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		$Y_2(Cr_2O_7)_3$	
K_2SO_4		$Be(ClO_2)_2$	

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

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		
Electronegativity		
Ionic Bond		
Electrostatic attraction		
Intramolecular force		

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		
Gold (III) Chloride		
Magnesium Phosphide		
Francium Nitride		

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

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	
Boiling Point	
Solubility	
Reactivity	

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

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	CuO	
CO_2	$ZrCl_4$	
$CaBr_2$	Mn_3N_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.

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.

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		NF_3	
SiO_2		B_2Te_3	

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

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

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

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		
Ammonia		
Methane		
Arsenic TriBromide		

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			
PCl_3			
CN^-			
BBr_3			
H_2O			
CH_3COOH			
$CH_3 - NH - CH_3$			
O_3			

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		
London Forces		
Dipole Dipole Forces		
Hydrogen Bonding		

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	SiO_2	
CH_4	NH_3	
P_2S_3	As_2Se_3	

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	
HNO	
NCl_3	
CBr_2H_2	
CH_3COOH	

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)

Highest Boiling Point **Lowest Boiling Point**

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

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)			

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

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

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Unit B: Gases

General Outcome 1
Students will explain molecular behaviour, using models of the gaseous state of matter.

Students will:
20–B1.1k describe and compare the behaviour of real and ideal gases in terms of kinetic molecular theory

State the 3 Laws of the Kinetic Molecular Theory Below:
1.
2.
3.

Compare Ideal vs Real Gases by completing the table below

Ideal Gases	Real Gases

20–B1.2k convert between the Celsius and Kelvin temperature scales

Complete the following conversion table below

Kelvin	Celsius
200K	
	2.385C
12.29K	
	-273.15C

20–B1.3k explain the law of combining volumes

Gay Lussac's Law is the idea that if a gas's temperature increases, then so does its pressure if the mass and volume of the gas are held constant.

Using this information, determine the formula for Gay Lussac's law of combining volumes.

20–B1.4k illustrate how Boyle's and Charles's laws, individually and combined, are related to the ideal gas law (PV = nRT)
• express pressure in a variety of ways, including units of kilopascals, atmospheres and millimetres of mercury
• perform calculations, based on the gas laws, under STP, SATP and other defined conditions.

20–B1.2sts explain that the goal of science is knowledge about the natural world
• describe examples of natural phenomena and processes and products (such as breathing, diffusion, weather, hot air balloons, scuba diving equipment, automobile air bags, gas turbines and internal combustion engines) that illustrate the properties of gases.

Complete the chart below:

Gas Law	Formula	Simple Explanation	Everyday Life Example
Boyle's Law			
Charles' Law			
Combined Gas Law			
Ideal Gas Law			

Solve the following problems:

1. At a birthday party a child sits on a partially filled balloon, decreasing its volume by 1/2. What is the new pressure inside the balloon?

2. In a cryogenics (extreme cold) demonstration, a scientist takes a small, partially inflated balloon out of liquid nitrogen (at a very low temperature). As the balloon rests on the table, it begins to grow in size. Explain this phenomenon.

3. Huge weather balloons partially filled with helium are sent high into the earth's atmosphere to examine the air. As a balloon rises into the air, the air pressure outside the balloon decreases rapidly. If the atmospheric pressure becomes one-third of its original pressure, what will happen to the balloon volume? Explain.

4. Use the kinetic molecular theory to explain why on a cold autumn morning a camper's air mattress may appear to be somewhat flatter than it was when blown up the afternoon before. Assume no leaks.

5. The gas inside a piston was heated from 125 mL to 250 mL. If the temperature inside the piston was originally 15°C, calculate the new temperature in °C.

6. One of the cylinders in an automobile engine is heated and the piston moves. Allowing the gas inside to expand, The original pressure was 1.85 atm, while its original volume was 175 mL, measured at 18°C. The final measured pressure was 0.86 atm and the temperature was measured at 382°C. Calculate the final volume of the cylinder.

7. a. Carbon monoxide gas reacts with oxygen gas to form carbon dioxide gas. Write a balanced equation for the reaction.

b. Given Avagadro's Hypothesis, what volume of oxygen will you expect to completely react with 4.0 L of carbon monoxide, if both gases are at the same temperature and pressure?

