KEY

Chemistry 20 FINAL REVIEW (2015)

Unit A: Bonding

General Outcome 1
Students will describe the role of modelling, evidence and theory in explaining and understanding the structure, chemical bonding and properties of ionic compounds.

Students will:
20–A1.1k recall principles for assigning names to ionic compounds

Name the following compounds:

Compound	Name	Compound	Name
Na_2S	sodium sulfide	$Y_2(Cr_2O_7)_3$	yttrium dichromate
K_2SO_4	potassium sulfate	$Be(ClO_2)_2$	beryllium chlorite

20–A1.2k explain why formulas for ionic compounds refer to the simplest whole-number ratio of ions that result in a net charge of zero

Using Electron Dot Diagrams, demonstrate the formation of Lithium Phosphide.

Molecular Formula	Electron Transfer Diagram
Li_3P	

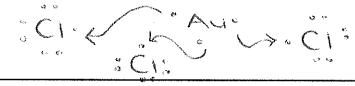
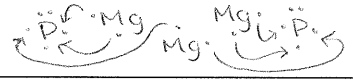
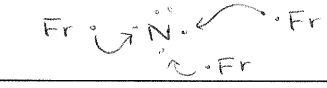
20–A1.3k define valence electron, electronegativity, ionic bond, electrostatic attraction and intramolecular force

Define the words below, giving an example for each.

Term	Definition	Example
Valence electron	e⁻ on the outer shell	
Electronegativity	the pull of an atom on e⁻ of another	F = 4.0
Ionic Bond	transfer of e⁻, bonded via electrostatic attract	
Electrostatic attraction	attraction of positive and negative ions	⊕ ⊖
Intramolecular force	force within a molec.	polarity ionic bond (electrostatic)

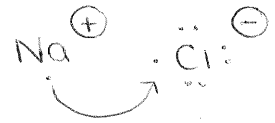
20–A1.4k use the periodic table and electron dot diagrams to support and explain ionic bonding theory

Complete the table below

Compound Name	Molecular Formula	Electron Dot Diagram
Copper (II) Bromide	$CuBr_2$	
Gold (III) Chloride	$AuCl_3$	
Magnesium Phosphide	Mg_3P_2	
Francium Nitride	Fr_3N	

20-A1.5k explain how an ionic bond results from the simultaneous attraction of oppositely charged ions

Define the term Electrostatic Attraction, and demonstrate the force using an electron dot diagram of your choice.

Definition of Electrostatic Attraction	Example
Attraction between negative and positive ions after e^- transfer	

20-A1.6k explain that ionic compounds form lattices and that these structures relate to the compounds' properties; e.g., melting point, solubility, reactivity

Sodium Chloride has a face-centered cubic (fcc) lattice with a two-atom basis or as two interpenetrating face centered cubic lattices (OCTAHEDRAL). The first atom is located at each lattice point, and the second atom is located half way between lattice points along the fcc unit cell edge. The melting point of NaCl is 801C, a very high temperature in comparison with compounds that do not form lattice structures (i.e. carbon monoxide's melting point is -205C)

Using the information above, determine the effect of lattice structure on the properties indicated below:

Melting Point	Larger lattice = stronger = ↑ MP
Boiling Point	Larger lattice = stronger = ↑ BP
Solubility	As lattice strength ↑ = solubility ↓
Reactivity	Lattice stabilizes so less reactive

Students will:
20-A1.1sts explain that the goal of science is knowledge about the natural world
• identify everyday processes and products in which ionic compounds are significant, such as in the composition of household products and foods and in life processes

Research 5 ionic compounds used in everyday life, determine their molecular formula and the significance of their compound in their everyday use.

