Practice Exam for Exam 2

1. Photodissociation of water

$$H_2O_{(l)} + h\nu \rightarrow H_{2\,(g)} + \tfrac{1}{2}\, O_{2\,(g)}$$

has been suggested as a source of hydrogen. The $\Delta H_{rxn}°$ for the reaction, calculated from thermochemical data, is +285.8 kJ/mol water. Calculate the ***wavelength, in nm***, that would be required to effect this reaction.

$$?\ \text{nm} = \frac{hc}{E} = \frac{(6.626\times10^{-34}\ \text{J s})(2.998\times10^{8}\ \text{m s}^{-1})}{1\ \text{molecule H}_2\text{O}\times\dfrac{1\ \text{mole H}_2\text{O}}{6.022\times10^{23}\ \text{molecules H}_2\text{O}}\times\dfrac{285.8\ \text{kJ}}{1\ \text{mole H}_2\text{O}}\times\dfrac{10^{3}\ \text{J}}{1\ \text{kJ}}}\times\frac{1\ \text{nm}}{10^{-9}\ \text{m}}$$

$$= 418.6\ \text{nm}$$

2. A compound of tin and chlorine is a colorless liquid. The vapor has a density of 7.49 g/L at 151°C and 1.00 atm. What is the ***molecular weight*** of the compound? ***Why*** do you think the compound is molecular and not ionic? Write the ***Lewis formula*** for the compound.

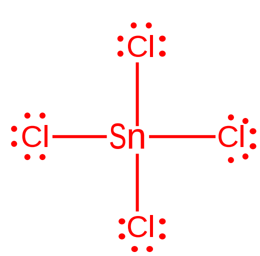
$$M = \frac{dRT}{P} = \frac{(7.49\ \text{g/L})(0.082058\ \frac{\text{L atm}}{\text{mol K}})(424\ \text{K})}{1.00\ \text{atm}} = 26\underline{0}.59\ \text{g mol}^{-1}$$

There are a couple of reasons to suspect that the compound is molecular and not ionic:

- The compound is a liquid at room temperature. Ionic compounds tend to be solids with relatively high melting points.
- The electronegativity difference between Sn and Cl is only 1.20 which is below the threshold of 1.7 for a compound to be considered ionic.

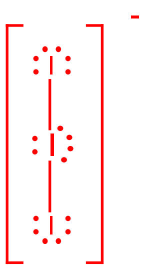
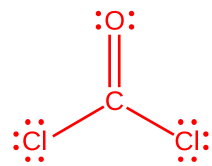
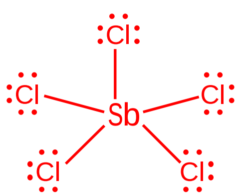
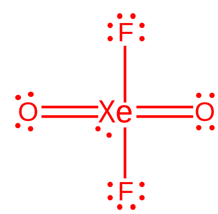
With a molar mass of 261 g and assuming there is only 1 Sn atom there must be 4 Cl atoms

$$261 - 119 = 142 \qquad \frac{142}{35.5} = 4$$



So the formula is $SnCl_4$ which has the Lewis structure

3. For the following molecules (a) draw the ***Lewis Structure***, (b) give the ***electron pair geometry***, (c) give the ***molecular geometry***, (d) state whether or not it is ***polar***, and (e) give the ***hybridization on the central atom***.

I_3^- 	b. trigonal bipyramidal	$COCl_2$ 	b. trigonal planar
	c. linear		c. trigonal planar
	d. non-polar		d. polar
	e. sp^3d		e. sp^2
$SbCl_5$ 	b. trigonal bipyramidal	XeO_2F_2 	b. trigonal bipyramidal
	c. trigonal bipyramidal		c. see-saw
	d. non-polar		d. polar
	e. sp^3d		e. sp^3d

4. Calculate the ***wavelength***, in nm, of light emitted when an electron drops from the 5th energy level to the 2nd energy level in a He^+ ion.

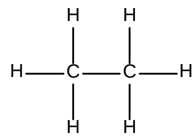
$$\frac{1}{\lambda} = \frac{Z^2 R_H}{hc}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$= \frac{(2)^2 (2.180 \times 10^{-18}\ \text{J})}{(6.626 \times 10^{-34}\ \text{J s})(2.998 \times 10^{8}\ \text{m s}^{-1})}\left(\frac{1}{2^2} - \frac{1}{5^2}\right)$$

$$= 9.218339 \times 10^{6}\ \text{m}^{-1}$$

$$\lambda = 1.084794 \times 10^{-7}\ \text{m} \times \frac{1\ \text{nm}}{10^{-9}\ \text{m}} = 108.5\ \text{nm}$$

5. Estimate the ***enthalpy change*** for the combustion of ethane, C_2H_6, using bond energies. The Lewis structure of ethane is:



$2\ C_2H_6 + 7\ O_2 \rightarrow 4\ CO_2 + 6\ H_2O$

$$\Delta H \approx BE(\text{broken}) - BE(\text{formed})$$
$$= \left[2(C-C) + 6(C-H) + 7(O=O)\right] - \left[8(C=O) + 12(O-H)\right]$$
$$= \left[2(346\text{ kJ}) + 6(414\text{ kJ}) + 7(498\text{ kJ})\right] - \left[8(799\text{ kJ}) + 12(463\text{ kJ})\right]$$
$$= -5286\text{ kJ}$$

6. Give the ***molecular orbital diagram*** for N_2, N_2^+, and N_2^-. State which is ***more stable and why*** you determined it to be more stable.

Orbital	N_2	N_2^+	N_2^-
σ_{2p}^*	[ ]	[ ]	[ ]
π_{2p}^*	[ ][ ]	[ ][ ]	[↑][ ]
π_{2p}	[↑↓][↑↓]	[↑↓][↑]	[↑↓][↑↓]
σ_{2p}	[↑↓]	[↑↓]	[↑↓]
σ_{2s}^*	[↑↓]	[↑↓]	[↑↓]
σ_{2s}	[↑↓]	[↑↓]	[↑↓]
	B.O. = 3	B.O. = 2.5	B.O. = 2.5

B.O = ½ (bonding e^- - antibonding e^-)

Because N_2 has the highest bond order, it should be the most stable.