



Chemistry 11 (SCH3U)

Due Date: Friday, August 28th @ 9 am

Culminating Assessment – Part 2 (10%)

Name of Student: _____

Instructions

1. Answer all questions fully; make sure you are answering all parts of the questions.
2. *Neat, complete solutions are required. Full marks may not be awarded for a question if insufficient work is shown.*
3. GOOD LUCK 😊

Mark Breakdown

Knowledge (25%)	Thinking/ Inquiry (25%)	Communication (20%)	Application (30%)	Weighted Mark
/22	/22	/21	/23	

Part A: Multiple Choice

Select the best answer for each of the following questions. Record your answer by circling your response.

1. The element Strontium can be found in period ____ and group _____. (1K)
 - A) 2, 4
 - B) 4, 2
 - C) 5, 2
 - D) 2, 5
 - E) 2, 38

2. The element **from period three** that is represented by **X** in the ionic compound MgX_2 is: (1A)
 - A) Chlorine.
 - B) Oxygen.
 - C) Nitrogen.
 - D) Fluorine.
 - E) Bromine.

3. According to the isotope notation pictured on the right, which of the following statements is/are correct? (1T)

- A) Copper has 29 neutrons.
 - B) Copper has a mass number of 29.
 - C) Copper has 34 neutrons.
 - D) Copper has 63 protons.
 - E) None of the above statements are correct about copper.

$${}^{63}_{29}\text{Cu}$$

4. Which of the following single displacement reactions will **not** occur? (1T)
 - A) $\text{Na}_{(s)} + \text{MgCl}_{2(aq)} \rightarrow$
 - B) $\text{Cu}_{(s)} + \text{H}_2\text{O}_{(l)} \rightarrow$
 - C) $\text{K}_{(s)} + \text{AlCl}_{3(aq)} \rightarrow$
 - D) $\text{Cr}_{(s)} + \text{FeCl}_{3(aq)} \rightarrow$
 - E) All of the above reactions will occur.

5. Which of these compounds is an example of a **basic oxide**? (1A)
 - A) sulfur trioxide
 - B) carbon dioxide
 - C) dinitrogen pentoxide
 - D) magnesium oxide
 - E) all of the above options would be acidic oxides

6. Which type of reaction is described below? **(1A)**
Aqueous sulfuric acid is heated to produce water, oxygen gas, and sulfur dioxide.
- A) Combustion.
 - B) Synthesis.
 - C) Decomposition.
 - D) Single displacement.
 - E) Double displacement.
7. Of the chemicals listed below, which **is not** an example of an empirical formula? **(1T)**
- A) C_6H_6
 - B) $C_5H_{12}O$
 - C) $Na_2S_2O_3$
 - D) SCl_2
 - E) It is impossible to tell if any of these is an example of an empirical formula.
8. A 2.60 mol sample of an unknown substance has a mass of 135.2 g. Based on this data, the substance is: **(1T)**
- A) Bromine.
 - B) Yttrium.
 - C) Chromium.
 - D) Gallium.
 - E) Tellurium.
9. If there is 5.00 mol of a sample of methane molecules (CH_4) what is the amount, in mol, of Hydrogen atoms present? **(1A)**
- A) 4.00 mol
 - B) 5.00 mol
 - C) 20.0 mol
 - D) 25.0 mol
 - E) There is not enough information to answer this question.
10. When a solution of H_3PO_4 was analyzed, it was found that only a very small percentage of the hydrogen atoms in H_3PO_4 actually became H^+ ions in solution. This would indicate that phosphoric acid is; **(1A)**
- A) A strong acid.
 - B) A weak acid.
 - C) A strong base.
 - D) A weak base.
 - E) Very good at ionizing.