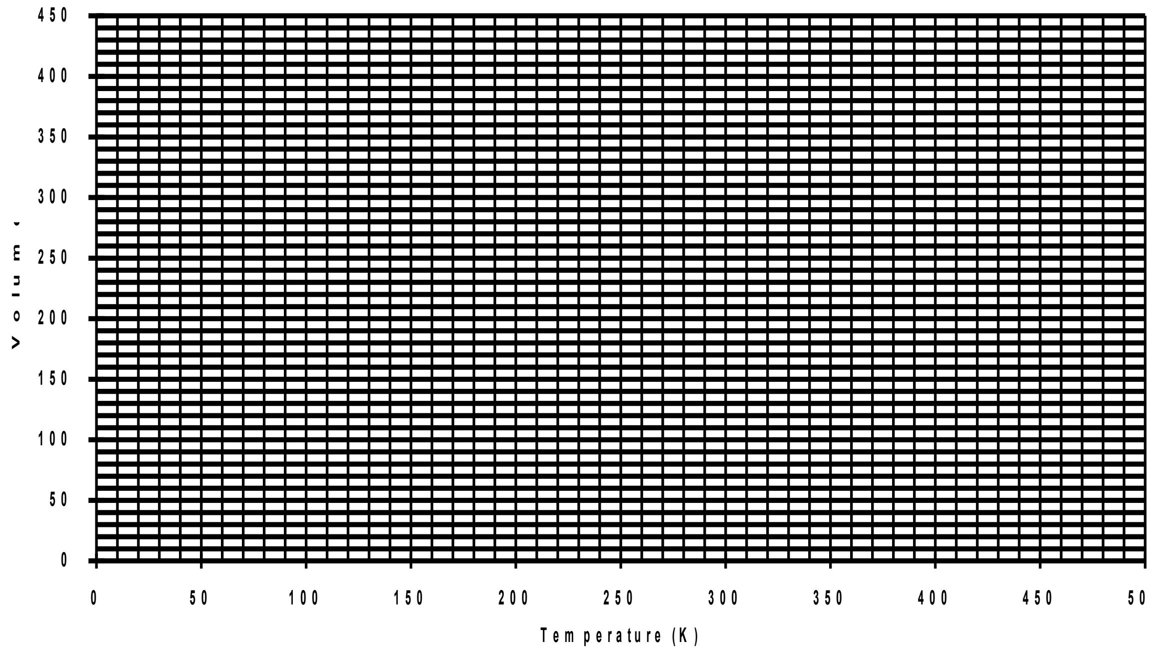
c. If the 4.0 L of carbon monoxide above contains 1.08×10^{23} molecules, how many molecules of oxygen will you find in 2.6 L of oxygen gas at the same temperature and pressure?

d. Avogadro's Hypothesis states that equal volumes of gases (at the same temperature and pressure) contain equal numbers of particles. If instead you have equal masses of the three gases in the reaction above, which gas will occupy the largest volume assuming the gasses are all at the same temperature and pressure?

8. An expandable container is filled with a given volume of gas. While the pressure of the gas is kept constant, the container is heated. The temperature is recorded in degrees Celsius, and the volume of the contained gas is recorded as well. The data are shown in the following table.

Temperature (°C)	**Temperature (K)**	**Volume**
0°C	__________	293 mL
50°C	__________	347 mL
100°C	__________	401 mL
150°C	__________	455 mL

Convert °C into Kelvin and write these values into the table. Then plot the data on the grid supplied.



a. What type of proportion does this graph illustrate? Explain.

b. What is the value of V/T for this experiment?

c. To what graphical quantity does V/T correspond?

d. Is V/T constant or does it vary?

