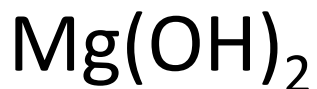
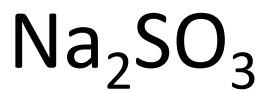
ID anion – (polyatomic) BrO_3^-

Balance ions to be neutral



Polyatomic Naming and Formula Writing Practice

Name these:



List ions and write formulas for:

Potassium Chromate

Sodium Hydroxide

Calcium Sulfate

Challenge!!

- Break up into groups of 4.
- Rules:
 - You have 5 minutes to come up with (4) naming and (4) formula writing questions and their solutions. Each student makes up 1 of each!
 - Your goal: Stump your classmates!
 - After 5 minutes swap questions with other groups, see who can stump the class!

Warm Up!

- Identify the formulas for:
- Sodium sulfate
- Magnesium nitrate
- Ammonium Iodide
- Name These!

CsClO

LiOH

$(\text{NH}_4)_3\text{P}$

Today's Agenda

- How do we name and write formulas for transition metals and acids?
- Return and go over quiz
- Review work from Friday
- Work on Transition Metals and acid naming

Mixed Review!

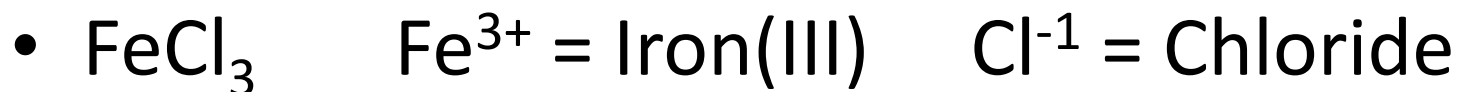
- Write formulas:
- Sodium oxide –
- Lithium chromate –
- Cesium selenide –
- Magnesium phosphate –
- Name these:
- NH_4Cl –
- $\text{Sr}(\text{C}_2\text{H}_3\text{O}_2)_2$ –
- Ba_3P_2 –
- CaCO_3 –

Transition Metal Ion Containing Compounds

- Treat all **representative** element metals, **non-metals** and **polyatomic** ions as before.
- Naming Rules!
 1. There is **more than one** possible charge!
 2. The charge is denoted in **roman numerals** after the name of the metal.
 3. See **periodic table** for common ionic charges!
 4. If periodic table lists only **1** charge, treat it as **representative** element metal.

Transition Metals can be Tricky!

- Examples:



We call this Iron(III) chloride

- Iron can also exist as a +2 ion!



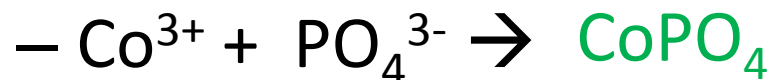
We call this Iron(II) chloride

- Note that we treat the anion the same as before – **change its name** and list it **second!**

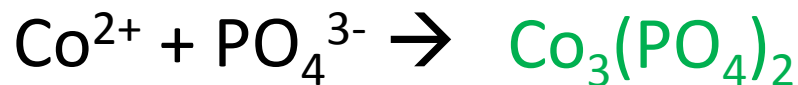
Transition Metal Formula Writing Rules

- There is **more than one possible charge** for most transition metal cations.
- The charge is denoted in **roman numerals** after the name of the metal.

- Cobalt(III) Phosphate



- Cobalt(II)Phosphate



Try These!!

- Name the following:
- AgCl
- $\text{Pb}(\text{NO}_3)_2$
- FeSO_4
- $\text{Fe}_2(\text{SO}_4)_3$
- Write the formulas for
- Tin(IV) bromide
- Nickel(II) nitrate
- Cobalt (III) oxide
- Manganese (II) perchlorate

Naming and Writing Formulas for Acids!

- 1st – determine if the compound is an acid
 - a. If you are given a formula, is the first element **hydrogen**? If yes, it's an **ACID** so follow the acid rules
 - b. If given the **name**, is the **word** acid in the name?
- Acid Naming Rules
- If the anion name ends in **-IDE**

The acid name will be hydro-----ic acid.

Br⁻¹ ends in ide, the acid is HBr = hydro**bromic** acid

Naming Acids con't

- The anion sulfate = SO_4^{2-} ends in ATE

Ending changes to -IC

H_2SO_4 = Sulfuric acid

The anion nitrite = NO_2^{1-} ends in ITE

Ending changes to -OUS

HNO_2 = Nitrous acid

If anion is...

- ide → goes to hydro-----ic acid
- ate → goes to -----ic acid
- ite → goes to -----ous acid

Acid Formula Writing Rules

- Identify anion **name** and **formula**
- Identify anion **charge**
- **Balance** anion charge with equal number of hydrogens.
- Hydrogens **precede** the anion formula.

