

Chemistry SOL Review—Nomenclature, Formulas and Reactions

Periodic Table of the Elements

Non-metals above the staircase

Metals below the staircase

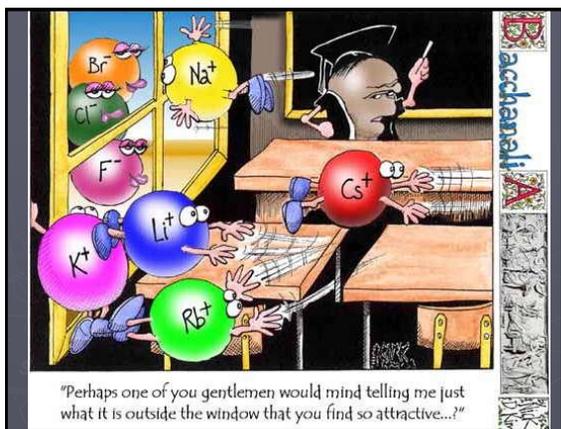
Chemistry SOL Review—Nomenclature, Formulas and Reactions

Periodic Table of the Elements

Non-metals above the staircase

Metals below the staircase

The yellow shaded metals can take on multiple charges/oxidation states (except Zn, Ag, and Cd).



Chemistry SOL Review—Nomenclature, Formulas and Reactions

Types of Compounds (Ionic vs. Molecular)

Ionic compounds form from metals and non-metals (across the tracks) and transfer electrons between elements.

You figure out the formula for an ionic compound by criss-crossing charges to subscripts and reducing subscripts if possible.

Ca²⁺ and F⁻¹ form _____

Li¹⁺ and PO₄³⁻ form _____

Pb⁴⁺ and S²⁻ form _____

Mn²⁺ and ClO₃⁻¹ form _____

Chemistry SOL Review—Nomenclature, Formulas and Reactions

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You figure out the formula for an ionic compound by criss-crossing charges to subscripts and reducing subscripts if possible.

Ca²⁺ and F⁻¹ form **CaF₂**

Li¹⁺ and PO₄³⁻ form **Li₃PO₄**

Pb⁴⁺ and S²⁻ form **Pb₂S₄** which reduces to **PbS₂**

Mn²⁺ and ClO₃⁻¹ form **Mn(ClO₃)₂**

Chemistry SOL Review—Nomenclature, Formulas and Reactions

Naming Ionic Compounds

- Write the name of the cation.
- If the anion is an element, change its ending to *-ide*; if the anion is a polyatomic ion, simply write the name of the polyatomic ion.
- If the cation can have more than one possible charge, write the charge as a Roman numeral in parentheses.

Name the following compounds

CaF₂ _____

Li₃PO₄ _____

PbS₂ _____

Mn(ClO₃)₂ _____

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Naming Ionic Compounds

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Name the following compounds

CaF₂ **Calcium fluoride**

Li₃PO₄ **Lithium phosphate**

PbS₂ **Lead (IV) sulfide**

Mn(ClO₃)₂ **Manganese (II) chlorate**

Chemistry SOL Review—Nomenclature, Formulas and Reactions

- ▶ The correct formula for copper (I) bromide is —
 - CuBr
 - CuBr₂
 - Cu₂Br
 - Cu₂Br₃
- ▶ Elements from which two groups in the periodic table would *most* likely combine with each other to form an ionic compound?
 - 1 and 2
 - 16 and 17
 - 1 and 17
 - 17 and 18
- ▶ Which is the correct formula for iron (III) sulfate?
 - Fe₃(SO₄)₂
 - FeSO₄
 - Fe₂(SO₄)₃
 - Fe₂(SO₃)₃

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- ▶ The type of bond found in magnesium chloride is —
 - covalent
 - nonpolar
 - ionic
 - metallic
- ▶ When naming a transition metal that has more than one oxidation number, the numeric value of the oxidation number is indicated by a —
 - Roman numeral _
 - Greek prefix
 - subscript
 - suffix
- ▶ The formula H₂SO₄ is representative of which of the following?
 - A catalyst
 - A base
 - An acid
 - An organic compound

Chemistry SOL Review—Nomenclature, Formulas and Reactions

Molecular Compounds

Molecular compounds are composed of two non-metals (above the staircase)

Indicate # of each atom using prefixes (mono, di, tri, tetra, penta, hexa, hepta, octa, nona, deca)

The first element does not use mono if there's only one.

