Ap Chem Summer Assignment #1

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1 Summer Assignment 1

1.1 How many significant figures are there each of the following values

1. 0.002330 has **4** significant figures. Since the leading zeroes (those before the 2) don't count, the significant figures consist of 2330, or 4 significant figures.

2. 13.00 has **4** significant figures. Since all non-zero digits are significant (the 13) as well as all digits after the decimal, every digit in this number is significant, giving us 4 significant figures.

3. 322.1221 has **7** significant figures. Since all non-zero digits are significant, every digit in this number is significant. That gives us 7 significant figures.

4. 1204.30 has **6** significant figures. Since all non-zero digits are significant (the $12_{4.3}$) as well as all digits after the decimal and zeroes between non-zero digits, every digit in this number is significant, giving us 6 significant figures.

5. 0.0002 has **1** significant figure. Since all leading zeroes (those before the 2) don't count, the significant figures consist of just the 2, which means it has only 1 significant figure.

6. 2200.0 has 5 significant figures. Since all non-zero digits (the 22) as well as zeroes before

7. 6 significant figures

1.2 Perform the indicated calculations on the following measured values, giving the final answer with the correct number of significant figures.

1. $16.81 + 3.2257 = 20.0357 \approx 20.04$
2. $324.6 * 815.991 = 264870.6786 \approx 264900$
3. $2.85 + 3.4621 + 1.3 = 7.6121 \approx 7.6$
4. $7.442 - 7.429 = 0.013$
5. $1.65 * 14 = 23.1 \approx 23$
6. $\frac{27}{4.148} = 6.509161 \approx 6.5$
7. $[\frac{(3.901-3.887)}{3.901}] * 1.00 = [\frac{0.014}{3.901}] * 1.00 \approx 0.0036 * 1.00 = 0.0036$
8. $6.404 * 2.91 * (18.7 - 17.1) = 6.404 * 2.91 * 1.6 \approx 30$

1.3 A sample of motor oil with a mass of 440 g occupies 500 mL. What is the density of the motor oil?

We have the following values:

$$\begin{aligned} d &=? \\ m &= 440g \\ v &= 500mL \end{aligned}$$

We can utilize the formula $d = \frac{m}{v}$ (density = mass/volume)

$$\begin{aligned} d &= \frac{m}{v} \\ &= \frac{440g}{500mL} \\ &= 0.88\frac{g}{mL} \\ &\approx 0.9\frac{g}{mL} \end{aligned}$$

1.4 The density of an object is 16.3 g/mL. Its volume is 0.125 L. What is the mass of the object?

We can apply vector analysis to solve for the correct units

$$\frac{16.3\text{g} \quad 1000\text{ mL}}{1\text{mL} \quad 1\text{L}}$$

We are left with

$$\begin{aligned}
&= \frac{16.3g * 1000mL}{(mL)(L)} \\
&= \frac{16.3g * 1000\cancel{mL}}{(\cancel{mL})(L)} \\
&= \frac{16300g}{(L)} \\
&\approx 16300g/L
\end{aligned}$$

Now we have the following values:

$$\begin{aligned}
d &= 16300g/L \\
m &= ? \\
v &= 0.125L
\end{aligned}$$

We can plug these variables into $d = \frac{m}{v}$ to calculate for mass

$$16300g/L = \frac{m}{0.125L}$$

Re-arranging the equation in terms of mass, we get the following

$$\begin{aligned}
m &= 16300 * 0.125 \ \frac{g\cancel{L}}{\cancel{L}} \\
&= 2037.5g \\
&\approx 2040g
\end{aligned}$$

1.5 A sample of uranium weighing 30.923 g was dropped in a graduated cylinder containing 22.30 mL of water. The volume of the water plus the sample was 23.90 mL. What is the density of uranium?

The volume of the object is going to be the difference between the volume of the water and the volume of the water + object.

$$23.90mL - 22.30mL = 1.60mL \tag{1}$$

Now we have the following values:

$$\begin{aligned} d &= ? \\ m &= 30.923g \\ v &= 1.60mL \end{aligned}$$

We can apply the same $d = \frac{m}{v}$ to calculate for density

$$\begin{aligned} d &= \frac{m}{v} \\ &= \frac{30.923g}{1.60mL} \\ &= 19.33\frac{g}{mL} \\ &\approx 19.3\frac{g}{mL} \end{aligned}$$

1.6 How many protons, neutrons and electrons are in each of the following ions?

1. Protons = 26. Neutrons = 30. Electrons = 23
2. Protons = 20. Neutrons = 20. Electrons = 18
3. Protons = 9. Neutrons = 10. Electrons = 10
4. Protons = 15. Neutrons = 16. Electrons = 18
5. Protons = 53. Neutrons = 74. Electrons = 54
6. Protons = 53. Neutrons = 74. Electrons = 46

1.7 Given the position in the periodic table, what is the most likely oxidation state (or common ion charge) that each element will have when forming an ion?