Formula Writing

- Chromic acid
- Work backwards!! Hmmm if it ends in ic – it used to end in ate!
- Anion = chromate CrO_4^{2-}
- If charge is 2^- How many H's balance it out?

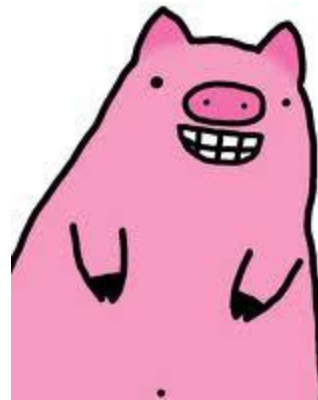
What ion does H form? H^+



Formula Writing

- Hydroiodic acid
- Work backwards!! Hmmm if it has hydro and ends in ic – it used to end in ide!
- Anion = iodide I^{1-}
- If charge is $1-$ How many H's balance it out?

HI



Hi, guys.

More formula writing...

- Phosphorous acid
- Work backwards!! Hmmm if it ends in ous – it used to end in ite!
- Anion = phosphite PO_3^{3-}
- If charge is $3-$ How many H's balance it out?
 H_3PO_3

Now your turn...

- Name these!
- H_2CO_3
- HNO_3
- HF
- HBrO_2
- Write formulas for:
- Hydrochloric acid
- Perchloric acid
- Sulfurous acid

Warm Up!

- When naming acids if the anion ends in
-ide the acid name contains _____
-ate the acid name ends in _____
-ite the acid name ends in _____

What determines the number of H^+ atoms are needed for an acid?

How many H's are needed in phosphoric acid?

Today's Agenda

- (Last naming day!) How do we name and write formulas for molecular compounds?
- Review acid naming
- Name and write formulas for molecular compounds
- Practice!

Acid Practice

1. HCl
 2. HNO₂
 3. H₃PO₄
 4. HCN
 5. HIO₄
 6. H₃PO₃
1. sulfurous acid
 2. hydrosulfuric acid
 3. chlorous acid
 4. bromic acid
 5. hydroselenic acid
 6. chromic acid

Molecular Compounds!

1. Molecular compounds are made from two (or more) **non-metals**.
2. Molecular Compound **Naming** Rules.
 - a. Prefixes are used to denote the number of atoms in each element in the compound

mono

di

tri

tetra

penta

hexa

hepta

octa

nona

deca

hendeca

dodeca

Naming Rules

- b. When there is only **one** atom of the first element in the compound, the prefix, “mono” should be **omitted**.
- c. Change the **ending** of the **last** element to – “ide”.

N_2O_7 - 2 nitrogens and 7 oxygens

prefix for 2 is di

prefix for 7 is hepta

Dinitrogen heptaoxide

Examples for Naming

- CO_2 - 1 carbon, 2 oxygens

since there is only one carbon and it's the first element, we DO NOT need a prefix.

the prefix for 2 is di **Carbon Dioxide**

- EXTRA

- P_4S_{10} – 4 phosphorous, 10 sulfurs

the prefix for 4 is tetra

the prefix for 10 is deca

Tetraphosphorous decasulfide

Molecular Compound **Formula** Rules

- Prefixes are used to denote the **number** of atoms in each **element** in the compound.
- Example:
- Nitrogen monoxide - one nitrogen (no prefix) and one oxygen (mono = 1) **NO**
- Dinitrogen trioxide – two nitrogens (di = 2) and three oxygens (three=3) **N₂O₃**

Try These!

- Name these
- PF_3
- SO_3
- ICl
- Write formulas for these
- Dinitrogen monoxide
- Bromine pentafluoride
- Boron tribromide

Warm Up!

- Acid Naming

HCl

H_2SO_4

HNO_2

- Molecular Formula Writing

Nitrogen dioxide

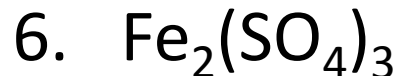
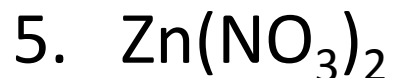
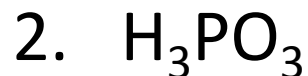
Trisulfur pentoxide

Dihydrogen

Today's Agenda

- What is the difference between an ionic compound, molecular compound, and acid?
- Distinguish different types of compounds.
- Review!!

Mixed Review – 1st ID Ionic, Acid, Molecular



A. chlorous acid

B. bromic acid

C. hydroselenic acid

D. dinitrogen monoxide

E. Boron tribromide

F. Nickel(II) nitrate

G. Cobalt (III) oxide

Warm Up!