Examples:

OF₂ is named oxygen difluoride

N₂O is named dinitrogen monoxide

You try:

NO₂ _____

P₂O₄ _____

Chemistry SOL Review—Nomenclature, Formulas and Reactions

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Examples:

OF₂ is named oxygen difluoride

N₂O is named dinitrogen monoxide

You try:

NO₂ **nitrogen dioxide**

P₂O₄ **diphosphorus tetroxide**

Chemistry SOL Review—Nomenclature, Formulas and Reactions

- ▶ The correct name for P₂O₅ is —
 - phosphorus (V) pentoxide
 - phosphorus oxide
 - phosphorus (II) oxide
 - diphosphorus pentoxide
- ▶ Which compound contains both ionic and covalent bonds?
 - NH₄Cl
 - MgBr₂
 - CH₄
 - NH₃
- ▶ Which of the following is the name of the molecule PCI₃?
 - Phosphorus trichloride _
 - Phosphorus chloride
 - Potassium trichloride
 - Potassium chloride

Chemistry SOL Review—Nomenclature, Formulas and Reactions

► The formula for dinitrogen tetroxide is —

- A N₂O₄
 B N₃O₃
 C N₂O₂
 D NO

► What is the correct Lewis dot structure for arsenic?

- A 
 B 
 C 
 D 

Chemistry SOL Review—Nomenclature, Formulas and Reactions

Molecular and Empirical Formulas

•Molecular Formulas provide the true number of atoms in a compound (often a multiple of the Empirical formula)

•Empirical formulas give the ratio of the elements found in a compound

•Structural formulas show how the atoms are connected.

Molecular Formula	Empirical Formula
C ₆ H ₆	CH
C ₂ H ₆	CH ₃
C ₂ H ₂ O ₄	CHO ₂



Chemistry SOL Review—Nomenclature, Formulas and Reactions

Elemental analysis of nicotine reports 74.2% carbon, 8.64% hydrogen and 17.2% nitrogen. Determine the simplest (empirical) formula for nicotine.

Solution:

We will assume 100 grams of sample, therefore,

$$74.2 \text{ g C} \left(\frac{1 \text{ mol C}}{12.0 \text{ g}} \right) = 6.18 \text{ mol of C atoms}$$

$$8.64 \text{ g H} \left(\frac{1 \text{ mol H}}{1.01 \text{ g}} \right) = 8.57 \text{ mol of H atoms}$$

$$17.2 \text{ g N} \left(\frac{1 \text{ mol N}}{14.0 \text{ g}} \right) = 1.23 \text{ mol of nitrogen atoms}$$

The ratio for these three elements is,

$$6.18 \text{ mol of C atoms} : 8.57 \text{ mol of H atoms} : 1.23 \text{ mol of N atoms}$$

dividing through by the smallest number we can get whole numbers

$$5.03 \text{ C} : 6.97 \text{ H} : 1 \text{ N}$$

the empirical formula for nicotine is C₅H₇N.

Chemistry SOL Review—Nomenclature, Formulas and Reactions

Example

The compound ethylene glycol is often used as an antifreeze. It contains 38.7% carbon, 9.75% hydrogen, and the rest oxygen. The molecular weight of ethylene glycol is 62.07 g. What is the molecular formula of ethylene glycol?

1. Calculate the empirical formula. Assume 100 g of the compound, which will contain 38.70 g carbon, 9.75 g hydrogen and the rest oxygen

$$? \text{ g O} = 100 \text{ g} - 38.70 \text{ g C} - 9.75 \text{ g H} = 51.55 \text{ g O.}$$

2. Calculate the moles of each element present:

$$? \text{ g mol C} = 38.70 \text{ g C} \times \frac{1 \text{ mol C}}{12.01 \text{ g C}} = 3.22 \text{ mol C}$$

$$? \text{ g mol H} = 9.75 \text{ g H} \times \frac{1 \text{ mol H}}{1.008 \text{ g H}} = 9.67 \text{ mol H}$$

$$? \text{ g mol O} = 51.55 \text{ g O} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = 3.22 \text{ mol O}$$

3. Next calculate the ratio of molecular weight to empirical formula weight. The molecular weight is given. The empirical formula is CH₃O, so the empirical formula weight is 12.01 + 3(1.008) + 16.00 = 31.03.

