Exam 1

# Part 1: Multiple Choice (2 points each)

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

1. If an atom is 0.1 nm in diameter, how many atoms must be lined up to make a row 1 cm long?
	1. 104
	2. 106
	3. 108
	4. 1010
	5. 1012
2. Which of the following ionic compounds is insoluble in water?
	1. BaCl2
	2. BaSO4
	3. NaOH
	4. Ba(NO3)2
	5. MgCl2
3. Which one of the following is *not* classified correctly?
	1. Distilled water is a compound.
	2. Gold is an element.
	3. Air is a solution.
	4. Table salt (sodium chloride) is a mixture.
	5. Salad dressing is a suspension.
4. Hydrogen peroxide decomposes to produce water and oxygen. Which relationship regarding the quantities of reactants and products associated with this reaction is *not* correct?

2H2O2 (l)  2H2O (l) + O2 (g)

* 1. 68.0 g  36.0 g + 32.0 g
	2. 34.0 g  18.0 g + 16.0 g
	3. 90.5 g  47.9 g + 42.6 g
	4. 2*x* g  2*x* g + *x* g
	5. *y*(34.0 g)  *y*(18.0 g) + (32 g)(*y*/2)
1. Which of the compounds, NaH, PH3, CH4, IBr3 are organic compounds?
	1. only CH4
	2. only NaH
	3. Na H and PH3
	4. PH3, CH4, and IBr3
	5. all of the above
2. Identify the oxidation state of Ca in CaF2 (aq).

 Ca(*s*) + 2 HF(*aq*)  CaF2(*aq*) + H2(*g*)

* 1. -2
	2. -1
	3. 0
	4. +1
	5. +2
1. The mass number is equal to
	1. the sum of the number of the electrons and protons.
	2. the sum of the number of the neutrons and electrons.
	3. the sum of the number of protons, neutrons, and electrons.
	4. the sum of the number of protons and neutrons.
	5. none of the above
2. What kind of mixture can be separated by decantation?
	1. Two insoluble solid compounds
	2. An insoluble solid and a liquid compound
	3. Two liquid compounds
	4. Any mixture
	5. none of the above
3. What are the spectator ions in the following reaction?

Ba2+ (aq) + 2 OH- (aq) + 2 Na+ (aq) + CO32- (aq) → 2 Na+ (aq) + 2 OH- (aq) + BaCO3 (s)

* 1. Ba2+
	2. OH-
	3. Na+
	4. CO32-
	5. more than one
1. The meter stick in the image is being used to measure the length of a piece of wood. How many significant figures should be used to express this measured length?
	1. 1
	2. 2
	3. 3
	4. 4
	5. 5

# 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. Usain Bolt holds the world record for the 100 m dash at 9.58 s. What was his average speed in miles/hour for this distance? It is interesting to compare this value with the average speed for walking (3 mph), bicycling (12 mph), and horse racing (38 mph) (8 points).

$$\frac{100 m}{9.58 s}×\frac{100 cm}{1 m}×\frac{1 in}{2.54 cm}×\frac{1 ft}{12 in}×\frac{1 mi}{5280 ft}×\frac{3600 s}{1 hr}=23.4\frac{mi}{hr}$$

|  |  |
| --- | --- |
| Hydrocarbon | Density (g/mL) |
| Hexane  | 0.6600 |
| 2,3-Dimethylbutane | 0.6616 |
| 3-Methylpentane | 0.6532 |
| 2,2-Dimethylbutane | 0.6485 |
| 2- Methylpentane | 0.6645 |

1. There are five hydrocarbon compounds that have the formula C6H14. (These are isomers; they differ in the way that C and H atoms are attached) All are liquids at room temperature but have slightly different densities (8 points).
	1. You have a pure sample of one of these hydrocarbons, and to identify it you decide to measure its density. You determine that a 5.0 mL samples (measured in a graduated cylinder) has a mass of 3.2745 g (measured on an analytical balance). Assume that the accuracy of the value for mass and volume is plus or minus one (±1) in the last significant figure. What is the density of the liquid?

$$D=\frac{m}{V}=\frac{3.2745 g}{5.0 mL}=0.6549\frac{g}{mL}≈0.65\frac{g}{mL}$$

* 1. Can you identify the unknown hydrocarbon based on your experiment? \_\_\_No
	2. Can you eliminate any of the five possibilities based on the data? If so, which one(s)?

No

* 1. You need a more accurate volume measurement to solve this problem, and you redetermine the volume to be 4.93 mL. Based on this new data, what is the unknown compound?

$$D=\frac{m}{V}=\frac{3.2745 g}{4.93 mL}=0.664198783\frac{g}{mL}≈0.664\frac{g}{mL}$$

Therefore, the hydrocarbon is 2-methylpentane.

