

# Ontario High School Grade 11 Chemistry

**Summer 2024, Chapter 3 Notes** 



# Welcome to Wizeprep

#### These notes were created on Jun 4th, 2024

We're always updating our content. Check back for more.





#### Welcome to Your Course Notes

I'm Dana, your Wizeprep chemistry tutor. I put these notes and the corresponding online course together especially for Grade 11 Chemistry at Ontario High School. It's formulated to tell you everything you need to know, in a quick and easy format so you can get better grades, spend less time studying, and more time living.

Dana 4.4/5 🛨 MSc

#### **Find Your Course Online**

These course notes correspond to an online course full of video lectures, practice problems, instructor Q&A and more. Access it with this QR code or at wizeprep.com/in-course-experience/Sch3U-High-School



98%

Of Wizeprep **Students Get Better Grades**  66

After discovering Wizeprep at the beginning of my second semester, my grades have gone up significantly. I feel so much more confident when taking my exams.



**Emily, Undergraduate Student** 

# Your Wizeprep Resources



#### **Get Better Grades**

98% of students who study with Wizeprep reported higher grades



#### **Really Understand Concepts**

Our instructors know how to make complex topics feel simple



#### **Cut Your Study Time in Half**

Quick, curated lessons allow you to focus your study time where it matters

#### **Find in These Course Notes**

#### 🔀 Relevant Theory

All the theory and expert knowledge you need to fully understand your course.

#### **Practice Questions**

Tons of practice problems, similar to those expected on your exam.

#### **Exam Tips**

Unique exam writing tips proven to help you score higher.

#### **Find Online**

#### □ Bite-Sized Video Lessons

Each section corresponds to a minutes-long video explanation by your expert instructors.

#### Solutions to Problems

See the solutions to the practice problems as well as a step-by-step breakdown of the answers.

#### 24/7 Instructor Q&A

Need help clarifying a concept? You have direct access to your instructor.

#### Not subscribed yet?

Get started for free on Wizeprep.com



# **Table of Contents**

Chapter 3. Chemical Bonding	3.3.4. Example: Drawing Lewis Structure with
	Double Bond
3.1. Bonding Theory	3.3.5. Example: Drawing Lewis Structures for
3.1.1. Types of Chemical Bonds	lons
3.1.2. Electronegativity	3.3.6. Practice Level 1
3.1.3. Metallic Bonding	3.3.7. Practice Level 2
3.1.4. Valence Electrons and Ions	3.3.8. Practice Level 3
3.1.5. Properties of Ionic and Molecular Compounds	3.4. Valence Shell Electron Pair Repulsion Theory (VSEPR)
<ul><li>3.1.6. Example: Identifying Chemical Bonds</li><li>3.1.7. Practice Level 1</li></ul>	3.4.1. Valence Shell Electron Pair Repulsion Theory (VSEPR)
3.1.8. Practice Level 2	3.4.2. Example: VSEPR Shapes
3.1.9. Practice Level 3	3.4.3. Practice Level 1
3.2. Naming Conventions	3.4.4. Practice Level 2
3.2.1. Naming Ionic Compounds	3.4.5. Practice Level 3
3.2.2. Naming Molecular Compounds	3.5. Intermolecular Forces
3.2.3. Example: Providing Chemical Formulae for	3.5.1. Molecular Polarity
Ionic Compounds	3.5.2. Types of Intermolecular Forces Theory
3.2.4. Example: Naming Molecular Compounds	3.5.3. How to Determine Molecular Polarity
3.2.5. Practice Level 1	3.5.4. Example: Molecular Polarity
3.2.6. Practice Level 2	3.5.5. Example: Strength of Intermolecular
3.2.7. Practice Level 3	Forces
3.3. Lewis Diagrams	3.5.6. Practice Level 1
3.3.1. Lewis Dot Diagrams	3.5.7. Practice Level 2
3.3.2. Drawing Lewis Structures	3.5.8. Practice Level 2

3.5.9. Practice Level 3

3.3.3. Example: Lewis Structures

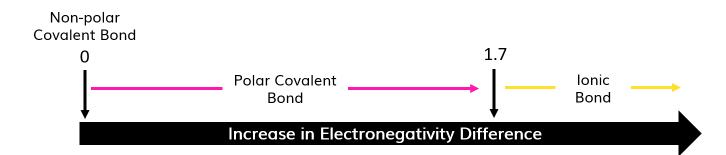
# 3. Chemical Bonding

# 3.1 Bonding Theory

3.1.1

# **Types of Chemical Bonds**

• We classify chemical bonds based on the difference in electronegativity between the atoms that form said bond



