Northern Arizona University **Exam #1**
CHM 151, General Chemistry I Dr. Brandon Cruickshank
Section 6, Fall 2008 September 25, 2008

Name (PRINT) _____

INSTRUCTIONS:

- PRINT your name above and on the cover sheet.
- Code the answers to the True-False and Multiple-Choice questions on the scantron form. Mark **A** for true and **B** for false. There is only **one** correct answer for each multiple choice question. There is **no** partial credit given for this section.
- Show all work on the problems section because partial credit is awarded for this section.
- On the scantron form, write the color of your exam.
- Below your name above, answer the following question. What is your favourite colour? You will receive 1 bonus pt.
- There are **88** points on this exam.

GOOD LUCK! ENJOY!!

PART I: True-false statements (3 points each)

1. An oxygen atom contains 10 electrons. **FALSE**

2. The number 1.250×10^3 contains **3** significant figures. **FALSE**

3. Metal atoms tend to form cations when they react to form ionic compounds. **TRUE**

4. The formula, N_2O_4, is an empirical formula. **FALSE**

PART II: Multiple Choice (3 points each)

5. The term used to indicate how close a measurement is to the true value of the quantity that was measured is:

[a] exactness **[b] accuracy *** [c] uncertainty [d] precision [e] significance

6. Report the answer to the following calculation to the correct number of significant figures:

$$(83.5 - 79.631) \div 264.0 =$$

[a] 0.01466 [b] 0.01 [c] 0.02 **[d] 0.015 *** [e] 0.0147

7. Which of the following metric prefixes multiplies the base unit by a factor **less** than 1?

I) centi II) milli III) kilo
IV) nano V) micro

[a] II only [b] I, II, and IV [c] III only [d] I, II, III, and V **[e] I, II, IV and V ***

8. The diameter of an atom is approximately 0.10 nm. How many **miles** is this? (1 mile = 1609 m)

[a] 6.2×10^{-14} mi* [b] 1.0×10^{-10} mi [c] 1.6×10^{-7} mi [d] 1.6×10^{2} mi [e] 6.2×10^{4} mi

9. The scientist who determined the numerical value for the charge of an electron was:

[a] John Dalton **[b] Robert Millikan*** [c] J.J. Thomson
[d] Ernest Rutherford [e] Raymond Chang

10. Which statement about the classification of matter is **false**?

[a] Sulfur (S) is a nonmetal.
[b] Calcium (Ca) is an alkali metal. *
[c] A fifty pound sample of soil is a heterogeneous mixture.
[d] When crystalline sugar is heated until it melts, a physical change has occurred.

11. Which of the following statements are **true**?

I. A typical sodium *ion* has 10 electrons.
II. The sum of the protons and electrons in an atom is equal to the atomic mass.
III. The number of protons in an atom determines the identity of the atom.
IV. The charge on an iron ion with 23 electrons is +2.

[a] I and III * [b] I, II, and III [c] III and IV [d] II, III, and IV [e] all of the above

12. The element lithium, used to be in a soda called Lithiated Lemon-Lime Soda, which became 7 UP in 1936. The element lithium consists of just two isotopes. They are ^{6}Li and ^{7}Li. Using the periodic table, which isotope of lithium is **least** abundant?

[a] ^{6}Li * [b] ^{7}Li [c] cannot be determined from the information given
[d] neither, their abundances are the same

13. The **molecular mass** of $Mg_3(PO_4)_2$ is:

[a] 71.28 amu [b] 167.9 amu [c] 198.9 amu **[d] 262.9 amu *** [e] 462.2 amu

14. Cinnamic alcohol is used mainly in perfumery, particularly soaps and cosmetics. Its molecular formula is **$C_9H_{10}O$**. Calculate the *percent composition* by mass of **hydrogen** in cinnamic alcohol.

[a] 80.56% [b] 11.93% **[c] 7.51% *** [d] 92.49% [e] 0.751%

15. A compound that contains only Se and Cl is 52.7% Se by mass. What is the **empirical formula** of this compound?

[a] SeCl **[b] $SeCl_2$ *** [c] $SeCl_4$ [d] Se_5Cl_9 [e] none of these

16. A compound has the empirical formula, $C_9H_{18}O$. If the molar mass of the compound is 284.5 g/mol, what is the **molecular formula** of the compound?

