Exam 1

# Part 1: Multiple Choice (2 points each)

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

1. Without doing any calculations, list the elements in C2H6O in order of decreasing mass percent composition:
   1. H > C > O
   2. O > C > H
   3. C > O > H
   4. O > H > C
   5. O = H = C
2. The nighttime and daytime temperature on Mercury are 13 K and 683 K respectively. The melting point and boiling point of sulfur is 246 °F and 832 °F. On Mercury sulfur exists
3. only in the liquid state.
4. only in the solid state.
5. as both a liquid and gas.
6. as both a liquid and solid.
7. all of the above
8. Sodium belongs to which group on the periodic table?
9. Alkali metals
10. Na
11. Alkaline earth metals
12. Halogens
13. 11
14. none of the above
15. An atom has an atomic number of 34 and a mass number of 76 is an isotope of an atom that has
16. Z = 32 and A = 76
17. Z = 34 and A = 80
18. 42 neutrons and 34 protons
19. 42 protons and 34 neutrons
20. 34 electrons & 42 neutrons
21. By analogy with the oxoanions of sulfur, H2TeO3 (aq) would be
22. hydrotellurous acid
23. pertelluric acid
24. telluric acid
25. tellurous acid
26. none of the above
27. Which of the following statements does not describe a chemical property of oxygen?
28. Iron rusts in its presence.
29. Carbon reacts with oxygen to form carbon dioxide.
30. The pressure is caused by collision of oxygen molecules with the sides of a container.
31. When coal is burned in oxygen, the process is called combustion.
32. none of the above
33. \_\_\_\_\_\_\_\_ contains the smallest percent oxygen by mass.
34. Carbon dioxide
35. Dinitrogen tetraoxide
36. Tetraphosphorus decoxide
37. Sulfur dioxide
38. all of the above
39. 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
40. Which of the following organic molecules would form a slightly ionizable substance in water?
41. Acetic acid, CH3COOH
42. Acetaldehyde, CH3CHO
43. Ethanol, CH3CH2OH
44. 1,2-ethanediol, HOCH2CH2OH
45. none of the above
46. How long should you rinse your eyes if you splash chemicals in them?
47. 1 minute
48. Until they stop stinging.
49. 15 minutes
50. You don’t need to rinse.
51. 30 seconds

# 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 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. Can an extensive property be used to identify a substance? Explain why or why not (2 points).

No, extensive properties change with the size of the sample and so cannot be used to identify a substance.

1. Explain the difference between a strong electrolyte and a nonelectrolyte (4 points).

Strong electrolytes completely ionize or dissociate in solution and conduct electricity well. A nonelectrolyte does not ionize or dissociate at all in water and therefore cannot conduct an electrical current.

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. 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. In the movie *The Italian Job*, thieves steal gold bullion. One plan was to carry the ingots of gold off in suitcases. Each suitcase was 19 inches × 14 inches × 10 inches (6 points).
   1. What is the volume of a suitcase in mL?
   2. Approximately how much would each suitcase weigh when filled with gold? The density of gold is 19.3 g/mL.

|  |  |
| --- | --- |
| Mass (amu) | Natural Abundance (%) |
| 39.9872 | 78.70 |
| 40.9886 | 10.13 |
| 41.9846 | 11.17 |

1. The 1997 mission to Mars included a small robot, the *Sojourner,* that analyzed the composition of Martian rocks. Magnesium oxide from a boulder dubbed “Barnacle Bill” was analyzed and found to have the following composition:

If essentially all of the oxygen in the Martian MgO sample is oxygen-16 (which has an exact mass of 15.9948 amu), is the average atomic mass of magnesium on Mars the same as on Earth (24.31 amu) (10 points)?

+

**24.31**69514 amu ≈ 24.32 amu

Yes 24.32 amu is about the same as 24.31 amu.

Or another way to solve the problem:

+

Yes 24.32 amu is about the same as 24.31 amu.