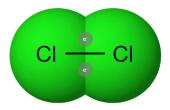
#### **Covalent Bonds:**

• Covalent bonds are bonds where electrons are shared between two non-metals

#### **Non-polar Covalent Bonds:**

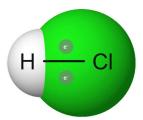
• In non-polar covalent bonds, electrons are shared equally between two of the same nonmetals

Examples:  $H_2$ ,  $O_2$ ,  $N_2$ ,  $Cl_2$ 



#### **Polar Covalent Bonds:**

- In polar covalent bonds, electrons are shared unequally between two different non-metals
- There is a difference in electronegativity,  $0 < \Delta EN < 1.7$ . Since electrons are shared unequally in this bond, we say that there is a dipole moment

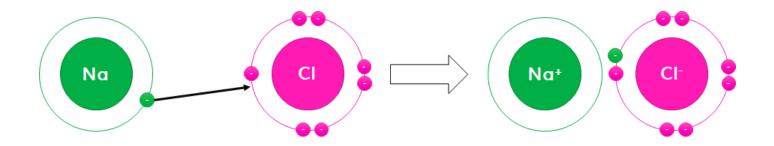


- The dipole moment is a vector with both magnitude and direction
  - $\circ$  Partial negative charge ( $\delta$ -) is assigned to the atom with the higher electronegativity
  - $\circ$  Partial positive charge ( $\delta$ +) is assigned to the atom with the lower electronegativity
- The greater the difference in electronegativity (EN), the greater the dipole moment!



#### **Ionic Bonds**

- Are between a metal and a non-metal. You might see ionic compounds called salts like NaCl
- There is a large difference in EN (1.7 <  $\Delta$ EN) in these bonds
- The metal gives electrons to the non-metal. There is a complete transfer of electrons Example: NaCl



#### Watch the video tutorial for this lesson (05:56)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=75300&activity\_type=CourseLesson



#### 3.1.2 **Electronegativity**

### Electronegativity

- Valence electrons are involved in chemical bonding.
- The type of bond depends on the difference in electronegativity (ΔΕΝ) between bonding species.
- Electronegativity is the tendency for an atom to draw bonding electrons to itself.

#### ■ WATCH OUT!

This is similar to electron affinity but not the same! Electron affinity involves a single atom/ion, whereas electronegativity involves two bonded atoms.

					Ir	ncreas	se in E	lectro	onega	tivity						<b>&gt;</b>
H 2.2																
Li 1.0	Be 1.6											<b>B</b> 2.0	C 2.5	<b>N</b> 3.0	O 3.5	<b>F</b> 4.0
<b>Na</b> 0.9	Mg 1.3											AI 1.6	Si 1.9	P 2.2	<b>S</b> 2.6	CI 3.2
K 0.8	Ca 1.0	Sc 1.4	Ti 1.5	<b>V</b> 1.6	Cr 1.7	Mn 1.5	Fe 1.8	Co 1.9	Ni 1.9	<b>Cu</b> 1.9	Zn 1.6	Ga 1.8	Ge 2.0	As 2.2	Se 2.6	<b>Br</b> 3.0
<b>Rb</b> 0.8	Sr 1.0	Y 1.2	<b>Z</b> r 1.3	Nb 1.6	Mo 2.2	Tc 1.9	<b>Ru</b> 2.2	Rh 2.3	Pd 2.2	<b>Ag</b> 1.9	Cd 1.7	In 1.8	Sn 2.0	<b>Sb</b> 1.9	Te 2.1	<b>I</b> 2.7
Cs 0.8	<b>Ba</b> 0.9	Lu 1.1	Hf 1.3	Ta 1.5	<b>W</b> 2.4	<b>Re</b> 1.9	Os 2.2	lr 2.2	Pt 2.3	<b>Au</b> 2.5	Hg 2.0	TI 1.6	Pb 2.3	Bi 2.0	Po 2.0	<b>At</b> 2.2

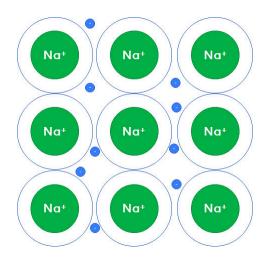
Watch the video tutorial for this lesson (01:33)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=74624&activity\_type=CourseLesson



# **Metallic Bonding**

- The diagram below shows many atoms of a metal element surrounded by a sea of electrons
  that are free to move around; we say that the electrons are delocalized
  Examples: Aluminum, Iron, Zinc
- Conduction electrons are valence electrons that are free to move
- These conduction electrons are what give the metal their properties!
  - o Ductile, malleable, conduct thermal energy, conduct electricity, have luster and shine



