1. Consider the reaction of ethane with hydrogen to give methane:

$$C_2H_6(g) + H_2(g) \rightarrow 2\ CH_4(g)$$

Calculate the value of ΔH for the reaction, given the following thermochemical equations:

$$C(s) + 2\ H_2(g) \rightarrow CH_4(g) \qquad \Delta H = -74.9\ kJ$$
$$2\ C(s) + 3\ H_2(g) \rightarrow C_2H_6(g) \qquad \Delta H = -84.5\ kJ$$

(5%)

2. Sodium bicarbonate decomposes according to the reaction

$$2\ NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

For the decomposition reaction, $\Delta H = 64.5$ kJ/mol and $\Delta S = 167$ J/mol K. Is the reaction spontaneous at 355 K ?

(10%)

3. The following reaction has a standard free-energy change of 78.7 kJ at 25℃.

$$2\ CH_4(g) \rightarrow C_2H_6(g) + H_2(g)$$

Calculate the equilibrium constant for this reaction, and decide whether the position of equilibrium will be closer to reactants or products. (10%)

4. At an initial concentration of N_2O_5 of 1.510 M at 45℃, the concentration decreased by 0.131 M in 2.32 h. Calculate the initial rate of the reaction in units of M s^{-1}.

$$2\ N_2O_5 \rightarrow 4\ NO_2 + O_2(g)$$

(5%)

5. (a) Determine the rate law of the reaction

$$2\ UO_2^{+}(aq) + 4\ H^{+}(aq) \rightarrow U^{4+}(aq) + UO^{2+}(aq) + 2\ H_2O(l)$$

using the following rate data.

Initial concentration of UO^{2+} (M)	H^+ (M)	Rate (M s^{-1})
0.0010	0.20	2.65×10^{-5}
0.0010	0.80	1.04×10^{-4}
0.0030	0.20	2.34×10^{-4}

(b) Also calculate the value of the rate constant. (10%)

6. The standard free-energy change for the following reaction is $\Delta G^\circ = 140.0$ kJ/mol O_2,

$$2\ SO_3(g) \rightleftharpoons 2\ SO_2(g) + O_2(g)$$

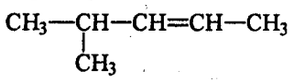
What is the equilibrium constant for this reaction at 25℃ ? (10%)

7. Calculate the pH of a mixture of 50.0 mL of 0.100 M CH_3CO_2H and 50.0 mL of 0.100 M NaOH. (5%)

8. The molar solubility of magnesium hydroxide in water is 1.44×10^{-4} mol/L, and Ksp = 1.2×10^{-11}. The pH of this solution is 10.45. What is the solubility of $Mg(OH)_2$ in a solution buffered to pH 9.00 ? (10%)

9. Predict the method of radioactive decay of the unstable nuclide $^{24}_{10}Ne$. (5%)

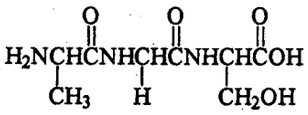
10. Name the following compound:



(5%)

11. Draw the structures of the polymers that result from the addition polymerization reactions of each of the following monomers.
a. CH_2=CHCl
b. CH_2=C(CH_3)-CH=CH_2 (10%)

12. Indicate which amino acids are obtained by hydrolyzing the tripeptide



(10%)

13. Consider the following reaction at 25℃.

$$Zn(s) + Cu^{2+} \rightarrow Zn^{2+}(aq) + Cu(s) \quad E^{o}_{cell} = 1.10\ V$$

What is the cell potential for this system when the concentrations are 5.00 M Cu^{2+} and 0.050 M Zn^{+2} ? (5%)