- What is the charge on Cu in Cu_2O ?
- What is the charge on Ti in TiPO_4 ?
- What is the charge on Ni in NiCl_2 ?

- How would you find the molecular mass of these compounds?
- What is the molecular mass of NiCl_2 ?

Today's Agenda

- How can we use ratios to experimentally determine chemical formulas?
- Quiz!
- Using ratios to solve word problems.
- Atomic mass and molecular mass and how they relate to actual mass.
- **Homework:** Prelab setup in notebook and prelab practice problems. Background info due Tues. Problems due Wed.

Ratios

- A ratio is just a comparison of two different things.
- Example: if there are 15 females and 20 males in a group (total 35).
- The ratio would be 15/20 or 15:20.
- If there were 7 black labs and 12 golden labs in a doggy daycare, what's the ratio of black to goldens? 7/12 or 7:12

Ratio Problems

- If there are 50 total candies, 22 chocolate santas and 28 candy canes, what is the ratio of santas to candy canes? 22/28
- If there were 75 total candies with the same ratio, how many santas would there be?

22 santas out of 50 total – $22/50$

$$22/50 = x/75$$

$$\frac{22}{50} = \frac{x}{75}$$

$$x = 33 \text{ santas}$$

Try these

- The ratio of Kate's stickers to Jenny's stickers is 7:4. Kate has 21 stickers.
How many stickers does Jenny have?
- Chef Robert's secret recipe requires 7 eggs for every 2 cups of flour. How many eggs will he need if he uses 8 cups of flour?

Warm Up!

- Ammonia is a compound consisting of a 1 : 3 ratio of nitrogen and hydrogen atoms.
- (a) If a sample of ammonia contains 1563 nitrogen atoms, how many atoms of hydrogen are present?
- (b) If a sample of ammonia contains 1425 hydrogen atoms, how many nitrogen atoms are present?

Today's Agenda

- How can we determine the chemical formula by monitoring a reaction and solving ratio's?
- Discuss math problems relevant to lab.
- Check pre-lab - discuss background information and procedures.
- Start the lab!

Lab Experiment

- Use masses that WE measure to determine the chemical formula.
- Remember that each element has a MASS associated with it! Read this from the periodic table!
- These masses are related to mass that we can measure with balances.

Equation

$$\frac{M_B}{M_A} = \frac{AM_B \times \text{number of B atoms}}{AM_A \times \text{number of A atoms}}$$

Given AB_x Find x !

$$M_B = 0.3$$

$$M_A = 0.25$$

$$AM_B = 40$$

$$AM_A = 66$$

The Experiment

- Know M_A and we will find M_{ABx}
 - How will we find M_{Bx} ?

$$M_{ABx} - M_A = M_{Bx}$$

- Use atomic masses to find x!

If we make 0.57g of M_{ABx} and we started with 0.25g of M_A , ($AM_A=58.6$, $AM_B = 25.1$), what is x? If the charge on B is -1 what is the charge on the A ion? AB_3 , A^{3+}

Warm Up!

- What are the two types of bonds?
- What are two criteria for forming an ionic compound?
- What type of ions do metals form?
- Give one example of an ionic compound, an acid, and a molecular compound.

Today's Agenda

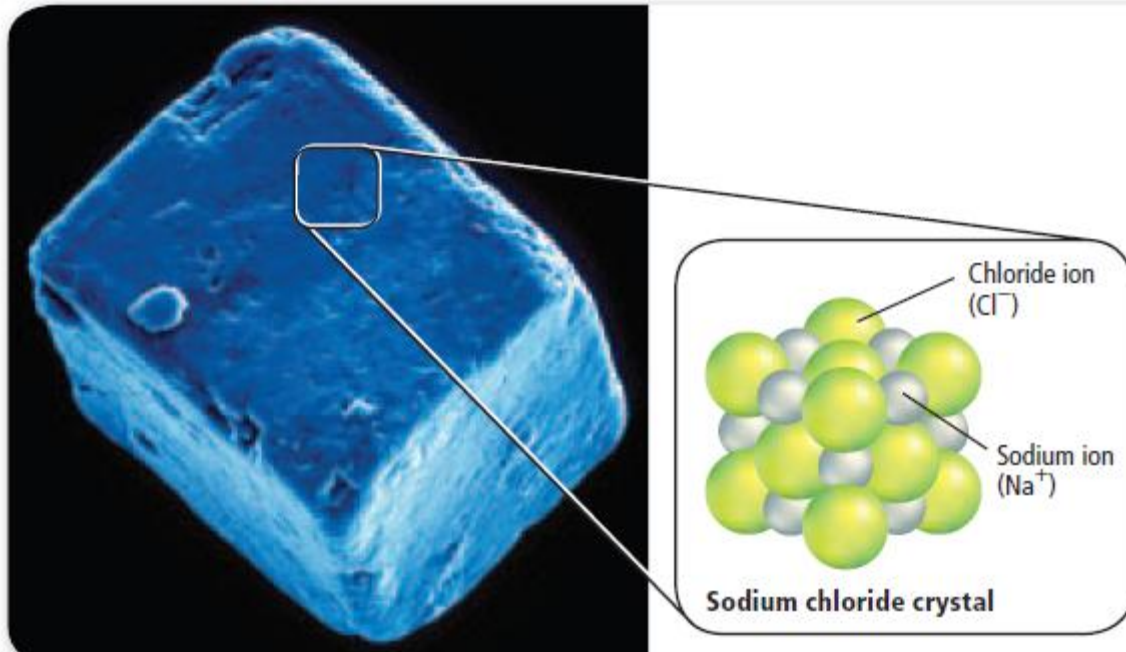
- Review naming and properties of ionic compounds.
- Lab discussion.
- Properties of ionic compounds
- Properties of metal compounds
- Ionic vs. covalent bonds