1. The active agent in many hair bleaches is hydrogen peroxide. The amount of H2O2 in 14.8 g of hair bleach was determined by titration with a standard potassium permanganate solution (15 points).
	1. What is the balanced oxidation-reduction reaction in acidic conditions? Given the unbalanced equation:

MnO4- (aq) + H2O2 (aq) → O2 (g) + Mn2+ (aq)

Red: **(**MnO4- (aq) + 8 H+ (aq) + 5 e- → Mn2+ (aq) + 4 H­2O (l)**)×2**

Ox: **(**H2O2 (aq) → O2 (g) + 2 H+ (aq) + 2 e-**)×5**

2 MnO4- (aq) + 5 H2O2 (aq) + 16 H+ (aq) + 10 e- → 5 O2 (g) + 10 H+ (aq) + 2 Mn2+ (aq) + 8 H­2O (l) + 10 e-

2 MnO4- (aq) + 5 H2O2 (aq) + 6 H+ (aq) → 5 O2 (g) + 2 Mn2+ (aq) + 8 H­2O (l)

* 1. How many moles of MnO4- were required for the titration if 43.2 mL of 0.105 M KMnO4 was needed to reach the end point?

$$43.2 mL×\frac{1 L}{1000 mL}×\frac{0.105 mol KMnO\_{4}}{1 L}×\frac{1 mol MnO\_{4}^{-}}{1 mol KMnO\_{4}}=0.004536 mol MnO\_{4}^{-}≈0.00454 mol MnO\_{4}^{-} $$

* 1. How many moles of H2O2 were present in the 14.8 g sample?

$$0.004536 mol MnO\_{4}^{-}×\frac{5 mol H\_{2}O\_{2}}{2 mol MnO\_{4}^{-}}=0.01134 mol H\_{2}O\_{2}≈0.0113 mol H\_{2}O\_{2} $$

* 1. How many grams of H2O2 were in the sample?

$$0.01134 mol H\_{2}O\_{2}×\frac{34.014 g H\_{2}O\_{2}}{1 mol H\_{2}O\_{2}}=0.38571876 g H\_{2}O\_{2}≈0.386 g H\_{2}O\_{2} $$

* 1. What is the mass percent of H2O2 in the sample?

$$\%H\_{2}O\_{2}=\frac{m\_{H\_{2}O\_{2}}}{m\_{sample}}×100=\frac{0.386 g H\_{2}O\_{2}}{14.8 g H\_{2}O\_{2}}×100=2.61\% H\_{2}O\_{2}$$

* 1. What is the reducing agent in the redox reaction? \_\_\_\_\_\_\_H2O2
1. Explain the difference between a strong and weak electrolyte. Give an example of each (4 points).

A strong electrolyte is either an ionic compound that is soluble in water or a molecular compound that ionizes completely in water. Possible examples are NaCl or HCl. A weak electrolyte is only slightly soluble or does not ionize to any great extent in water. Possible examples are AgCl or HC2H3O2.

1. A general chemistry class carried out an experiment to determine the percentage (by mass) of acetic acid in vinegar. Ten students reported the following values: 5.22%, 5.28%, 5.22%, 5.30%, 5.19%, 5.23%, 5.33%, 5.26%, 5.15%, and 5.22% (8 points).
	1. Determine the average value.

$$\overbar{\%}=\frac{5.22\%+5.28\%+5.22\%+ 5.30\%+5.19\%+5.23\%+5.33\%+5.26\%+5.15\%+5.22\%}{10}$$

$$\overbar{\%}=\frac{52.40\%}{10}=5.240\%$$

|  |  |  |  |
| --- | --- | --- | --- |
|   | % | d | d2 |
| 1 | 5.22 | 0.02 | 0.0004 |
| 2 | 5.28 | -0.04 | 0.0016 |
| 3 | 5.22 | 0.02 | 0.0004 |
| 4 | 5.30 | -0.06 | 0.0036 |
| 5 | 5.19 | 0.05 | 0.0025 |
| 6 | 5.23 | 0.01 | 0.0001 |
| 7 | 5.33 | -0.09 | 0.0081 |
| 8 | 5.26 | -0.02 | 0.0004 |
| 9 | 5.15 | 0.09 | 0.0081 |
| 10 | 5.22 | 0.02 | 0.0004 |
| Average | 5.24 |   |   |
| Sum |   |   | 0.0256 |
| St Dev | 0.05 |   |   |

* 1. Determine the standard deviation.

$$σ=\sqrt{\frac{Σd^{2}}{n-1}}$$

* 1. How many of these results fell within one standard deviation of the average value?

5.24% + 0.05% = 5.29%

5.24% - 0.05% = 5.19%

7 results fall within one standard deviation.

1. How can one compound contain both ionic and covalent bonds? Give an example (4 points).

An ionic compound that contains a polyatomic ion, such as NaNO3, has both ionic bonds (that hold the sodium and nitrate ions together) as well as covalent bonds (that hold the atoms within the nitrate ion together).