11. Which of the following statements is/are true? **(1K)**
- A) At 25°C, pure water has equal concentrations of H_3O^+ and OH^-
 - B) Increasing the temperature of a liquid solvent will allow more solid solute to dissolve.
 - C) Water is a good solvent for polar substances because it is also polar.
 - D) All of the above statements are true.
 - E) None of the above statements are true.
12. Boric acid solution is used as an eyewash in science labs. What **mass** of boric acid is present in 250.0 g of solution that is 2.50 % (m/m) boric acid in water? **(1A)**
- A) 6.25 g
 - B) 6.25 mL
 - C) 1.00×10^4 g
 - D) 1.00×10^4 mL
 - E) Impossible to determine given the data provided.
13. A student is mixing up a solution for an exciting experiment. Unfortunately, try as she might, she simply cannot dissolve any of the solute in 250.0 mL of solution. Clearly, this solute is: **(1K)**
- A) Soluble.
 - B) Slightly soluble.
 - C) Insoluble.
 - D) Hydrated.
 - E) None of the above accurately describes this solute.
14. A 1 L sample of a solution was emptied into a 4 L container, which was then filled with water. Which of the following is true of the resulting solution in the 4 L container? **(1T)**
- A) Its concentration **increased** by a factor of four.
 - B) Its concentration **increased** by a factor of three.
 - C) Its concentration **stayed constant** since the amount of solute did not change.
 - D) Its concentration **decreased** by a factor of four.
 - E) Its concentration **decreased** by a factor of three.

Part B: Matching and Definitions

Matter, Chemical Trends and Chemical Bonding Matching

1. Match the terms listed directly below with the most appropriate definition, example, or statement from options a-e. (2K)

____ dipole-dipole interaction

____ covalent bond

- a. a weak attractive force acting between all molecules whether polar or non-polar
- b. an intermolecular force of attraction that forms between the slightly positive end of one polar molecule and the slightly negative end of an adjacent polar molecule
- c. an unusually strong dipole–dipole force between a hydrogen atom attached to a highly electronegative atom (N, O, or F)
- d. the electrostatic force of attraction between a positive ion and a negative ion
- e. the bond that results from the sharing of a pair of electrons by two atoms

2. Explain why the reactivity of the gas atoms in Group 17, the halogens, decreases as you go down the group, but the reactivity of the metal atoms in Group 1, the alkalis, increases as you go down the group. (1K, 2C)

Chemical Reactions Matching

1. Match the terms listed directly below with the most appropriate definition, example, or statement from options a-e. (2K)

____ Metal carbonate

____ Acid

- a. This reaction produces soot, carbon dioxide, carbon monoxide, and water.
- b. The reaction between a metal oxide and water will produce this.
- c. The reaction between a nonmetal oxide and water will produce this.
- d. The reaction between a metal oxide and carbon dioxide will produce this.
- e. This reaction produces carbon dioxide and water.

2. Compare and contrast complete combustion and incomplete combustion. (1K, 2C)

Quantities in Chemical Reactions Matching

1. Match the terms listed directly below with the most appropriate definition, example, or statement from options a-e. (2K)

____ Law of Conservation of Mass

____ Stoichiometry

- a. The study of the quantitative relationship between amounts of reactants used and products formed in a chemical reaction.
- b. A single particle of an ionic compound.
- c. States that the percentage composition of a specific compound is constant.
- d. States that matter can neither be created nor destroyed during a chemical reaction.
- e. A technique that identifies chemicals based on their molar mass.

2. Explain why being asked to find the molecular formula from an empirical formula for an ionic compound doesn't make chemical sense. (1K, 1C)

Solutions and Solubility Matching

1. Match the terms listed directly below with the most appropriate definition, example, or statement from options a-e. (2K)

____ Homogeneous

____ Precipitate

- a. A solution with more than one phase.
- b. A solution with only one phase.
- c. An insoluble solid formed when two solutions mixed.
- d. When two liquids mix together completely.
- e. When two liquids do not mix together fully.

2. Define the term **standard solution** and give an example when it would be used in chemistry.

(1K, 1C)

Part C: Application & Short Answer

1. Complete the table below.

Chemical Formula	Calculate the ΔE_n of bonds (electronegativity difference) (2A)	Lewis Molecular Diagram (2C, 2T)	Circle the type of compound (2K)	Circle the Molecular Shape (2K)
CCl_4			Nonpolar covalent Polar covalent	Linear Bent Trigonal planar Trigonal pyramid Tetrahedral
PH_3			Nonpolar covalent Polar covalent	Linear Bent Trigonal planar Trigonal pyramid Tetrahedral

2.

a. Calculate the relative atomic mass of an element that is

- 0.0050000 % of isotope mass 234.040947 u,
- 0.72000 % of isotope mass 235.043924 u, and
- 99.275% of isotope mass 238.050784 u

(1A, 1C)

b. What is the element that has the relative atomic mass worked out in part a.? Describe what evidence you used to come to your decision.