Ionic Compounds

- Ionic compounds are made from ions with opposite charge.
- Cations are formed from metals. Their charge is sometimes called their oxidation state (or number).
- The oxidation state of Mn in MnCl_2 is +2.
(What you made in lab!)

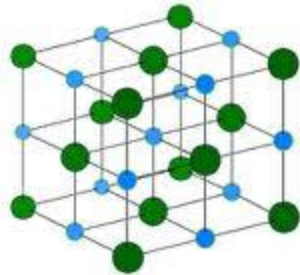
Physical Structure

- Cations and anions are held together by **electrostatics**...also called attractive forces.



Properties of Ionic Compounds

- Melting point, boiling point, and hardness of these crystals depend on how they organize themselves in a solid crystal



- High melting and boiling points, hard crystals
- Conduction of electricity depends on how easily these ions can move around. Salt crystals do not allow for ions to move!

Electrolytes

- When ionic compounds are liquid or if they are dissolved in a solution, they can conduct an electric current.

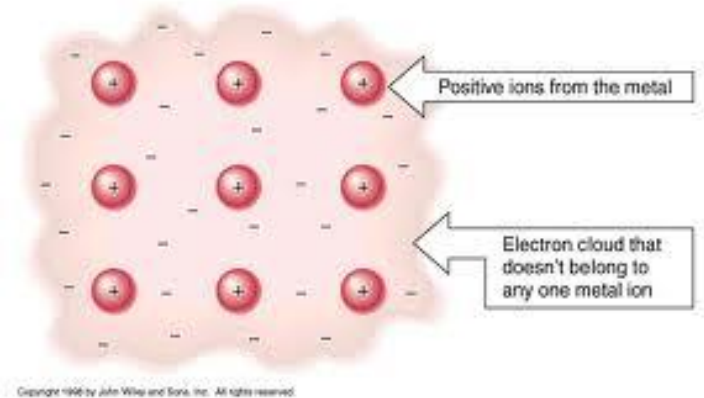
Electrolytes! Our bodies run using electrical signals and salt pumps, so we NEED electrolytes! If you sweat a lot or are sick and do not replenish your “salt” ions, you get sick because you throw off your body’s normal processes!

Metallic Compounds

- Compounds made only of metals, NOT ionic!
- Bonding of metals are similar to ionic compounds because they are based on the attraction of particles .
- 8 – 12 metal atoms closely surround each metal atom in a lattice .

Electron Sea Model

- Electrons are not directly attached to any metal atom but are delocalized.



- Metals are great conductors of electricity because their electrons can flow throughout the metallic solid structure.

Properties of Metals

- High boiling points and melting points.
- Durable, malleable, and ductile.
- Thermal and electrical conductivity – delocalized electrons move heat and move as part of an electric current.
- Hardness and strength – transition metals are harder and stronger than alkali metals because of an increase in electrons

Alloys

- Metal alloys – mixture of elements that have metallic properties.

Steel – increased strength because of the mixture of iron and carbon or Mn, Cr, V, W.

- Substitutional alloys – some of the atoms are replaced by other atoms of similar size (sterling silver)
- Interstitial alloys – small holes in a metallic crystal are filled with smaller atoms (steel)

Review Questions

- What is an oxidation state?
- What are the properties of ionic compounds?
- What are the properties of metallic compounds?

- Explain the difference between substitutional and interstitial alloys.

Warm Up

- Why do ionic solids have high melting and boiling points?
- What is an electrolyte?

