KEY

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	only 1 type of molecule	A combo of solvent + solute = aqueous
Examples (3)	$H_2O(l)$ $H_2O_2(l)$ $NaCl(s)$	$H_2SO_4(aq)$ $NaCl(aq)$ $Ca(OH)_2(aq)$

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.

$$H_2S(aq) + H_2O(l) \rightarrow 2H_3O^+ + S^{2-}(aq)$$

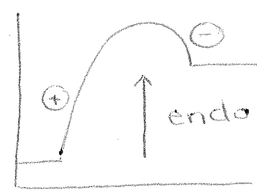
↑ H_3O^+ in the atmospheric = acid rain.

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.

solvent break (endo) (+)
solute break (endo) (+)
solute + solvent combine (exo) (−)

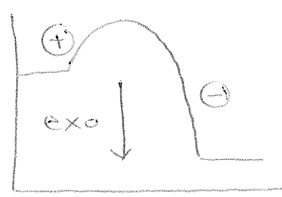
Endo > Exo



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.

See above steps

Exo > Endo



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	NE	molecular (pure)
Sodium Chloride	E	salt (ionic)
Sulfuric Acid	E	strong acid
Lactic Acid	SE	weak 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.

$$\frac{\%\ \text{mass}}{\text{solution}} = \frac{3.283\ g}{1298.3\ mL} \times 100\% = \boxed{0.2529\ \%}$$

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?

$$ppm = \frac{mg}{L} = \frac{0.5\ mg}{mL} \times \frac{1000\ mL}{1\ L} = \boxed{500\ ppm}$$

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

$$\#\ g\ K_2CO_3 = \frac{2.5\ mol}{L} \times 0.20\ L \times \frac{138.21\ g}{1\ mol} = \boxed{69.11\ g}$$

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

$$\#\ L\ LiBr = 100\ g \times \frac{1\ mol}{86.85\ g} \times \frac{1\ L}{4.0\ mol} = \boxed{0.2879\ L}$$

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.

$$FeCl_3 \longrightarrow 3Cl^- + Fe^{3+}$$

$$\frac{\#\ mol}{L} = 200\ g \times \frac{1\ mol}{162.2\ g} \times \frac{1}{0.45\ L} = \boxed{2.740\ M\ Fe}$$

$Fe^{3+} = 2.74 M$

$Cl^- = 8.22 M$

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

$$\frac{\#\ mol}{L} = 6.50\ g \times \frac{1\ mol}{40\ g} \times \frac{1}{0.50\ L} = 0.325\ M = C_1$$

$$C_1V_1 = C_2V_2$$

$$(0.325\ M)(0.5\ L) = (0.125\ M)\ V_2$$

$V_2 = 1.3\ L$ total

$1.3 - 0.5 = \boxed{0.80\ L\ \text{add}}$

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	↑	↓	—	↑	Like dissolve like
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

$$\frac{\#\text{mol}}{\text{L}} = 0.102\text{ g} \times \frac{1\text{ mol}}{58.44\text{ g}} \times \frac{1}{12.038\text{ L}} = \boxed{1.45 \times 10^{-4}\text{ M @ }42°\text{C}}$$

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
Calculate Mass of Solid Measure using a scale Add ½ solvent, stir Transfer to Volumetric flask Use funnel, rinse all glasswear Add remaining solvent, to line, using eye dropper. Invert 20x, check, refill	Calculate Volume $C_1V_1 = C_2V_2$ Transfer to Volumetric flask using pipette Add remaining solvent to line, using eye dropper. Invert 20x, check, refill.

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.

Biomag = ↑ conc of a toxin going up the trophic levels of a food chain.

ie// DDT, mercury, etc.

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

$CH_3COO^-(aq)$, $Cl^-(aq)$, $SO_4^{2-}(aq)$

↓ Add Cu^+

$CuCl_{(s)}$ ⟵ ⟶ x no Cl^- ions

CH_3COO^-, SO_4^{2-}

↓ Add Pb^{2+}

$PbSO_{4(s)}$ ⟵ ⟶ x no SO_4^{2-} ions

CH_3COO^-

↓ Add Ag^+

(s) $AgCH_3COO$ ⟵ ⟶ x no CH_3COO^- ions

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	$Ca(OH)_2$	S. Base
Hydro Sulfuric Acid	$H_2S(aq)$	S. Acid
Ammonia	NH_3	W. Base
Sufuric Acid	$H_2SO_4(aq)$	S. Acid
Acetic Acid	CH_3COOH	W. Acid
Methane	CH_4	Organic
Phosphoric Acid	H_3PO_4	W. Acid
Radium Hydroxide	$Ra(OH)_2$	S. Base