1. In an experiment similar to the Copper Reactions Experiment, a 2.543 g sample of aluminum was carried through a series of reactions. For each reaction (1) predict the products, (2) classify each reaction as combination, decomposition, single replacement, or a double replacement reaction (3) calculate the theoretical yield of the aluminum product at each step (15 points).
   1. Aluminum, Al, + lead(II) nitrate, Pb(NO3)2

2 Al (s) + 3 Pb(NO3)2 (aq) → 3 Pb (s) + 2 Al(NO3)3 (aq)

Single replacement reaction

* 1. Aluminum nitrate, Al(NO3)3, + sodium hydroxide, NaOH

Al(NO3)3 (aq) + 3 NaOH (aq) → 3 NaNO3 (aq) + Al(OH)3 (s)

Double replacement reaction

* 1. Aluminum hydroxide, Al(OH)3, + hydrochloric acid, HCl

Al(OH)3 (s) + 3 HCl (aq) → AlCl3 (aq) + 3 H2O (l)

Acid-base reaction

* 1. Aluminum chloride, AlCl3, + magnesium, Mg

2 AlCl3 (aq) + 3 Mg (s) → 3 MgCl2 (aq) + 2 Al (s)

Single replacement reaction

* 1. If 3.455 g of aluminum was actually recovered, what is the percent recovery?

1. You and your lab partner are asked to determine the density of an aluminum bar. The mass is known accurately to 4 significant figures. To measure the volume you use two methods: A and B. You use a simple metric ruler and find the results in A. Your partner uses a precision micrometer and obtains the results in B (8 points).

|  |  |
| --- | --- |
| **Method A (g/cm3)** | **Method B (g/cm3)** |
| 2.2 | 2.703 |
| 2.3 | 2.701 |
| 2.7 | 2.705 |
| 2.4 | 5.811 |

The accepted density of aluminum is 2.702 g/cm3.

1. Calculate the average deviation of the individual values.

|  |  |  |  |
| --- | --- | --- | --- |
| **Method A (g/cm3)** | **Deviation A**  **d = xav** - x | **Method B (g/cm3)** | **Deviation B**  **d = xav** - x |
| 2.2 | 2.702 – 2.2 = 0.**5**02 ≈ 0.5 | 2.703 | 2.702 – 2.703 = -0.001 |
| 2.3 | 2.702 – 2.3 = 0.**4**02 ≈ 0.4 | 2.701 | 2.702 – 2.701 = 0.001 |
| 2.7 | 2.702 – 2.7 = 0.**0**02 ≈0.0 | 2.705 | 2.703 – 2.705 = -0.002 |
| 2.4 | 2.702 – 2.2 = 0.**3**02 ≈ 0.3 | 5.811 | * 1. – 5.811 = -3.108 |

1. Should all the experimental results be included in your calculation when you calculate the average density? If not, justify your answer.

For method A all of the values should be included. However, for method B, the last trial should be omitted because the deviation of -3.108 g/cm3 is much larger than the other deviation values and may be the result of a gross error.

1. Calculate the average density of the individual values.
2. A pulverized rock sample believed to be pure calcium carbonate is subjected to chemical analysis and found to contain 51.3% Ca, 7.7% C and 41.0% O. Is this rock sample pure calcium carbonate? If not, why not? Clearly explain (6 points).

No, the percentages of 51.3% Ca, 7.7% C, and 41.0% O different from the percent composition of calcium carbonate of 40.043% Ca, 12.001%C, and 47.956% O. The rock is not pure calcium carbonate.

1. A 35.47 mL sample of 0.2430 M sulfuric acid, H2SO4, is mixed with 65.35 mL of a 0.4199 M sample of potassium hydroxide, KOH (18 points).
   1. What is the limiting reagent? Use an ICE table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | H2SO4 (aq) + | 2 KOH  (aq) → | K2SO4 (aq) + | 2 H2O (l) |
| I | 8.619 mmol | 27.44 mmol | 0 mmol | ∞ |
| C | -x | -2x | +x | +x |
| E | 8.619 mmol –x =  8.619 mmol – 8.619 mmol =  0 mmol | 27.44 mmol -2x =  27.44 mmol – 2(8.619 mmol ) =  27.44 mmol – 17.24 =  10.20 mmol | x =  8.619 mmol | ∞ |

Compare ratios

therefore, KOH is the excess reagent and H2SO4 is the limiting reagent.

* 1. What is the total volume of the solution?
  2. Determine the concentration of all ions in the solution.

* 1. What is the resulting pOH of the solution?
  2. What is the pH of the solution?