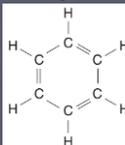
$$\frac{\text{molecular weight}}{\text{empirical formula weight}} = \frac{62.07}{31.03} = 2$$

Therefore the molecular formula is twice the empirical formula: C₂H₆O₂.

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► The diagram shows the structural formula of benzene. The empirical and the molecular formulas of benzene are, respectively —

- A CH, C₂H₂
 B CH, C₃H₃
 C C₃H₃, C₆H₆
 D CH, C₆H₆



► The empirical formula for a substance is CH₂. If the molecular mass of the substance is 56, the molecular formula is —

- A C₂H₄
 B C₃H₆
 C C₄H₈
 D C₅H₁₀

► The empirical formula for C₆H₁₂ is —

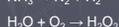
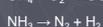
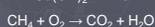
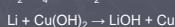
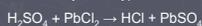
- A C₃H₆
 B C₂H₄
 C CH₃
 D CH₂

Chemistry SOL Review—Nomenclature, Formulas and Reactions

Types of Reactions

- AX + B → BX + Y single replacement
- AX + BY → AY + BX double replacement
- AB → A + B decomposition
- A + B → AB combination or synthesis
- C_xH_y + O₂ → CO₂ + H₂O combustion

You identify each type



Chemistry SOL Review—Nomenclature, Formulas and Reactions

Types of Reactions

- $AX + B \rightarrow BX + Y$ single replacement
<http://www.youtube.com/watch?v=QSZ-3wScePM>
- $AX + BY \rightarrow AY + BX$ double replacement
<http://jchemed.chem.wisc.edu/JCESoft/CCA/pirelli/pages/cca1NaHgCl2.html>
- $AB \rightarrow A + B$ decomposition
- $A + B \rightarrow AB$ combination or synthesis
- $C_xH_y + O_2 \rightarrow CO_2 + H_2O$ combustion

You identify each type

- $H_2SO_4 + PbCl_2 \rightarrow HCl + PbSO_4$ Double Replacement
- $Li + Cu(OH)_2 \rightarrow LiOH + Cu$ Single Replacement
- $CH_4 + O_2 \rightarrow CO_2 + H_2O$ Combustion
- $NH_3 \rightarrow N_2 + H_2$ Decomposition
- $H_2O + O_2 \rightarrow H_2O_2$ Synthesis or combination

Chemistry SOL Review—Nomenclature, Formulas and Reactions

Balancing Equations

Chemical Reactions should have the same number of atoms on each side to follow the *Law of Conservation of Mass*. Use coefficients (numbers in front) to balance the equations.



Al	1	Al	1
Fe	2	Fe	1
Cl	2	Cl	3

Count the number of atoms on each side and track the changes as you make them.

Chemistry SOL Review—Nomenclature, Formulas and Reactions

Balancing Equations

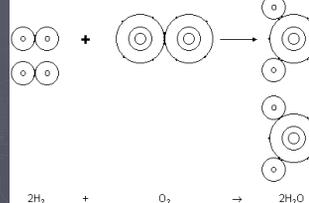
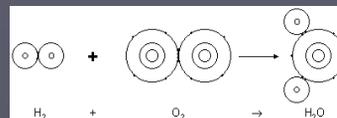
Chemical Reactions should have the same number of atoms on each side to follow the *Law of Conservation of Mass*. Use coefficients (numbers in front) to balance the equations.



Al	1	→	2	Al	1	→	2
Fe	1	→	3	Fe	1	→	3
Cl	2	→	6	Cl	3	→	6

Count the number of atoms on each side and track the changes as you make them.

Chemistry SOL Review—Nomenclature, Formulas and Reactions



Chemistry SOL Review—Nomenclature, Formulas and Reactions

- Which of the following best represents the reaction between hydrochloric acid and sodium hydroxide?

- A $2HCl + 2NaOH \rightarrow Na(OH)_2 + H_2Cl_2$
- B $HCl_2 + 2Na(OH)_2 \rightarrow 2H_2O + 2NaCl + OH$
- C $HCl + NaOH \rightarrow H_2O + NaCl$
- D $2HCl + Na(OH)_2 \rightarrow 2H_2 + NaCl + O_2$

- Which of these reactions shows simple chemical decomposition?