Agenda

- What are the properties of covalent compounds and how do we draw structures?
- (Chapter 8) Properties of molecular compounds
- Lewis structures

Properties of Molecular Compounds

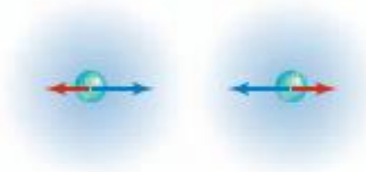
- Molecular compounds are made of covalent bonds, and can range from the very small to the very large (as in polymers, proteins or even DNA).
- Covalent bonding involves the SHARING of valence electrons instead of atoms stealing from one another (like ionic bonding).

Covalent Bonding

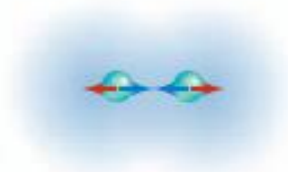
← Force of repulsion
→ Force of attraction



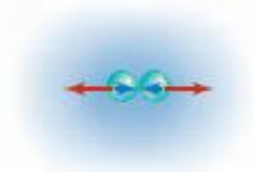
The atoms are too far apart to have noticeable attraction or repulsion.



Each nucleus attracts the other atom's electron cloud. Repulsion occurs between nuclei and between electron clouds.



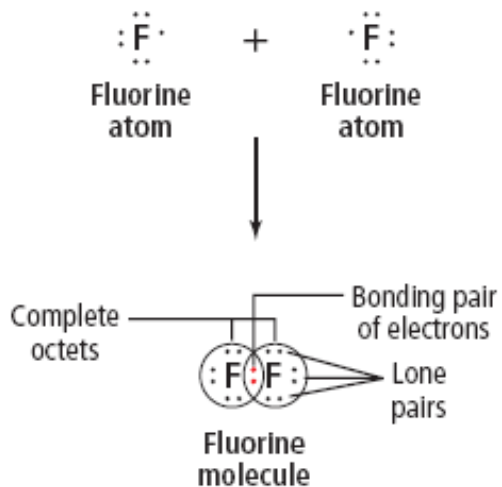
The distance is right for the attraction between one atom's protons and the other atom's electrons to make the bond stable.



If the atoms are forced closer together, the nuclei and electrons repel each other.

Diatomic Molecules

The periodic table shows elements color-coded by groups. A blue box highlights Hydrogen (H) and a group of elements (N, O, F, Cl, Br, I) that form diatomic molecules. The lanthanide and actinide series are shown below the main table.

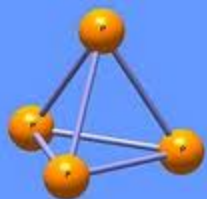
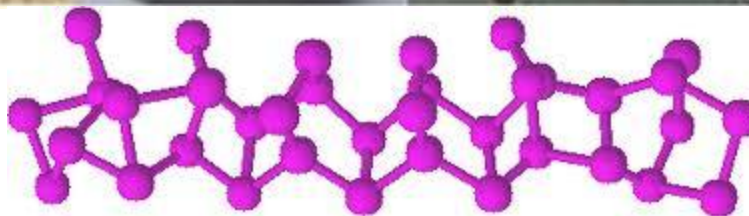
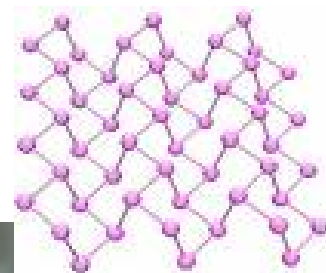


N_2 , O_2 , F_2 , Cl_2 , Br_2 , I_2 , and H_2

Properties of Molecular Solids

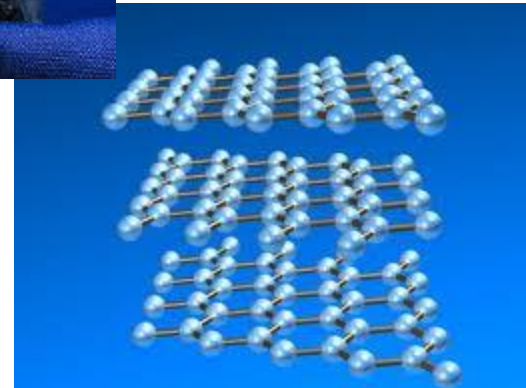
- Molecular substances tend to be gases, liquids or **brittle**, **low melting** solids

Phosphorous changes form with heat and pressure!

