Your name: _____ 1 pt

3.1. Composition Calculations (23 pts)

1. Which compounds listed below are empiric formulas (circle all that apply)   4 pts

   a) C_2H_4 b) $H_2C_4F_5$ c) N_2O d) BH_3 e) $H_2S_2O_4$ f) $P_3F_6O_2$

2. A compound contains 1 gram of H, 16 grams of S and 24 grams of O. What is the compound's **empiric** formula? (5 pts)

Element	Mass(g)	Atomic weight (g/mol)	n (mol)	n/n_{min}
H	1.0	1	1	2
S	16.0	32	0.5	1
O	24.0	16	1.5	3

Empiric formula H __ S __ O __

2	1	3

3. A sample of a compound with a molecular mass of 186 g/mol contains the masses of C, H and O listed in the table below. What is the compound's **molecular** formula ? (6 pts)

Element	Mass(g)	Atomic weight (g/mol)	n (mol)	n/n_{min}	× 2
C	1.0000	12	0.0833	1	2
H	0.2083	1	0.2083	2.5	5
O	2.6666	16	0.1666	2	4

Molecular formula C __ H __ O __

4	10	9

$$\frac{MW}{empiric\ wt} = \frac{186}{93} = 2 \quad empiric \quad MW = 2\times12 + 5 + 4\times16$$
$$93$$

4a. A student measures the masses of Fe nd O in a compound and finds the values listed in the table below. What is the implied empiric formula? (5 pts)

Element	Mass (g)	Atomic weight (g/mol)	n (mol)	n/n_{min}
Fe	2.000	55.9	0.3578	1
O	0.572	16.0	0.3578	1

Empiric formula Fe __ O __

1	1

4b. The student claims the molecular mass of the compound he examined in 4a has a mass of 159.6 g/mol. Is this consistent with the data in 4a ?   YES   ~~NO~~
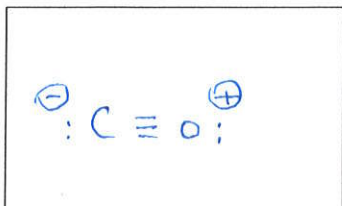
Circle answer (3 pts)
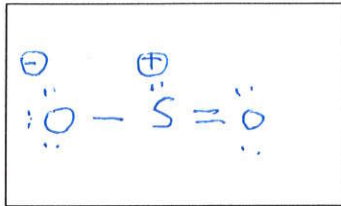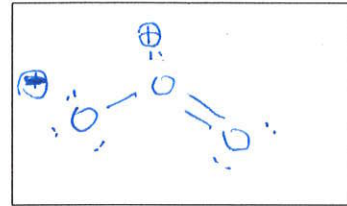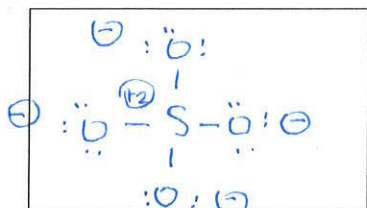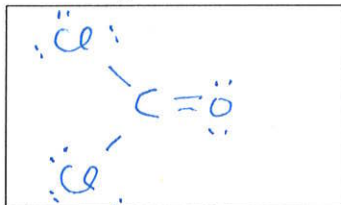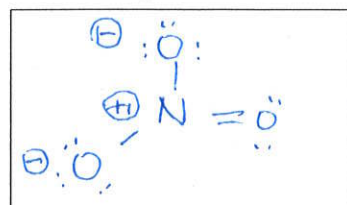
____/24 includes name point

3.2. Lewis Octet Rules and Formal Charge (24 points)

Assuming the Lewis Octet rule is strictly obeyed, supply the Lewis structures for the molecules below. Make sure to show all lone pairs and if present, any formal charges. (4 points each/24 points total)

CO

SO_2

O_3

SO_4^{-2}

$COCl_2$ (C in middle; O and Cl attached to it)

NO_3^{-1}

3.3. Resonance Part 1 (4 pts)

Which, if any of the structures you drew above exhibit resonance? (circle choices below)

CO (SO₂) (O₃) SO_4^{2-} $COCl_2$ (NO₃⁻)