e. Extrapolate values for the volume occupied by the gas at

150 K______

75 K______

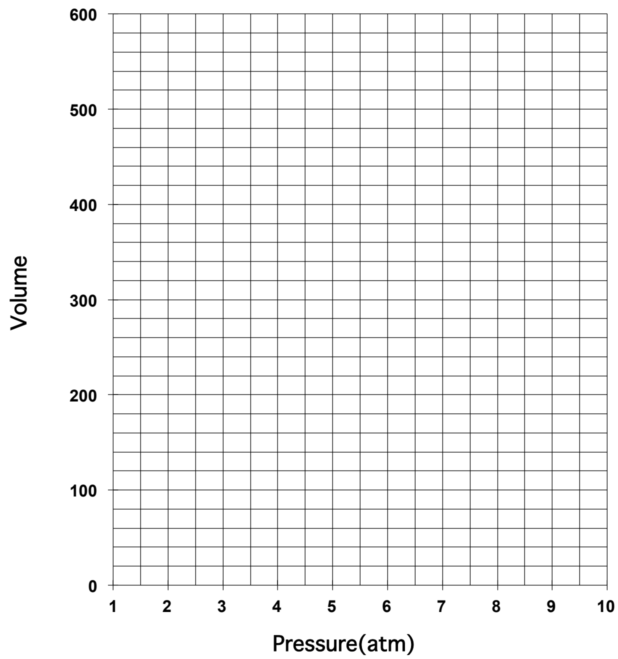
0 K_______

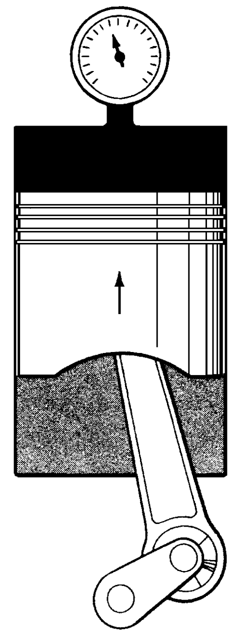
f. What gas law does the graph illustrate?

g. Express this relationship in the form of a mathematical equation.

9. The piston in the following figure is moving further into the cylinder. As it moves both volume and the pressure of the gas are measured. Graph the data on the grid provided and answer the following questions.

Volume	**Pressure**
500 cm^3	1 atm
250 cm^3	2 atm
167 cm^3	3 atm
125 cm^3	4 atm
100 cm^3	5 atm
83 cm^3	6 atm
71 cm^3	7 atm
63 cm^3	8 atm
56 cm^3	9 atm
50 cm^3	10 atm





a. What type of proportion does this graph illustrate? Explain.

b. If the cylinder can suddenly accommodate a volume of 1000 cm^3.   Predict the corresponding pressure value.

c. What pressure will be observed if the volume of the contained gas equals 375 cm^3?

d. Which gas law does the graph illustrate?

e. Express this relationship in the form of a mathematical equation.

Students will:
20–B1.1sts explain that science provides a conceptual and theoretical basis for predicting, interpreting and explaining natural and technological phenomena
• describe how the development of technologies capable of precise measurements of temperature and pressure (such as thermocouples, thermistors and Bourdon gauges) led to a better understanding of gases and to the formulation of the gas laws

Students will:
20–B1.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
• state hypotheses and make predictions based on information about the pressure, temperature and volume of a gas
• describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information
• design an experiment to illustrate Boyle's and/or Charles's gas laws
• design an investigation to determine the universal gas constant (R) or absolute zero
• explore how people who are connected with the land, such as Aboriginal peoples and agricultural workers, have used plant and animal responses to changes in atmospheric pressure as indicators of changing weather

Students will:
20–B1.2s conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information
• perform an experiment, in which variables are identified and controlled, to illustrate gas laws
• use thermometers, balances and other measuring devices effectively to collect data on gases
• use library and electronic research tools to collect information on real and ideal gases and on applications of gases, such as hot air and weather balloons
• perform an investigation to determine molar mass from gaseous volume

Using your previous knowledge, complete the chart below

	Boyle's Law	**Charles' Law**	**Combined Gas Law**	**Avogadro's Hypothesis**	**Ideal Gas Law**
Manipulated Variable					
Responding Variable					
Controlled Variables (min 3)					
Summary of Experiment					
Expected Results					
Real Life Application					

Students will:
20–B1.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
• graph and analyze experimental data that relate pressure and temperature to gas volume
• identify the limitations of measurement
• identify a gas based on an analysis of experimental data

Chemistry 20 FINAL REVIEW (2015)
Unit C: Solutions / Acid Base

General Outcome 1
Students will investigate solutions, describing their physical and chemical properties.