(1K, 1C)

3. Write the correct IUPAC chemical names for the following chemical compounds. (3C, 3T)

a. $\text{Mn}(\text{CNO})_4$ _____

b. $\text{Al}_2(\text{SO}_3)_3 \cdot 3\text{H}_2\text{O}$ _____

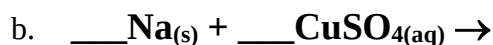
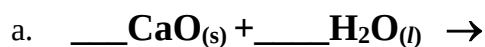
c. N_2O _____

d. H_2SO_4 (aq) _____

e. Fe_2O_3 _____

f. F_2 _____

4. Write the products for the following chemical reactions; then balance the reaction. Be sure to include the states of matter. If a reaction does not occur, write "No Reaction". (2A, 2T)



5. Write a balanced chemical equation for the following reactions. Include all states of matter.

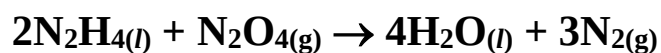
a. aqueous copper (II) sulfate reacts with aqueous sodium phosphate to produce solid copper (II) phosphate and aqueous sodium sulfate

(1A, 1C, 1T)

b. the complete combustion of the hydrocarbon *liquid*, octane C_8H_{18} . (Use only integers!)

(1A, 1C, 1T)

6. A Chemist has just completed an experiment wherein she reacted 15.0 g of liquid hydrazine, N_2H_4 , with excess gaseous dinitrogen tetroxide, N_2O_4 . The reaction is shown below



- a. According to the balanced chemical equation above, determine the mass of N_2 that would be produced is all 15.0g of N_2H_4 reacted. **(1A, 1C, 1T)**
- b. If 17.9 g of Nitrogen gas is collected at the end of the experiment, use your answer from part a to determine the percentage yield. **(1T, 1A)**
7. a. Calculate the empirical formula of a hydrocarbon that is 85.6 % carbon and 14.4 % hydrogen. **Show your work and clearly highlight or circle your answer.** **(1A, 1C, 1T)**
- b. If the molar mass of this compound is 126.18 g/mol, what is the molecular formula? **(1C, 1T)**

8. Vitamin A is chemically known as retinol ($C_{20}H_{30}O$). When we eat an average carrot, the body ends up receiving about 0.00240g of retinol. Calculate the following;

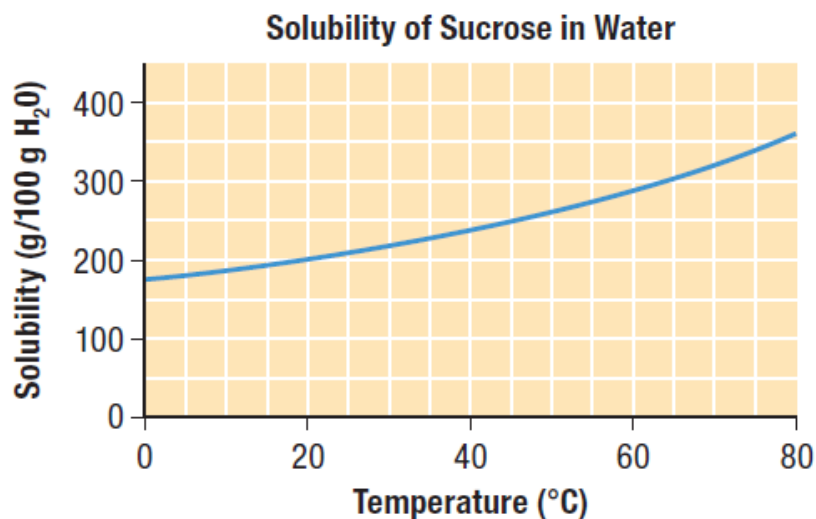
a. The **amount**, in mol, of retinol the body receives by consuming a carrot. **(1A)**

b. **Number of** retinol molecules contained in that amount. **(1A)**

c. **Number of atoms** present in the retinol. **(1T)**

9. Examine the solubility curve provided on the right.

a. What is the solubility of a saturated solution of sucrose at a temperature of 45°C? **(1A)**



b. Suppose a solution contains 150 g of sucrose dissolved in 50 g of water at 5°C. Is the solution **saturated, unsaturated, or supersaturated**? Explain your answer. **(1K, 1C)**

