Electrochemical kinetics (heterogeneous dynamic electrochemistry)

P79. A typical exchange current density, that for H^+ discharge at platinum, is 0.79 mA cm^{-2} at 25.0 °C. Calculate the current density at an electrode when its overpotential is 10 mV (a), 100 mV (b), and –0.5 V (c). Take $\alpha = 0.50$. ((a) 0.309 mA cm^{-2}, (b) 5.42 mA cm^{-2}, (c) –13.3 A cm^{-2})

P80. The exchange current density for H^+ discharge at zinc is about $5 \cdot 10^{-11}$ A cm^{-2}. Can zinc be deposited from a unit activity aqueous solution of a zinc salt? Take $\alpha = 0.50$ and T = 25 °C. The minimal exchange current density for hydrogen evolution is j(min) = 1 mA cm^{-2}. ($j(H^+) = 1.33 \cdot 10^{-4}$ A cm^{-2}. Since this value is lower than 1 mA cm^{-2}, H_2 cannot be formed, so, Zn is deposited on the electrode instead.)

P81. Estimate the limiting current density at an electrode in which the concentration of Ag^+ is 2.5 mmol dm^{-3} at 25.0 °C. The thickness of the Nernst diffusion layer is 0.40 mm. The ionic conductivity of Ag^+ ion at infinite dilution and 25.0 °C is 61.9 S cm^2 mol^{-1}. (0.994 A/m^2)

P82. Calculate the minimum (zero-current) potential difference of a Ni-Cd cell, and the maximum possible power output when 100 mA is drawn at 25.0 °C. Standard redox potential values are listed below. (E = 1.30 V and P = 0.130 W)

P83. The corrosion current density j_{corr} at an iron anode is 1.0 A m^{-2}. What is the corrosion rate in mm/year? Assume uniform corrosion. Iron has a density of 7.874 g cm^{-3} and a molar mass of 55.845 g/mol. (0.773 mm/year)

P84. Which of the following metals has a thermodynamic tendency to corrode in moist air at pH = 7.0: Fe, Cu, Pb, Al, Ag, Cr, Co? Take as a criterion of corrosion a metal ion concentration of at least 10^{-6} mol dm^{-3}. Use the standard redox potential values from the list below. (In the absence of O_2: Fe, Al, Co, Cr; in the presence of O_2: all.)

Standard redox potential values:

Half-reaction	$E^{\ominus}$ (V)
$Al^{3+} + 3e^- \rightarrow Al$	–1.66
$Cd(OH)_2 + 2e^- \rightarrow Cd + 2OH^-$	–0.81
$Zn^{2+} + 2e^- \rightarrow Zn$	–0.76
$Cr^{3+} + 3e^- \rightarrow Cr$	–0.74
$Fe^{2+} + 2e^- \rightarrow Fe$	–0.44
$Co^{2+} + 2e^- \rightarrow Co$	–0.28
$Pb^{2+} + 2e^- \rightarrow Pb$	–0.13
$Fe^{3+} + 3e^- \rightarrow Fe$	–0.04
$2H^+ + 2e^- \rightarrow H_2$	0.00
$Cu^{2+} + 2e^- \rightarrow Cu$	0.40
$NiO(OH) + H_2O + e^- \rightarrow Ni(OH)_2 + OH^-$	0.49
$Cu^+ + e^- \rightarrow Cu$	0.52
$Ag^+ + e^- \rightarrow Ag$	0.80
$O_2 + 4H^+ + 4e^- \rightarrow 4\ H_2O$	1.23