Students will:
20–C1.1k recall the categories of pure substances and mixtures and explain the nature of homogeneous mixtures

Using the chart provided, describe the difference between pure substances and homogenous mixtures and proved 3 examples of each

	Pure Substances	**Homogenous Mixture**
Definition		
Examples (3)		

20–C1.2k provide examples from living and nonliving systems that illustrate how dissolving substances in water is often a prerequisite for chemical change

After a volcano erupts, releasing hydrosulfuric acid into the atmosphere. In a nearby lake, aquatic life (including both fish and plants) begin to die. Using the ionization equation of hydrosulfuric acid, explain the effect of the volcanic gases on the lake and the aquatic ecosystem.

20–C1.3k explain dissolving as an endothermic or exothermic process with respect to the breaking and forming of bonds

Water combining with ammonium nitrate is a known endothermic reaction. Explain, using the solution process model and relevant graphs, how the overall reaction is endothermic.

In combining calcium carbonate with water is a known exothermic reaction. Explain, using the solution process model and relevant graphs, how the overall reaction is endothermic.

20–C1.4k differentiate between electrolytes and nonelectrolytes

Determine, using the chart below, whether the compounds are electrolytes or non electrolytes. Use E for Electrolyte, NE for Non Electrolye and SE for Slightly Electrolytic. In the description area, provide reasoning for your determination.

Compound	**Electrolyte? (E/NE/SE)**	**Description (reasoning)**
Hydrogen Peroxide		
Sodium Chloride		
Sulfuric Acid		
Lactic Acid		

20–C1.5k express concentration in various ways; i.e., moles per litre of solution, percent by mass and parts per million

20–C1.6k calculate, from empirical data, the concentration of solutions in moles per litre of solution and determine mass or volume from such concentrations

1. Determine the % by mass of a solution containing 3.283g of solute in a 1.2983L of aqueous solution.

2. Remember for this question, parts per million or ppm can be calculated by solute (by weight or volume) divided by 1 million parts solvent (by weight or volume) and can be calculated in terms of g/m^3 or mg/L or mg/kg. Using this information, determine the concentration of 0.5mg/mL solution in ppm?

3. How many grams of potassium carbonate are needed to make 200.0mL of a 2.500M solution?

4. How many litres of 4.000M solution can be made using 100.0g of lithium bromide?

20–C1.8k use data and ionization/dissociation equations to calculate the concentration of ions in a solution

What is the concentration of an aqueous solution of 450.0mL that contains 200.0g of iron(III)chloride? Determine the ion concentrations present in solution.

20–C1.7k calculate the concentrations and/or volumes of diluted solutions and the quantities of a solution and water to use when diluting

A solution is created using 6.50g of sodium hydroxide added to 500.0mL of water in a volumetric flask. Determine how much water must be added to the solution in order to dilute it further to a concentration of 0.125M

20–C1.9k define solubility and identify related factors; i.e., temperature, pressure and miscibility

20–C1.10k explain a saturated solution in terms of equilibrium; i.e., equal rates of dissolving and crystallization

Explain the effect of the following factors on solubility using the chart below:

	Increasing Temperature	**Decreasing Temperature**	**Increasing Pressure**	**Increasing Volume of Solvent**	**Polarity of Solvent**
Dissolving a solid solute into a liquid solvent					
Dissolving a gaseous solute into a liquid solvent					

Determine the solubility of 0.102g of sodium chloride dissolving into 12.038mL of warm water with a temperature of 42.0C

20–C1.11k describe the procedures and calculations required for preparing and diluting solutions.

Using the space below, list the complete steps for creating a solution using a solid solute. Compare this with creating a solution using a stock solution.

Solid Solution Preparation	**Stock Solution Preparation**

Students will:

20–C1.1sts explain how science and technology are developed to meet societal needs and expand human capability

• provide examples of how solutions and solution concentrations are applied in products and processes, scientific studies and daily life

20–C1.2sts explain that science and technology have influenced, and been influenced by, historical development and societal needs

• compare the ways in which concentrations of solutions are expressed in chemistry laboratories, household products and environmental studies

20–C1.3sts explain that scientific and technological activity may arise from, and give rise to, such personal and social values as accuracy, honesty, perseverance, tolerance, open-mindedness, critical-mindedness, creativity and curiosity

• explain the Responsible Care program developed by the Canadian Chemical Producers' Association

20–C1.4sts explain how science and technology have both intended and unintended consequences for humans and the environment
• explain the significance of biomagnification in increasing the concentration of substances in an ecosystem

20–C1.5sts explain that the appropriateness, risks and benefits of technologies need to be assessed for each potential application from a variety of perspectives, including sustainability
• explain the role of concentration in risk-benefit analyses for determining the safe limits of particular substances, such as pesticide residues, heavy metals, chlorinated or fluorinated compounds and pharmaceuticals.

