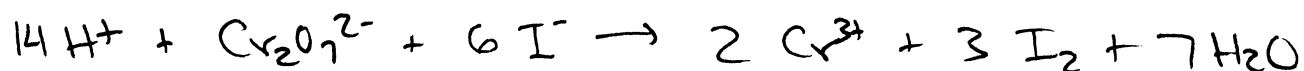
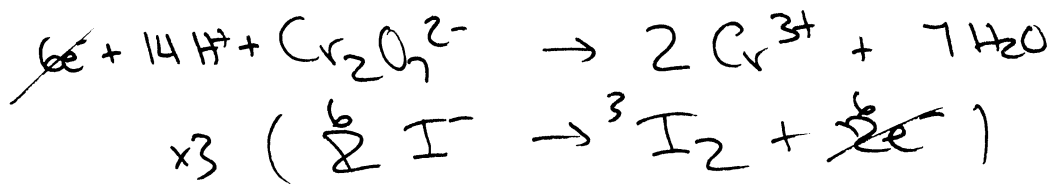


1. (16 pts) The iodide ion is a weak reducing agent and will reduce strong oxidizing agents in a redox titration. For instance, the concentration of dichromate ion in a solution can be determined by titration with iodide.

a) Balance the titration reaction in acidic solution: $\text{Cr}_2\text{O}_7^{2-} + \text{I}^- \rightarrow \text{Cr}^{3+} + \text{I}_2$



b) What is the molarity of the dichromate ion in a solution if a 25.00-mL sample of the solution requires 36.72 mL of 0.157 M KI for complete titration?

$$\text{mol I}^- = M \cdot V$$

$$= (0.157 \frac{\text{mol}}{\text{L}})(.03672 \text{L})$$

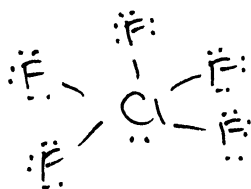
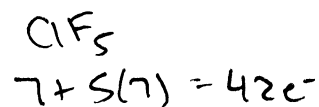
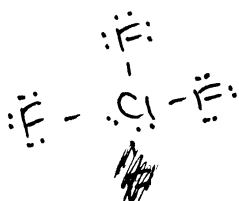
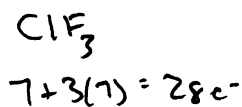
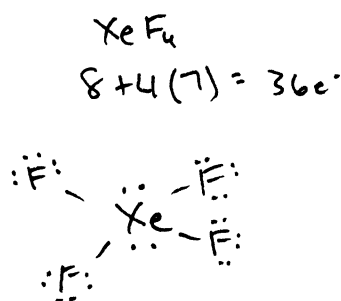
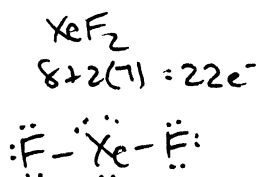
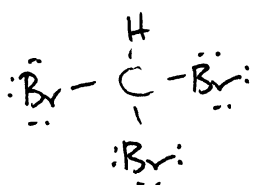
$$= 0.005765 \text{ mol I}^-$$

$$\times \left(\frac{1 \text{ mol Cr}_2\text{O}_7^{2-}}{6 \text{ mol I}^-} \right) = 9.608 \times 10^{-4} \text{ mol Cr}_2\text{O}_7^{2-}$$

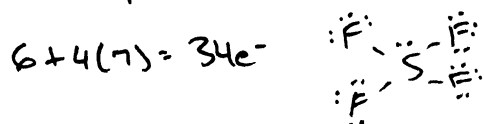
$$[\text{Cr}_2\text{O}_7^{2-}] = \frac{9.608 \times 10^{-4} \text{ mol}}{.02500 \text{ L}} = \boxed{0.0384 \text{ M}}$$

2. (30 pts) Fill in the following table. Show Lewis structures in the provided space below.