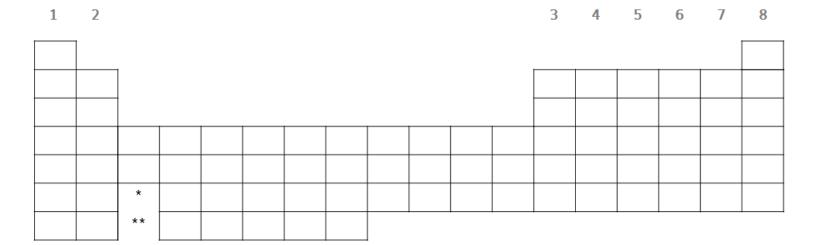
#### Watch the video tutorial for this lesson (01:13)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=76425&activity\_type=CourseLesson



### **Valance Electrons and Ions**

- Valence electrons are the electrons found in the outermost shell of an atom. These are the electrons that participate in **bonding**
- The simplest way of determining the number of valence electrons an atom has is by looking at which group an atom is in



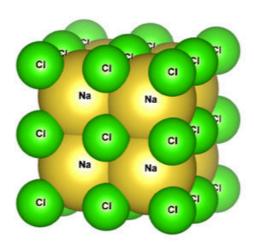
- Atoms will form ions by losing or gaining electrons, such that they obtain a full valence shell (full octet).
  - Metals will lose electrons to form cations
  - o Non-metals will gain electrons to form anions
- Multivalent atoms are atoms that can form more than one stable ion. Most transition metals are multivalent
- Polyatomic ions are ions containing more than one atom

#### Watch the video tutorial for this lesson (03:52)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School? activity\_id=75301&activity\_type=CourseLesson

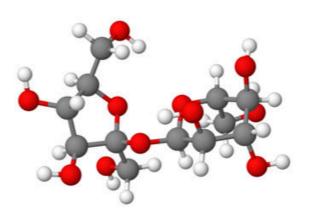


# **Properties of Ionic and Molecular Compounds**



#### Ionic Compounds

- Formed by electrostatic attraction between cations and anions
- •Formula has a combination of a metal and a non-metal
- ·Most ionic compounds are solid
- ·Conduct electricity in aqueous solutions



#### **Molecular Compounds**

- •Formed by the sharing of electron pairs between atoms
- •Formula has a combination of two or more non-metals
- Most are liquids and gases
- Poor electrical conductivity in aqueous solutions (with some exceptions)

#### Watch the video tutorial for this lesson (02:40)

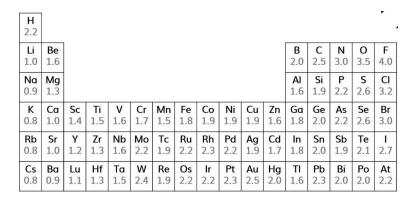
https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=75737&activity\_type=CourseLesson



#### 3.1.6 Example: Identifying Chemical Bonds

# **Example: Identifying Chemical Bonds**

Identify the type of bonding between the atoms of the following molecules



a) CO

Solution available online

b) F<sub>2</sub>

Solution available online

c) BeO

Solution available online

Watch the video tutorial for this lesson (02:26)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=75735&activity\_type=CourseLesson



#### 3.1.7

Out of the following choice, which bond is the most polar?

H-Br	0
H-F	0
H-CI	0
H-I	0

#### View Solutions on Wizeprep.com

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=113274&activity\_type=QuizQuestion

# **3.1.8** Which of the following compounds displays ionic bonding?

(	NH <sub>3</sub>	
(	NaBr	
(	CO <sub>2</sub>	
(	$Na_2SO_4$	

#### View Solutions on Wizeprep.com

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=113273&activity\_type=QuizQuestion

# **Practice: Identifying Chemical Bonds**

Determine if the elements in the following compounds are metals or non-metals. Describe the type of bonding that occurs in the compound. Use the following abbreviations:

M = metalNM = non-metalI = ionic bondC = covalent bond

Compound	Element 1 (metal or non- metal?)	Element 2 (metal or non- metal?)	Bond Type
NaCl			
СаО			
HF			
AgBr			
СО			

#### View Solutions on Wizeprep.com

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=113790&activity\_type=QuizQuestion

# **3.2** Naming Conventions

3.2.1

# **Naming Ionic Compounds**

#### **Naming Binary Ionic Compounds**

- Binary ionic compounds are composed of a monoatomic cation and a monoatomic anion Example: NaCl is made up of Na<sup>+</sup> cations and Cl<sup>-</sup> anions
- To name a binary ionic compounds. **first name the metal cation**, followed by the **base name of the non-metal anion with the ending -ide**. Subscripts in the formula do not affect the name **Example**: MgO

#### Naming Binary Ionic Compounds with Multivalent Cations

• Transition metals could form different charged ions. These atoms are known as **multivalent** atoms. You have to indicate the charge when naming the compound