Everyday Compound	Molecular Formula	Explanation of Use
Table Salt	NaCl	flavor, curing
Drain Cleaner	NaOH	strong base to clear drain
Toothpaste	NaF	F^- used to strengthen teeth
Bleach	NaOCl	cleaning product
Baking Soda	Na_2CO_3	neutralize acid in baking

20-A1.2sts explain that scientific knowledge and theories develop through hypotheses, the collection of evidence, investigation and the ability to provide explanations
• describe how an understanding of electronegativity contributes to knowledge of relative bond strength, melting points and boiling points of ionic compounds

Using the difference in electronegativity, determine the compound with the highest boiling point (of the pair)

Compounds (place electronegativity diff under each compound)		Compound with higher boiling point (of the 2)
FrF (3.3)	CuO (1.5)	FrF
CO_2 (0.8)	$ZrCl_4$ (1.9)	$ZrCl_4$
$CaBr_2$ (2.0)	Mn_3N_2 (1.4)	$CaBr_2$

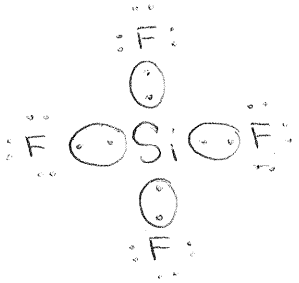
20–A1.3sts explain that scientific knowledge may lead to the development of new technologies, and new technologies may lead to or facilitate scientific discovery
• explain how scientific research and technology interact in the production and distribution of beneficial materials, such as semiconductors, ceramics and composite materials.

Define the word Semiconductor. Determine why silicon fluoride would be used as a semiconductor, although it is a molecular compound, based on differences in electronegativity.

A material that has an electrical conductivity between a conductor and a non conductor.

SiF_4 = 2.1 electroneg. diff.

Molecular compound however bonds are very polar (almost ionic).



20–A1.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
• design an investigation to determine the properties of ionic compounds (solubility, conductivity and melting point)
• describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information
• research the question, "Should all scientific research have a practical application?"
• design an experiment to explore the formation of ionic compounds

Create an experimental abstract to explain an experiment to explore the formation of an ionic compound.

Purpose: To determine rxns that will create an ionic compound.
To determine characteristics of an ionic compound.

Summary: React Baking soda (ionic) w/ Vinegar to create $NaCH_3COO(s)$ an ionic compound and test properties (conductivity, pH, melting point, flame test)

Students will:
20–A1.2s conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information
• draw electron dot diagrams • build models of ionic solids
• perform an investigation to illustrate properties of ionic compounds
• use the periodic table to make predictions about bonding and nomenclature
• use model-building software to collect and integrate information on the structure of ionic crystals

Students will:
20–A1.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
• analyze experimental data to determine the properties of ionic compounds
• use data from various sources to predict the strength of bonds between ions

General Outcome 2
Students will describe the role of modelling, evidence and theory in explaining and understanding the structure, chemical bonding and properties of molecular substances.

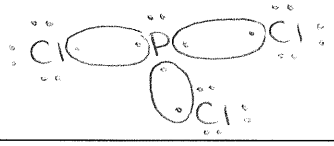
Students will:
20–A2.1k recall principles for assigning names to molecular substances

Name the following compounds:

Compound	Name	Compound	Name
CO	carbon monoxide	NF_3	nitrogen trifluoride
SiO_2	silicon dioxide	B_2Te_3	diboron tritellurium

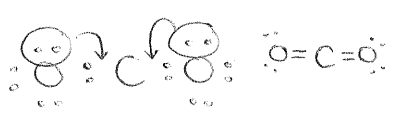
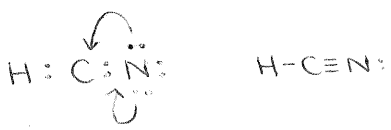
20–A2.2k explain why formulas for molecular substances refer to the number of atoms of each constituent element

Using Electron Dot Diagrams, demonstrate the formation of phosphorus trichloride

Molecular Formula	Electron Sharing Diagram
PCl_3	

20–A2.3k relate electron pairing to multiple and covalent bonds

Using LEWIS Dot Diagrams, demonstrate the formation of CO_2 and HCN

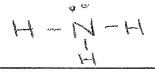
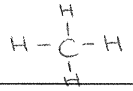
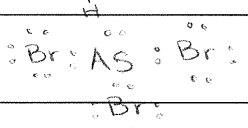
CO_2	HCN
C=4 O=6 O=6 16e⁻ 	H=1 C=4 N=5 10e⁻ 

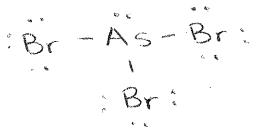
Explain the reason the compounds have multiple (double or triple) bonds present.

