Sample test

1. In an A $\rightleftharpoons$ B opposing reaction both sub-reactions are of first order, and the equilibrium constant at 25 °C is 2.15 . Starting from a 0.6 mol/dm^3 solution containing only A we find that that the concentration of A drops to 0.25 mol/dm^3 after 5 minutes.

   a) What are the equilibrium concentrations?

   b) What are the rate constants?

   (3 points)

2. The A $\longrightarrow$ B $\longrightarrow$ C consecutive reaction is of first order in both steps. We know the following:

   - The half-life of A at 23 °C is 2500 minutes
   - Starting from a solution only containing B, the half-life of B at 31 °C is 150 minutes
   - The rate constant of the second step is three times larger at 38 °C than at 23 °C

   How much time is necessary at 23 °C for B to reach its maximal concentration? What percentage of the maximum B do we lose if we make the reaction stop (for example, by lowering the temperature) after 3 hours?

   (5 points)

3. We construct a galvanic cell from the following electrodes: a cobalt plate is dipped into 0.15 dm^3 electrolyte containing 0.3 mol/dm^3 $Co(NO_3)_2$, and a nickel plate is immersed into 0.15 dm^3 of a 0.015 mol/dm^3 $Ni(NO_3)_2$ solution. The cell runs at 25 °C , and the mean activity coefficients are one.

   a) What are the half reactions and the total cell reaction?

   b) Which electrolyte do we have to dilute for the cell to be in equilibrium? Why? How much water is necessary?

   $\varepsilon^\circ_{Co/Co^{2+}}(25°C) = -0{,}277$ V, $\varepsilon^\circ_{Ni/Ni^{2+}}(25°C) = -0{,}257$ V

   (3 points)

4. A silver plate is dipped into 25 cm^3 of a 0.035 mol/dm^3 silver nitrate ($AgNO_3$) solution. We add 45 cm^3 of a 2.00 mol/dm^3 hydrogen bromide (HBr) solution to this system. After the reaction, in which the poorly soluble AgBr is produced, we immerse a hydrogen gas electrode (platinum plate and hydrogen gas with 66 kPa pressure) into our mix, and connect the metal parts. We use the resulting galvanic cell at 20 °C . The values of the mean activity coefficients are 0.95 . What is the total cell reaction taking place? What is the electromotive force of the cell? What is the molar Gibbs free energy change associated with the reaction? What is the solubility constant of AgBr in water at 20 °C?

   (*Help: you can ignore the small amount of AgBr that gets dissolved.*)

   Standard electrode potentials at 20 °C: $\varepsilon^\circ{}_{Ag/Ag^+} = 0{,}7996$ V, $\varepsilon^\circ{}_{Ag+Br^-/AgBr} = 0{,}0713$ V.

   (5 points)