Chemistry 139
Test 3-g

Name KEY

1) (2 points) A diagonal relationship exists between certain pairs of diagonally adjacent elements. The two elements (Li & Mg or Be & Al or B & Si) exhibit similar properties. For example, boron and silicon are both semiconductors, have chloride compounds that react with water, and have oxygen compounds that are acidic when dissolved in water.

Using your knowledge of effective nuclear charge (Z_{eff}) and periodic trends, ***explain the diagonal relationship***.

Z_{eff} increases moving left to right along the PT.
Z_{eff} decreases moving top to bottom along the PT.
Using Li + Mg: Starting w/ Li and moving right one place to Be would lead to a smaller radius for Be compared to Li, as the pull on the e^- is greater for Be due to higher Z_{eff}. Moving one place down from Be to Mg would give a larger radius for Mg, as its valence e^- are in a higher energy level farther from the nucleus. The effect of one move is cancelled by the other resulting in similar radii (Li 167 pm, Mg 145 pm).

2) (2 points) Circle the appropriate atom or ion that

a) has the least electronegativity (EN)	Li	(Rb)	O	Bi
b) has the lowest ionization energy (IE)	Mg	Ba	Ca	(Fr)
c) is the most metallic	Sn	C	Si	(Pb)
d) has the largest radius	(P^{3-})	P	P^+	P^-

3) (2 points) A monoatomic ion with a 4- charge has the ground state electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6$.

a) Write the symbol of this monoatomic ion? C^{4-}

b) Write the symbol of the neutral noble gas atom having the same configuration? Ar

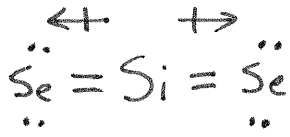
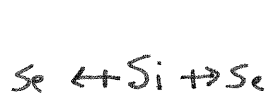
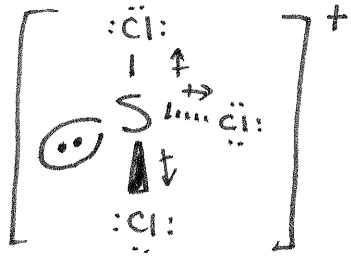
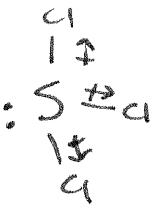
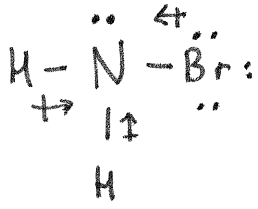
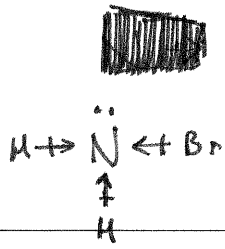
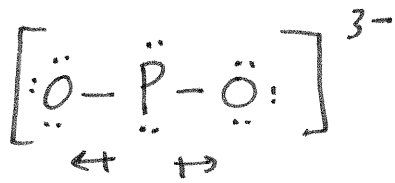
c) Write the symbol of an ion with a 3+ charge that is *isoelectronic* with the species in (a) and (b). Sc^{3+}

d) Write the symbol of an ion with a 2- charge that is *isoelectronic* with the species in (a) and (b). S^{2-}

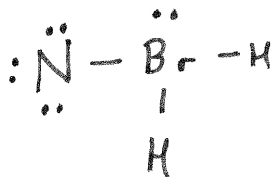
4) (4 points) Complete the electron configuration table.

Atom or Ion	Ground-state Electron Configuration (long form)	# of valence electrons
P	$1s^2 2s^2 2p^6 3s^2 3p^3$	5
Se^{2-}	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$	8

5) (8 points) Complete the table below. Follow the method developed in class.

Chemical Formula	Total Number of Valence Electrons	Draw the Complete Lewis Dot Structure Include ALL lone pair electrons	Are the bonds polar? If yes, identify the negative and positive ends by using dipole moment arrow.
$SiSe_2$ 4 + 6(2)	16		
SCl_3^+ 6 + 7(3) − 1	26		
NH_2Br 5 + 2(1) + 7	14		
PO_2^{3-} 5 + 2(6) + 3	20		

6) (1 point) A second structure could be written for NH_2Br. Draw this structure and compare it to the one drawn in question 5. Which one is a better Lewis Structure? Why?