1. Cs has a 1+ oxidation state
2. N has a 3- oxidation state
3. Br has a 1- oxidation state
4. K has a 1+ oxidation state
5. Al has a 3+ oxidation state
6. S has a 2- oxidation state

1.8 Would you expect the following atoms to gain or lose electrons when forming an ion? If so, how many would be gained or lost?

1. Be is in Group 2, therefore it will lose 2 electrons
2. Cl is in Group 17, therefore it will gain 1 electron
3. Al is in group 13, therefore it will lose 3 electrons
4. O is in group 16, therefore it will gain 2 electrons
5. F is in group 17, therefore it will gain 1 electron
6. Li is in group 1, therefore it will lose 1 electron

1.9 Name each of the following compounds:

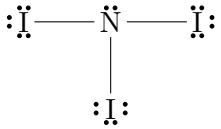
1. PbI_2 is named as Lead(II) iodide
2. NH_4Cl is named as Ammonium chloride
3. Fe_2O_3 is named as Iron(III) oxide
4. LiH is named as Lithium hydride
5. CsCl is named as Cesium chloride
6. $Cr(OH)_1$ is named as Chromium(III) hydroxide
7. $NaC_2H_2O_2$ is named as Sodium acetate
8. $K_2Cr_2O_7$ is named as Potassium dichromate
9. Na_2SO_4 is named as Sodium sulfate

1.10 Which of the following particulate diagrams best shows the formation of water vapor from hydrogen gas and oxygen gas in a rigid container at 125° C?

The correct answer would be **C**. Both Oxygen and Hydrogen exist freely as molecules with two atoms each, which eliminates options A and B. As the chemical composition of water is H_2O, there need to be twice as many hydrogen molecules as oxygen molecules, and so C is the only answer that makes sense.

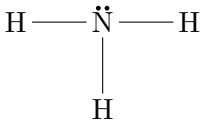
1.11 Name each of the following compounds. In addition, for the compounds in letters a-c, draw Lewis structures, predict VSEPR geometry and hybridization.

NI_3 is named as Nitrogen triiodide, and has the following Lewis Structure. It has a Trigonal pyramidal shape with 109.5° bond angles, and has a SP3 hybridization



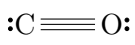
(2)

NH_3 is named as Ammonia, and has the following Lewis Structure. It has a trigonal pyramid shape with 107° bond angles, and has a SP3 hybridization



(3)

CO is named as Carbon monoxide, and has the following Lewis Structure. It has a linear shape with 180° Bond angles, and has a SP hybridization

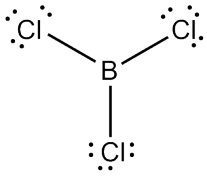


(4)

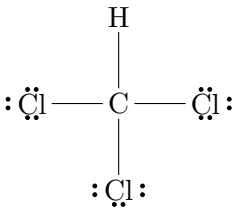
P_4O_{10} is named as Diphosphorus pentoxide, N_2O_4 is named as Dinitrogen tetroxide, PCl_3 is named as Phosphorus trichloride

1.12 Molecules that have geometries in one plane include which of the following? Draw the Lewis structures to prove your point

The lewis structure for BCl_3

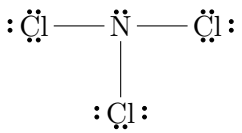


The lewis structure for $CHCl_3$ is



(5)

The lewis structure for NCl_3 is

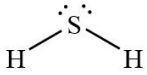


(6)

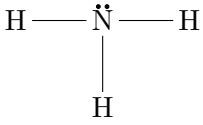
Therefore, the correct option is **A**. Both options II and III are tetrahedral and trigonal pyramidal respectively. Option I (BCL_3) is the only one that has a geometry in one plane (trigonal planar)

1.13 The electron-dot structure (Lewis structure) for which of the following molecules would have two lone pairs of electrons on the central atom? Again, draw the Lewis structures to prove your point.