Explain the term biomagnification. In your explanation, use a specific example including the chain effected and the actual influence on the organism.

Students will:
20–C1.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
• design a procedure to identify the type of solution
• design a procedure to determine the concentration of a solution containing a solid solute
• 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–C1.2s conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information
• use a conductivity apparatus to differentiate solutions
• perform an experiment to determine the concentration of a solution
• use a balance and volumetric glassware to prepare solutions of specified concentrations
• perform an investigation to determine the solubility of a solute in a saturated solution

Students will:
20–C1.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
• use experimental data to determine the concentration of a solution
• evaluate the risks involved in the handling, storage and disposal of solutions commonly used in the laboratory and in the home

Students will:
20–C1.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results
• compare personal concentration data with the data collected by other individuals or groups
• select and use appropriate numeric, symbolic, graphical and linguistic modes of representation to communicate ideas, plans and results
• use integrated software effectively and efficiently to incorporate data, graphics and text
• conduct, collectively, a risk-benefit analysis of the pollution of waterways by the release of effluents and propose a plan for reducing the impact on the ecosystem

Ms. Mogck found an unknown solution in the prep room and has no idea what it is. Design a procedure to identify the type of solution and determine the concentration of a solution containing a solid solute

General Outcome 2
Students will describe acidic and basic solutions qualitatively and quantitatively

Students will:
20–C2.1k recall International Union of Pure and Applied Chemistry (IUPAC) nomenclature of acids and bases

Complete the following chart

Compound Name	Molecular Formula	Type of Compound (Acid, Base, Salt, Organic)
Calcium hydroxide		
	$H_2S(aq)$	
Ammonia		
	$H_2SO_4(aq)$	
Acetic Acid		
	CH_4	
Phosphoric Acid		
	$Ra(OH)_2$	

20–C2.2k recall the empirical definitions of acidic, basic and neutral solutions determined by using indicators, pH and electrical conductivity

Determine the differences between acids, bases and neutral solutions by completing the following chart

	Acid	Base	Salt	Inorganic Gas
Example				
pH range				
pOH range				
Conduct?				
Color of bromo blue				
Color or phenolpthalein				

20–C2.3k calculate H_3O^+ (aq) and OH^-(aq) concentrations and the pH and pOH of acidic and basic solutions based on logarithmic expressions; i.e., pH = –log[H_3O^+] and pOH = –log[OH^-]

20–C2.4k use appropriate Système international (SI) units to communicate the concentration of solutions and express pH and concentration answers to the correct number of significant digits; i.e., use the number of decimal places in the pH to determine the number of significant digits of the concentration

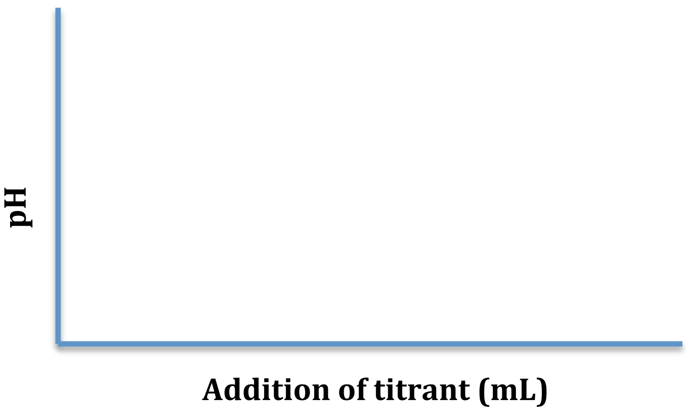
Complete the chart below, including proper units and sig figs for each

	Concentration of Solution	**pH**	**pOH**	**[H_3O^+]**	**[OH^-]**
3.182g of Calcium hydroxide dissolved in 1.293L of water					
12.1M HCl solution diluted from 10.0mL to 550.0mL					
1.25g solid phosphoric acid dissolved into 120mL of solution					

20–C2.5k compare magnitude changes in pH and pOH with changes in concentration for acids and bases

20–D2.5k draw and interpret titration curves, using data from titration experiments involving strong monoprotic acids and strong monoprotic bases

Draw a titration curve (graph) demonstrating the titration of a monoprotic strong acid with a strong base. Describe the changes in pH as the titration occurs and discuss what is happening during the titration.