Atom	Ions		
Cr	3+	6+	
Mn	2+	4+	7+
Fe	2+	3+	
Co	2+	3+	

• To name this type of ionic compounds, first name the metal cation, followed by the ion charge in roman numerals in parenthesis then the base name of the non-metal anion with the ending -ide

Example: Fe<sub>2</sub>O<sub>3</sub> is \_\_\_\_\_

#### **Naming Ionic Compounds with Polyatomic Ions**

• Naming ionic compounds that contain polyatomic ions are very similar to the naming of binary ionic compounds. First name the cation, followed by the base name of the anion. Subscripts in the formula do not affect the name

Example: NaNO<sub>3</sub> is \_\_\_\_\_

Ion	Name	Ion	Name	Ion	Name
$NH_4^+$	${f ammonium}$	$OH^-$	hydroxide	$CN^-$	cyanide
$SO_4^{2-}$	$\operatorname{sulfate}$	$O_2^{2-}$	peroxide	$CNO^-$	${ m cyanate}$
$HSO_4^-$	${\it bisulfate}$	$CH_3COO^-$	acetate	$SCN^-$	thiocyanate
$SO_3^{2-}$	$\operatorname{sulfite}$	$C\ell O_4^-$	perchlorate	$CO_3^{2-}$	$\operatorname{carbonate}$
$NO_3^-$	$_{ m nitrate}$	$C\ell O_3^-$	$\operatorname{chlorate}$	$HCO_3^-$	bicarbonate
$NO_2^-$	${f nitrite}$	$C\ell O_2^-$	$\operatorname{chlorite}$	$OOCOO^{2-}$	oxalate
$PO_4^{3-}$	${\it phosphate ion}$	$C\ell O^-$	hypochlorite ion	$S_2O_3^{2-}$	thio sulfate
$HPO_4^{2-}$	hydrogen phosphate	$CrO_4^{2-}$	${ m chromate}$	$Hg_2^{2+}$	mercury
$H_2PO_4^-$	dihydrogen phosphate	$Cr_2O_7^{2-}$	$\operatorname{dichromate}$ ion	$H_3O^+$	hydronium
$PO_3^{3-}$	phosphite ion	$MnO_4^-$	permanganate ion	$SiO_3^{2-}$	$\operatorname{silicate}$

#### Watch the video tutorial for this lesson (04:55)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=75234&activity\_type=CourseLesson



# **Naming Molecular Compounds**

- Covalent bonds are formed between two non-metals. The resulting compound is known as a molecular element or compound.
- Molecular elements are named the same as the element itself  $Example: O_2$  is ,  $H_2$  is
- Molecular compounds are usually written from least to most electronegative.
- To name a molecular compound:
  - Name the first element using the proper prefix (di, tri, etc.). If only one atom, avoid the prefix mono
  - o Name the second element with the proper prefix (including mono) using the "ide" ending

Number of Atoms	Prefix	Number of Atoms	Prefix
1	mono-	6	hexa-
2	di-	7	hepta-
3	tri-	8	octa-
4	tetra-	9	nona-
5	penta-	10	deca-

#### Example:

#### Watch the video tutorial for this lesson (02:22)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=75451&activity\_type=CourseLesson



# **Example: Providing Chemical Formulae for Ionic Compounds**

Give a chemical formula for the following compounds:



Solution available online

b) Manganese(II) oxide

Solution available online

c) Ammonium sulfate

Solution available online

#### Watch the video tutorial for this lesson (03:38)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=78118&activity\_type=CourseLesson



# **Example: Naming Molecular Compounds**

Name the following molecular compounds:

a) NF<sub>3</sub>

Solution available online

b) CCI<sub>4</sub>

Solution available online

c) N<sub>2</sub>O

Solution available online

#### Watch the video tutorial for this lesson (01:39)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=78117&activity\_type=CourseLesson



# **Practice: Naming Conventions**

In naming a binary molecular compound, the number of atoms of each element present in the molecule is indicated by:

	roman numerals	0
(	prefixes	0
(	superscripts	0
(	suffixes	0

#### View Solutions on Wizeprep.com

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School? activity\_id=113798&activity\_type=QuizQuestion

#### 3.2.6



#### MARK YOURSELF QUESTION

- 1. Grab a piece of paper and try this problem yourself.
- 2. When you're done, check the "I have answered this question" box below.
- 3. View the solution and report whether you got it right or wrong.

Practice: Naming Compounds
Name the following compounds.
a. KCIO
b. BaOH
c. PCl <sub>3</sub>
d. FeO
☐ I have answered this question

#### View Solutions on Wizeprep.com

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School? activity\_id=112594&activity\_type=QuizQuestion

#### 3.2.7



#### MARK YOURSELF QUESTION

- 1. Grab a piece of paper and try this problem yourself.
- 2. When you're done, check the "I have answered this question" box below.
- 3. View the solution and report whether you got it right or wrong.