The lewis structure for H_2S is

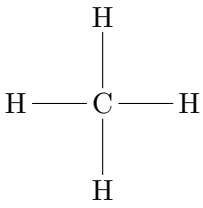


The lewis structure for NH_3 is



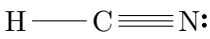
(7)

The lewis structure for CH_4 is



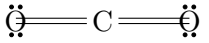
(8)

The lewis structure for HCN is



(9)

The lewis structure for CO_2 is



(10)

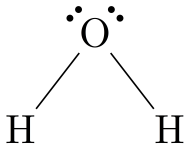
Therefore, the only correct answer is H_2S

1.14 Draw Lewis structures for (a) C2H2, (b) H2O, (c) NH3, (d) HCl (e) CCl4

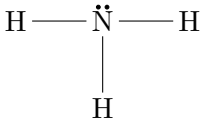
The lewis structure for C_2H_2 is

(11)

The lewis structure for H_2O is

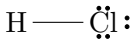


The lewis structure for NH_3 is



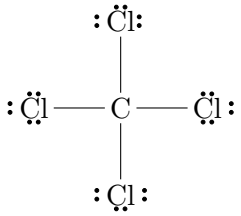
(12)

The lewis structure for HCL is



(13)

The lewis structure for CCl_4 is



(14)

1.15 Give the VSEPR geometry for each for each of the molecules listed in #14.

1. C_2H_2 has a linear VSEPR geometry
2. H_2O has a bent VSEPR geometry
3. NH_3 has a trigonal pyramidal VSEPR geometry
4. HCl has a linear VSEPR geometry
5. CCl_4 has a tetrahedral VSEPR geometry

1.16 Tell whether each of the molecules listed in #14 is polar or nonpolar.

1. C_2H_2 is nonpolar
2. H_2O is polar
3. NH_3 is polar
4. HCl is polar
5. CCl_4 is nonpolar

1.17 What primary type of intermolecular force (IMFs) would attract the molecules in #14. Which molecules would have the highest boiling points? The lowest? (Just estimate based on what you know.)

1. **The primary types of intermolecular forces (IMFs) that would attract the molecules in #14 are**
   (a) C_2H_2 is dominated by London dispersion forces
   (b) H_2O primarily has hydrogen bonds, a type of dipole-dipole force
   (c) NH_3 primarily has hydrogen bonds, a type of dipole-dipole force
   (d) HCl primarily has dipole-dipole forces
   (e) CCl_4 is dominated by London dispersion forces
2. **The molecules that have the highest boiling points and lowest boiling points are**
   (a) H_2O and NH_3 have the highest boiling points, since they have hydrogen bonds
   (b) C_2H_2 and CCl_4 have the lowest boiling points, since they have London dispersion forces

1.18 Name each of the following compounds:

1. P_4O_6 is named as Phosphorus trioxide
2. KOH is named as Potassium hydroxide
3. N_2 is named as Nitrogen

4. PH_3 is named as Phosphane
5. BF_3 is named as Boron trifluoride
6. AgCl is named as Silver(I) chloride
7. $KHCO_3$ is named as Potassium bicarbonate
8. $AgNO_3$ is named as Silver(I) nitrate

1.19 Write formulas for each of the following compounds:

1. The formula for sodium cyanide is NaCN
2. The formula for tin(II) fluoride is SnF_2
3. The formula for lead(II) nitrate is $Pb(NO_3)_2$
4. The formula for iron(III) oxide is Fe_2O_3
5. The formula for calcium phosphate is $Ca_3(PO_4)_2$
6. The formula for sodium bromate is $NaBrO_3$
7. The formula for hydrogen iodide is HI
8. The formula for sodium sulfate is Na_2SO_4
9. The formula for manganese dioxide is MnO_2
10. The formula for potassium chlorate is $KClO_3$
11. The formula for potassium hypochlorite is KclO
12. The formula for lithium hydride is LiH
13. The formula for barium chloride is $BaCl_2$
14. The formula for magnesium oxide is MgO
15. The formula for copper(I) oxide is Cu_2O

1.20 Give the names of the following acids

1. H_2SO_3 is named as Sulfurous acid
2. HI is named as Hydroiodic acid
3. HBr is named as Hydrobromic acid
4. HNO_2 is named as Nitrous acid
5. H_3PO_4 is named as Phosphoric Acid
6. HCl is named as Hydrochloric acid

1.21 Give formulas for the following acids:

1. Nitric acid has a formula of HNO_3
2. hydrofluoric acid has a formula of HF
3. sulfuric acid has a formula of H_2SO_4
4. hydrocyanic acid has a formula of HCN
5. acetic acid has a formula of CH_3COOH

1.22 Give the names and formulas of the seven diatomic elements.

1. H_2, or Hydrogen
2. N_2, or Nitrogen
3. O_2, or Oxygen
4. F_2, or Fluorine
5. Cl_2, or Chlorine
6. Br_2, or Bromine
7. I_2, or Iodine

1.23 Solve the following problems involving scientific notation without a calculator.

1. The solution is $8 * 10^7$

$$\begin{aligned}(2 * 10^3)(4 * 10^4) &= (2 * 4)(10^3 * 10^4) \\ &= 8(10^3 * 10^4) \\ &= 8 * 10^{3+4} \\ &= 8 * 10^7\end{aligned}$$