10. a. A chemistry teacher is making a 0.350 mol/L solution of nitric acid (HNO_3). Calculate the mass (in grams) of nitric acid she will need to make 500.0 mL of this solution. **(1A, 1C, 1T)**

b. Calculate the concentration of the solution described above in % (m/v). **(1A)**

c. Write a balanced chemical equation, total and net ionic equations and then determine spectator ions for the neutralisation reaction of the solution of nitric acid (HNO_3) with a solution sodium hydroxide (NaOH). **(1A, 1K, 1C, 1T)**

Balanced chemical equation: _____

Total ionic equation: _____

Net ionic equation: _____

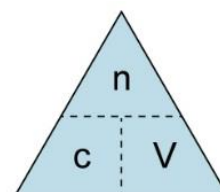
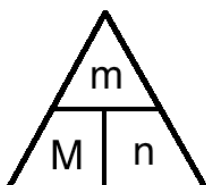
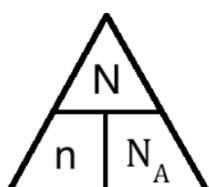
Spectator ion/ions: _____

11. Calculate the pH of a 0.008 mol/L solution sample of $\text{Ba}(\text{OH})_{2(\text{aq})}$ at 25 °C. **(1T, 1A)**

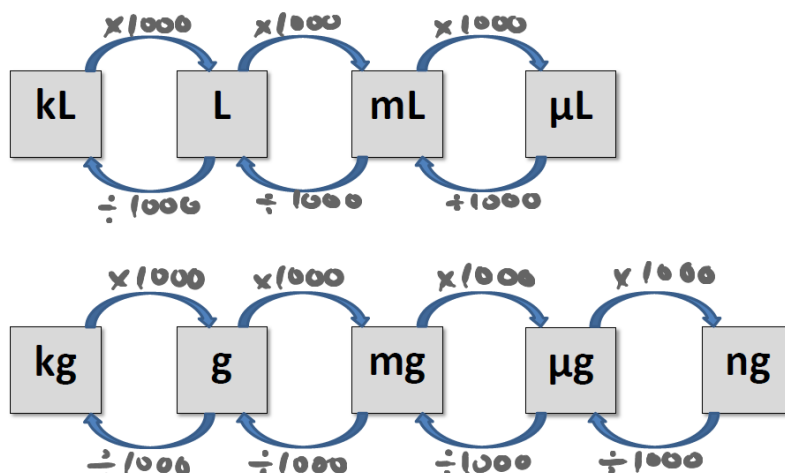
CONGRATULATIONS! 😊

FORMULA SHEET

Relative atomic mass = $\frac{(I_r \times \%abundance) + (I_r \times \%abundance) + \dots}{100}$			$n = \frac{N}{N_A}$
$N_A = 6.02 \times 10^{23}$	$n = cV$	$c_1V_1 = c_2V_2$	$n = \frac{m}{M}$
% composition = $\frac{\text{mass of component}}{\text{mass of compound}} \times 100\%$		% yield = $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$	



Name	Abbreviation	Equation	Application
percentage volume/volume	% V/V	$c_{v/v} = \frac{V_{\text{solute}}}{V_{\text{solution}}} \times 100 \%$	liquid–liquid mixtures
percentage weight/volume	% W/V	$c_{w/v} = \frac{m_{\text{solute}}}{V_{\text{solution}}} \times 100 \%$	solid–liquid mixtures
percentage weight/weight	% W/W	$c_{w/w} = \frac{m_{\text{solute}}}{m_{\text{solution}}} \times 100 \%$	solid–liquid or solid–solid mixtures
parts per million	ppm	$c_{\text{ppm}} = \frac{m_{\text{solute}}}{m_{\text{solution}}} \times 10^6 \text{ ppm}$	to express small concentrations (e.g., composition of air)
parts per billion	ppb	$c_{\text{ppb}} = \frac{m_{\text{solute}}}{m_{\text{solution}}} \times 10^9 \text{ ppb}$	to express very small concentrations (e.g., metal contaminants in water)
parts per trillion	ppt	$c_{\text{ppt}} = \frac{m_{\text{solute}}}{m_{\text{solution}}} \times 10^{12} \text{ ppt}$	to express extremely small concentrations (e.g., traces of medications in water)