# Practice: Determining Chemical Formulas based on Names

Write out the formula for the following. Make sure to use subscripts and brackets where appropriate.

a.	magnesium hydroxide:
b.	sodium chromate:
C.	ammonium nitrate:
d.	iron (III) phosphate:
] I hav	ve answered this question

#### View Solutions on Wizeprep.com

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=112595&activity\_type=QuizQuestion

# 3.3 Lewis Diagrams

3.3.1

# **Lewis Dot Diagrams**

• Lewis dot diagrams are diagrams in which the valence electrons of an atom are shown as dots distributed around the element's symbol.

Solution available online

#### **Bonds and Lewis Diagrams**

• We can use Lewis diagrams to show the formation of ionic compounds

#### Solution available online

• We also use Lewis diagrams to show the formation of molecular compounds. A line is used to indicate a shared pair of electrons. These diagrams are also known as Lewis structures or structural formulas

#### Solution available online

• Molecular compounds can have double (they share two pairs of electrons) and triple bonds (they three pairs of electrons). We show these using double or triple lines

#### Solution available online

#### Watch the video tutorial for this lesson (06:07)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=75393&activity\_type=CourseLesson



# **Drawing Lewis Structures**

#### **Steps for Drawing Lewis Structures**

Example: CCI<sub>4</sub>

Calculate the total number of valence electrons for the molecule.
 If drawing the Lewis structure for a ion, subtract one electron per positive charge and add one electron per negative charge

#### Solution available online

2. Write out all atoms, with the least electronegative atom in the middle

#### Solution available online

3. Connect surrounding atoms to the central atom with single bonds.

Solution available online

4. Place remaining electrons as **lone pairs** on surrounding atoms (except hydrogen), completing an octet around each atom

#### Solution available online

5. Place remaining electrons as lone pairs on the central atom.

#### Solution available online

6. Shift lone pairs to make double or triple bonds to satisfy the octet rule for all atoms

Solution available online

#### Watch the video tutorial for this lesson (05:02)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=75600&activity\_type=CourseLesson



3.3.3

# **Example: Lewis Structures**

Draw the Lewis structure of PCl<sub>3</sub>

Solution available online

#### Watch the video tutorial for this lesson (02:30)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=75601&activity\_type=CourseLesson



3.3.4

# **Example: Drawing Lewis Structure with a Double Bond**

Draw the Lewis structure for  $CO_2$ .

Solution available online

#### Watch the video tutorial for this lesson (02:56)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School? activity\_id=78190&activity\_type=CourseLesson



# **Example: Drawing Lewis Structures for Ions**

Draw the Lewis structure for the  $\mathrm{BF_4}^{\text{-}}$  ion.

Solution available online

#### Watch the video tutorial for this lesson (02:59)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=78191&activity\_type=CourseLesson



### **Practice: Periodic Table and Valence Electrons**

Which group of the periodic table can most easily donate an electron in a chemical reaction?

Halogens	0
Noble Gases	0
Alkali metals	0
Transition metals	0
Alkaline earth metals	0

#### **View Solutions on Wizeprep.com**

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School? activity\_id=112599&activity\_type=QuizQuestion

## **Practice: Valence Electrons**

Which molecule has the highest number of valence electrons?

NH <sub>3</sub>	0
CCI <sub>4</sub>	0
СО	0
Br <sub>2</sub>	0

#### **View Solutions on Wizeprep.com**

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=113778&activity\_type=QuizQuestion

# **Practice: Drawing Lewis Structures**

Draw the Lewis structure for the following molecules, then use the Lewis structures you drew to answer the following questions.

- a. CH<sub>2</sub>O
- b. H<sub>3</sub>O<sup>+</sup>
- c. NH<sub>4</sub><sup>+</sup>

#### Part 1

Whose Lewis structure has double bonds?

(	CH <sub>2</sub> O	0
	H <sub>3</sub> O <sup>+</sup>	0
(	NH <sub>4</sub> <sup>+</sup>	0
	none of them have double bonds	0

# **Practice: Drawing Lewis Structures**

Draw the Lewis structure for the following molecules, then use the Lewis structures you drew to answer the following questions.

- a. CH<sub>2</sub>O
- b. H<sub>3</sub>O<sup>+</sup>
- c. NH<sub>4</sub><sup>+</sup>

#### Part 2

Whose Lewis structure has a lone pair on the central atom?