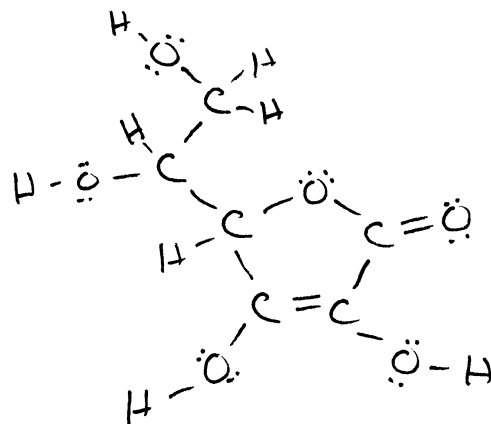
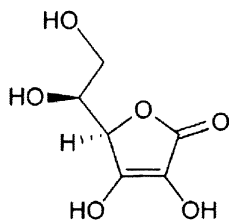
Molecule	Molecular Shape	Hybridization of Central Atom	Polar? (Yes or No)
CHBr ₃	tetrahedral	sp ³	yes
XeF ₂	linear	sp ³ d	no
XeF ₄	square planar	sp ³ d ²	no
ClF ₃	T-shaped	sp ³ d	yes
ClF ₅	square pyramidal	sp ³ d ²	yes



3. (6 pts) The sulfur atom in SF₄ is sp³d hybridized, and each S-F bond is the result of the overlap of a sp³d orbital from sulfur with a 2p orbital from fluorine.



4. (14 pts) Vitamin C, also known as ascorbic acid, has the chemical formula $C_6H_8O_6$. The shorthand Lewis structure is shown below. (Remember that in such shorthand structures, each point where lines meet represents a carbon atom and many hydrogen atoms are not shown.)



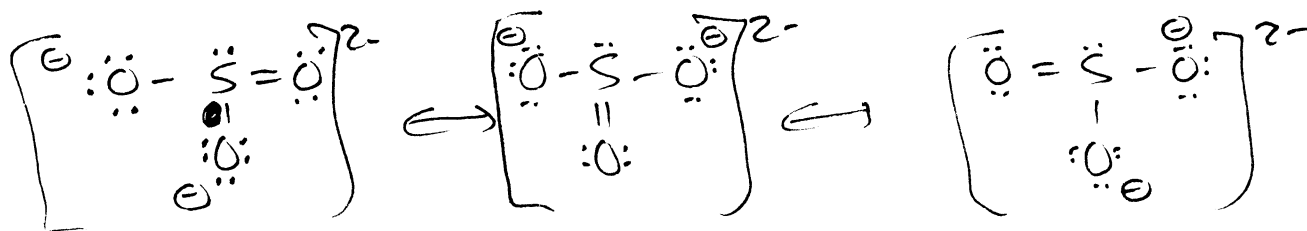
- a) How many carbons are sp^3 hybridized? 3
- b) How many carbons are sp^2 hybridized? 3
- c) How many carbons are sp hybridized? 0
- d) How many sigma bonds are in this molecule? 20
- e) How many pi bonds are in this molecule? 2
- f) Each O-H bond is formed by the overlap of which orbitals?



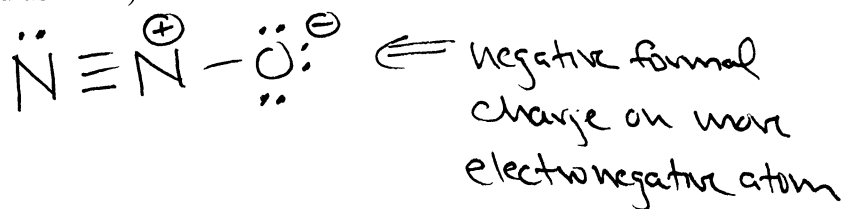
5. (12 pts) Draw the Lewis structure for each of the following. Where appropriate, show all equivalent resonance structures and all non-zero formal charge.

- a) SO_3^{2-} $6 + 3(6) + 2 = 26e^-$

~~4/26/20~~

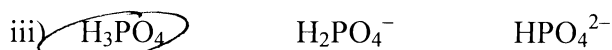
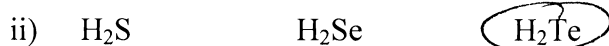


- b) N_2O (connected as NNO)

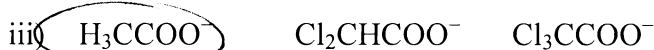


6. (12 pts) Acid and Base Strength.