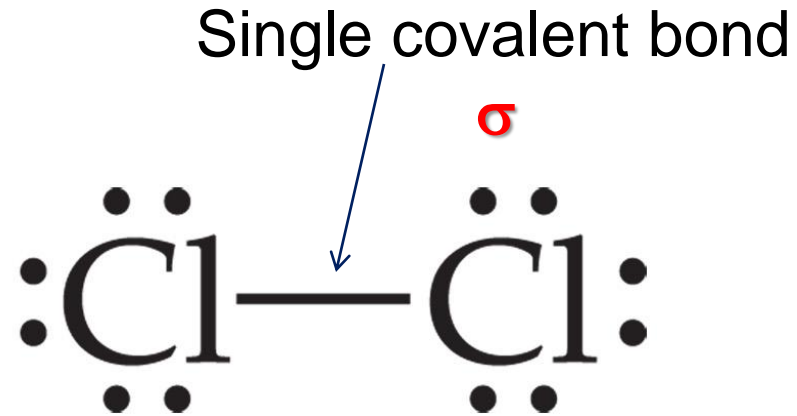


Molecular Compounds

- Molecular substances won't conduct electricity – not close enough for a flow of electrons to form!



Single Bonds



Lewis structures are representations of molecules showing all electrons, bonding and nonbonding.

Diatomic H and Cl are bonded by a sigma (σ) bond

Predicting Bonding

- Draw Lewis dot structure of each atom.

C

N

O

F

- How many electrons will each require to have a full octet?

Multiple Bonds

Double covalent bond

π



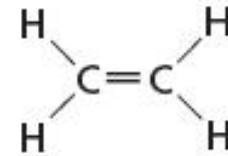
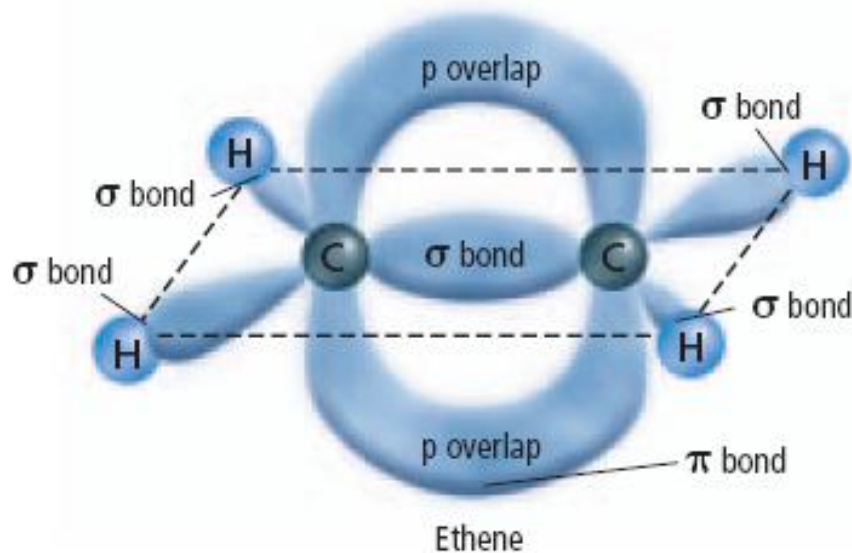
Diatomic oxygen requires a double bond (a pi π bond) to fulfill it's octet.



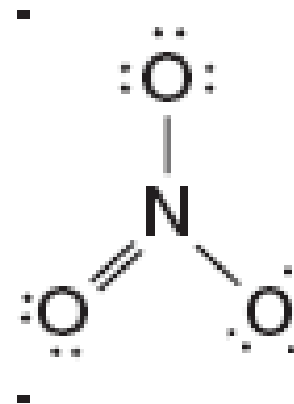
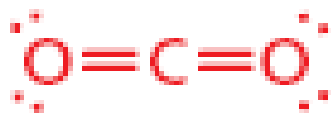
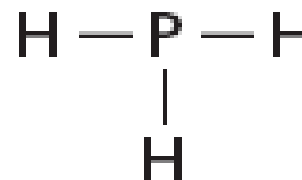
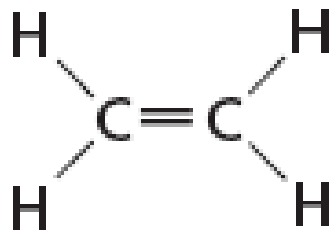
Diatomic nitrogen requires a triple bond (2 pi π bonds) to fulfill it's octet

Counting σ and π bonds

- When counting σ and π bonds, every bond has 1 σ , each additional bond is considered a π bond.



How many σ and π bonds?



