Chemistry 231 Final review Guide

Measurement, Dimensional Analysis, Atoms and Elements in Chemistry

1) Calculate: 4.39+9.6881 5.63*3.40 (5.003 – 2)/1.46

2) $_{x}^{y}Se$ What are the values of x and y?

3) Given tungsten (W-184), Determine number of protons, neutrons and electrons

4) How many **ions** can be obtained from the formation of rubidium carbonate when an amorphous sample of rubidium (Rb) that is 2.3cm long, 1.6cm wide and 0.55cm tall is completely reacted into rubidium carbonate? Density of rubidium = 1.532g/cm^3

5) Toluene (C_7H_8) has a density of 8.65 g/ml. What volume in liters of toluene should be used if James has 5.4 moles of it?

6) Given calcium:
   a) Write the nuclear notation for a calcium atom that has the same number of protons and neutrons
   b) Does the isotope have high or low natural abundance?
   c) How many valence electrons does a Ca atom have? What is group 2A also known as?

   d) Valence electrons in calcium travel about 2.212 km in 1.50 second. How many minutes would it take this valence electron to travel around the Earth? (24,901 miles) Note: 1 mile equals 1600 meters.

   e) A calcium atom has a radius of 231 nm. What is its volume in cm^3?

7) Chlorine has two naturally occurring isotopes, chlorine-35 having a mass of 34.9689 amu and chlorine-37 having a mass of 36.9659 amu. If chlorine has an atomic weight of 35.4527, what is the percent abundance of each isotope of chlorine?

8) James is trying to transfer currency. If one U.S dollars is equivalent to .60 James dollars, and 1 James dollar is equivalent to 12 James quarters, and 5 James quarter is equal to 1 James euros, how many James euros are in 77 U.S quarters?

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The Quantum Mechanical Model of the Atom

1) Consider Rhodium (z=45)

a) Provide Rhodium's electron configuration

b) Represent Rhodium using an orbital box diagram and state whether it is paramagnetic or diamagnetic

c) provide a valid set for electron's is Rh's highest energy subshell

d) using the electron configuration from part a, choose which possible cation of rhodium (ranging from +1 to +8) would most readily form and explain why.

e) how many electrons can be described with the quantum numbers n=4 l=2

2) Consider a hydrogen atom:

a) Without doing any calculations, determine which of the electron transitions in a hydrogen atom would emit photons with the shortest wavelength. Justify your answer.

n=2 → n=1 n=3 → n=2 n=3 → n=1 n=4 → n=2

b) An excited hydrogen atom absorbs a photon of light of wavelength 487 nm. If the electron ends up in the n=4 level, in what level was it originally?

c) Once the hydrogen starts returning to ground state and emits light, calculate the uncertainty in position of its electron (9.1094×10^{-28}g) if it is moving at 80% of the speed of light and if the uncertainty in the velocity is 2%?

d)If the total energy of a mole of a photon emitted from this exothermic process is 120 kJ, what is the wavelength of the photons?

3) Answer the following questions about **light and the photoelectric effect:**

a) Determine the longest wavelength of light that can remove an electron from a sample of potassium metal, if the binding energy for one electron in potassium is 4.59×10^{-18} J.

b)A photon of light strikes a detector in a camera's light meter with an energy of 6.00×10^{-17} J. What is the frequency and wavelength of this photon?

c) If a photon with a wavelength of 350 nm impacts a metal whose frequency threshold is 6.037×10^{13} hertz, will the metal surface eject and electron? If so, what is the velocity of the liberated electron?(mass of electron is $9.11 * 10^{-28}$g)

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Periodicity

1)Answer the following questions using principles of atomic and molecular structure. The elements in the table below (W, X, Y, and Z) are actual elements found in either period 2 or 3 in the periodic table.

Element	1st IE kJ/mol	2nd IE kJ/mol	3rd IE kJ/mol	4th IE kJ/mol
W	520	7298	11815	
X	900	1757	14850	21000
Y	801	2428	360	25000
Z	496	4562	6910	9543

a) Which of the elements listed above has a valence electron configuration of $3s^1$? Justify your answer.

b) For element Z, identify the core electrons and valence electrons

c) Which of the elements listed above is an alkaline earth metal? Explain.

d) Which of the elements listed above has the largest atomic radius? Explain.

e) Which element, X or Y has more protons? Assume both have the same principal valance energy level.

2)Using **modern periodic theory**, explain why:

a) The radius of the chlorine atom is smaller than the radius of the chloride ion, Cl^-

b) The first ionization energy of aluminum is lower than the first ionization energy of magnesium.

c) The difference between the atomic radii of Na and K is relatively large compared to the difference between the atomic radii of Rb and Cs.

3)Provide four ions that are isoelectronic to Mn at ground state. Rank these in **increasing atomic radii**.

4)Give the condensed electron configuration for Au (Z=79)

5)Rank the following the sets of elements by increasing effective nuclear charge:

Mg, Al, Cl, Na Mg^{2+}, Al, Cl, Na K, Na, Cs, Mg

Properties of Chemical Bonding and the Molecular Orbital Theory

1) Draw the Lewis Structure for acetic acid, CH_3CO_2H

Provide: the electron geometry and molecular geometry around each center C and O atom. For these center atoms, provide the bond angles, hybridization, and formal charge. Determine if this molecule is polar or non-polar. Can this molecule exhibit resonance? How many total lone pair electrons are there on the molecule? How many total pi bonds and sigma bonds on this molecule? At which bond between which atoms will have the highest polarity?

