Quest 2 Review Sheet

1) Rank the following in terms of increasing atomic radii and explain why:

N P

N O

N^{3-} O^{2-}

Mg^{2+} N^{+} Al^{3+}

Ca^{2+} Ga N K^{+} Li Be O^{2-} Cr

2) For all the following ions give the charge onto the ion and the number of valence electrons in front of the element.

Na I O S B Be Sr Ar Mg Al Ga

F Al H Si Ca

3) Name or write the formula for each of the following:

$Al_2(SO_4)_3$	Acetic Acid
$Na_3(PO_4)$	Phosphoric Acid
$Ti(CO_3)_2$	Cobalt (II) sulfate
N_3Br_8	PH_6
Chromium (IV) Nitrate	$Pt(SO_4)$
Hydrochloric Acid	Calcium Hydroxide

4) For each of the following, draw the **most stable** Lewis structure, and provide the total number of valence electrons, total bonding sites, total lone pairs, formal charges on all atoms, and the bond angles of the molecule:

I_3^-

Xenon tetrafluoride

SCl_4

$BeCl_2$

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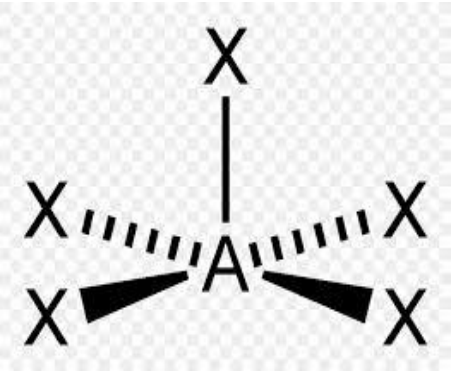
SF_3^+ ClF_4^+

5)Identify the electron geometry, molecular geometry, and bond angles of the following molecule:



6) Provide the bond angle for a molecule with molecular geometry of:

Bent	Square Planar
Tetrahedral	Octahedral
Trigonal Pyramidal	Trigonal Bipyramidal
Linear	T-shaped

7) James analyzes a compound containing the elements C , H , N , and O. When a 1.2359 g sample is burned in excess oxygen, 2.241 g of CO2(g) is formed. The combustion analysis also showed that the sample contained 0.0648 g of H. When the compound is analyzed for N content only, James finds that the mass percent of N is 28.84 percent. Determine the empirical formula of the original combusted sample.

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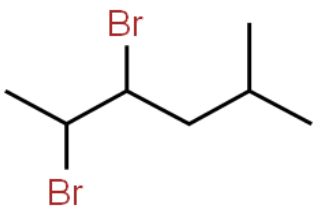
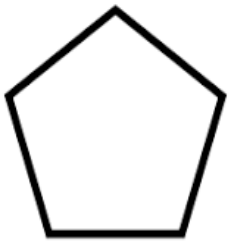
8) James finds that in a new organic compound he synthesizes, it contains 76.54% carbon and balance element Z, which has a molar mass of .02207kg/kmol. What is the empirical formula of ZC?

9) For skeleton structures, remember there is one implied carbon at the end of each chain and that carbon will always form a bond with 4 other molecules, assumed to be hydrogen if not shown otherwise. On other atoms, it is assumed that if they are not bonded with anything else, the remaining areas of electron densities are occupied by only lone pairs of electrons. Calculate the percent mass of carbon in each of the following organic compounds:

2,3 dibromo-5-methylhexane:



Cyclopentane:



2-chloro-2-methylbutane:

$CH_3CH_2C(CH_3)_2Cl$

10) Draw the orbital diagrams for:

Nitrogen

O^{-2}

Lithium

Ca^{2+}

Fluorine

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Challenge Problems:

1) A list of elements is provided:

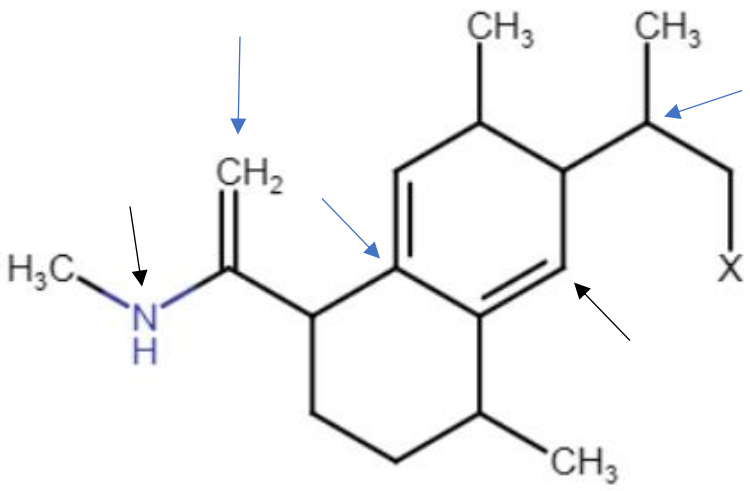
Al P Ar Kr Ca S K Li B C

a) What is effective nuclear charge? Describe the trend for effective nuclear charge and order the following in terms of increasing Z_{eff}:

b) From the same list as above, describe the trend in electronegativity and order the elements by increasing electronegativity.

c) In regard to bonds, remember that bond type between atoms are characterized by polar, nonpolar, and ionic. By using four different elements from the list above, choose the pair of elements that would be the most ionic in character, and the other pair to designate the most nonpolar (or least ionic).