A. Circle the strongest **acid** in each row:

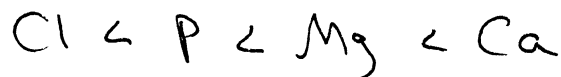


B. Circle the strongest **base** in each row:

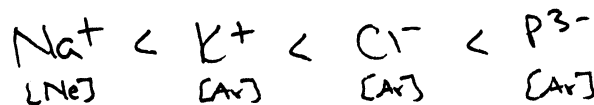


7. (14 pts) Periodic Trends.

a) Place the following atoms in order of increasing radii: Ca Mg P Cl



b) Place the following ions in order of increasing radii: P^{3-} K^+ Na^+ Cl^-



c) Place the following atoms in order of increasing ionization energy: Si K P Ca



d) Which element has the strongest (most negative) electron affinity? (Remember it's not what you might guess it to be.) Cl

8. (12 pts) Liquids.

a) Circle the molecule with the highest boiling point: I_2 ICl Cl_2

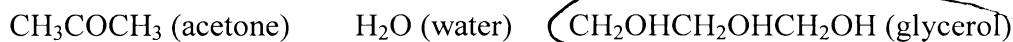
b) Circle the molecule with the highest boiling point: CCl_4 HCl NaCl

c) Circle the molecule with the highest surface tension: $\text{C}_2\text{H}_5\text{OH}$ CH_3OCH_3 C_5H_{10}

d) Circle the molecule with the highest vapor pressure: C_5H_{10} C_6H_{12} $\text{C}_4\text{H}_9\text{OH}$

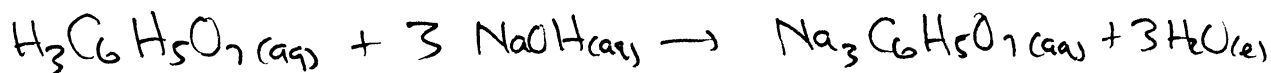
e) Circle the molecule with the highest polarizability: CH_4 HF CCl_4

f) Circle the molecule with the highest viscosity:



9. (20 pts) Citric acid ($\text{H}_3\text{C}_6\text{H}_5\text{O}_7$, 192.12 g/mol) is a weak acid with three acidic hydrogen atoms. A 2.00-g sample of citric acid is dissolved in 25.00 mL of water and titrated with 0.120 M NaOH.

a) What is the balanced titration reaction?



b) What volume of the NaOH solution must be added to completely neutralize the citric acid (i.e., how many milliliters of NaOH solution are added in the titration)?

$$(2.00 \text{ g}) \left(\frac{1 \text{ mole}}{192.12 \text{ g}} \right) = 0.0104 \text{ mole citric acid}$$

$$\times \left(\frac{3 \text{ mole NaOH}}{1 \text{ mole C.A.}} \right) = 0.0312 \text{ mole NaOH}$$

$$\text{mol} = M \cdot V$$

$$0.0312 \text{ mole} = \left(0.120 \frac{\text{mol}}{\text{L}} \right) V$$

$$V = 0.260 \text{ L}$$

$$= \text{~~260.0 mL~~}$$

$$= 260.2 \text{ mL}$$

c) At the end of the titration, what is concentration (molarity) of the resulting salt in the solution?

$$\text{new volume} = \underset{\text{original}}{25.00 \text{ mL}} + \underset{\text{added}}{260.2} = \text{~~285.0 mL~~} = 285.25 \text{ mL}$$

$$.0104 \text{ mole CA} \Rightarrow .0104 \text{ mole Na}_3\text{C}_6\text{H}_5\text{O}_7$$

$$[\text{Na}_3\text{C}_6\text{H}_5\text{O}_7] = \frac{0.0104 \text{ mole}}{\underset{.2853}{\text{~~0.2850 L~~}}} = 0.0365 \text{ M}$$

Remember to consider the pledge!!