Chemistry 115 – Exam 2 Study Guide

* Understand Dalton’s, Thomson, and the Nuclear atomic theory
* Know the components of an atom and some of the experiments that helped to identify these components.
* Know how to determine protons, neutrons, electrons, and mass number for and element from the isotopic notation for the element.
* Know the definitions/meaning of mole, aqueous, Avogadro’s number, molecule, formula unit. Know your nomenclature.
* Know how to convert from grams to moles to molecules/formula units/ atoms and back.
* Know how to determine empirical formulas and molecular formulas from percent composition and molar mass data.
* Know how to balance chemical equations and identify the type of chemical reaction.
* Be able to predict products

1. Element X has two naturally occurring isotopes with 69X at 60.10% (68.926 amu) and 71X at 39.90% (70.925 amu).
2. What is the atomic mass of X?

atomic mass = 41.424526 amu + 28.299074 amu

atomic mass = 69.723601 amu

atomic mass = 69.72 amu

1. What is the name and symbol of element X

name: Galluim symbol: Ga

1. Fill in the following table for four neutral atoms or ions. Include any charges appropriate.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
| Mass number | **93** | 46 | **71** | **177** |
| Atomic number | **42** | 21 | **32** | **53** |
| Number of protons | **42** | **21** | **32** | **53** |
| Number of neutrons | **51** | **25** | **39** | 124 |
| Number of electrons | **51** | 18 | **34** | 53 |
| Elemental symbol | **Mo** | **Sc** | **Ge** | I |

1. Name the following compounds

|  |  |  |  |
| --- | --- | --- | --- |
| Al(MnO4)3 | aluminum permanganate | Li2SO4 | Lithium sulfate |
| Cr(OH)3 | Chromium (III) hydroxide | HI (aq) | Hydroiodic acid |
| CsClO | Cesium hypochlorite | Al2(CrO4)3 | aluminum chromate |
| (NH4)3PO3 | ammonium phosphite | PbO2 | Lead(IV) oxide |
| HC2H3O2 (aq) | Acetic acid | Ni(HCO3)2 | nickel(II) bicarbonate |
| As2S5 | Diarsenic pentasulfide | Cd(CN)2 | cadmium cyanide |
| FeCl2 | iron(II) chloride | ZnF2·4 H2O | zinc fluoride tetrahydrate |
| Latin | ferrous chloride | SF6 | sulfur hexafluoride |

1. Write formulas for the following compounds

|  |  |  |  |
| --- | --- | --- | --- |
| Vanadium(III) chlorate | V(ClO3)3 | Mercury(II) phosphate | Hg3(PO4)2 |
| trichlorine heptoxide | Cl3O7 | Manganese(V) oxide | Mn2O5 |
| potassium acetate | KC2H3O2 | Cupric perchlorate | Cu(ClO4)2 |
| Zinc nitrite | Zn(NO2)2 | Xenon tetrafluoride | XeF4 |
| Chromium(III) carbonate | Cr2(CO3)3 | Oxalic acid | H2C2O4 (aq) |
| Copper (II) nitride | Cu3N2 | ammonium selenide | (NH4)2Se |
| Nitrous acid | HNO2 (aq) | Nickel(II) fluoride tetrahydrate | NiF2 · 4 H2O |

1. Succinic acid is a byproduct of the fermentation of sugar. It is often added to soft drinks to give them a sweet/salty taste. Succinic acid is 40.7% C, 5.12% H, and 54.2% O. What is the empirical formula of succinic acid?
2. Pyrogallol, a developer used in photography has an empirical formula of C2H2O and a molar mass of 126 g/mol. What is the molecular formula of the compound?

Molar mass of C2H2O = 2(12) + 2(1) + 16 = 42 g/mol

There are 126/42 or 3 units of this in the compound

Molecular formula = C6H6O3

1. Cacodyl, which has an intolerable garlicky order and is used in the maufacture of cacodylic acid, a cotton herbicide, has the mass composition 22.88% C, 5,76% H, 71.36% As, and a molar mass of 209.96 g/mol. What is the molecular formula of cacodyls ?

Empirical formula is C2H­6As

Molecular formula is C4H12As2

1. Oil of wintergreen is the methyl ester of hydroxybenzoic acid. Its chemical formula is C8H8O3.
   1. Calculate the molar mass of oil of wintergreen.
   2. Calculate the mass of 3.82 moles of oil of wintergreen.
   3. Calculate the number of molecules of oil of wintergreen in a sample containing 8.36 x 10-4 mol of oil of wintergreen.
   4. Calculate the number of moles of carbon in a 8.35 mol sample of oil of wintergreen.
   5. Calculate the mass of oxygen in a 4.29 g sample of oil of wintergreen.
   6. Calculate the mass of a sample of oil of wintergreen that contains 6.58 x 1019 atoms of hydrogen.
2. (tougher mole question) A dandruff shampoo contains pyrithion, C10H8N2O2S2, which acts as an antibacterial and antifungal agent.
3. What is the empirical formula of pyrithion?

C10H8N2O2S2 = (C5H4NOS)2 🡪 empirical formula is C5H4NOS

1. What is the molar mass of pyrithion?

C: (12.011 g/mol)(10) = 120.11 g/mol

H: (1.008 g/mol)(8) = 8.064 g/mol

N: (14.007 g/mol)(2) = 28.014 g/mol

O: (15.999 g/mol)(2) = 31.998 g/mol

S: (32.061 g/mol)(2) = 64.122 g/mol

252.308 g/mol ≈ 252.31 g/mol

1. What is the percent composition of pyrithion?
2. How many moles of pyrithion contain 8.2 x 1024 atoms of nitrogen?

or

1. How many grams of S are in 4.56 moles of pyrithion?
2. How many atoms of C are in 25.0 g pyrithion?

or

1. Write balanced chemical equations for each of the following:
   1. Solid copper reacts with solid sulfur(S8) to form solid copper(I) sulfide(Cu2S).