2) James synthesizes a new organic compound in his dormitory. The compound has a molecular formula that contains one new element, X, located at the end as a substituent.



**Reminder that for organic molecules, a sp^3 hybridization is preferred to be formed between carbons whenever possible by implied hydrogens unless otherwise noted. Carbons attachments are applied at the end and between every new line unless noted otherwise.

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a) For all of atoms that have an arrow pointing to it, label the hybridization.
b) Joey says that for every methyl group, an ending chain with a CH_3 attachment, contains a sp^3 hybridization that correlates with an electron geometry of trigonal planar and molecular geometry of tetrahedral. Is Joey right with his description? Explain why or why not.

c) Label the electron geometries and molecular geometries of the arrowed atoms from above.

d) This new compound, named Jamesonnium, has a density when it is in liquid phase of 26.5kg/m^3. When 100 moles of Jamesonnium is condensed into a solid, it measures to a length of 3.5 m by 7.54 m by 6.69 m. What is the mass in kg of 100 moles of Jamesonnium?

When solid Jamesonnium is reacted with ammonia, a strong conjugate base and nucleophile, an SN_2 reaction occurs that expels the X alkyl group. In order to catalyze this reaction, heat is applied and X is energized into its excited state as an ion. The electron configuration for X at this moment is [Ar]$3d^6$

e) Give an example of an elemental cation that would have the same configuration at ground state.

When X leaves its excited state, a proton is emitted at a speed of 124 km/hr.

f) What is the de Broglie wavelength, in nm, for this proton? (mass of proton is $1.672*10^{-24}$g)

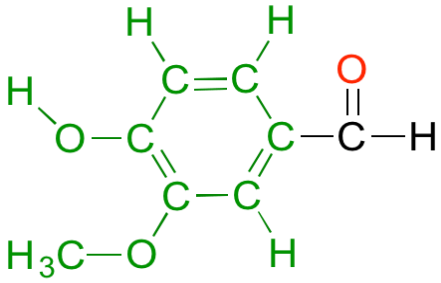
g) What is the total energy of 1 mole of this proton in kJ/mol?

Once atom X has returned from its excited state to ground state, it is finally extracted from Jamesonnium. James the Impostor sends an electric current in a closed vessel containing solely of X and records the successive ionization energies required for X to eject an electron. From this technique, properties of the atom can be determined.

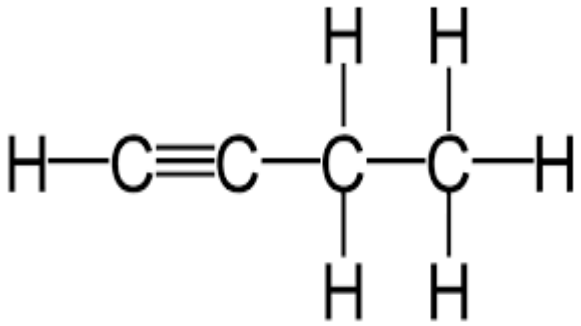
First Ionization Energy	1649 kJ/mol
Second Ionization Energy	1426 kJ/mol
Third Ionization Energy	1715 kJ/mol
Fourth Ionization Energy	2075 kJ/mol
Fifth Ionization Energy	2750 kJ/mol
Sixth Ionization Energy	3109 kJ/mol
Seventh Ionization Energy	66598 kJ/mol
Eighth Ionization Energy	70134 kJ/mol
Ninth Ionization Energy	72513 kJ/mol

h) In which group does element X belong?

3) The condensed structures of vanillin, the natural flavoring of vanilla, and 1-butyne, a flammable colorless gas, are shown below.



vanillin



1-butyne

a) Designate the number of sigma bonds and pi bonds in vanillin and 1-butyne.

b) How many grams of carbon are in 24.5 grams of vanillin?

4) James wants to represent a new molecule, named Jamesonnium, as a Lewis structure. Jamesonnium can simply be written as XPZ^- where:

X has an electronegativity of 1.8
Z has an electronegativity of 2.5
P has an electronegativity of 2.0

In this universe,
X has similar properties to carbon
Z is in period 5
P has 6 valence electrons

Draw all resonance structures of XPZ^- and explain which one is the most stable and why.

5) Give the number of electrons in pi* orbitals, bond order, and state whether the following molecules would be paramagnetic/diamagnetic and if it were a likely structure to exist:

NO^+ SCL^+