CH <sub>2</sub> O	0
$H_3O^+$	0
NH <sub>4</sub> <sup>+</sup>	0
none have lone pairs on the central atom	0

#### View Solutions on Wizeprep.com

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School? activity\_id=113777&activity\_type=QuizQuestion

# 3.4 Valence Shell Electron Pair Repulsion Theory (VSEPR)

3.4.1

# Valence Shell Electron Pair Repulsion Theory (VSEPR)

- The VSEPR theory states that repulsion of electron groups (lone pairs and bonds) in the valence shell will determine the 3D geometry of a molecule.
- In VSEPR theory, we focus on the number of electron groups around a central atom.
  - Bonding groups
  - Non-bonding groups
- To draw a VSEPR structure, you need the Lewis structure and the number of electron groups.
  - Wedges mean the bond is coming out of the page
  - Dashes mean the bond is going into the page
- We use all the electron groups to get the electron-pair geometry.
  - o To get the molecular geometry, we look at the atoms present

#### WIZE CONCEPT

- 1. Draw Lewis structure
- 2. Determine the electron-group geometry based on the total electron groups
  - a. Two electron groups: linear
  - b. Three electron groups: trigonal planar
  - c. Four electron groups: tetrahedral
- 3. Determine the molecular geometry that minimizes repulsions

Total Pairs	Bonding Pairs	Lone Pairs	Electron Pair Arrangement	Molecular Geometry	Stereochemical Drawing
2	2	0	Linear	Linear	X—A—X
3	3	0	Trigonal Planar	Trigonal Planar	X X
4	4	0	Tetrahedral	Tetrahedral	XXXXX
4	3	1	Tetrahedral	Trigonal Pyramidal	XXXXXX
4	2	2	Tetrahedral	Bent	X X

## Watch the video tutorial for this lesson (05:10)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=75655&activity\_type=CourseLesson



#### 3.4.2 **Example: VSEPR Shapes**

# **Example: VSEPR Shapes**

Determine the electron pair arrangement and molecular geometry for NH<sub>3</sub>

Solution available online

#### Watch the video tutorial for this lesson (02:57)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=75734&activity\_type=CourseLesson



# **Practice: VSEPR Terms and Definitions**

The VSEPR model includes several concepts related to atomic theory. Match the following terms and definitions.

<b>A.</b> the outermost energy level or orbit of an atom or ion	
<b>B.</b> a shared pair of electrons	
<b>C.</b> all pairs of valence electrons repel each other	
<b>D.</b> a pair of electrons that is not involved in bonding	
valence shell	
bonding pair	
lone pair	
electron pair repulsion	
View Calutions on Winomen com	

#### View Solutions on Wizeprep.com

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=113781&activity\_type=QuizQuestion

# **Practice VSEPR Shapes**

For the following molecular geometries, fill in the table below with:

- the total number of electron groups
- the number of lone pairs on the central atom
- the number of bonding groups

Molecular Geometry	Total number of electron groups	Number of lone pairs around the central atom	Number of bonding groups
Linear			
Trigonal Planar			
Bent			
Trigonal Pyramidal			
Tetrahedral			

#### View Solutions on Wizeprep.com

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School? activity\_id=114065&activity\_type=QuizQuestion

# Practice: Determining Electron Pair Arrangement and Molecular Geometries

Use the VSEPR theory with the following molecules to answer the following questions.

- a. PF<sub>3</sub>
- b. NH<sub>4</sub><sup>+</sup>
- c. H<sub>2</sub>S

#### Part 1

Which molecule has a tetrahedral electron pair arrangement?

(	PF <sub>3</sub>	0
(	NH <sub>4</sub> <sup>+</sup>	0
(	H <sub>2</sub> S	0
(	all of them have a tetrahedral electron pair geometry	0

# Practice: Determining Electron Pair Arrangement and Molecular Geometries

Use the VSEPR theory with the following molecules to answer the following questions.

- a. PF<sub>3</sub>
- b. NH<sub>4</sub><sup>+</sup>
- c. H<sub>2</sub>S

#### Part 2

Which molecule has a trigonal pyramidal molecular geometry?

(	PF <sub>3</sub>	0
(	NH <sub>4</sub> <sup>+</sup>	0
(	H <sub>2</sub> S	0
(	none of them have a trigonal pyramidal molecular geometry	0

#### View Solutions on Wizeprep.com

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=113779&activity\_type=QuizQuestion

# 3.5 Intermolecular Forces

3.5.1

# **Molecular Polarity**

- In polar covalent bonds, electrons are shared unequally between two different non-metals
- To determine if a molecule is polar, we need to look at the whole molecule, and not just the individual bonds
  - i. If there are **no polar bonds** in the molecule, the molecule is **non-polar!** Example: O<sub>2</sub>

ii. If there are **polar bonds that are symmetrical**, the dipole moments cancel each other out so the molecule is **non-polar!** 

Example: CO<sub>2</sub>

iii. If there are polar bonds that are not symmetrical, the dipole moments don't cancel each other out and we are left with a net dipole moment, hence the molecule is polar!
Example: H<sub>2</sub>O