1. A hand-operated flashlight does not use batteries. Instead, you move a lever, which turns a geared mechanism and finally results in light form the bulb (3 points).
	1. What type of energy is used to move the lever? \_\_\_mechanical energy
	2. What type or types of energy are produced? \_\_\_radiant energy and electrical energy
2. A brief winter storm leaves a dusting of snow on the ground. During the sunny but very cold day after the storm, the snow disappears even though the air temperature never gets above freezing. If the snow didn’t melt, where did it go (2 points)?

The snow sublimed to form water vapor.

1. An element has two naturally occurring isotopes. Isotope 1 has a mass of 120.9038 u and a relative abundance of 57.4%, and isotope 2 has a mass of 122.9042 u (8 points).
	1. What is the percent abundance of the second isotope?

$$100\%-57.4\%=42.6\%$$

* 1. What is the atomic mass of the element?

$$atomic mass=\sum\_{}^{}\left(m\_{isotope}\right)\left(\frac{\%abundance\_{isotope}}{100}\right)$$

$$atomic mass=\left(120.9038 u\right)\left(\frac{57.4}{100}\right)+(122.9041 u)\left(\frac{42.6}{100}\right)$$

$$atomic mass=69.3987812 u+ 52.3571466 u$$

$$atomic mass=121.7559278 u≈121.8 u$$

* 1. What is the name and symbol of the element? \_\_\_\_\_antimony, Sb
1. Write the a) conventional, b) total ionic and c)net ionic equations for the reactions which occur when the following aqueous solutions are mixed (6 points):
	1. hydrobromic acid and calcium bisulfite

2 HBr (aq) + Ca(HSO3)2 (aq) → CaBr2 (aq) + 2 H2SO3 (aq) decomposes:

2 HBr (aq) + Ca(HSO3)2 (aq) → CaBr2 (aq) +2 H2O (l) +2 SO2 (g)

2 H+ (aq) + 2 Br- (aq) + Ca2+ (aq) + 2 HSO3- (aq) → Ca2+ (aq) + 2 Br- (aq) + 2 H2O (l) +2 SO2 (g)

2 H+ (aq) + 2 HSO3- (aq) → 2 H2O (l) +2 SO2 (g) simplifies to:

H+ (aq) + HSO3- (aq) → + H2O (l) +SO2 (g)

* 1. iron(III) nitrate and ammonia

Fe(NO3)3 (aq) + NH3 (aq) replace NH3 with NH4OH to complete double displacement rxn

Fe(NO3)3 (aq) + 3 NH4OH (aq) → 3 NH4NO3 (aq) + Fe(OH)3 (s) replace NH4OH with NH3 and H2O

 Fe(NO3)3 (aq) + 3 NH3 (aq) + 3 H2O (l) → 3 NH4NO3 (aq) + Fe(OH)3 (s)

Fe3+(aq) + 3 NO3- (aq) + 3 NH3 (aq) + 3 H2O (l) → 3 NH4+ (aq) + 3NO3- (aq) + Fe(OH)3 (s)

Fe3+(aq) + 3 NH3 (aq) + 3 H2O (l) → 3 NH4+ (aq) + Fe(OH)3 (s)

1. Isoeugenol is the compound which gives the characteristic odor to nutmeg and contains carbon, hydrogen and oxygen. If a 0.500 g sample of isoeugenol is combusted it gives 1.341 g of carbon dioxide and 0.329 g of water. Isoeugenol has a molecular weight of about 164 g/mol. What is the molecular formula of isoeugenol (14 points)?

CxHyOz + O2 (g) 🡪 CO2 (g) + H2O (g)

0.500 g 1.341 g 0.329 g

$1.341 g CO\_{2}×\frac{1 mol CO\_{2} }{44.01 g CO\_{2}}×\frac{1 mol C}{1 mol CO\_{2}}=0.030470348 mol C×\frac{12.01 g C}{1 mol C}=0.365948875 g C$

$0.329 g H\_{2}O×\frac{1 mol H\_{2}O }{18.016 g H\_{2}O}×\frac{2 mol H}{1 mol H\_{2}O}=0.036523091 mol H×\frac{1.008 g H}{1 mol H}=0.036815275 g H$

$$mass O=0.500 g-0.3659 g C-0.03682 g H=0.097 g O×\frac{1 mol O}{16.00 g O}=0.006077241 mol O$$

$$C\_{\frac{0.030470348 }{0.006077241 }}H\_{\frac{0.036815275 }{0.006077241 }}O\_{\frac{0.006077241 }{0.006077241 }}=C\_{5.013845592}H\_{6.057892883}O\_{1}≈C\_{5}H\_{6}O$$

Empirical formula C5H6O

Empirical mass = 82.098 g/mol

Ratio = $\frac{molecular mass}{empirical mass}=\frac{164g/mol}{82.098 g/mol}=1.997612609≈2$

Molecular formula = (C5H6O)2 = C10H12O2