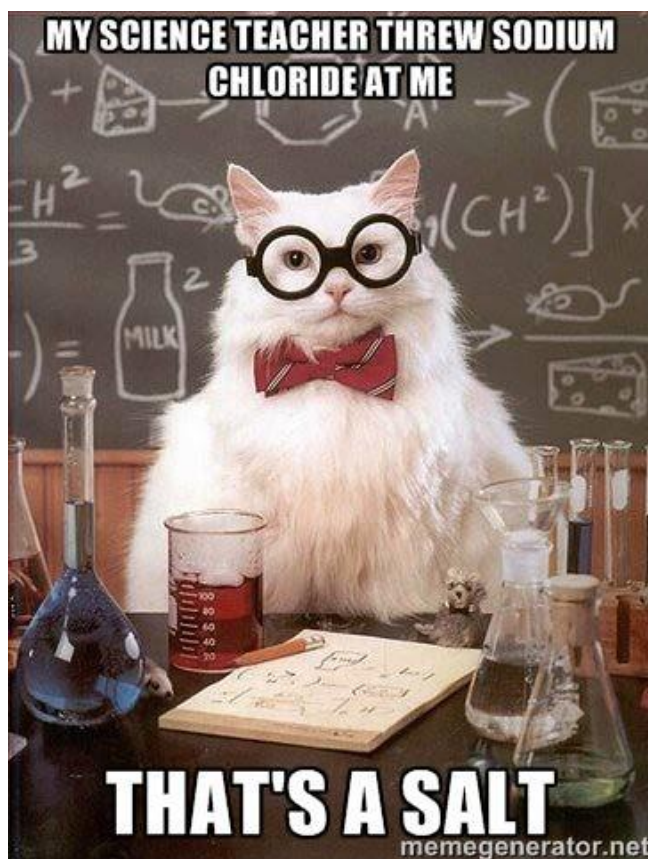


Regents Chemistry:

Practice Packet

Unit 6: Bonding



PRACTICE PACKET UNIT 6: BONDING

VOCABULARY: Define using your own words....

Anion: _____

Bond: _____

Brittle: _____

Cation: _____

Compound: _____

Covalent Bond: _____

Diatomic Molecule: _____

Ductile: _____

Dull: _____

Electrolyte: _____

Electronegativity: _____

Ionic Bonds: _____

Ionic Radius: _____

Ionization Energy: _____

Luster: _____

Malleable: _____

Metallic Bond: _____

Nonpolar covalent
Bond: _____

Nonpolar molecule: _____

Oxidation
number: _____

Polar covalent Bond: _____

PRACTICE PACKET UNIT 6: BONDING

Polar molecule: _____

Polyatomic ion: _____

Reactive: _____

Stock System: _____

PRACTICE PACKET UNIT 6: BONDING

LESSON 1: INTRO TO BONDING & TYPES OF BONDS

1. For each phrase, check either “bond breaking” or “bond forming”

		Bond Breaking	Bond Forming
a.	Energy is absorbed		
b.	Energy is released		
c.	$\text{Cl} + \text{Cl} \rightarrow \text{Cl}_2$		
d.	$\text{N}_2 \rightarrow \text{N} + \text{N}$		
e.	Stability of the chemical system increases		
f.	Stability of the chemical system decreases		

2. Identify which bond type is present in each substance below. Choices: *ionic*, *covalent*, *metallic*

	Substance	Bond type
a.	$\text{NaCl}_{(s)}$	
b.	$\text{CO}_2_{(g)}$	
c.	$\text{NO}_{(g)}$	
d.	$\text{Cu}_{(s)}$	
e.	$\text{MgBr}_2_{(g)}$	
g.	$\text{HCl}_{(aq)}$	
h.	$\text{SO}_2_{(g)}$	
i.	$\text{AlCl}_3_{(s)}$	
j.	$\text{Ag}_{(s)}$	
k.	$\text{NH}_4\text{Br}_{(s)}$	

Indicate which type of substance is described by each statement.