- A $H_2 + I_2 \rightarrow 2HI$
- B $2NaCl \rightarrow 2Na + Cl_2$
- C $NaF + HCl \rightarrow HF + NaCl$
- D $I_2 + 2NaCl \rightarrow 2NaI + Cl_2$

- Which of the following is the balanced chemical equation for the reaction shown?

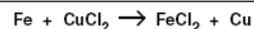
- A $Al + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2$
- B $2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$
- C $2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2$
- D $2Al + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2$

Aluminum +Sulfuric Acid →
Aluminum Sulfate + Hydrogen Gas

Chemistry SOL Review—Nomenclature, Formulas and Reactions

- The type of reaction represented by the equation is —

- A single-replacement
- B double-replacement
- C synthesis
- D decomposition



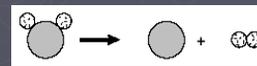
- $A(s) + B(s) \rightarrow D(g) + \text{heat}$

The reaction shown above is —

- A an endothermic reaction
- B an exothermic reaction
- C a decomposition reaction
- D a double-replacement reaction

- What type of reaction does this illustration represent?

- A Decomposition
- B Synthesis
- C Single-replacement
- D Double-replacement



Chemistry SOL Review—Nomenclature, Formulas and Reactions

► A balanced chemical equation has equal numbers of atoms of each type on both sides of the equation. This illustrates the principle of —

- A conservation of energy
- B conservation of mass
- C action and reaction
- D natural selection

Chemistry SOL Review—Nomenclature, Formulas and Reactions

Drawing Lewis Structures and Predicting Geometric Shapes

Step 1: Count the number of valence electrons $\text{PO}_3^{3-} = 5 + 3(6) + 3 = 26$ valence e- in the compound

Chemistry SOL Review—Nomenclature, Formulas and Reactions

Drawing Lewis Structures and Predicting Geometric Shapes

Step 1: Count the number of valence electrons in the compound $\text{PO}_3^{3-} = 5 + 3(6) + 3 = 26$ valence e-

Step 2: Connect the atoms around the central atom by single bonds



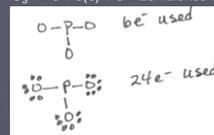
Chemistry SOL Review—Nomenclature, Formulas and Reactions

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Step 3: Place remaining electrons on the outside atoms to fulfill octet rule



Chemistry SOL Review—Nomenclature, Formulas and Reactions

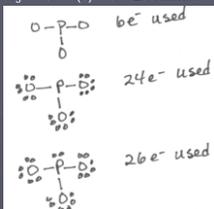
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Step 4: Place any remaining electrons on the central atom.



Chemistry SOL Review—Nomenclature, Formulas and Reactions

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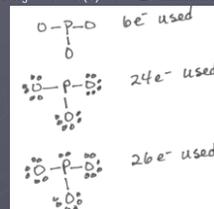
Step 2: Connect the atoms around the central atom by single bonds

Step 3: Place remaining electrons on the outside atoms to fulfill octet rule

Step 4: Place any remaining electrons on the central atom.

Step 5: If the central atom does not have an octet, share pairs of electrons as bonds from outside atoms.

Step 5 unnecessary



Chemistry SOL Review—Nomenclature, Formulas and Reactions

Drawing Lewis Structures and Predicting Geometric Shapes

Step 1: Count the number of valence electrons $\text{CO}_2 = 4 + 2(6) + 16$ valence e- in the compound

Chemistry SOL Review—Nomenclature, Formulas and Reactions

Drawing Lewis Structures and Predicting Geometric Shapes

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Chemistry SOL Review—Nomenclature, Formulas and Reactions

Drawing Lewis Structures and Predicting Geometric Shapes

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Step 2: Connect the atoms around the central atom by single bonds



Step 3: Place remaining electrons on the outside atoms to fulfill octet rule



Step 4: Place any remaining electrons on the central atom.

skip 4

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Drawing Lewis Structures and Predicting Geometric Shapes

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skip 4



Step 4: Place any remaining electrons on the central atom.

