Reactions in Basic Solution

Balance the following redox equations. Assume that all reactions take place in a basic environment where OH^- and H_2O are readily available.

575. $CO_2 + NH_2OH \rightarrow CO + N_2 + H_2O$

576. $Bi(OH)_3 + K_2SnO_2 \rightarrow Bi + K_2SnO_3$

(Both of the potassium-tin-oxygen compounds dissociate into potassium ions and tin-oxygen ions.)

Mixed Review

Balance each of the following redox equations. Unless stated otherwise, assume that the reaction occurs in acidic solution.

577. $Mg + N_2 \rightarrow Mg_3N_2$

578. $SO_2 + Br_2 + H_2O \rightarrow HBr + H_2SO_4$

579. $H_2S + Cl_2 \rightarrow S + HCl$

580. $PbO_2 + HBr \rightarrow PbBr_2 + Br_2 + H_2O$

581. $S + HNO_3 \rightarrow NO_2 + H_2SO_4 + H_2O$

582. $NaIO_3 + N_2H_4 + HCl \rightarrow N_2 + NaICl_2 + H_2O$ (N_2H_4 is hydrazine; do not separate it into ions.)

583. $MnO_2 + H_2O_2 + HCl \rightarrow MnCl_2 + O_2 + H_2O$

584. $AsH_3 + NaClO_3 \rightarrow H_3AsO_4 + NaCl$ (AsH_3 is arsine, the arsenic analogue of ammonia, NH_3.)

585. $K_2Cr_2O_7 + H_2C_2O_4 + HCl \rightarrow CrCl_3 + CO_2 + KCl + H_2O$ ($H_2C_2O_4$ is oxalic acid; it can be treated as $2H^+ + C_2O_4^{2-}$.)

586. $Hg(NO_3)_2 \xrightarrow{\text{heat}} HgO + NO_2 + O_2$ (The reaction is not in solution.)

587. $HAuCl_4 + N_2H_4 \rightarrow Au + N_2 + HCl$ ($HAuCl_4$ can be considered as $H^+ + AuCl_4^-$.)

588. $Sb_2(SO_4)_3 + KMnO_4 + H_2O \rightarrow H_3SbO_4 + K_2SO_4 + MnSO_4 + H_2SO_4$

589. $Mn(NO_3)_2 + NaBiO_3 + HNO_3 \rightarrow Bi(NO_3)_2 + HMnO_4 + NaNO_3 + H_2O$

590. $H_3AsO_4 + Zn + HCl \rightarrow AsH_3 + ZnCl_2 + H_2O$

591. $KClO_3 + HCl \rightarrow Cl_2 + H_2O + KCl$

592. The same reactants as in item 591 can combine in the following way when more $KClO_3$ is present. Balance the equation.

$$KClO_3 + HCl \rightarrow Cl_2 + ClO_2 + H_2O + KCl$$

593. $MnCl_3 + H_2O \rightarrow MnCl_2 + MnO_2 + HCl$

594. $NaOH + H_2O + Al \rightarrow NaAl(OH)_4 + H_2$ in basic solution

595. $Br_2 + Ca(OH)_2 \rightarrow CaBr_2 + Ca(BrO_3)_2 + H_2O$ in basic solution

596. $N_2O + NaClO + NaOH \rightarrow NaCl + NaNO_2 + H_2O$ in basic solution

597. Balance the following reaction, which can be used to prepare bromine in the laboratory:

$$HBr + MnO_2 \rightarrow MnBr_2 + H_2O + Br_2$$

598. The following reaction occurs when gold is dissolved in *aqua regia*. Balance the equation.

$$Au + HCl + HNO_3 \rightarrow HAuCl_4 + NO + H_2O$$

Electrochemistry: Chap. 20, Sec. 2

Use the reduction potentials in the table on page 915 to determine whether the following reactions are spontaneous as written. Report the E^0_{cell} for the reactions.

599. $Cu^{2+} + Fe \rightarrow Fe^{2+} + Cu$

600. $Pb^{2+} + Fe^{2+} \rightarrow Fe^{3+} + Pb$

601. $Mn^{2+} + 4H_2O + Sn^{2+} \rightarrow MnO_4^- + 8H^+ + Sn$

602. $MnO_4^{2-} + Cl_2 \rightarrow MnO_4^- + 2Cl^-$

603. $Hg_2^{2+} + 2MnO_4^{2-} \rightarrow 2Hg + 2MnO_4^-$

604. $2Li^+ + Pb \rightarrow 2Li + Pb^{2+}$

605. $Br_2 + 2Cl^- \rightarrow 2Br^- + Cl_2$

606. $S + 2I^- \rightarrow S^{2-} + I_2$

If a cell is constructed in which the following pairs of reactions are possible, what would be the cathode reaction, the anode reaction, and the overall cell voltage?

607. $Ca^{2+} + 2e^- \rightleftarrows Ca$
$Fe^{3+} + 3e^- \rightleftarrows Fe$

608. $Ag^+ + e^- \rightleftarrows Ag$
$S + 2H^+ + 2e^- \rightleftarrows H_2S$

609. $Fe^{3+} + e^- \rightleftarrows Fe^{2+}$
$Sn^{2+} + 2e^- \rightleftarrows Sn$

610. $Cu^{2+} + 2e^- \rightleftarrows Cu$
$Au^{3+} + 3e^- \rightleftarrows Au$

Mixed Review

Use reduction potentials to determine whether the reactions in the following 10 problems are spontaneous.

611. $Ba + Sn^{2+} \rightarrow Ba^{2+} + Sn$

612. $Ni + Hg^{2+} \rightarrow Ni^{2+} + Hg$

613. $2Cr^{3+} + 7\,H_2O + 6Fe^{3+} \rightarrow Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+}$

614. $Cl_2 + Sn \rightarrow 2Cl^- + Sn^{2+}$

615. $Al + 3Ag^+ \rightarrow Al^{3+} + 3Ag$

616. $Hg_2^{2+} + S^{2-} \rightarrow 2Hg + S$

617. $Ba + 2Ag^+ \rightarrow Ba^{2+} + 2Ag$

618. $2I^- + Ca^{2+} \rightarrow I_2 + Ca$

619. $Zn + 2MnO_4^- \rightarrow Zn^{2+} + 2MnO_4^{2-}$

620. $2Cr^{3+} + 3Mg^{2+} + 7H_2O \rightarrow Cr_2O_7^{2-} + 14H^+ + 3Mg$