1. This problem is about the atmosphere.

(a) What are the three major constituents of the atmosphere and what is their relative proportion? Roughly calculate the molecular weight of the air. (5 points)

(b) Near the Earth's surface, if the atmospheric condition is at the standard temperature and pressure, what is the number density of the air in the unit of molecule $cm^{-3}$? Given the universal gas constant = 0.082057 L-atm $mole^{-1}$ $k^{-1}$. The Avogadro's number is $6.022 \times 10^{23}$. (10 points)

2. List the types of chemical bond and tell the difference. Also give some examples for each type of chemical bond. (15 points)

3. A 40.0 ml sample of 0.1 *M* acetic acid ($CH_3COOH$) solution was titrated with 0.1 *M* NaOH. Calculate the pH of the solution under the following conditions.

(a) After the addition of 10.0 ml of NaOH (10 points)

(b) After the addition of 40.0 ml of NaOH (10 points)

Given $K_a = 1.754 \times 10^{-5}$ for $CH_3COOH$.

4. Given the following balanced equation

$$CO_{2(g)} \leftrightarrow CO_{(g)} + \frac{1}{2} O_{2(g)}$$

and equilibrium constant $K = 1.72 \times 10^{-46}$ at 25 $^0$C.

What is the concentration of CO in equilibrium at 25 $^0$C in a sample of gas originally containing 1.00 *M* $CO_2$? Make any necessary assumption. (20 points)

5. A unimolecular decomposition has the following form,

$$A \longrightarrow B + C \quad \text{reaction constant} = k.$$

Given the $m = [A]_o$, where the subscript "o" denotes the initial concentration of species A at $t = 0$.

(a) Derive a general form of solution for [A] at reaction time $t$. (10 points)

(b) For a given reaction the half-life $t_{1/2}$ is defined as the time required for its concentration to reach a value that is half-way between its initial and final values. Calculate the $t_{1/2}$ for the above reaction. (10 points)

(c) The thermal decomposition of peroxy-acetyl nitrate (commonly called "PAN") is in a way as described above. If the reaction constant of PAN is $3.6 \times 10^{-4}$ $sec^{-1}$ at 25 $^0$C, what is the chemical lifetime of PAN? What is the half-life of PAN? (10 points)