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_3 b) $H_2C_4F_6$ c)N_2O_4 d) PH_3 e) $H_2S_2O_3$ f) $P_3F_6O_2$

2. A compound contains 1 gram of Na, 0.696grams of S and 1.391 grams of O. What is the compound's **empiric** formula? (5 pts)

Element	Mass(g)	Atomic weight (g/mol)	n(mol)	n/n_{min}
Na	1.0	23	0.043	2
S	0.696	32	0.0218	1
O	1.391	16	0.087	4

Empiric formula Na S O
2 1 4

3. A sample of a compound with a molecular mass of 88 g/mol contains the masses of C, H and O listed in the table below. What is the compound's **molecular** formula ? (6 pts)

empiric

Element	Mass(g)	Atomic weight (g/mol)	n	n/n_{min}
C	2.40	12	0.2	2
H	0.40	1	0.4	4
O	1.60	16	0.1	1

Empiric MW = 2(12) + 4(1) + 16 = 44

Molecular formula C H O
4 8 2

$\frac{88}{44} = 2$

4a. A student measures the masses of Cu 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}
Cu	3.175	63.5	0.05	2
O	0.400	16.0	0.025	1

Empiric formula Cu O
2 1

MW = 143

4b. The student claims the molecular mass of the compound he examined in 4a has a mass of 286 g/mol. Is this consistent with the data in 4a ? YES NO

Circle answer (3 pts)

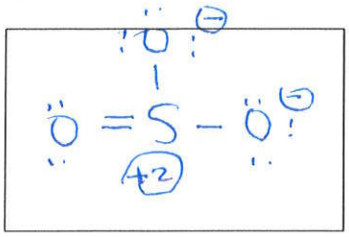
___/24 includes name point

$\frac{286}{143} = 2$

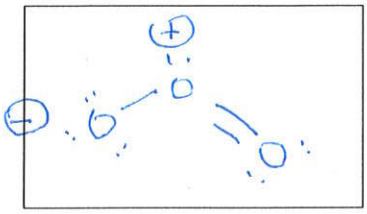
B

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

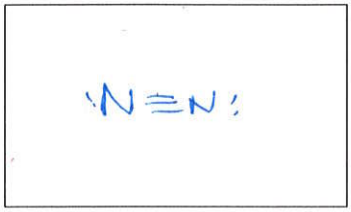
Assuming the Lewis Octet rule is strictly obeyed, supply the Lewis structures for the molecules below. Make sure to show all lone pairs and if present, any formal charges. (4 points each/24 points total)



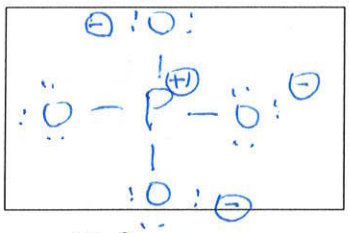
SO_3



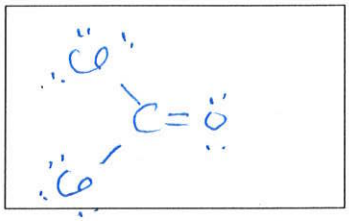
O_3



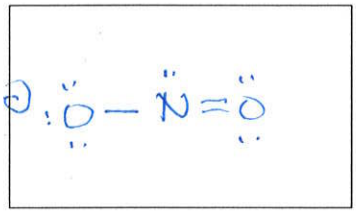
N_2



PO_4^{-3}



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



NO_2^{-1}

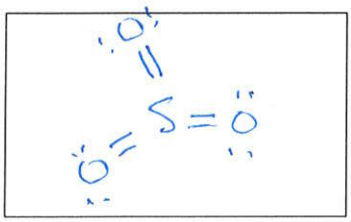
3.3. Resonance Part 1 (4 pts)

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

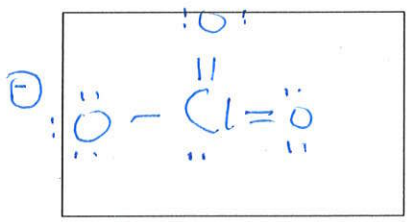
SO_3 O_3 N_2 PO_4^{3-} $COCl_2$ NO_2^-

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

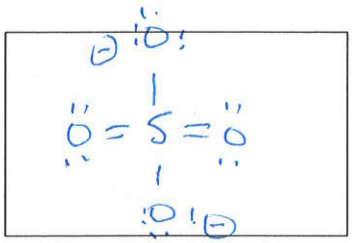
Assuming you can break the Octet rule to satisfy the minimize formal charge rule, provide the best Lewis structures for the molecules below. Make sure to include all lone pairs and if relevant, formal charges.



SO_3



ClO_3^-



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_3 2 ClO_3^- 5/4 = 1.25 SO_4^{2-} 6/4 = 1.5

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

SO_3 ClO_3^- SO_4^{2-}

____/48

3.6. Molecular Structure Using VSEPR Theory (2 pts each/10 pts total) p 3/3

Provide the likely structures of the molecules below:

CO_2 linear PCl_5 tr. gonal bi pyramid

NO_2^- bent H_2O bent

NH_3 tr. gonal pyram. d

3.7. Liquids and Solids (16 points)

a) Name the three strongest kinds of intermolecular interactions holding liquids and solids together

1) ionic 2) covalent 3) H-bonds

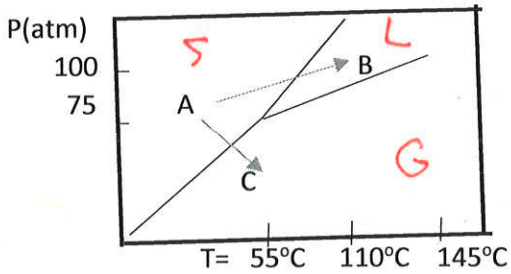
b) Order the compounds below from highest to lowest melting point (2 pt each/6 pts total)

H_2O, H_2Se, H_2Te H_2O > H_2Te > H_2Se

CH_4, CF_4, CBr_4 CBr_4 > CF_4 > CH_4

CO, H_2, SiO_2 SiO_2 > CO > H_2

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 melting

e) Name of phase change going from A→ C

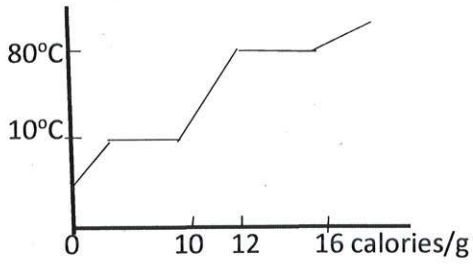
f) What is the ~temperature and pressure of the critical point?

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 convert 2 grams of the of the material to gas? 32 calories



___/28