Choices: *covalent (molecular)*, *ionic*, *metallic*

		Type of substance
a.	Can conduct electricity in the solid and liquid phases; high melting and boiling points; malleable	
b.	Soft substance with low melting point and poor electrical conductor	
c.	Can conduct electricity when aqueous or molten (liquid); high melting and boiling points; hard and brittle	

PRACTICE PACKET UNIT 6: BONDING

3. For each example provide the type of element/compound, type of bond, and determine when and if it conducts electricity:

	Type of element or compound (metallic, ionic, molecular)	Type of Bond (Metallic, ionic, covalent, both ionic and covalent)	Conducts electricity? (check all that apply)			
			No	(s)	(l)	(aq)
a. Li_2O						
b. F_2						
c. CH_4						
d. Fe						
e. Na_3PO_4						
f. CaO						
g. Na						
h. PH_3						

Regents Challenge:

- A solid sample of a compound and a liquid sample of the same compound are each tested for electrical conductivity. Which test conclusion indicates that the compound is ionic?
 - Both the solid and the liquid are good conductors.
 - Both the solid and the liquid are poor conductors.
 - The solid is a good conductor, and the liquid is a poor conductor.
 - The solid is a poor conductor, and the liquid is a good conductor.
- Which sample of matter has particles arranged in a crystalline structure?
 - Ne(g)
 - $\text{Br}_2(l)$
 - NaCl(aq)
 - $\text{CuSO}_4(s)$
- Which sample of matter has a crystal structure?
 - $\text{Hg}(l)$
 - $\text{H}_2\text{O}(l)$
 - $\text{NaCl}(s)$
 - $\text{CH}_4(g)$
- Which substance is an electrolyte?
 - CH_3OH
 - $\text{C}_6\text{H}_{12}\text{O}_6$
 - H_2O
 - KOH
- The data table below represents the properties determined by the analysis of substances *A*, *B*, *C*, and *D*.

Substance	Melting Point ($^{\circ}\text{C}$)	Boiling Point ($^{\circ}\text{C}$)	Conductivity
<i>A</i>	-80	-20	none
<i>B</i>	20	190	none
<i>C</i>	320	770	as solid
<i>D</i>	800	1250	in solution

Which substance is an ionic compound?

- A*
- B*
- C*
- D*

PRACTICE PACKET UNIT 6: BONDING

Lesson 2: Bond Polarity

1. Electronegativity values generally _____ down a group and _____ across a period.
Metals tend to have _____ electronegativity values and nonmetals have _____ values.
2. What is a nonpolar covalent bond? Explain the electronegativity differences attributed to this type of bond.
3. What is a polar bond? Explain the electronegativity differences attributed to this type of bond.

4. Using your table above find the electronegativity difference for the two atoms in each substance. Then, check which bonds are present. If it's a metal and a nonmetal it is automatically Ionic; If covalent, indicate polar or non-polar.

Substance	Electronegativity difference(s)	Ionic Bond	Covalent Bond	
			Polar	Nonpolar
I ₂				
PCl ₃				
CO ₂				
NaCl				
NH ₃				
KCl				

5. What is a dipole?
6. How do you determine which atom gets the partial negative charge?
7. Indicate which atom will have the positive charge and which will have the negative charge in the following polar bonds:

H-Cl

H-F

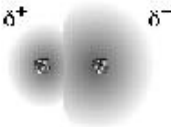


S-F

N-O

PRACTICE PACKET UNIT 6: BONDING

8. Compare the degree (which compound is most polar, which is least polar) of polarity in HF, HBr, HCl, and HI.

9. Classify the type of molecule the diagrams below represent (Ionic, Polar Covalent, or Nonpolar Covalent), and explain your reasoning.

Electron Distribution Diagram	Type of Compound	Reason for Classification of Compound
		
		
		

Regents Questions:

- The electronegativity difference between the atoms in a molecule of HCl can be used to determine
 - the entropy of the atoms
 - the atomic number of the atoms
 - the first ionization energy of the atoms
 - the polarity of the bond between the two atoms
- Which formula represents a molecule with the most polar bond?
 - CO
 - NO
 - HI
 - HCl
- The degree of polarity of a chemical bond in a molecule of a compound can be predicted by determining the difference in the
 - melting points of the elements in the compound
 - densities of the elements in the compound
 - electronegativities of the bonded atoms in a molecule of the compound
 - atomic masses of the bonded atoms in a molecule of the compound