2. The solution is $4.2 * 10^{12}$

$$\begin{aligned}(6 * 10^5)(7 * 10^6) &= (6 * 7)(10^5 * 10^6) \\ &= 42(10^5 * 10^6) \\ &= 42 * 10^{5+6} \\ &= 42 * 10^{11} \\ &= 4.2 * 10^{12}\end{aligned}$$

3. The solution is $1.05 * 10^{14}$

$$\begin{aligned}(7 * 10^4)(5 * 10^6)(3 * 10^2) &= (7 * 5 * 3)(10^4 * 10^6 * 10^2) \\ &= 105(10^4 * 10^6 * 10^2) \\ &= 105 * 10^{4+6+2} \\ &= 105 * 10^{12} \\ &= 1.05 * 10^{14}\end{aligned}$$

4. The solution is $2.5 * 10^3$

$$\begin{aligned}\frac{(2 * 10^7)}{(8 * 10^3)} &= \frac{2}{8} * \frac{10^7}{10^3} \\ &= \frac{2}{8} * \frac{10^{7-3}}{1} \\ &= 0.4 * 10^{7-3} \\ &= 0.4 * 10^4 \\ &= 4 * 10^3\end{aligned}$$

5. The solution is $2 * 10^2$

$$\begin{aligned}\frac{(4 * 10^6)}{(2 * 10^4)} &= \frac{4}{2} * \frac{10^6}{10^4} \\ &= 2 * 10^{6-4} \\ &= 2 * 10^2\end{aligned}$$

6. The solution is $5 * 10^{10}$

$$\begin{aligned}\frac{(2 * 10^3)}{(4 * 10^{-8})} &= \frac{2}{4} * \frac{10^3}{10^{-8}} \\ &= 0.5 * 10^{3-(-8)} \\ &= 0.5 * 10^{3+8} \\ &= 0.5 * 10^1 1 \\ &= 5 * 10^{10}\end{aligned}$$

7. The solution is $6 * 10^8$

$$\begin{aligned}\frac{(5 * 10^6)(2 * 10^3)(3 * 10^3)}{(5 * 10^4)} &= \frac{(5 * 2 * 3)(10^6 * 10^3 * 10^3)}{(5 * 10^4)} \\ &= \frac{(30)(10^{6+3+3})}{(5 * 10^4)} \\ &= \frac{(30)(10^{12})}{(5 * 10^4)} \\ &= \frac{(3 * 10^{13})}{(5 * 10^4)} \\ &= \frac{3}{5} * \frac{10^{13}}{10^4} \\ &= 0.6 * 10^{13-4} \\ &= 0.6 * 10^9 \\ &= 6 * 10^8\end{aligned}$$

8. The solution is $5 * 10^2$

$$\begin{aligned}
\frac{(4 * 10^6)(5 * 10^{-3})}{(8 * 10^{-4})(5 * 10^3)} &= \frac{(4 * 5)(10^6 * 10^{-3})}{(8 * 5)(10^{-4} * 10^3)} \\
&= \frac{(20)(10^{6-3})}{(40)(10^{-4+3})} \\
&= \frac{(20)(10^3)}{(40)(10^{-1})} \\
&= \frac{(2)(10^4)}{(4)(10^1)} \\
&= \frac{2}{4} * \frac{10^4}{10^1} \\
&= 0.5 * 10^{4-1} \\
&= 0.5 * 10^3 \\
&= 5 * 10^2
\end{aligned}$$

1.24 The structures and normal boiling points of dimethyl ether and ethanol are given in the table above.

1. **Which of the following diagrams best helps to explain the difference in boiling point of the two compounds?**

   The answer is **B**, since it best shows the difference between hydrogen bonds.

2. **Describe your reasoning for selecting the answer you did and specifically identify the type of intermolecular forces represented.**

   Dimethyl either consists of dipole-dipole interactions or dispersion forces, whereas Ethanol consists of hydrogen bonds, and diagram B best highlights that.

1.25 Shown below are three models that can be used to represent a molecule of ammonia. Select one of the models. Each model has its pros and cons.

I chose to compare the benefits and drawbacks of the **lewis structure** model.

1. **One aspect of the ammonia molecule that the model represents accurately/well**

The Lewis structure model allows the reader to easily see where all the electrons are, as well as if each atom obeys the octet rule. You can also which electrons are bonding, as well as which electrons are non-bonding and lone pairs.

2. **One aspect of the ammonia molecule that the model does not represent accurately/well.**

   It is difficult to show resonance structures with a lewis structure. There is also a lack of 3 dimensional modeling with the lewis structure. Lewis structures only imply shape, in order to find the 3 dimensional shape of a molecule, you have to use other knowledge, using VSEPR.