1. (20%) Describe the following terms.
(1) osmotic pressure, (2) Fermi level, (3) Boltzmann distribution law,
(4) n-type semiconductor, (5) activity.

2. (10%) $\Delta G = \Delta H - T\Delta S$ is an equation of the second thermodynamics.
Please describe the relationship between this equation and chemical reaction.

3. (20%) Please describe:
(i) physical adsorption and chemisorption.
(ii) the Langmuir adsorption isotherm

4. (10%) Derive the expression for the half-life of a reaction with the rate law: $-d[A]/dt = k[A]^{1/2}$

5. (10%) (i) State the Arrhenius law.
(ii) 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 to apply.
(R is the gas constant, equal to 8.314 J K^{-1} mol^{-1})

6. (10%) Calculate E^o at 25°C for the cell

$$Cd \mid Cd^{2+} \parallel Cu^{2+} \mid Cu$$

and determine the cell reaction and its equilibrium constant.
Here $Cd^{2+} + 2e^- = Cd$ $E^o = -0.4022$ V
$Cu^{2+} + 2e^- = Cu$ $E^o = +0.3394$ V

7. (20%) An enzymatic reaction is represented as

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

The concentration of enzyme-substrate complex [ES] is assumed to maintain at a constant value throughout the reaction.
Please derive an equation to express the reaction rate.