## Watch the video tutorial for this lesson (01:53)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=75593&activity\_type=CourseLesson

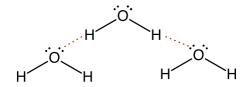


# **Types of Intermolecular Forces**

- Intermolecular forces are forces of attraction between molecules.
- Intermolecular forces define physical properties of compounds (boiling points, melting points, surface tension etc.)
- The stronger the intermolecular forces are, the higher the boiling and melting points will be

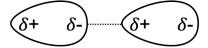
## **Hydrogen Bonding**

- The strongest of the intermolecular forces
- Hydrogen bonded to N, O, or F is attracted to lone pairs of electrons on other N, O or F



#### **Dipole - Dipole**

- Second strongest intermolecular force
- The more polar a molecule is, the stronger the forces
- Interaction between two polar molecules; opposite dipoles attract ( $\delta$  and  $\delta$ +)



#### **London Dispersion Forces**

- The weakest of intermolecular forces.
- All molecules have London dispersion forces.
- The bigger the molecule, the stronger the forces
- Molecules interact randomly and distort each other's electron clouds, causing temporary dipoles
- Electrons randomly move around and at some point, more electrons may be on one side than the other in a non-polar molecule, creating a temporary dipole. This can happen with another non-polar molecule as well and the two can interact

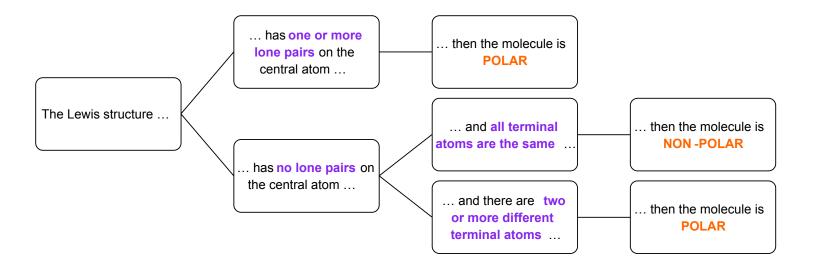


#### Watch the video tutorial for this lesson (05:38)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=74643&activity\_type=CourseLesson



# **How to Determine Molecular Polarity**



#### Watch the video tutorial for this lesson (01:05)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=78534&activity\_type=CourseLesson



# **Example: Molecular Polarity**

Determine if the following molecules are polar or not:  $CCI_4$  and  $CHCI_3$ 

Solution available online

#### Watch the video tutorial for this lesson (03:08)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=75729&activity\_type=CourseLesson



# **Example: Strength of Intermolecular Forces**

Determine which compound in the following pairs of molecules will have the higher melting point.

a)  $I_2$  or  $Br_2$ 

Solution available online

b) HF or HBr

Solution available online

#### Watch the video tutorial for this lesson (03:17)

https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=78068&activity\_type=CourseLesson



# **Practice: Intermolecular Forces and Boiling Points**

Which of the following molecules would exhibit the highest boiling point based on intermolecular forces?

H <sub>2</sub> O	0
CH <sub>4</sub>	0
NCI <sub>3</sub>	0

#### **View Solutions on Wizeprep.com**

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=113610&activity\_type=QuizQuestion

# **Practice: Molecular Polarity**

Which of the following molecules is non-polar?

SCI <sub>2</sub>	0)
OCI <sub>2</sub>	0
BeCl <sub>2</sub>	0)
all of the above molecules are polar	0)

#### View Solutions on Wizeprep.com

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School? activity\_id=113791&activity\_type=QuizQuestion

Describe the strongest intermolecular forces in the following compounds.

**A.** Dipole-Dipole

**B.** Hydrogen Bonding

C. London Dispersion

_
4





#### View Solutions on Wizeprep.com

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=112596&activity\_type=QuizQuestion

# **Practice: Comparing Boiling Points**

Hexane,  $C_6H_{14}$  (M = 86g/mol) has a boiling point of 68°C. Ethanol,  $CH_3CH_2OH$  (M = 46g/mol) has a boiling point of 78°C. Mark each of the following statements as TRUE or FALSE.

- a. Ethanol must have stronger intermolecular attractions, based on its higher boiling point.
- b. Ethanol has a higher boiling point because of greater London dispersion force
- c. Both hexane and ethanol have hydrogen bonding.
- d. Ethanol has a higher boiling point due to hydrogen bonding.