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Chemistry SOL Review—Nomenclature, Formulas and Reactions

► The correct structural formula for C_2H_4 is —



Chemistry SOL Review—Nomenclature, Formulas and Reactions

- If the above diagram were the correct representation for the Lewis structure of a molecule, then the X would be representative of the element —

A oxygen
B fluorine
C nitrogen
D sulfur

- The figure shows a compound containing hydrogen (H) and an unknown element Z. To which group on the periodic table does element Z belong?

A 13
B 14
C 15
D 16



- The type of formula that shows the arrangements of atoms and bonds is called —

A empirical
B chemical
C molecular
D structural

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Drawing Lewis Structures and Predicting Geometric Shapes

VSEPR THEORY

Valence

Shell

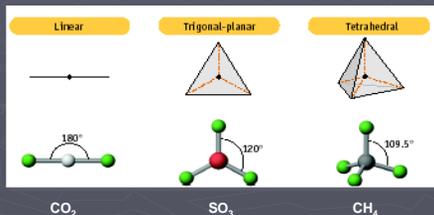
Electron

Pair

Repulsion

Molecules adopt the shape that minimizes electron pair repulsions.

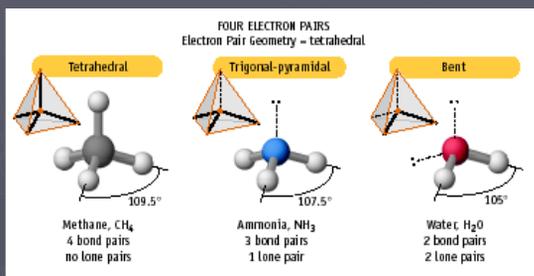
The electron pairs/groups around the central atom get as far apart as possible.



Chemistry SOL Review—Nomenclature, Formulas and Reactions

Drawing Lewis Structures and Predicting Geometric Shapes

Geometries for Four Electron Pairs Around a Central Atom



Chemistry SOL Review—Nomenclature, Formulas and Reactions

- Which of the following is the correct molecular shape of CH_4 ?

A Bent
B Linear
C Pyramidal
D Tetrahedral

- What shape does the molecule BF_3 have?

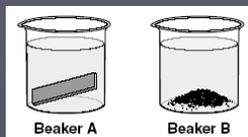
A Bent
B Linear
C Tetrahedral
D Trigonal planar

Chemistry SOL Review—Nomenclature, Formulas and Reactions

Reaction Rates and Kinetics

Ways to speed up reactions:

1. Decrease particle size (grind the sample)
2. Increase heat
3. Add catalyst
4. Increase concentration of reagents

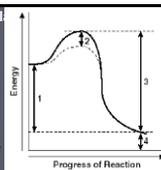


<http://chemed.chem.wisc.edu/JCESoft/CCA/pirelli/pages/cca3heart.html>

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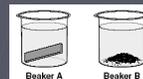
- The diagram is a potential energy curve for a reaction. Which number represents the effect of a catalyst on the reaction?

A 1
B 2
C 3
D 4



- Each beaker shown contains 2.2 grams of iron and 1 liter of 3M H_2SO_4 at STP. Which reaction will go to completion first and why?

A Beaker A because of increased surface area
B Beaker B because of increased surface area
C Beaker A because of a higher concentration level
D Beaker B because of a higher concentration level



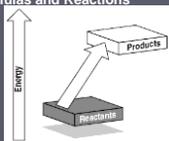
- A catalyst is a substance used in chemical reactions to —

A provide a higher activation energy pathway
B decrease collisions between reactant molecules
C increase the rate of the reaction
D change the equilibrium to favor products

Chemistry SOL Review—Nomenclature, Formulas and Reactions

► This diagram of a chemical reaction shows that the reaction is —

- A endothermic
- B exothermic
- C reversible
- D at equilibrium



► If the temperature of a reaction is increased, the reaction proceeds at a much quicker rate because the —

- A activation energy increases
- B energy of the products increases
- C frequency of collisions between reactants increases
- D energy of the activated complex Increases

► In the above reaction, a cloudiness at completion due to colloidal suspension of sulfur appears. If the reaction is carried out at various temperatures, at which temperature would it proceed at the fastest rate?

- A 20° C
- B 30° C
- C 40° C
- D 50° C