[a] C_4H_9O [b] $C_9H_{18}O$ **[c] $C_{18}H_{36}O_2$ *** [d] $C_{27}H_{54}O_3$ [e] $C_{45}H_{90}O_5$

17. Ibuprophen, $C_{13}H_{18}O_2$, is typically given in 9.7×10^{-4} mole/tablet doses. How many **grams** are typically in one tablet?

[a] 1.0×10^{3} g [b] 4.7×10^{-6} g **[c] 0.20 g *** [d] 1.8 g [e] none of these

18. Which of the following contains the **greatest** number of **atoms**?

[a] 1.0 mol of carbon dioxide, CO_2 * [b] 2.0 mol potassium, K [c] 75 g vanadium, V
[d] 9.0 g of water, H_2O [e] 6.0×10^{23} atoms of carbon, C

19. Balance the following equation with whole number coefficients, than add together the coefficients. Don't forget to count coefficients of one. The **sum** of the coefficients is:

$$\_\_\_\_\_\ CH_4 + \_\_\_\_\_\ Cl_2 \rightarrow \_\_\_\_\_\ CCl_4 + \_\_\_\_\_\ HCl$$

[a] 4 [b] 6 [c] 8 **[d] 10 *** [e] 12

20. Acetylene, C_2H_2 (molar mass = 26.0 g/mol), is often used as a fuel in welding. The correct balanced equation for the combustion of acetylene is:

$$2\ C_2H_2\ (g) + 5\ O_2\ (g) \rightarrow 4\ CO_2\ (g) + 2\ H_2O\ (g)$$

The $CO_2(g)$ produced by burning hydrocarbon fuels could contribute to the problem of global warming. If a welder's tank contains 520.0 g of C_2H_2 (20.0 moles), how many **moles** of **CO_2** have been released into the atmosphere when the tank is used up?

[a] 2.00 mol [b] 4.00 mol [c] 10.0 mol [d] 20.0 mol **[e] 40.0 mol ***

21. An unknown salt contains only the sulfate anion (SO_4^{2-}) and one of the **alkali** metals. 0.500 g of the unknown salt is reacted with excess $BaCl_2$ to form 0.322 g of $BaSO_4(s)$ [molar mass = 233.39 g/mol].

$$M_2SO_4 + BaCl_2 \rightarrow 2\ MCl + BaSO_4$$

Assume the reaction goes to completion. What is the formula of the unknown salt? [**Hint:** Can you calculate the molar mass of the unknown salt?]

[a] Rb_2SO_4 [b] Li_2SO_4 **[c] Cs_2SO_4 *** [d] Na_2SO_4 [e] K_2SO_4

22. Which of the following compounds are **soluble** in water?

I) $MgCO_3$ II) $(NH_4)_2SO_4$ III) $CaSO_4$ IV) $Cu(NO_3)_2$ V) K_2O

[a] II, III [b] I, IV **[c] II, IV, V *** [d] IV only [e] all are soluble

23. In accordance with the solubility rules, which of the following is **true** when solutions of NaOH(*aq*) and $BaCl_2(aq)$ are mixed?

[a] $BaCl_2$ will precipitate.
[b] NaOH will precipitate.
[c] $Ba(OH)_2$ will precipitate.
[d] NaCl will precipitate.
[e] No precipitate will form. *

PART III: Problems

24. Naming compounds. [6pts]

[a] Write correct **names** for the following formulas.

1) Cu_2S **copper(I) sulfide**

2) N_2O_4 **dinitrogen tetroxide**

3) Na_3PO_4 **sodium phosphate**

[b] Write correct chemical **formulas** for the following compounds.

1) dinitrogen pentoxide **N_2O_5**

2) iron(III) hydroxide **$Fe(OH)_3$**

3) magnesium iodide **MgI_2**

25. How many **hydrogen atoms** are present in a 50.0 g sample of sucrose ($C_{12}H_{22}O_{11}$, molar mass = 342.3 g/mol)? [4 pts]

$$50.0 \text{ g sucrose} \times \frac{1 \text{ mol sucrose}}{342.3 \text{ g sucrose}} \times \frac{22 \text{ mol H}}{1 \text{ mol sucrose}} \times \frac{6.022 \times 10^{23} \text{ H atoms}}{1 \text{ mol H}} = \mathbf{1.94 \times 10^{24}\ H\ atoms}$$

