Exam 1

# Part 1: Multiple Choice (2 points each)

## Directions: Please circle the *best* answer for each of the following questions.

1. Which of the following properties of a compound could also be applied to an element?
	1. Compounds are made up of two or more different types of atoms.
	2. A compound can be separated into different elements with their own unique properties.
	3. Compounds have characteristic physical properties.
	4. Compounds have different chemical properties than the elements that compose them.
	5. none of the above
2. Which of the following statements is true?
3. A scientific law is fact.
4. Once a theory is constructed, it is considered fact.
5. A hypothesis is speculation that is difficult to test.
6. An observation explains why nature does something.
7. A scientific law summarizes a series of related observations.

1. Which of the following are examples of intensive properties?
2. density
3. volume
4. mass
5. all of the above
6. none of the above
7. Which of the following contains the fewest atoms?
8. 4.0 g Li
9. 4.0 g Na
10. 4.0 g Rb
11. 4.0 g K
12. 4.0 g Ca
13. Which species contains the greatest number of electrons?
	1. F
	2. O2-
	3. S2-
	4. Cl
	5. Na
14. What is the name for Sn(SO4)2?
15. Stannic sulfide
16. Tin(IV) sulfate
17. Tin(IV) sulfite
18. Stannous sulfate
19. b & d
20. Which of the following solutions will have the highest electrical conductivity?
21. 0.045 M aluminum sulfate
22. 0.0500 M ammonium carbonate
23. 0.10 M lithium bromide
24. 0.10 M sodium iodide
25. 0.10 M potassium fluoride
26. Which pair of compounds is insoluble in water?
27. AgNO3 and KNO3
28. Na2S and CuS
29. (NH4)2SO4 and AgI
30. PbSO4 and Pb3(PO4)2
31. none of the above
32. If you get some chemicals in your eyes, you should:
33. rinse in the eye wash
34. inform your instructor
35. see an eye doctor
36. all of the above
37. none of the above
38. Which of the following could be described as a polar covalent, partially ionized substance with poor conductivity?
	1. 0.1 M CH3CO2H (aq)
	2. Glacial acetic acid, CH3CO2H (l)
	3. 0.1 M NaOH
	4. 0.1 M KBr
	5. KClO3 (s)

# Part 2: Short Answer

## Directions: Answer each of the following questions. Be sure to use complete sentences where appropriate. For full credit be sure to show all of your work.

1. A small hole in the wing of a space shuttle requires a 20.7 cm2 patch. If the patching material costs NASA $3.25/in2 (6 points).
	1. What is the patch’s area in square kilometers, km2?

$$20.7 cm^{2}×\left(\frac{0.001 km}{100 cm}\right)^{2}=2.07×10^{-9} km^{2}$$

* 1. What is the cost of the patch?
	2. $cm^{2}×\left(\frac{1 in}{2.54 cm}\right)^{2}×\frac{\$3.25}{1 in^{2}}=\$10.42764586=\$10.43$
1. Three different analytical techniques were used to determine the quantity of sodium a Mars Milky Way Dark candy bar. The actual quantity of sodium in the candy bar was 115 mg. Each technique was used to analyze five portions of the same candy bar, with the following results (expressed in milligrams of sodium per candy bar): (5 points)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Technique 1 | Technique 2 | Technique 3 |
| 109 | 110 | 114 |
| 111 | 115 | 115 |
| 110 | 120 | 116 |
| 109 | 116 | 115 |
| 110 | 113 | 115 |
| Average | 109.8 ≈ 110 | 114.8 ≈ 115 | 115 |
| Standard Deviation | 0.8 | 3.7 | 0.7 |

* + - * 1. Which technique(s) is(are) accurate? \_\_\_\_\_\_\_2 and 3\_\_\_\_\_\_\_\_\_\_
				2. Which technique(s) is(are) precise? \_\_\_\_\_\_\_1 and 3\_\_\_\_\_\_\_\_\_\_
				3. Which technique is precise and accurate? \_\_\_\_\_\_\_3\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
1. A process called neon fusion takes place in massive starts. In one of the reactions in this process, an alpha particle (helium-4 nucleus) combines with a neon-21 nucleus to produce another elements and a neutron (5 points).
	* + - 1. How many protons, neutrons, and electrons are in neon-21? \_\_\_10, 11, 10
				2. Complete the equation that describes this process.

$$+\rightarrow + $$

$$+\rightarrow +$$

1. Ammonia gas rapidly reacts with hydrogen chloride gas, making ammonium chloride solid (12 points).
	* + - 1. Write a balanced chemical equation for the reaction.