In order to complete an octet, molecular compounds share more than 1 pair e⁻

20–A2.4k draw electron dot diagrams of atoms and molecules, writing structural formulas for molecular substances and using Lewis structures to predict bonding in simple molecules

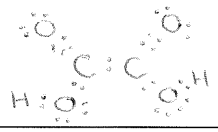
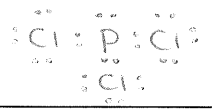
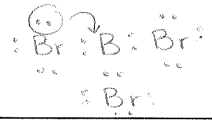
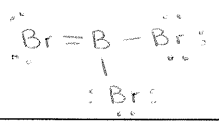
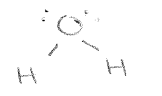
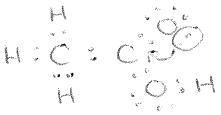
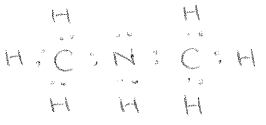
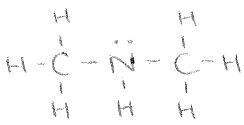
Complete the table below

Compound Name	Molecular Formula	Electron Dot Diagram
Water	H_2O	O=6 H=2 
Ammonia	NH_3	N=5 H=3 
Methane	CH_4	C=4 H=4 
Arsenic TriBromide	$AsBr_3$	As=5 Br=7×1 



20-A2.5k apply VSEPR theory to predict molecular shapes for linear, angular (V-shaped, bent), tetrahedral, trigonal pyramidal and trigonal planar molecules
20-A2.6k illustrate, by drawing or by building models, the structure of simple molecular substances

Complete the chart below

Molecular Formula	Lewis Dot Diagram	Structural Diagram	VSEPR Shape
HOOCCOOH			trig planar x 2 bent tetra x 2
5 21 PCl_3			trig pyramidal
4 5 1 CN^-			linear
3 21 BBr_3			trig planar
H_2O			bent tetrahed.
CH_3COOH			tetrahed. trig planar bent tetra
$CH_3 - NH - CH_3$			tetrahed x 2 trig pyramid
18 O_3			bent

20-A2.7k explain intermolecular forces, London (dispersion) forces, dipole-dipole forces and hydrogen bonding

Define the words below, giving an example for each.

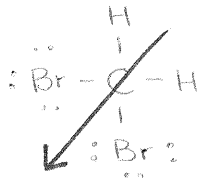
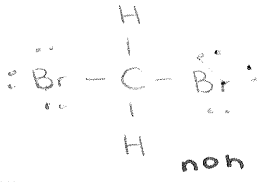
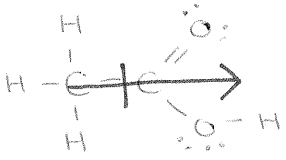
Term	Definition	Example
Intermolecular Forces	forces between molec	H bonding
London Forces	Momentary dipole attraction due to e⁻ move	As # e ↑ LF ↑ = BP ↑
Dipole Dipole Forces	The attraction of a slight neg / pos. due to polarity	$\delta+ \cdots \delta-$
Hydrogen Bonding	Attraction of H on one molec to the lone e⁻ on another	H bonds solidify and ice expands

20-A2.8k relate properties of substances (e.g., melting and boiling points, enthalpies of fusion and vaporization) to the predicted intermolecular bonding in the substances

Using the difference in electronegativity, determine the compound with the highest boiling point (of the pair)

Compounds (place electronegativity diff under each compound)	Compound with higher boiling point (of the 2)
CO_2 0.8 SiO_2 1.5	SiO_2
CH_4 0.4 NH_3 0.8	NH_3
P_2S_3 0.4 As_2Se_3 0.4	equal

20-A2.9k determine the polarity of a molecule based on simple structural shapes and unequal charge distribution

Molecular Formula	Structural Diagram Including Polarity Arrows
H_2S	 0.4 only tiny bit polar
HNO	 N-H 0.8 N-O 0.4
NCl_3	 0.2 NON POLAR
CBr_2H_2	 C-Br 0.4  non polar
CH_3COOH	 C-O 0.8

20-A2.10k describe bonding as a continuum ranging from complete electron transfer to equal sharing of electrons.