PRACTICE PACKET UNIT 6: BONDING

LESSON 3: LEWIS (ELECTRON) DOT DIAGRAMS FOR IONIC COMPOUNDS

1. Complete the table below (electron dot diagrams for ions)

	Ion	Electron Configuration	Electron-dot Diagram		Ion	Electron Configuration	Electron-dot structure
a.	sodium Na ⁺			e.	oxide O ²⁻		
b.	aluminum Al ³⁺			f.	bromide Br ⁻		
c.	calcium Ca ²⁺			g.	phosphide P ³⁻		
d.	magnesium Mg ²⁺			h.	sulfide S ²⁻		

2. Complete the table below (electron dot diagrams for ionic compounds)

	Ionic compound (name & formula)	Electron-dot Diagram	Total # of ions		Ionic compound (name & formula)	Electron-dot structure	Total # of ions
a.	sodium fluoride NaF			f.	aluminum chloride AlCl ₃		
b.	potassium chloride KCl			g.	sodium sulfide Na ₂ S		
c.	calcium iodide CaI ₂			h.	lithium hydride LiH		
d.	magnesium oxide MgO			i.	aluminum oxide Al ₂ O ₃		
e.	rubidium oxide Rb ₂ O			j.	calcium phosphide Ca ₃ P ₂		

PRACTICE PACKET UNIT 6: BONDING

LESSON 4: LEWIS (ELECTRON) DOT DIAGRAMS FOR COVALENT SUBSTANCES

1. Complete the chart.

	Molecule (name & formula)	Total # of valence e-'s	Electron-dot structure		Molecule (name & formula)	Total # of valence e-'s	Electron-dot structure
a.	methane CH ₄			g.	carbon tetrachloride CCl ₄		
b.	nitrogen N ₂			h.	carbon dioxide CO ₂		
c.	ammonia NH ₃			i.	phosphorus trichloride PCl ₃		
d.	water H ₂ O			j.	dihydrogen monosulfide H ₂ S		
e.	oxygen O ₂			k.	carbon monoxide CO		
f.	fluorine F ₂			l.	hydrogen H ₂		

PRACTICE PACKET UNIT 6: BONDING

MORE PRACTICE:

Draw the Lewis (electron) dot structures for the following molecular (covalent) substances.

Cl ₂	SH ₂
H ₂	CF ₄
CS ₂	CH ₃ Br
SF ₂	HF

PRACTICE PACKET UNIT 6: BONDING

LESSON 5: MOLECULAR POLARITY

1. Fill in the chart below.

	Molecule	Bond Polarity (polar or nonpolar covalent)	Distribution of charge? (symmetrical or asymmetrical)	Molecular Polarity (polar or nonpolar molecule)
a.	$\begin{array}{c} \text{H}-\overset{\cdot\cdot}{\text{N}}-\text{H} \\ \\ \text{H} \end{array}$			
b.	$\text{:}\ddot{\text{O}}=\text{C}=\ddot{\text{O}}\text{:}$			
c.	$\begin{array}{c} \text{:}\ddot{\text{Cl}}-\text{P}-\ddot{\text{Cl}}\text{:} \\ \\ \text{:}\ddot{\text{Cl}}\text{:} \end{array}$			
d.	$\text{:}\ddot{\text{O}}=\ddot{\text{O}}\text{:}$			
e.	$\text{:}\text{C}\equiv\text{O}\text{:}$			
f.	$\begin{array}{c} \text{H}-\overset{\cdot\cdot}{\text{O}}\text{:} \\ \\ \text{H} \end{array}$			
g.	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$			

2. How can a molecule be nonpolar if it contains polar bonds?

PRACTICE PACKET UNIT 6: BONDING

3. Fill in the chart below:

Molecule	Dot Diagram	Distribution of Charge (symmetrical or asymmetrical)	Molecular Polarity (polar or nonpolar molecule)
CCl₄			
NF₃			
Br₂			
CS₂			

PRACTICE PACKET UNIT 6: BONDING

LESSON 6: INTERMOLECULAR FORCES (IMF'S)

