# Chemistry 2850 Practice Test 3

Time: 50 min

Marks: 46

Aids permitted: calculator, one 8.5 × 11-inch formula sheet

1. Give a precise definition of the half-life of a reaction. [2 marks]

2. Explain briefly the idea behind relaxation experiments. [4 marks]

3. Sketch the potential energy profile for an elementary reaction. Identify on your sketch the forward and reverse activation energies, and the $\Delta U$ of the reaction. Indicate whether $\Delta U$ is positive or negative for your sketch. [5 marks]

4. In collision theory, we assume that all collisions of sufficient energy lead to formation of product. Name one factor that might make this assumption incorrect. [2 marks]

5. Define the entropy of activation. [2 marks]

6. For the reaction $2A_{(aq)} \rightarrow B$, the following data have been obtained in a reaction mixture which originally contained 0.624 mol/L of pure A.

| $t$/min | 10 | 20 | 30 | 40 |
|---|---|---|---|---|
| [B]/mol L$^{-1}$ | 0.089 | 0.153 | 0.200 | 0.230 |

   Previous experiments indicated that the reaction could be either first or second order with respect to [A]. If possible, give the order of the reaction and calculate the rate constant. If not, explain why you can't determine the order. [16 marks]

7. The reaction $2Fe(CN)^{3-}_{6(aq)} + 2S_2O^{2-}_{3(aq)} \rightarrow 2Fe(CN)^{4-}_{6(aq)} + S_4O^{2-}_{6(aq)}$ displays first-order kinetics. Measurements of the rate constant at different temperatures are given below:[1]

| $T$/°C | 20 | 30 | 40 | 50 | 60 | 70 |
|---|---|---|---|---|---|---|
| $k/10^{-4}$min$^{-1}$ | 1.52 | 2.13 | 3.28 | 5.29 | 9.31 | 14.06 |

   (a) Calculate the activation energy and preexponential factor for this reaction. [10 marks]
   Note: In this question, it isn't necessary to draw the graph.

   (b) Calculate the entropy and enthalpy of activation at 25°C. [5 marks]
   Hint: The preexponential factor needs to be in units of s$^{-1}$ in this question.

[1] Y. Li et al., J. Phys. Chem. B **104**, 10956 (2000).

**Useful data**

$h = 6.626\,068\,8 \times 10^{-34}\,\mathrm{J/Hz}$

$k_B = 1.380\,650\,3 \times 10^{-23}\,\mathrm{J/K}$

$R = 8.314\,472\,\mathrm{J\,K^{-1}mol^{-1}}$

To convert degrees Celsius to Kelvin, add 273.15.