NH3 (g) + HCl (g) → NH4Cl (s)

* + - * 1. Complete an ICE table when 3.0 g of ammonia react with 5.0 g of hydrogen chloride.

|  |  |  |  |
| --- | --- | --- | --- |
|  | NH3 (g) + | HCl (g) → | NH4Cl (s) |
| I | $$3.0 g NH\_{3}×\frac{1 mol NH\_{3}}{17.031 g NH\_{3}}=0.18 mol$$ | $$5.0 g HCl×\frac{1 mol HCl}{36.61 g HCl}=0.14 mol$$ | 0 mol  |
| C | -x | -x | +x |
| E | 0.18 mol – x =0.18 mol – 0.14 mol =0.04 mol | 0.14 mol – x =0 mol | x = 0.14 mol  |

 Calculate the grams of ammonium chloride produced.

$$0.14 mol NH\_{4}Cl×\frac{53.492 g NH\_{4}Cl}{1 mol NH\_{4}Cl}=7.5 g NH\_{4}Cl$$

* + - * 1. If 6.449 g of ammonium chloride are produced, what is the percent yield?

$$\%yield=\frac{m\_{actual}}{m\_{theoretical}}×100=\frac{6.449 g}{7.5 g}×100=86\%$$

* + - * 1. How many grams of the excess reactant remain at the end of the reaction?

$$0.04 mol NH\_{3}×\frac{17.031 g NH\_{3}}{1 mol NH\_{3}}=0.7 g NH\_{3}$$

1. Suppose you have designed a new thermometer called the X thermometer. On the X scale the boiling point of water is 130 °X and the freezing point of water is 10 °X. At what temperature will the readings on the Fahrenheit and X thermometers be the same (6 points)?

 (10 °X, 32 ° F) and (130 °X, 212 °F)

$$m=\frac{y\_{2}-y\_{1}}{x\_{2}-x\_{1}}$$

$$m=\frac{212 ℉-32℉}{130 °X-10 °X}=\frac{180 ℉}{120 °X}=\frac{3 ℉}{2 °X}$$

$$b=y-mx$$

$$b=\left(212 ℉\right)-\left(\frac{3 ℉}{2 °X}\right)(130 °X)$$

$$b=\left(212 ℉\right)-195 ℉=17 ℉$$

$$T\_{F}=\left(\frac{3 ℉}{2 °X}\right)T\_{X}+17 ℉$$

$$let T\_{F}=T\_{X} $$

$$ T\_{X}=\left(\frac{3 ℉}{2 °X}\right)T\_{X}+17 ℉$$

$$\left(\frac{-1 ℉}{2 °X}\right)T\_{X}=17 ℉$$

$$T\_{X}=\frac{17 ℉}{\left(\frac{-1 ℉}{2 °X}\right)}=-34 ℉$$

1. Argon has a larger average atomic mass than potassium, yet it is placed before potassium in the modern periodic table. Explain (3 points).

Despite being heavier (on average), argon contains 18 protons, whereas potassium contains 19 protons. Since the modern periodic table is organized by increasing atomic number, argon is placed before potassium.

1. When 5.0 g of sulfur is combined with 5.0 g of oxygen, 10.0 g of sulfur dioxide is formed. What mass of oxygen would be required to convert 5.0 g of sulfur into sulfur trioxide (6 points)?

$$For SO\_{2}=\frac{5.0 g O}{5.0 g S}=\frac{2}{1} $$

each oxygen is $\frac{5.0 g}{2}=2.5 g$, so

$$For SO\_{3}=\frac{? g O}{5.0 g S}=\frac{3}{1}$$

$$?=5.0 g+2.5 g=7.5 g O$$

1. Ethylene gas, C2H4, reacts with water at high temperature to yield ethyl alcohol, C2H6O.
	1. Write the balanced chemical equation (10 points).

C2H4 (g) + H2O (l) → C2H6O (l)

* 1. How many grams of hydrogen are in 15.43 g of ethylene?

 $15.43 g C\_{2}H\_{4}×\frac{1 mol C\_{2}H\_{4} }{28.054 g C\_{2}H\_{4}}×\frac{4 mol H}{1 mol C\_{2}H\_{4}}×\frac{1.008 g H}{1 mol H}=2.218 g H$

* 1. How many grams of ethyl alcohol will result from the reaction of 1.33 × 1024 molecules of water with excess ethylene gas?