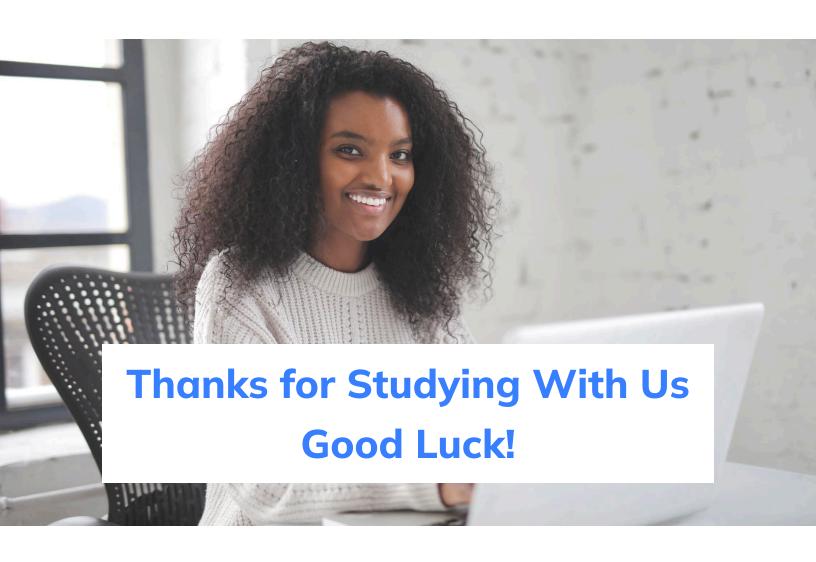
a.	
	•
b.	
	•
c.	
	•
d.	
	•

#### View Solutions on Wizeprep.com

Solutions to these questions, as well as step-by-step breakdowns of the answers at:



https://www.wizeprep.com/in-course-experience/Sch3U-High-School?activity\_id=113792&activity\_type=QuizQuestion



# Find this, and much, much more on Wizeprep.com



#### **Bite-Sized Video Lessons**

Each section corresponds to a minutes-long video explanation by your expert instructors.



#### **Solutions to Problems**

See the solutions to the practice problems as well as a step-by-step breakdown of the answers.



#### 24/7 Instructor Q&A

Need help clarifying a concept? You have direct access to your instructor.

# Also on Wizeprep.com



# **Crash Courses**

A live review of all testable concepts, exam-like practice problems, tips & tricks, and Q&A. Led by an instructor who is an expert on your course.

✓ Live Online Session ✓ Booklet ✓ Solutions ✓ Recording



# **Weekly Tutorials**

A weekly, live review of lecture topics led by an instructor who knows your course inside and out.

✓ Live Online Session
✓ Booklet
✓ Solutions
✓ Recording

First week free!



# **Mock Exam Walkthroughs**

A realistic practice exam based on past exams from your course. An instructor experienced with your course will walk through the solutions.

✓ Live Online Session ✓ Booklet ✓ Solutions ✓ Recording

# Wizeprep MCAT







Chemistry



Org Chem



**Biochem** 



**Physics** 





Psych

#### **Two Plans**

#### **ELITE 515 LIVE**

Flexible live schedules, face-time with our MCAT instructors.



515+ performance guarantee

#### **SELF-PACED**

Watch 144 hours of expert MCAT instruction whenever you have time.

#### **Both Plans Include...**

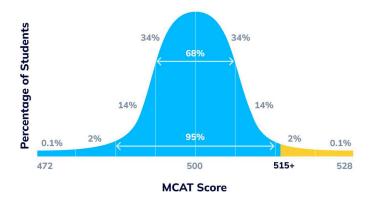
- 144 hrs of expert instruction
- 15 full-length practice exams
- ✓ 100+ practice passages
- 405+ passage-based questions

- All AAMC materials
- Personalized study plan
- 6 top-quality textbooks
- Unlimited Q&A with MCAT experts



#### **Performance Guarantee**

The Elite 515 program promises you a score of at least 515 on the MCAT or money back. A 515 puts you within the top 2% of scores!



#### Find Free MCAT Resources on Wizeprep.com/MCAT

#### **Free Live Events**

Learn about the med school application process and more.

#### Free Diagnostic Exam

Predict your MCAT score and assesses strengths and weaknesses.

#### Free Trial

Don't just take our word for it. Try out the first few lessons vourself.

# Other Courses at Ontario High **School**



# Grade 12 **Chemistry**

Resource for SCH4U



# **Grade 12 Calculus** & Vectors

Resource for MCV4U



## **Grade 12 Biology**

Resource for SBI4U



# Grade 10 **Principles of Mathematics**

Resource for MPM2D



# **Grade 12 Data** Management

Resource for MDM4U



# Grade 12 Advanced

**Functions** 

Resource for MHF4U



# Grade 11 **Functions**

Resource for MCR3U



### **Grade 12 Physics**

Resource for SPH4U



## **Grade 11 Biology**

Resource for SBI3U



# **Grade 9 Math** (De-streamed)

Resource for MTH1W