3.4 Beyond the Octet Rule (4 pts each/12 points total)

Assuming you can break the Octet rule to satisfy the minimize formal charge rule, provide the best Lewis structures for the molecules below. Make sure to include all lone pairs and if relevant, formal charges.
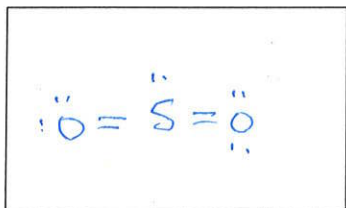
SO_2
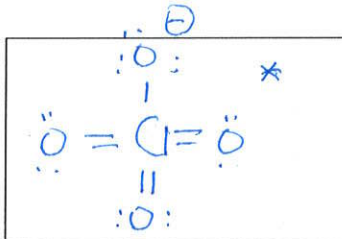
ClO_4^-
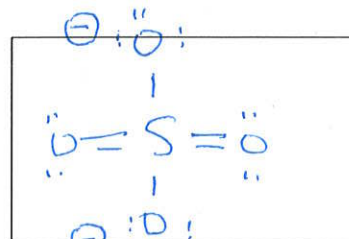
SO_4^{2-}

3.5 Bond Order and Resonance Part 2: 8 pts

a) Compute the Bond Order to the three molecules in 3.4: (6 pts total/2 pts each)

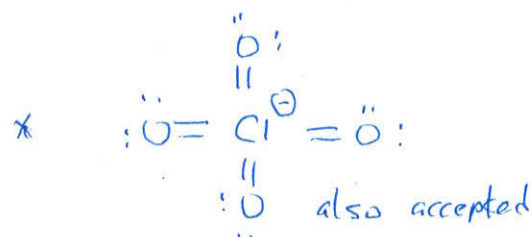SO_2 ___2___ ClO_4^- _7/4 = 1.75_ SO_4^{2-} _6/4 = 1.5_

b) Circle any of the molecules your drew in 3.4. that exhibit resonance (2 pts)

SO_2 (ClO₄⁻)   (SO₄²⁻)

___/48

*   :Ö= Cl⁻ =Ö: also accepted

A

3.6. Molecular Structure Using VSEPR Theory (2 pts each/10 pts total)

Provide the likely structures of the molecules below:

N_2 _____linear_____ PCl_5 _____trigonal bipyramid_____

NO_3^- _____triangle_____ H_2O _____bent_____

NH_3 _____trigonal pyramid_____

3.7. Liquids and Solids (18 points)

a) Name the five main kinds of intermolecular interactions holding liquids and solids together.

1)_____ionic_____   2)_____covalent_____   3)_____H-bonds_____

4)_____dipole-dipole_____ 5)_____dispersion_____

b) Order the compounds below from highest to lowest melting point (1 pt each/ 3 pts total)
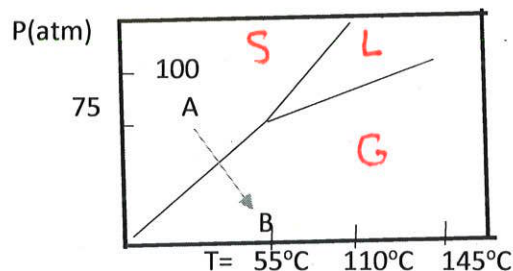
H_2O, H_2Se, H_2Te _____H_2O_____ > _____H_2Te_____ > _____H_2Se_____

CCl_4 , CF_4, CBr_4 _____CBr_4_____ > _____CCl_4_____ > _____CF_4_____

CO, CH_4, SiO_2 _____SiO_2_____ > _____CO_____ > _____CH_4_____

c) Indicate where Liquid(L), Solid(S) and Gas(G) phases exist on the diagram to the right (3 pts)

d) Name of phase change going from A→B
_____Sublimation_____

P(atm)

100   S   L

75   A

G

B

T= 55°C   110°C   145°C

e) What is the ~temperature and pressure of the critical point?
T_{crit}= _____145°C_____ P_{crit}=_____100 atm_____   (2 pts)

f) On diagram to the right, what is the melting point?
_____10_____ °C

g) Where is the boiling point ? _____80_____ °C

h) How many calories are needed to melt 2 grams of the of the material ? _____24_____ calories   (2 pts)

80°C

10°C

0   10 12   16 calories/g

_____/28