1. (10%) What concentrations of the following have the same ionic strength as 0.1 M NaCl?

(1) $CuSO_4$, (2) $Ni(NO_3)_2$, (3) $Al_2(SO_4)_3$, (4) Na_3PO_4, (5) $K_4Fe(CN)_6$

2. (10%) Calculate the emf of the cell.

$$Co \mid Co^{2+} \parallel Ni^{2+} \mid Ni$$

$$\left(\begin{array}{ll} Ni^{2+} + 2e^- \longrightarrow Ni & E^o = -0.25V \\ Co^{2+} + 2e^- \longrightarrow Co & E^o = -0.28V \end{array} \right)$$

(a) $[Ni^{2+}] = 1.0$ M, and $[Co^{2+}] = 0.1$ M
(b) $[Ni^{2+}] = 0.01$M, and $[Co^{2+}] = 1.0$ M

3. (10%) Describe some of the most important characteristic of a chemisorbed layer. In what ways does a physisorbed layer differ?

4. (10%) A second-order reaction in solution has a rate constant (k) of 5.7×10^{-5} dm^3 mol^{-1} s^{-1} at 25°C and of 16.4×10^{-5} dm^3 mol^{-1} s^{-1} at 40°C. Calculate the activation energy (E) and the preexponential factor (A), assuming the Arrhenius law ($k = Ae^{-E/RT}$; R is the gas constant, equal to 8.314 J K^{-1} mol^{-1}) to apply.
(Note: $\log 16.4 \times 10^{-5} = -3.785$, $\log 5.7 \times 10^{-5} = -4.244$)

5. (20%) $\Delta G = \Delta H - T\Delta S$ is a equation of the second thermodynamics. Please (i) define the meaning of G, H, S, respectively.
(ii) describe the relationship between this equation and chemical reaction.

6. (20%) Obtain the rate equation corresponding to the mechanism

$$E + S \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_2} E + P$$

Here E and S are the enzyme and substrate, P is the product. Usually the substrate concentration is much higher than that of the enzyme concentration. Under these conditions the concentration of the enzyme-substrate complex ES must be very much less than that of the substrate. Express the catalytic constant k_{cat} and the Michaelis constant K_m in terms of k_1, k_{-1}, and k_2.

7. (20%)
(i) Derive the integrated rate equation for a reversible reaction of stoichiometry $A \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} Y + Z$
Take the initial concentration of A as a_o and the concentration at time t as $a_o - x$.
(ii) Obtain the integrated equation in terms of k_1 and the equilibrium constant $K = k_1/k_{-1}$