CHEM105 Test 3 *Name on back only please ….*

Please show all equations, all substitutions, and all work to receive any credit

1. Use these experimental data to find the rate law and rate constant for the reaction A + B → C

Experiment #	[A]	[B]	Initial Rate (M/sec)
1	0.020	0.100	1.0×10^{-5}
2	0.020	0.200	1.0×10^{-5}
3	0.060	0.100	9.0×10^{-5}

2. The rate constant k for a different reaction was found to be 2.0×10^{-5} M^{-1}/sec at a temperature of 298 K and 4.0×10^{-5} M^{-1} /sec at a temperature of 308 K. Calculate the activation energy for this reaction.

3. At a temperature of 298 K, by what factor would the reaction rate increase if the reaction's activation energy were lowered from 20 kJ/mole to 15 kJ/mole? Clearly explain why and use well-labeled diagrams to show how this increase would occur.

4. Compare the relative acidities of Cl_3CCOOH and H_3CCOOH by drawing the structure for each and by clearly showing and discussing the underlying reasons for this difference.

5. A mixture contained 0.15 M of acetic acid (CH_3COOH) and 0.10 M of the acetate ion (CH_3COO^-). The Ka for acetic acid is 1.8×10^{-5}. Determine the pH, pOH, $[H_3O^+]$, and $[OH^-]$ for the solution that is at a temperature of 298K.

6. At a temperature of 298 K, K_w is 1.0×10^{-14} for the water auto-ionization reaction:

   $2\ H_2O\ (l) \quad \leftrightarrows \quad H_3O^+\ (aq) \quad + \quad OH^-\ (aq)$

   The change in enthalpy for this reaction is <u>+56.48 kJ/mol.</u>

   a. Calculate the value of the equilibrium constant, K_w, at a body temperature of 310 K.

   b. Predict whether the equilibrium constant, K_w, would be expected to increase or decrease with an increase in temperature from 298 K to 310 K. Fully support your answer.

   c. For a little extra credit, calculate the neutral pH for this 310 K body temperature.

7. Identify oxidation numbers for each element in the following substances:

    a. MnO_2

    b. CrO_4^{2-}

    c. CO

    d. HNO_2

8. Co^{2+} has a standard reduction potential of -0.28 V; Ag+ has a standard reduction potential of +0.80 V. A galvanic cell was constructed to produce electricity using a Co solid electrode in a $CoCl_2$ (aq) solution in one container and an Ag solid electrode in an $AgNO_3$ (aq) solution; the two containers were connected using a salt bridge. A voltmeter was connected to the two electrodes.

    a. Calculate the E^o_{cell}.

    b. Write the equation for the reduction reaction.

    c. Write the equation for the oxidation reaction.

    d. Write the equation for the overall reaction and the expression for Q for this reaction.

    e. Calculate the standard change in Gibbs Free Energy, ΔG^o, for this reaction.

    f. Calculate the equilibrium constant for this reaction at a temperature of 298 K.

9. The bicarbonate ion (HCO_3^-) is an abundant ion found in ground water and has a K_a of 5.6×10^{-11}.

    a. Write the chemical equation for bicarbonate reacting as a base with water.

    b. Write the chemical equation for bicarbonate reacting as an acid with water.

    c. Determine K_b for the carbonate ion (CO_3^{2-}) reacting as a base with water.