1. List the noble gases from highest to lowest boiling point. Explain your answer based on intermolecular forces of attraction.
2. Explain in terms of intermolecular forces, why I_2 is a solid, Br_2 is a liquid but Cl_2 and F_2 are gases even though they are all Halogens.
3. Why does gasoline (C_8H_{18}) exist in the liquid form while methane (CH_4), the gas we use to power our Bunsen burners, exists in the gas form even though both compounds are nonpolar?
4. Identify the type of bonding and, if covalent, the type of intermolecular forces that exist in the following substances:

Substance	Type of Bonding	Type of IMF
H_2O		
N_2		
HCl		
$LiCl$		

5. Which of the following will have the higher boiling point? Explain your answer using intermolecular forces. NH_3 or N_2

PRACTICE PACKET UNIT 6: BONDING

- Why does dry ice (solid CO_2) evaporate before sodium chloride?
- In terms of the forces of attraction holding them together, explain why a NaCl crystal has a melting point of 800°C while an ice cube of pure water has a melting point of 0°C .
- List the following substances from highest to lowest melting point; use attractive force to justify your answers. KCl , Cl_2 , CH_4 , H_2O , PCl_3

Regents Questions

- The table below shows the normal boiling point of four compounds.

Compound	Normal Boiling Point ($^\circ\text{C}$)
$\text{HF}(\ell)$	19.4
$\text{CH}_3\text{Cl}(\ell)$	-24.2
$\text{CH}_3\text{F}(\ell)$	-78.6
$\text{HCl}(\ell)$	-83.7

Which compound has the strongest intermolecular forces?

- A) $\text{HF}(\ell)$ B) $\text{CH}_3\text{Cl}(\ell)$
C) $\text{CH}_3\text{F}(\ell)$ D) $\text{HCl}(\ell)$
- Base your answer to the following question on the information below.

Some Properties of Three Compounds at Standard Pressure

Compound	Boiling Point ($^\circ\text{C}$)	Solubility in 100. Grams of H_2O at $20.^\circ\text{C}$ (g)
ammonia	-33.2	56
methane	-161.5	0.002
hydrogen chloride	-84.9	72

Explain, in terms of intermolecular forces, why ammonia has a higher boiling point than the other compounds in the table.

PRACTICE PACKET UNIT 6: BONDING

Unit Review/Study Guide

INTRODUCTION TO BONDING

Elements are the simplest form of matter and cannot be decomposed. Compounds can be formed between two or more elements. They can be decomposed chemically.

a. Which of the following is a compound? Ne H₂O Be F

b. Which of the following cannot be decomposed by chemical means?

 C₁₂H₂₄ NH₃ Li CS₂

Atoms bond in order to obtain a stable electron configuration, like noble gases, called the **octet**. Most atoms will gain or lose electrons in order to have eight valence electrons. However, small elements such as H, Li, and Be will settle for two valence electrons. Obtaining an octet makes the atoms more stable and they can release energy. The electrons obtain the octet by sharing or transferring electrons.

a. Draw the Lewis dot diagram of the following elements:

 Na Mg Al Si

 P S Cl Ar

b. Draw the Lewis dot diagram of the following ions:

 Na⁺ Mg⁺² Al⁺³

 P⁻³ S⁻² Cl⁻

c. Explain why the metals lost electrons but the nonmetals gained electrons.

d. Fill the blanks with **release or absorb**: "When atoms bond they _____ energy. In order to break a bond, energy must be _____."

PRACTICE PACKET UNIT 6: BONDING

IONIC BONDING

Compounds that form between a metal and a nonmetal contain **ionic bonds**, transferring electrons. Ionic bonds are strong. Ionic compounds have high melting points, are generally solids at room temperature, and conduct in the liquid phase.

- | | | | |
|---|-------------------|--------------------------------|-----------------|
| a. Which of the following has ionic bonds? | NaCl | NH ₃ | Mg |
| b. Which of the following transfers electrons? | MgBr ₂ | Li | CO ₂ |
| c. Which of the following has a lower melting point? | Cu | C ₆ H ₁₂ | LiF |
| d. Which of the following can conduct in the aqueous phase? | NO | KI | Ne |

COVALENT BONDING

Compounds that form between two nonmetals have **covalent bonds**, sharing electrons. Covalent bonds are weaker than ionic bonds. Covalent compounds have low melting points, are generally gases, liquids, or powdery solids at room temperature, and never conduct. These are also known as **molecular compounds**.