Strengths/Lengths of Covalent Bonds

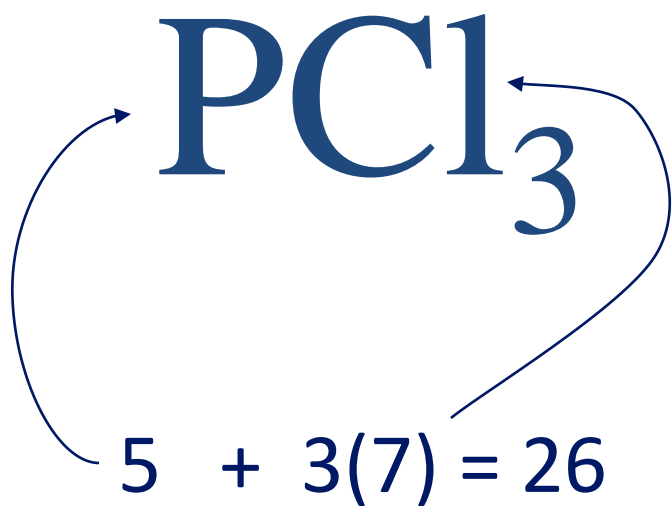
Table 8.1

Covalent Bond Type and Bond Length

Bond Strength

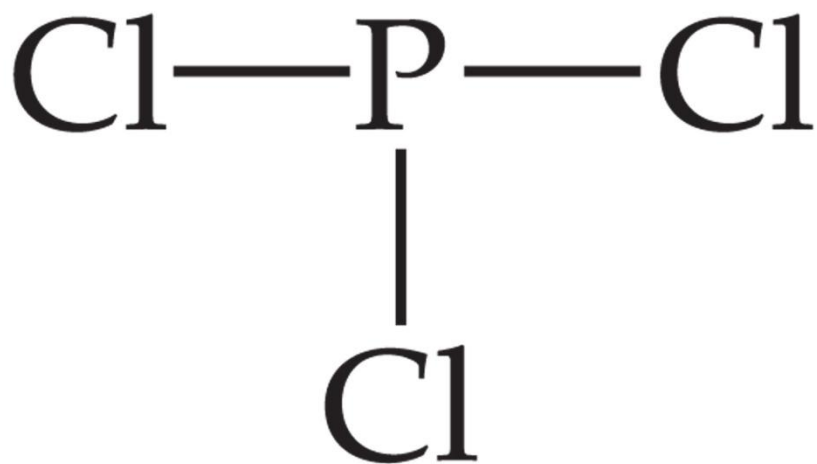
Molecule	Bond Type	Bond Length	Bond-Dissociation Energy
F ₂	single covalent	1.43×10^{-10} m	159 kJ/mol
O ₂	double covalent	1.21×10^{-10} m	498 kJ/mol
N ₂	triple covalent	1.10×10^{-10} m	945 kJ/mol

Writing Lewis Structures



1. Find the sum of valence electrons of all atoms in the polyatomic ion or molecule.
 - If it is an anion, add one electron for each negative charge.
 - If it is a cation, subtract one electron for each positive charge.

Writing Lewis Structures

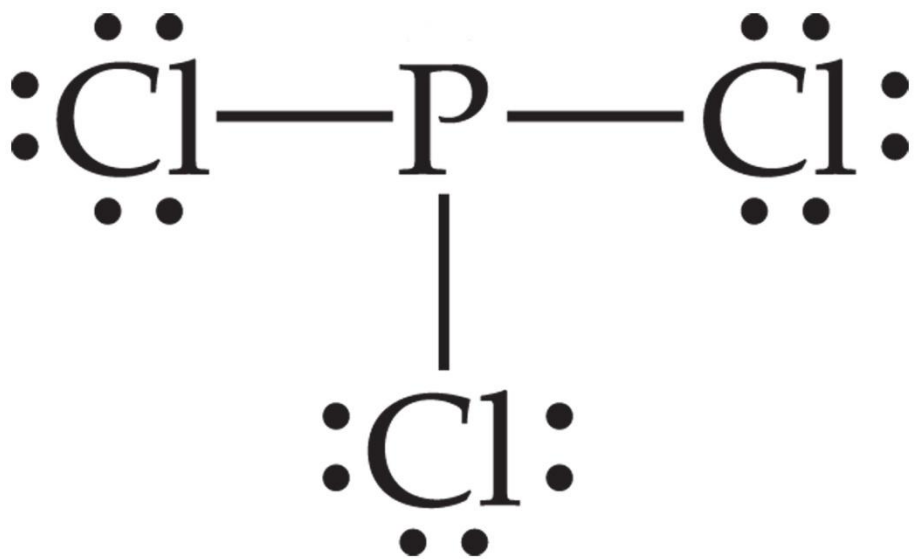


2. The central atom is the *least* electronegative element that isn't hydrogen. Connect the outer atoms to it by single bonds.

