General Chemistry C, Fall 2023
Problem Set 2

- *Due date: 2023/10/11 10:00 AM.*
- *Write down how you calculate the answer step-by-step (don't forget about the units).*
- *Please upload a PDF file containing your answers to NTU COOL.*

1. (3 pt) Explain why the third ionization energy of manganese is much higher than three times its first ionization energy (IE_1 = 717.4 kJ/mol, IE_2 = 1509 kJ/mol, IE_3 = 3248 kJ/mol).

2. (3 pt) The electron affinity of an iodine atom is 295 kJ/mol. Calculate the longest photon wavelength (in nm) required to eject an electron from an iodine anion in the gas phase.

3. (8 pt) Determine the *molecular shapes* and *hybridization types of the central atom* for the following molecules: (a) NO_2^-, (b) $COCl_2$, (c) H_3O^+, and (d) ICl_4^-.

4. (4 pt) Draw resonance structures of HSO_4^- ion.

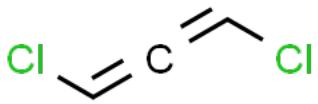
5. (6 pt) Use valence bond theory and the hybridization concept to describe the chemical bonding in a carbon dioxide (CO_2) molecule.

6. (6 pt) (a) Compare the relative bond energies of O_2, O_2^+, O_2^-, and O_2^{2-} using MO theory. (b) Which of these molecules are diamagnetic?

7. (8 pt) Caffeine ($C_8H_{10}N_4O_2$) can be found in many beverages and food. (a) Draw the Lewis structure of caffeine, including lone electron pairs (you may use your Google friend). (b) How many σ bonds and π bonds exist in a caffeine molecule? (c) Label the hybridization types of the four nitrogen atoms in caffeine.

8. (4 pt) Draw the skeleton chemical structure of cholesterol ($C_{27}H_{46}O$, and yes, you may use your Google friend again). Label all the chiral centers in this molecule.

9. (4 pt) Does this molecule have a non-zero dipole moment?



10. (4 pt) Arrange all the isomers of trichlorobenzene in the order of decreasing dipole moment.