20–C2.6k explain how the use of indicators, pH paper or pH meters can be used to measure H3O+ (aq)

Determine the pH of a solution if it turns thymol blue = yellow, bromocresol green = blue and thymolphthalein = colorless.

20–C2.7k define Arrhenius (modified) acids as substances that produce H3O+ (aq) in aqueous solutions and recognize that the definition is limited

20–C2.8k define Arrhenius (modified) bases as substances that produce OH– (aq) in aqueous solutions and recognize that the definition is limited

Using modified Arrhenius theory, determine whether the substances below are acids, bases or amphiprotic

Ammonia:

Potassium dihydrogen phosphate

Hydrogen sulfide

20–C2.9k define neutralization as a reaction between hydronium and hydroxide ions

20–C2.10k differentiate, qualitatively, between strong and weak acids and between strong and weak bases on the basis of ionization and dissociation; i.e., pH, reaction rate and electrical conductivity

20–C2.11k identify monoprotic and polyprotic acids and bases and compare their ionization/dissociation.

Complete the following chart

	Strong Acid	**Weak Acid**	**Strong Base**	**Weak Base**
Definition				
Ionization (100%, more than 50%, less than 50%)				
Conductivity				
Reaction Rate				
pH				
pOH				

Students will:
20–C2.1sts explain that the goal of technology is to provide solutions to practical problems
• relate the concept of pH to solutions encountered in everyday life, such as pharmaceuticals, shampoo and other cleaning products, aquatic and terrestrial environments, and blood/blood products

20–C2.2sts explain that technological problems often require multiple solutions that involve different designs, materials and processes and that have both intended and unintended consequences
• provide examples of processes and products that use knowledge of acid and base chemistry (the pulp and paper industry, the petrochemical industry, food preparation and preservation, cleaning aids, sulfuric acid in car batteries, treating accidental acid or base spills using neutralization and dilution)
• explain the significance of the strength and concentration of solutions in everyday life (pharmaceuticals, chemical spills, transportation of dangerous goods, toxicity)
• identify examples in Alberta in which holistic practices used by some Aboriginal communities can be used to moderate the impact of development in industries such as the petrochemical industry

Students will:
20–C2.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
• design an experiment to differentiate among acidic, basic and neutral solutions
• design an experiment to differentiate between weak and strong acids and between weak and strong bases
• 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–C2.2s conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information
• construct a table or graph to compare pH and hydronium ion concentration, illustrating that as the hydronium ion concentration increases, the pH decreases
• use a pH meter to determine the acidity and/or alkalinity of a solution

Students will:
20–C2.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
• use indicators to determine the pH for a variety of solutions
• assess, qualitatively, the risks and benefits of producing, using and transporting acidic and basic substances, based on WHMIS and transportation of dangerous goods guidelines

Students will:
20–C2.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results
• research, collectively, the relationship between sulfuric acid and industrialization
• evaluate technologies used to reduce emissions that lead to acid deposition

Chemistry 20 FINAL REVIEW (2015)
Unit D: Stoichiometry

General Outcome 1
Students will explain how balanced chemical equations indicate the quantitative relationships between reactants and products involved in chemical changes.