OR

$$50.0 \text{ g sucrose} \times \frac{1 \text{ mol sucrose}}{342.3 \text{ g sucrose}} \times \frac{6.022 \times 10^{23} \text{ sucrose molecules}}{1 \text{ mol sucrose}} \times \frac{22 \text{ H atoms}}{1 \text{ molecule sucrose}} = \mathbf{1.94 \times 10^{24}\ H\ atoms}$$

26. Phosphoric acid can be prepared from calcium phosphate according to the following reaction:

$$\underset{310.\ g/mol}{Ca_3(PO_4)_2\ (s)} + \underset{98.0\ g/mol}{3\ H_2SO_4\ (l)} \rightarrow \underset{136\ g/mol}{3\ CaSO_4\ (s)} + \underset{98.0\ g/mol}{2\ H_3PO_4\ (l)}$$

[a] If 0.664 mole of $Ca_3(PO_4)_2$ are combined with 1.53 mole of H_2SO_4, how many **grams** of H_3PO_4 can be produced? [4 pts]

$$0.664\ mol\ Ca_3(PO_4)_2 \times \frac{2\ mol\ H_3PO_4}{1\ mol\ Ca_3(PO_4)_2} = 1.33\ mol\ H_3PO_4$$

$$1.53\ mol\ H_2SO_4 \times \frac{2\ mol\ H_3PO_4}{3\ mol\ H_2SO_4} = 1.02\ mol\ H_3PO_4$$

H_2SO_4 is the limiting reagent; it limits the amount of product that can be produced. The amount of product produced is 1.02 mol H_3PO_4. We convert to grams.

$$1.02\ mol\ H_3PO_4 \times \frac{98.0\ g\ H_3PO_4}{1\ mol\ H_3PO_4} = \mathbf{100.\ g\ H_3PO_4}$$

[b] If 62.6 g of H_3PO_4 is actually produced in the above reaction, what is the **percent yield** for the reaction? [2 pts]

$$\%\ yield = \frac{actual\ yield}{theoretical\ yield} \times 100 = \frac{62.6\ g}{100.\ g} \times 100 = \mathbf{62.6\%}$$

[c] How many **moles** of excess reactant remain after the reaction is complete? [3 pts]

From the theoretical yield:

$$mol\ Ca_3(PO_4)_2\ in\ excess = initial\ mol\ Ca_3(PO_4)_2 - mol\ Ca_3(PO_4)_2\ reacted$$

$$mol\ Ca_3(PO_4)_2\ reacted = 1.02\ mol\ H_3PO_4 \times \frac{1\ mol\ Ca_3(PO_4)_2}{2\ mol\ H_3PO_4} = 0.510\ mol\ Ca_3(PO_4)_2$$

mol $Ca_3(PO_4)_2$ in excess = 0.664 mol − 0.510 mol = **0.154 mol $Ca_3(PO_4)_2$**

Potentially Useful Information

Avogadro's number = 6.022×10^{23} particles/mole

1 g = 6.022×10^{23} amu

electron charge = -1.6022×10^{-19} C

1 in = 2.54 cm (exactly)

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

1 lb = 454 g

1 L = 1.06 qt

4 qts = 1 gal

1 mi = 1609 m

$$\text{molar mass} = \frac{\text{g of substance}}{\text{mol of substance}}$$

SOLUBLE COMPOUNDS	INSOLUBLE EXCEPTIONS
Compounds containing alkali metal ions (Li^+, Na^+, K^+, Rb^+, Cs^+) and the ammonium ion (NH_4^+)	None
Nitrates (NO_3^-), bicarbonates (HCO_3^-), and chlorates (ClO_3^-)	None
Halides (Cl^-, Br^-, I^-)	Halides of Ag^+, Hg_2^{2+}, and Pb^{2+}
Sulfates (SO_4^{2-})	Sulfates of Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, and Pb^{2+}
INSOLUBLE COMPOUNDS	**SOLUBLE EXCEPTIONS**
Carbonates (CO_3^{2-}), phosphates (PO_4^{3-}), chromates (CrO_4^-), and sulfides (S^{2-})	Compounds containing alkali metal ions and the ammonium ion
Hydroxides (OH^-)	Compounds containing alkali metal ions and the Ba^{2+} ion