Non Sibi High School

Andover's Chem 250: Introductory/Basic Chemistry

Chapter 16, Review Quiz 1 Answers

1

Determine all oxidation numbers in:

a. As^{3-}
b. F_2
c. $HO_2{}^-$
d. $IO_4{}^-$
e. KH

a. As = -3
b. F = 0
c. H = +1, O = -1
d. O = -2, I = +7
e. K = +1, H = -1

2

Determine all oxidation numbers, identify the reducing agent and oxidizing agent, and balance the following equation that occurs in aqueous acidic solution using the smallest possible whole-number coefficients:

$$UO^{2+} + MnO_4^- \longrightarrow UO_2{}^{2+} + MnO_2$$

$$UO^{2+}(O = -2, U = +4) + MnO_4^-(O = -2, Mn = +7) \longrightarrow$$
$$UO_2{}^{2+}(O = -2, U = +6) + MnO_2(O = -2, Mn = +4)$$

reducing agent = UO^{2+} (U increases from +4 to +6)
oxidizing agent = $MnO_4{}^-$ (Mn decreases from +7 to +4)

oxidation: $(UO^{2+} + H_2O \longrightarrow UO_2{}^{2+} + 2H^+ + 2e^-) \times 3$
reduction: $(MnO_4{}^- + 4H^+ + 3e^- \longrightarrow MnO_2 + 2H_2O) \times 2$
balanced equation: $3UO^{2+} + 2MnO_4^- + 2H^+ \longrightarrow 3UO_2{}^{2+} + 2MnO_2 + H_2O$

3

Rank the solid alkali metals K, Li, and Na from weakest to strongest reducing agent under standard conditions. Justify your answer using a table of standard reduction potentials.

weakest = Na(+2.71 V) $<$ K(+2.92 V) $<$ Li (+3.05 V) = strongest

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Rank the aqueous cations Ag^{+}, Al^{3+}, and Cd^{2+} from weakest to strongest oxidizing agent under standard conditions. Justify your answer using a table of standard reduction potentials.

weakest = Al^{3+}(-1.66 V) $<$ Cd^{2+}(-0.40 V) $<$ Ag^{+}(+0.80 V) = strongest

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For each spontaneous reaction below, calculate E°_{cell} and then balance the equation.

a. chlorine gas + aqueous potassium bromide
b. solid aluminum metal + aqueous hydrochloric acid
c. solid gold metal + aqueous nitric acid
d. solid zinc metal + aqueous cadmium(II) nitrate

a. $E^{\circ}_{cell} = (+1.36\,V) + (-1.07\,V) = 0.29\,V$

$$Cl_2(g) + 2Br^-(aq) \longrightarrow 2Cl^-(aq) + Br_2(l)$$

b. $E^{\circ}_{cell} = (+1.66\,V) + (0\,V) = 1.66\,V$

$$2Al(s) + 6H^+(aq) \longrightarrow 2Al^{3+}(aq) + 3H_2(g)$$

c. nonspontaneous
d. $E^{\circ}_{cell} = (+0.76\,V) + (-0.40\,V) = 0.36\,V$

$$Zn(s) + Cd^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cd(s)$$

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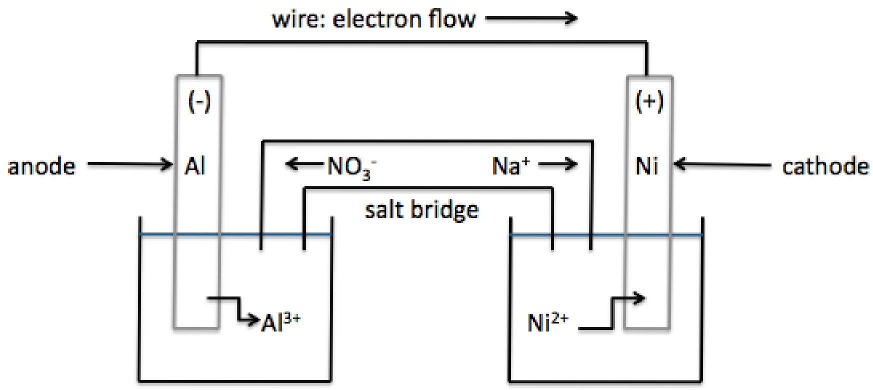
A galvanic cell was constructed using a strip of nickel metal and a strip of aluminum metal, a 1 M solution of $NiSO_4$ and a 1 M solution of $Al(NO_3)_3$, and an aqueous solution of $NaNO_3$ in the salt bridge. For the spontaneous reaction that occurred, calculate E°_{cell} and ΔG°, then balance the equation. Also sketch the galvanic cell.

$$E^\circ_{cell} = (+1.66\,V) + (-0.25\,V) = 1.41\,V$$

$$\Delta G^\circ = -6\left(\frac{96,500\,C}{1\,mol}\right)\left(\frac{1.41\,J}{1\,C}\right) = -8.16 \times 10^5\,J/mol = -816\,kJ/mol$$

$$2Al(s) + 3Ni^{2+}(aq) \longrightarrow 2Al^{3+}(aq) + 3Ni(s)$$



7

Calculate the minimum voltage required to bring about the reaction $Cr^{3+}(aq) + Ag(s) \longrightarrow Cr(s) + Ag^+(aq)$ by electrolysis under standard conditions, then balance the equation.

$$E^\circ_{cell} = (-0.74\,V) + (-0.80\,V) = -1.54\,V$$

$$\text{minimum voltage} = |E^\circ_{cell}| = 1.54\,V$$

$$Cr^{3+}(aq) + 3Ag(s) \longrightarrow Cr(s) + 3Ag^+(aq)$$

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For the electrolysis of molten NaI, write the half-reaction that occurs at the anode and the half-reaction that occurs at the cathode, then balance the equation.

oxidation (at anode): $(2I^- \longrightarrow I_2 + 2e^-) \times 1$
reduction (at cathode): $(Na^+ + 1e^- \longrightarrow Na) \times 2$
balanced equation: $2I^- + 2Na^+ \longrightarrow I_2 + 2Na$

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