- | | | | |
|--|------------------|-------------------|-------------------|
| a. Which of the following has covalent bonds? | HF | LiCl | Rb |
| b. Which of the following shares electrons? | H ₂ O | Ag | CaCl ₂ |
| c. Which of the following can never conduct electricity? | Kr | Rb ₂ O | H ₂ O |
| d. Which of the following has both ionic and covalent bonds? | Li | NH ₃ | CaCO ₃ |
| e. Which of the following is a molecular compound? | H ₂ O | Mg | LiBr |

METALLIC BONDING

Metallic Bonds form when a metal loses their valence electrons and a “sea of mobile electrons” form that allows the metal to conduct electricity in the solid or liquid phase.

- | | | | |
|---|------|--------------------------------|-------------------|
| a. Which of the following is metallic? | NaCl | NH ₃ | Mg |
| b. Which of the following has a sea of mobile electrons? | Cu | C ₆ H ₁₂ | LiF |
| c. Which of the following can conduct in the solid phase? | Ne | Ag | CaCl ₂ |

PRACTICE PACKET UNIT 6: BONDING

NAMING COMPOUNDS/FORMULA WRITING

When **Ionic Compounds**, always name the positive, cation first and then the negative, anion last. The elements are named in the same order they appear on the periodic table. When compounds have more than 2 elements, it contains a polyatomic ion. Use Table E on page 2 of your reference tables. Transition Metals are in the middle group of the periodic table. Nonmetals are on the right side of the staircase. They have multiple charges or oxidation numbers and so you must show which charge you are using with roman numerals. Polyatomic ions are a group of 2 or more atoms that are bonded very strongly and act as one ion. Name the following:



To write a formula of an ionic compound, write the two ions separately showing their charges. Charges are on the periodic table. Then, swap the two numbers and drop the sign. Write the formula for the following:

Sodium fluoride

Cesium oxide

Strontium acetate

Aluminum phosphate

Iron(III) iodide

Manganese (VII) oxide

When naming **Covalent Compounds**, use prefixes to indicate the number of each atom present in the compound. Determine the prefix of each element using the subscript #. Remember, if only 1 atom is present for the first element do not use the prefix mono for that atom. Name the following:



PRACTICE PACKET UNIT 6: BONDING

To write a formula of a covalent compound, write the least electronegative element first. Determine the prefix of each element using the subscript #. Write the formula for the following:

Sulfur hexafluoride

Nitrogen dioxide

Carbon Dioxide

Nitrogen monoxide

LEWIS STRUCTURES/GEOMETRY

Ionic Lewis diagrams show the ions involved in the bond, but no arrangement. Covalent Lewis diagrams show the sharing of electrons with lines representing two electrons.

- a. Draw the following, be sure to show all shared and unshared pairs. *Remember water is bent!!*

LiF

NH₃

MgF₂

CH₄

Cl₂

H₂O

POLARITY

Bonds are **polar** when two atoms have different electronegativities and share unevenly. The more electronegative atom has the electrons more of the time. **Nonpolar bonds** form when two atoms have the same electronegativity values and share equally.

- a. Label the bonds as polar or nonpolar:

NH₃

CH₄

Cl₂

H₂O

Molecules are polar when the molecule is asymmetrical. They are nonpolar if the molecule is symmetrical.

- b. Label the molecule as polar or nonpolar (Use your drawing to help you):

NH₃

CH₄

Cl₂

H₂O

PRACTICE PACKET UNIT 6: BONDING

INTERMOLECULAR FORCES

Intermolecular forces are what keeps molecules together (not atoms – atoms are held together in molecules with bonds). IMFs are responsible for melting points, boiling points, and various other properties. Nonpolar molecules have the weakest attractive forces dependent on their size (the bigger the stronger). Polar molecules have stronger forces dependent on their polarity. **Hydrogen bonds** are a special case of polar forces between H and either F, O, or N. Molecules that are hydrogen bonded have higher melting and boiling points than other polar covalent compounds.

a. Which of the following has the highest melting point? _____

HF HCl HBr HI

b. Which of the above has the lowest boiling point? _____