Students will:
20–D1.1k predict the product(s) of a chemical reaction based upon the reaction type

20–D1.2k recall the balancing of chemical equations in terms of atoms, molecules and moles

20–D1.4k write balanced ionic and net ionic equations, including identification of spectator ions, for reactions taking place in aqueous solutions

Students will:
20–D1.2s conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information
• translate word equations for chemical reactions into chemical equations, including states of matter for the products and reactants
• balance chemical equations for chemical reactions, using lowest whole-number coefficients

Create a balance molecular equation, a total ionic equation and a net ionic equation for each of the following reactions described below:

1. A reaction of sodium hydroxide with ammonium carbonate

2. A reaction of lithium sulfate with gold(III)fluoride

3. A reaction of rubidium iodate with lead(II)nitrate

20–D1.5k calculate the quantities of reactants and/or products involved in chemical reactions, using gravimetric, solution or gas stoichiometry

1. a. Determine the balanced chemical reaction occurring when pentane (C_5H_{12}) burns

b. What mass of $CO_2(g)$ is produced when 10.0g of pentane is burned?

c. What mass of $H_2O(l)$ is made when the burning of pentane gives 106L of CO_2 at 98kPa and 36C?

2. Tetraethyl lead $Pb(C_2H_5)_4$ is an antiknock ingredient which was added to some gasolines. Tetraethyle lead burns according to the equation

$$2Pb(C_2H_5)_4 + 27O_2(g) \rightarrow 2PbO(s) + 16CO_2 + 20H_2O$$

a. What volume of oxygen is consumed when 100.0g of PbO(s) are formed?

b. How many molecules of carbon dioxide are formed when 1.00×10^{-6}g of tetraethyl lead is burned?

c. How many molecules of water are formed when 135 molecules of oxygen react?

d. What volume of oxygen in millilitres is required to react with 1.00×10^{15}molecules of tetraethyl lead?

3. One of the most efficient drying agents known is P_4O_{10} in fact, P_4O_{10} will even remove water from pure H_2SO_4 to produce SO_3

$$1\ P_4O_{10}(s) + 6\ H_2SO_4(l) \rightarrow 4H_3PO_4(aq) + 6SO_3(g)$$

Pure $H_2SO_4(l)$ has a density of 1.84g/mL. If 25.0mL of $H_2SO_4(l)$ react, what mass of $P_4O_{10}(s)$ also reacts and what volume of $SO_3(g)$ at STP is produced?

4. Ozone, O_3 in the upper atmosphere protects the earth from the sun's harmful UV radiation. One step in the destruction of the ozone layer by chlorine containing compounds is $Cl(g) + O_3(g) \rightarrow ClO(g) + O_2(g)$. The volume of ozone in the upper atmosphere is estimated to be 1.5×10^{15}L at STP. Each Cl atom is continually "recycled" so as to be capable of destroying an average of about 1.0×10^{5} molcules of ozone. What mass of Cl atoms woud be required to use us the available ozone if the ozone were not "regenerated".

5. a. A 1.00mL sample of pure phosphorice acid is titrated with 43.8mL of 0.853M NaOH, what is the molarity of the pure phosphoric acid?

b. Calculate the density of pure phosphoric acid.

Students will:
20–D1.1sts explain that the products of technology are devices, systems and processes that meet given needs; however, these products cannot solve all problems
• analyze the chemical reactions involved in various industrial and commercial processes and products that use stoichiometric and chemical principles:
– production of urea
– fertilizers
– fuel combustion
– water treatment
– air bag deployment
- neutralization of excess stomach acid

General Outcome 2
Students will use stoichiometry in quantitative analysis.

20–D1.3k contrast quantitative and qualitative analysis

Students will:
20–D2.1k explain chemical principles (i.e., conservation of mass in a chemical change), using quantitative analysis

Complete the following chart below

	Qualitative Analysis	Quantitative Analysis	Conservation of Mass
Definition			
Example			
Why is this important to chemistry ?			
Lab Design (how would you test this concept)			

20–D2.2k identify limiting and excess reagents in chemical reactions

1. a. What mass of CS_2 is produced when 17.5g of C are reacted with 39.5g of SO_2 to produce CS_2 and CO(g)?

b. What mass of the excess reactant will be left over?

2. a. What mass of NO is produced when 87.0g of Cu are reacted with 225g of HNO_3 according to the reaction below $3Cu(s) + 8HNO_3(aq) \rightarrow 3Cu(NO_3)_2 (aq) + 2NO(g) + 4H_2O(l)$

b. What mass of the excess reactant will be left over?

3. What volume of CO_2 at STP can be made when 0.0250L of pentane (C_5H_{12}) (Density = 626.0g/L) is reacted with 40.0L of oxygen at STP?