Keep track of the electrons:

$$26 - 6 = 20$$

Writing Lewis Structures

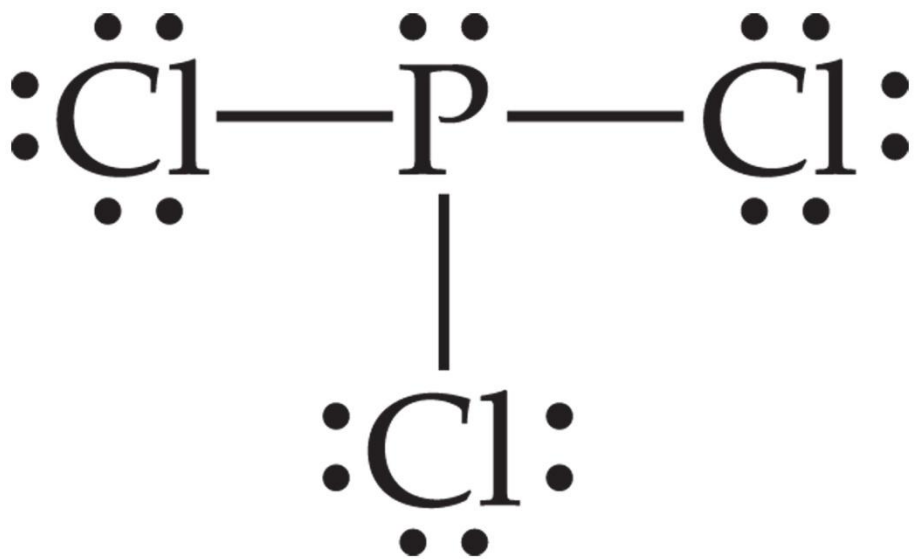


3. Fill the octets of the outer atoms.

Keep track of the electrons:

$$26 - 6 = 20 - 18 = 2$$

Writing Lewis Structures



4. Fill the octet of the central atom.

Keep track of the electrons:

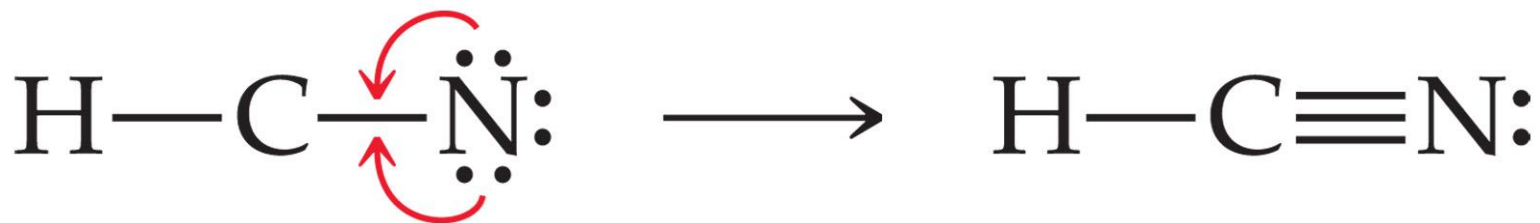
$$26 - 6 = 20 - 18 = 2 - 2 = 0$$

Writing Lewis Structures



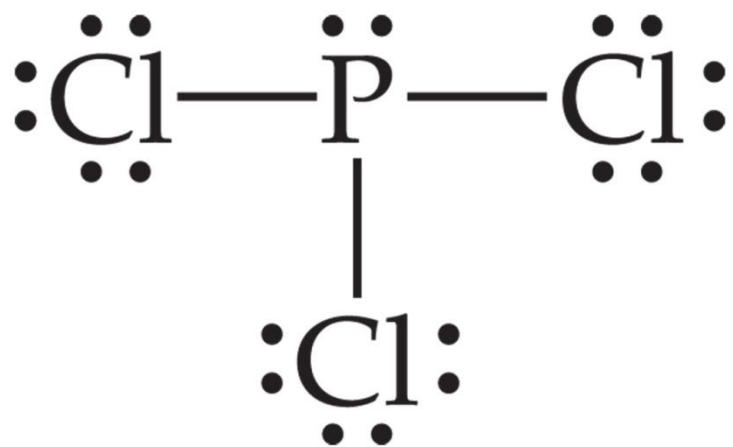
5. If you run out of electrons before the central atom has an octet...

...form multiple bonds until it has a full octet.



Warm up

- How many σ , π bonds and lone pairs?



- How many total valence electrons in CH_4 , CH_2Cl_2 , and CCl_4 ?

Agenda

- How do you draw a proper Lewis structure?
- Drawing Lewis structures.
- Sub and expanded octets
- Worksheet

Draw Lewis Structures!

- NH_3
- N_2
- PBr_3
- CH_4
- CH_3Cl
- CO_2
- NO_3^{-1}
- HCN
- SO_4^{2-}
- PCl_5