While this structure puts the least EN atom in the center of the molecule, it gives Br 3 bonds and N 1 bond rather than Br w/ 1 bond and N w/ 3 bonds.

The number of bonds relates to the number of e⁻ needed to complete an atom's octet. This 2nd structure is NOT as good as the one in #5.

7) (5 points) Lithium reacts with nitrogen to produce lithium nitride, a black solid.

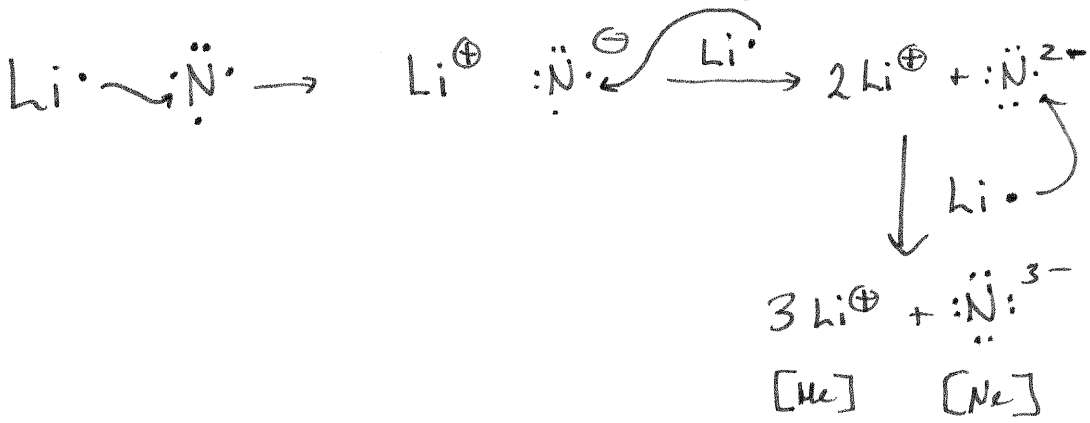
a) What type of compound is **lithium nitride**, ionic or covalent? ionic

b) Write the Lewis Dot symbols for a ~~scandium~~ lithium *atom* and an ~~oxygen~~ nitrogen *atom*. Li· ·N·

c) Write the *formula unit* for **lithium nitride**. Li_3N

Li^+ $:\ddot{N}:^{3-}$

d) Confirm the formula unit by making **lithium nitride** using Lewis dot structures. Clearly indicate that each element achieves an octet in the formation of **lithium nitride** (a shorthand electron configuration for one of the ions may be useful here).

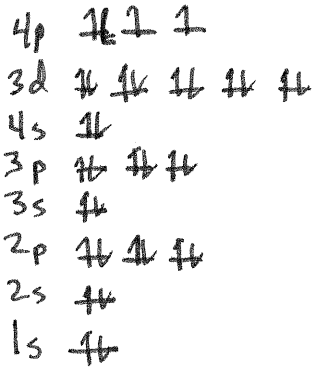


8) (2 point) Circle the bond type that would form for the following element combinations.

a) Se and Br **ionic** (**covalent**) **metallic** b) P and Mg (**ionic**) **covalent** **metallic**

c) Ba and Na **ionic** **covalent** (**metallic**) d) O and H **ionic** (**covalent**) **metallic**

10) (2 points) Draw the <u>orbital energy diagram</u> for Se.



11) (2 points) You have a heat source, an iron pan, a liter of water, table salt, and sugar. How would you demonstrate the difference between properties of ionic and covalent compounds using just these materials?

	ionic	covalent
	salt	sugar
solubility ($in\ H_2O$)	yes	yes
	////	////
melting pt	very high	lower
reacts w/ O_2	no	yes, it ultimately burns

Although, rusting of the pan in salt water is faster than in sugar water at room temp.

Since both sugar + salt dissolve in water, solubility alone does not distinguish the two compounds (If you could pass electricity through each solution that would help identify salt as ionic as its solution conducts)

Differences in melting point would be the best support given the materials on hand.

Extra Credit (2 points): How would you describe what a chemical bond is to someone with no chemistry background?