4. If 50.0mL of 0.100M HCl is allowed to react with 30.0mL of 0.200M NaOH, which reagent is in excess?

5. If 0.250g of $Ba(OH)_2$ is combined with 15.0mL of HBr(g) at 12.0C and 860mmHg, what mass of $BaBr_2(s)$ can be formed?

20–D2.3k define theoretical yields and actual yields

Students will:
20–D1.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
• plan and predict states, products and theoretical yields for chemical reactions
• design an experiment to identify an ion; e.g., precipitation, flame test
• 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–D1.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
• interpret stoichiometric ratios from chemical reaction equations
• perform calculations to determine theoretical yields
• use appropriate SI notation, fundamental and derived units and significant digits when performing stoichiometric calculations

20–D2.4k explain the discrepancy between theoretical and actual yields

1. Consider the reaction $I_2O_5(g) + 5\ CO(g)$ -------> $5\ CO_2(g) + I_2(g)$
a) 80.0 grams of iodine(V) oxide, I_2O_5, reacts with 28.0 grams of carbon monoxide,CO. Determine the mass of iodine I_2, which could be produced?

b) If, in the above situation, only 0.160 moles, of iodine, I_2 was produced.
i) what mass of iodine was produced?

ii) what percentage yield of iodine was produced.

2. A research supervisor told a chemist to make 100 g of chlorobenzene from the reaction of benzene with chlorine and to expect a yield no higher that 65%. What is the minimum quantity of benzene that can give 100 g of chlorobenzene if the yield is 65%? The equation for the reaction is:

$$\mathbf{C_6H_6 + Cl_2 \rightarrow C_6H_5Cl + HCl}$$

benzene chlorobenzene

3. Certain salts of benzoic acid have been used as food additives for decades. The potassium salt of benzoic acid, potassium benzoate, can be made by the action of potassium permanganate on toluene.

$C_7H_8 + 2\ KMnO_4 \rightarrow KC_7H_5O_2 + 2\ MnO_2 + KOH + H_2O$
toluene potassium benzoate

If the yield of potassium benzoate cannot realistically be expected to be more than 68%, what is the minimum number of grams of toluene needed to achieve this yield while producing 10.0 g of $KC_7H_5O_2$?

4. Dimethylhydrazine, $(CH_3)_2NNH_2$, was used as a fuel for the Apollo Lunar Descent Module, with N_2O_4 being used as the oxidant. The products of the reaction are H_2O, N_2, and CO_2.
a) Write a balanced chemical equation for the combustion reaction.

b) If 150 kg of $(CH_3)_2NNH_2$ react with 460 kg of N_2O_4, what is the theoretical yield of N_2?

c) If a 30 kg yield of N_2 gas represents a 68% yield, what mass of N_2O_4 would have been used up in the reaction?

20–D2.5k draw and interpret titration curves, using data from titration experiments involving strong monoprotic acids and strong monoprotic bases

20–D2.6k describe the function and choice of indicators in titrations

20–D2.7k identify equivalence points on strong monoprotic acid–strong monoprotic base titration curves and differentiate between the indicator end point and the equivalence point.

Results of 20.0mL of potassium hydroxide titrated with 2.2M HCl solution

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Initial Buret Reading	0.10mL	6.43mL	13.81mL	20.12mL
Final Buret Reading	6.43mL	13.81mL	20.12mL	26.40mL

Determine the average volume of HCl used in the titration

Determine the concentration of the unknown potassium hydroxide

Draw and label a titration curve for the titration described.

Determine an appropriate indicator to use in this titration and explain your choice.

Completely draw and label a titration set up for the lab described above. Include appropriate titles in your diagram

Students will:
20–D2.1sts explain that scientific knowledge may lead to the development of new technologies, and new technologies may lead to or facilitate scientific discovery
• describe how industries apply principles of stoichiometry to minimize waste and maximize yield

20–D2.2sts explain how the appropriateness, risks and benefits of technologies need to be assessed for each potential application from a variety of perspectives, including sustainability
• assess the significance of specific by-products from industrial, commercial and household chemical reactions
• analyze the use of technologies, such as smokestacks and catalytic converters, to reduce emissions that are harmful to the environment, such as SO2(g) and greenhouse gases.

Students will:
20–D1.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results
• use integrated software effectively and efficiently to incorporate data and text