## CHEM-E4106 Electrochemistry D

## Exam 23.2.2021

- 1. a) Why do ions have activity coefficients less than one already in diluted electrolytes?
  - b) What is limiting current? Why is it important to know it?
  - c) With which mechanisms an ion can move in a solution?
  - d) How do you observe diffusion in an impedance plot (Nyquist plot)?
  - e) What is a trace-ion? Why is it used in electrochemical analysis?
  - f) Which forces affect the organization of the double layer?
- A Galvanic cell can be constructed connecting via a slat bridge one beaker contains 0.15 M Cd(NO3)<sub>2</sub> and a Cd metal electrode and the other beaker contains 0.20 M AgNO<sub>3</sub> and a Ag metal electrode. Estimate the cell voltage of

Cd(s)|Cd(NO<sub>3</sub>)<sub>2</sub>(aq, 0.15 mol dm<sup>-3</sup>)|AgNO<sub>3</sub>(aq, 0.20 mol dm<sup>-3</sup>)|Ag(s)

at 25 °C by taking into account the activity coefficients estimated *via* the Debye-Hückel equation.

- 3. Slightly soluble CaF<sub>2</sub> is used in toothpastes and when brushing teeth it is dissolved increasing the water conductivity. The solubility constant of CaF<sub>2</sub> at room temperature is 3.30 (mol/dm<sup>3</sup>)<sup>3</sup> whereas the freshwater conductivity is 500  $\mu$ S/cm. What is the conductivity of CaF<sub>2</sub> saturated freshwater?
- 4. An electrochemical  $Fe^{3+}|Fe^{2+}$  redox reaction was studied on a Pt disk electrode at 298 K and results given the table below were obtained. What are  $i_0$  and  $\alpha$  for the anodic and cathodic reactions?

	-50	-80	-100	-120	-150	-200	50	80	100	120	150	200
η												
(mV)												
i	8.01	16.1	25.1	41.0	82.4	264	5.45	-8.71	-11.9	-16.3	-26.0	-56.6
(mA cm <sup>-2</sup> )												

5. Toyota uses PtCo/C as a cathode electrocatalyst in their automotive polymer electrolyte fuel cell. Oxygen reduction reaction kinetics of this kind of a catalyst synthetized by atomic layer deposition was investigated with a rotating ring electrode in 0.5 M H<sub>2</sub>SO<sub>4</sub> using five different rotation rates. The obtained *i*-*E* data is given in the Excel file. Calculate *n* and  $k^0$  using following parameters:  $D(O_2) = 1.10^{-5}$  cm<sup>2</sup> s<sup>-1</sup>,  $c(O_2) = 1.60^{-6}$  mol cm<sup>-3</sup> and v = 0.01 cm<sup>2</sup> s<sup>-1</sup>.