2) A molecule has 3 sigma bonds, 1 pi bond, and no lone pair of electrons on its center atom. What is the molecular geometry of this molecule?

3) In general, what is hybridization?

4) Complete a molecular orbital diagram, for N_2^{+1} and N_2^{-2}

Which are paramagnetic and which are diamagnetic? Rank N_2^{+1}, N_2 and N_2^{-2} from weakest to strongest bond order.

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Stoichiometry

$$N_2H_4(g) + N_2O_4(g) \rightarrow 3\ N_2(g) + 4H_2O(g)$$

1)When 92 g of dinitrogen tetroxide and excess N_2H_4 and are mixed and react according to the equation above, what is the maximum mass of H_2O that can be produced?

2)Solid lithium hydroxide is used in space vehicles to remove exhaled carbon dioxide from the living environment by forming solid lithium carbonate and liquid water. What mass of gaseous carbon dioxide can be absorbed by 1.00 kg of lithium hydroxide?

3) James reacts a metal chloride (M) with silver nitrate solution to give a precipitate of silver chloride according to following equation:

$$MCl_2\ (aq) + 2AgNO_3(aq) \rightarrow M(NO_3)_2(aq) + 2AgCl(s)$$

When a solution containing 0.4750 g of metal chloride is made to react with silver nitrate, 1.435 grams of silver chloride are formed. Identify the metal

4) A 55.0 mL sample of 0.102 M potassium sulfate solution is mixed with 35.0 mL of 0.114 M lead(II) acetate solution.

a) If the recovered mass of precipitate is 1.01 grams, what was the percent yield and theoretical yield?

5)James synthesizes a new compound in an alternate universe. In this reaction, 2.3 moles of X react with 1.6 moles of Y, and 71 grams of Z are produced. What is the molar mass of Z? $3X + 4Y \rightarrow 5Z$

This reaction has a 50% yield.

6)James is trying to prepare a solution into a 1.0 L volumetric flask containing aluminum sulfate. How much aluminum sulfate, in moles, does James need to prepare if he wants to produce a solution that is exactly 0.88 M in Al^{+3} once he fills up the solution to the mark on the flask? How much in grams?

7)If there are 5:4 times the amount of compound B as there is of compound A and they react such that $5A+4B \rightarrow C$ and assuming the molar mass of compound of A and B are 4:5, which reactant will go to completion first?

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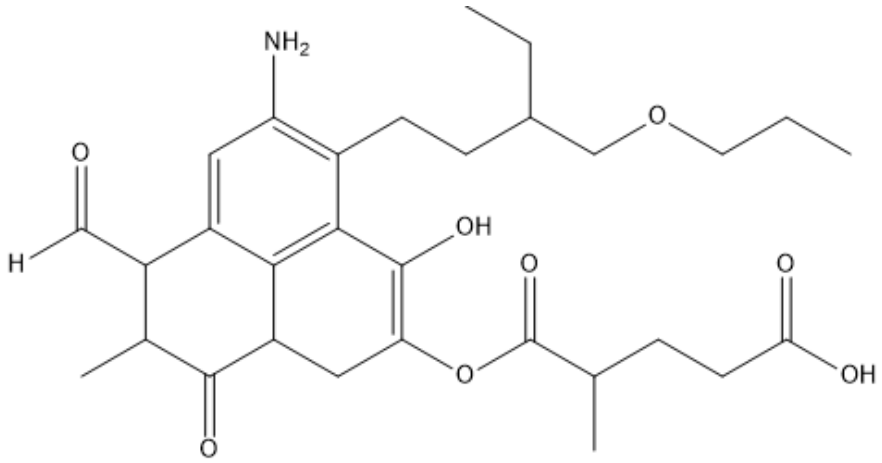
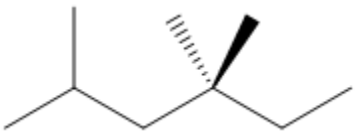
Organic Chemistry

1) This wacky molecule has everything. Identify every functional group you see:

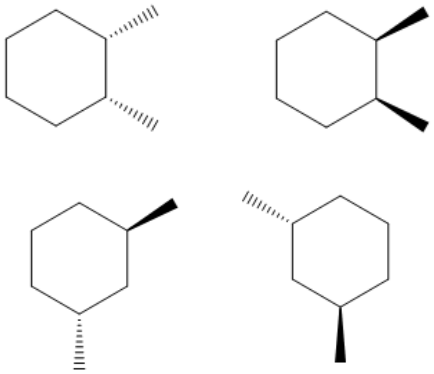


2) How many chiral carbons are on the above molecule?

3) Draw the enantiomer for the following molecule:



4) Is the molecule optically active? How are the following pairs of molecules related (enantiomer, diastereomer, identical)



5) Is this molecule cis or trans? Draw the opposite configuration