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	HCl	NaOH	NaCl	I_2
pH range	0 - 7	7 - 14	7	7
pOH range	7 - 14	0 - 7	7	7
Conduct?	✓	✓	✓	X
Color of bromo blue	Yellow	Blue	Green	Green
Color or phenolpthalein	Colorless	Pink	Colorless	Colorless

20–C2.3k calculate H3O+ (aq) and OH–(aq) concentrations and the pH and pOH of acidic and basic solutions based on logarithmic expressions; i.e., pH = –log[H3O+] 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

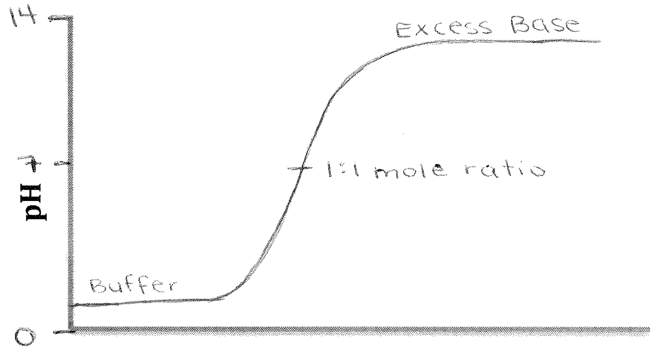
Complete the chart below, including proper units and sig figs for each

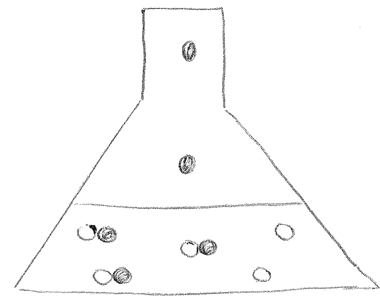
	Concentration of Solution	**pH**	**pOH**	**$[H_3O^+]$**	**[OH-]**
3.182g of Calcium hydroxide dissolved in 1.293L of water	$\frac{mol}{L}$ $Ca(OH)_2$ $= 3.182g$ $\times \frac{1 mol}{74.093g}$ $\times \frac{1}{1.293L}$ $= 0.0332 M$ $Ca(OH)_2$	pH = 14 − pOH 12.822	pOH = −log [OH] pOH = −log(0.0664) pOH = 1.178	$[H_3O^+]$ $= \frac{1.0\times10^{-14}}{[OH^-]}$ $[H_3O^+]$ $= 1.506 \times 10^{-13} M$	$\rightarrow 2OH^-$ $[OH^-]$ $= 0.0664 M$
12.1M HCl solution diluted from 10.0mL to 550.0mL	12.1 M HCl	pH $= -\log[H_3O^+]$ pH = −1.083	14 − pH = pOH pOH = 15.083	[HCl] $= [H_3O^+]$ 12.1 M	$[OH^-]$ $= \frac{1.0\times10^{-14}}{[H_3O^+]}$ $[OH^-]$ $= 8.26 \times 10^{-16} M$
1.25g solid phosphoric acid dissolved into 120mL of solution	$\frac{mol}{L}$ H_3PO_4 $= 1.25g$ $\times \frac{1 mol}{98 g}$ $\times \frac{1}{0.120L}$ $= 0.106 M$ H_3PO_4	pH = $-\log[H_3O^+]$ pH = 0.496	pOH = 14 − pH 13.504	$\rightarrow 3H_3O^+$ = 0.319M	$[OH^-]$ $= 10^{-pOH}$ $= 3.136 \times 10^{-14} M$

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.





Addition of titrant (mL)

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.

thymol blue = Y (2.8 - 8.0)
bromo green = B > 5.4
thymolphth = C < 9.4

2.8 - 5.4

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:

$NH_3 + H_2O \longrightarrow H_3O^+ + NH_2^-$ ✗

$NH_3 + H_2O \longrightarrow OH^- + NH_4^+$ ✓

BASE

Potassium dihydrogen phosphate

$KH_2PO_4 + H_2O \longrightarrow H_3O^+ + HPO_4^{2-}$ ✓

$KH_2PO_4 + H_2O \longrightarrow OH^- + H_3PO_4$ ✓

AMPHIPROTIC

Hydrogen sulfide

$H_2S + H_2O \longrightarrow H_3O^+ + HS^-$ ✓

$H_2S + H_2O \longrightarrow OH^- + H_3S^+$ ✗

ACID

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	Acid that completely gives up H^+	Holds on to its H^+	Accepts H^+ easily / gives up OH^-	Holds on to OH^- / accepts H^+
Ionization (100%, more than 50%, less than 50%)	100%	< 50%	100%	< 50%
Conductivity	✓	slight	✓	slight
Reaction Rate	Fast	slow	Fast	slow
pH	0 – 4	5 – 6	10 – 14	8 – 9
pOH	10 – 14	8 – 9	0 – 4	5 – 6

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