Using your knowledge of the continuum of bonding, place the following compounds in order of boiling point. List in order from HIGHEST to LOWEST.

$H_3O^+(aq)$	AgCl(aq)	Cu(s)	$NF_3(aq)$	$CCl_4(aq)$	LiF(aq)
C	I	Metal	C	C	I
1.2	1.3		1.0	0.6	3.0

Highest Boiling Point **Lowest Boiling Point**

Cu	LiF	AgCl	H_3O^+	NF_3	CCl_4
Metal	Ionic		Polar	Covalent	Non Polar

Students will:

20-A2.1sts explain that the goal of science is knowledge about the natural world

- identify everyday processes and products in which molecular substances are significant, such as in the composition of household products and foods and in life processes
- identify examples of processes and products in which molecular substances are significant, such as in the use of adhesives and rubber by Aboriginal peoples

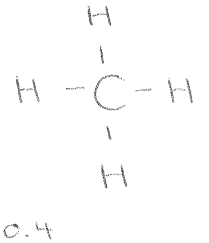
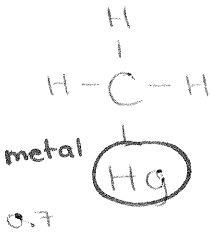
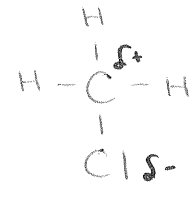
Research 5 molecular (covalent) compounds used in everyday life, determine their molecular formula and the significance of their compound in their everyday use.

Everyday Compound	Molecular Formula	Explanation of Use
Orange Juice	$C_6H_8O_7$	Citric Acid
Sugar	$C_{12}H_{22}O_{11}$	Sweetener
Vodka	C_2H_5OH	Alcohol, cleaner
Asprin	$C_9H_8O_4$	Acetyl Salicylic Acid = Pain Med
Natural Gas	CH_4	Methane for heat

20-A2.2sts explain that scientific knowledge and theories develop through hypotheses, the collection of evidence, investigation and the ability to provide explanations

- relate chemical properties to predicted intermolecular bonding by investigating melting and boiling points

Complete the chart below

	Methane	Methyl Mercury	Chloro Methane
Molecular Formula	CH_4	CH_3Hg	CH_3Cl
Melting Point	-182.0°C	92.0°C	-97.4°C
Boiling Point	-161.5°C	356.7°C	-24.2°C
Lewis Dot Diagram including polarity arrows or charges (where necessary)	 0.4	 0.7	 0.6

Using the information in the chart above, explain the difference in the three compounds boiling points and melting points.

Methane = non polar molecular compound
= weakest bonds
= least e^- = ↓ LF = ↓ BP

Chloromethane = polar molecular compound
= strong bonds, ↑ e^-, ↑ LF, ↑ BP

Methyl mercury = contains heavy metal (ionic)
= ↑ # e^-, ↑ LF, ↑ BP

20–A2.3sts explain that scientific knowledge is subject to change as new evidence becomes apparent and as laws and theories are tested and subsequently revised, reinforced or rejected
• explain how scientific research and technology interact in the production and distribution of beneficial materials, such as polymers, household products and solvents
• investigate how basic knowledge about the structure of matter is advanced through nanotechnology research and development.

Students will:
20–A2.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
• state a hypothesis and make a prediction about the properties of molecular substances based on attractive forces; e.g., melting or boiling point, enthalpies of fusion and vaporization
• describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information

Students will:
20–A2.2s conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information
• build models depicting the structure of simple covalent molecules, including selected organic compounds
• carry out an investigation to determine the melting or boiling point of a molecular substance
• use a thermometer and a conductivity apparatus to collect data
• carry out an investigation to compare the physical properties of molecular substances