16 Cu(s) + S8 (s) ----> 8 Cu2S(s)

* 1. Sulfur dioxide gas(SO2) reacts with oxygen gas(O2) to form sulfur trioxide gas(SO3)

2 SO2 (g) + O2 (g) --> 2 SO3.

* 1. Aqueous hydrochloric acid(HCl) reacts with solid manganese(IV) oxide (MnO2) to form aqueous manganese(II) chloride(MnCl2), liquid water, and chlorine gas.

MnO2(s) + 4HCl(aq) →MnCl2(aq) + Cl2(g) + 2H2O(l)

* 1. Liquid benzene(C6H6) reacts with gaseous oxygen(O2) to form carbon dioxide(CO2) and liquid water(H2O).

2 C6H6 (l) + 15 O2 (g) 🡪 12 CO2 (g) + 6 H2O (l)

* 1. Solid magnesium reacts with aqueous copper(I) nitrate to form aqueous magnesium nitrate and solid copper.

Mg(s)+2CuNO3(aq) ---> Mg(NO3)2(aq)+2Cu(s)

* 1. Gaseous dinitrogen pentoxide decomposes to form nitrogen dioxide and oxygen gas.

2N2O5(g)🡪 4NO2+O2(g)

* 1. Solid calcium reacts with aqueous nitric acid to form aqueous calcium nitrate and hydrogen gas.

Ca(s) + 2HNO3(aq) -> Ca(NO3)2(aq) + H2(g).

1. Balance the following chemical equations
   1. Na2S + Cu(NO3)2 🡪 2 NaNO3 + CuS
   2. 4 HCl + O2 🡪 2 H2O + 2 Cl2
   3. 2 H2 + O2 🡪2 H2O
   4. FeS + 2 HCl 🡪 FeCl2 + H2S
   5. BaO2 + H2SO4 🡪 BaSO4 + H2O2
   6. 2 Co(NO3)3 + 3 (NH4)2S 🡪 Co2S3 + 6 NH4NO3
   7. Li2O + H2O 🡪2 LiOH
   8. Hg2(C2H3O2)2 + 2 KCl 🡪 Hg2Cl2 + 2 KC2H3O2
   9. 2 C6H14 + 19 O2 🡪 12 CO2 + 14 H2O
   10. C3H8 + 5 O2 🡪 3 CO2 + 4 H2O
2. Below are some reactions, please balance and identify the type of reaction that is taking place:

2 Al (s) + 3 MnSO4 (aq) 🡪 Al2(SO4)3 (aq) + 3 Mn (s)  Single Replacement

2 LiNO3 (s) + heat 🡪 2 LiNO2 (s) + O2 (g)  Decomposition

H2SO4 (aq) + 2 NH4OH (aq) 🡪 (NH4)2SO4 (aq) + 2 H2O (l) Neutralization

4 Co (s) + 3 O2 (g) 🡪 2 Co2O3 (s) Combustion

1. *Predict the Products and Balance:*
2. C10H16 (l) + **14** O2 (g) 🡪 **10 CO2** (g) **+ 8 H2O** (g)

Type of Reaction: **combustion**

1. **2** MgO (s) 🡪 **2 Mg** (s) **+ O2** (g)

Type of Reaction: **decomposition**

1. Ca (s) + CuCl2 (aq) 🡪 **Cu** (s)  **+ CaCl2** (aq)

Type of Reaction: **single displacement**

1. **2** Al(OH)3 (s) + **3** H2SO4 (aq) 🡪 **Al2(SO4)3** (aq) **+ 6 H2O** (l)

Type of Reaction: **neutralization**

1. **2** Rb (s) + Br2 (l) 🡪 **2 RbBr** (aq)

Type of Reaction: **combination**

1. **2** Na (s) + **2** H2O (l) 🡪 **H2** (g) **+ 2 NaOH** (aq)

Type of Reaction: **single displacement**

1. **2** Ca (s) + O2 (g) 🡪 **2 CaO** (s)

Type of Reaction: **combination**

1. Zn (s) + NaOH (aq) 🡪 no reaction (Na is above Zn in the activity series)

Type of Reaction: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **3** Hg(OH)2 (s) + **2** H3PO4 (aq) 🡪 **Hg3(PO4)2**(s)  **+ 6 H2O** (l)

Type of Reaction: **neutralization**

1. C2H5OH (l) + **3** O2 (g) 🡪 **2 CO2** (g) **+ 3 H2O** (g)

Type of Reaction: **combustion**

1. **2** Al (s) + **3** FeO (s) 🡪 **Al2O3**(s)  **+ 3 Fe** (s)

Type of Reaction: **single displacement**

1. **2** Ca3(PO4)2 (s) + **3** SiO2 (s) 🡪 **6 CaO** (s) **+ Si3(PO4)4** (s)

Type of Reaction: **double displacement**

1. Fe2(SO4)3 (aq) + **6** KOH (aq) 🡪 **3 K2SO4** (aq) **+ 2 Fe(OH)3** (s)

Type of Reaction: **double displacement**

1. **2** Ca3(PO4)2 (s) + **3** Si(CO3)2 (s) 🡪 **6 CaCO3** (s)  **+ Si3(PO4)4** (s)

Type of Reaction: **double displacement**