$1.33×10^{24} molecules H\_{2}O×\frac{1 mol H\_{2}O }{6.022 ×10^{23} molecles H\_{2}O}×\frac{1 mol C\_{2}H\_{6}O}{1 mol H\_{2}O}×\frac{46.069 g C\_{2}H\_{6}O}{1 mol C\_{2}H\_{6}O}=101.746649 g C\_{2}H\_{6}O≈102 g C\_{2}H\_{6}O$

1. Interpretation of Reactions by Ionic Type Equations. Aqueous solutions of the following substances or their mixtures with water if they are only slightly soluble, are mixed. Write first the conventional equation, second the total ionic equation, and lastly the net ionic equation. If you predict no appreciable reaction, indicate this, and state why (9 points).
* Magnesium chloride and sodium carbonate

Conventional equation: MgCl2 (aq) + Na2CO3 (aq) $⟶$ MgCO3 (s) + 2NaCl (aq)

Total ionic equation: Mg2+(aq) + 2Cl-(aq) + 2Na+(aq) + CO32-(aq)$ ⟶$MgCO3(s) + 2Na+(aq) + 2Cl-(aq)

Net ionic equation: Mg2+(aq) +CO32-(aq)$ ⟶$MgCO3(s)

* Aqueous ammonia and hydrofluoric acid

Conventional equation: NH3 (aq) + HF (aq) $⟶$ NH4F (aq)

Ionic equation and net ionic equation: NH3 (aq) + HF (aq) $⟶$ NH4+ (aq) + F- (aq)

* Nitric acid and magnesium acetate

Conventional equation: 2HNO3 (aq) + Mg(CH3COO)2 (aq) $⟶$ Mg(NO3)2 (aq) + 2CH3COOH (aq)

Ionic equation: 2H+ (aq) + 2NO3-(aq) + Mg2+ (aq) + 2CH3COO- (aq) $⟶$Mg2+ (aq) + 2NO3- (aq) + 2CH3COOH (aq)

Net ionic equation: H+ (aq) + CH3COO- (aq)  $⟶$ CH3COOH (aq)

1. Write the names and formulas of the following compounds from this list of elements: Li, Fe, Al, O, C, and N (6 points).
	* + - 1. A molecular substance AB2, where A is a group 14 element and B is a group 16 element.

CO2, carbon dioxide

* + - * 1. An ionic compound X4Y3, where X is a transition metal and Y is a group 14 element.

Fe4C3, iron(III) carbide or ferric carbide

* + - * 1. An ionic compound C3D, where C is a group 1 element and D is a group 15 element.

Li3N, lithium nitride

1. Combustion of a 1.000 g sample of an organic compound known to contain carbon, hydrogen, and oxygen produces 2.360 g of carbon dioxide and 0.640 g of water (12 points).
	1. What is the empirical formula?

$$2.360 g CO\_{2}×\frac{1 mol CO\_{2}}{44.009 g CO\_{2}}×\frac{1 mol C}{1 mol CO\_{2}}=0.053625395 mol C×\frac{12.011 g C}{1 mol C}=0.644094619 g C$$

$$0.640 g H\_{2}O×\frac{1 mol H\_{2}O}{18.015 g H\_{2}O}×\frac{2 mol H}{1 mol H\_{2}O}=0.071051901 mol H×\frac{1.008 g H}{1 mol H}=0.071620316 g H$$

$$m\_{O}=1.000 g-0.644094619 g C-0.071620316 g H=0.284286065 g O×\frac{1 mol O}{15.999 mol O}=0.017798927 mol O$$

$$C\_{\frac{0.053625395 mol}{0.017798927 mol }}H\_{\frac{0.071051901 mol}{0.017798927 mol }}O\_{\frac{0.017798927 mol}{0.017798927 mol}}=C\_{3.012844257}H\_{3.998660168}O\_{1}=C\_{3}H\_{4}O$$

* 1. The molar mass of the gas cyclopronanone is about 56 g/mol. Write the balanced combustion reaction.

$$ratio=\frac{molar mass}{empirical mass}=\frac{56\frac{g}{mol}}{\left(3\left(12.011\frac{g}{mol}\right)+4\left(1.008\frac{g}{mol}\right)+1\left(15.999\frac{g}{mol}\right)\right)}≈1$$

2 C3H4O (g) + 7 O2 (g) → 6 CO2 (g) + 4 H2O (l)