Solubility Chart (Ionic compounds)

Solubility	Ion	Exceptions
very soluble (aq) ≥ 0.1 mol/L	NO_3^-	none
	Cl^- and other halides	except with Cu^+ , Ag^+ , Hg_2^{2+} , Pb^{2+}
	SO_4^{2-}	except with Ca^{2+} , Ba^{2+} , Sr^{2+} , Hg^{2+} , Pb^{2+} , Ag^+
	$\text{C}_2\text{H}_3\text{O}_2^-$	Ag^+
	Na^+ and K^+	none
	NH_4^+	none
slightly soluble (s) < 0.1 mol/L	CO_3^{2-}	except with Group 1 ions and NH_4^+
	PO_4^{3-}	except with Group 1 ions and NH_4^+
	OH^-	except with Group 1 ions, Ca^{2+} , Ba^{2+} , Sr^{2+}
	S^{2-}	except with Groups 1 and 2 ions and NH_4^+

Metal Activity Series

Metal	Displaces hydrogen from acids	Displaces hydrogen from cold water	
lithium			Most Reactive
potassium			
barium			
calcium			
sodium			
magnesium			
aluminum			
zinc			
chromium			
iron			
cadmium			
cobalt			
nickel			
tin			
lead			
hydrogen			
copper			
mercury			
silver			
platinum			
gold			Least Reactive

Halogen Activity Series

most reactive	
	F Cl Br I
least reactive	

Carbon-containing ions

Name	Formula	Charge
hydrogen carbonate	HCO ₃	1-
carbonate	CO ₃	2-
cyanide	CN	1-
cyanate	CNO	1-
thiocyanate	SCN	1-
oxalate	OOCCOO	2-

Chromium-containing ions

Name	Formula	Charge
chromate	CrO ₄	2-
dichromate	Cr ₂ O ₇	2-

Halogen-containing ions

Chlorine		
Name	Formula	Charge
hypochlorite	ClO	1-
chlorite	ClO ₂	1-
chlorate	ClO ₃	1-
perchlorate	ClO ₄	1-

*fluorine, bromine, and iodine follow the same pattern

Nitrogen-containing ions

Name	Formula	Charge
nitrite	NO ₂	1-
nitrate	NO ₃	1-

Sulfur-containing ions

Name	Formula	Charge
hydrogen sulfite	HSO ₃	1-
hydrogen sulfate	HSO ₄	1-
sulfite	SO ₃	2-
sulfate	SO ₄	2-
thiosulfate	S ₂ O ₃	2-

Phosphorous-containing ions

Name	Formula	Charge
dihydrogen phosphite	H ₂ PO ₃	1-
dihydrogen phosphate	H ₂ PO ₄	1-
hydrogen phosphite	HPO ₃	2-
hydrogen phosphate	HPO ₄	2-
phosphite	PO ₃	3-
phosphate	PO ₄	3-

Others

Name	Formula	Charge
Hydroxide	OH	1-
Ammonium	NH ₄	1+

Naming Prefixes

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

Useful relations:

$$\text{pH} = -\log_{10} [\text{H}_3\text{O}^+] \quad \text{pOH} = -\log_{10} [\text{OH}^-]$$

$$[\text{H}_3\text{O}^+] = 10^{-\text{pH}} \quad [\text{OH}^-] = 10^{-\text{pOH}}$$

$$K_w = [\text{H}_3\text{O}^+] [\text{OH}^-] = 1.0 \times 10^{-14} \quad (\text{at } 25^\circ\text{C})$$

$$\text{At } 25^\circ\text{C} \quad \text{pH} + \text{pOH} = 14$$

For electronegativity values use your usual Periodic Table!