SURREY SUPPLEMENT: REDOX REACTIONS AND STOICHIOMETRY

1) Balance the following oxidation-reduction equations. All reactions occur in acidic solutions.

   a) $Zn + NO_3^- \longrightarrow Zn^{2+} + NH_4^+$
   b) $ReO_2 + Cl_2 \longrightarrow HReO_4 + Cl^-$
   c) $HNO_2 + MnO_4^- \longrightarrow NO_3^- + Mn^{2+}$
   d) $Cu + NO_3^- \longrightarrow Cu^{2+} + NO$

2) Balance the following oxidation-reduction equations. All reactions occur in basic solutions.

   a) $S_2O_3^{2-} + OCl^- \longrightarrow SO_4^{2-} + Cl^-$
   b) $NiO_2 + Fe \longrightarrow Ni(OH)_2 + Fe(OH)_3$
   c) $SbH_3 + H_2O \longrightarrow Sb(OH)_4^- + H_2$
   d) $P_4 \longrightarrow PH_3 + HPO_3^{2-}$

3) Balance the following oxidation-reduction equations under the specific conditions noted:

   a) $Pb + PbO_2 + SO_4^{2-} \longrightarrow PbSO_4$ (acidic solution)
   b) $CrI_3 + Cl_2 \longrightarrow CrO_4^{2-} + IO_4^- + Cl^-$ (basic solution)
   c) $XO_2^+ + YO^+ \longrightarrow X_2O_4^{3-} + Y^- + Y_3O_7^{2-}$ (basic solution)
   d) $Z_2O_3 + X(CN)_6^{3-} \longrightarrow Z^- + O_2 + X^{3+} + NO_2 + CO_2$ (acidic conditions)
   e) $Sn^{4+} + X(CNO)_4^{2-} \longrightarrow Sn^{2+} + XO_2^{3+} + CO_3^{2-} + NO$ (basic conditions)
   f) $C_7H_8 + MnO_4^- \longrightarrow C_7H_6O_2 + MnO_2 + Mn^{2+}$ (basic conditions)

4) Balance the following oxidation-reduction equation in basic conditions:

   $S_2O_3^{2-}(aq) + H_2O_2(aq) \longrightarrow S_3O_6^{2-}(aq) + SO_4^{2-}(aq) + H_2O(l)$

   Which substance is the oxidizing agent?

5) Iodine (I_2) reacts with thiosulfate ($S_2O_3^{2-}$) in acidic solution to form iodide (I^-) and tetrathionate ($S_4O_6^{2-}$). Calculate the volume in mL of 0.100 M $Na_2S_2O_3$ needed to react with 7.50 g of I_2.

ANSWERS TO SURREY SUPPLEMENT PROBLEM SET No. 1: REDOX REACTIONS AND STOICHIOMETRY

1) (acidic solution balancing)
   a) $4Zn + NO_3^- + 10H^+ \longrightarrow 4Zn^{2+} + NH_4^+ + 3H_2O$
   b) $3Cl_2 + 2ReO_2 + 4H_2O \longrightarrow 6Cl^- + 2HReO_4 + 6H^+$
   c) $5HNO_2 + 2MnO_4^- + H^+ \longrightarrow 5NO_3^- + 2Mn^{2+} + 3H_2O$
   d) $3Cu + 2NO_3^- + 8H+ \longrightarrow 3Cu^{2+} + 2NO + 4H_2O$

2) (basic solution balancing)
   a) $4ClO^- + S_2O_3^{2-} + 2OH^- \longrightarrow 4Cl^- + 2SO_4^{2-} + H_2O$
   b) $2Fe + 3NiO_2 + 6H_2O \longrightarrow 2Fe(OH)_3 + 3Ni(OH)_2$
   c) $SbH_3 + 3H_2O + OH^- \longrightarrow Sb(OH)_4^- + 3H_2$
   d) $P_4 + 2H_2O + 4OH^- \longrightarrow 2PH_3 + 2HPO_3^{2-}$

3) (given conditions balancing)
   a) (acidic) $Pb + PbO_2 + 4H^+ + 2SO_4^{2-} \longrightarrow 2PbSO_4 + 2H_2O$
   b) (basic) $64OH^- + 27Cl_2 + 2CrI_3 \longrightarrow 2CrO_4^{2-} + 6IO_4^- + 54Cl^- + 32H_2O$
   c) (basic) $2XO_2^+ + 10YO^+ + 22OH^- \longrightarrow X_2O_4^{3-} + Y^- + 3Y_3O_7^{2-} + 11H_2O$ (One of many possible answers)
   d) (acidic) $14Z_2O_3 + 2X(CN)_6^{3-} + 8H_2O \longrightarrow 2X^{3+} + 12NO_2 + 12CO_2 + O_2 + 28Z^- + 16H^+$ (One of many possible answers)
   e) (basic) $25Sn^{4+} + 56OH^- + 2X(CNO)_4^{2-} \longrightarrow 25Sn^{2+} + 2XO_3^{3+} + 8CO_3^{2-} + 8NO + 28H_2O$
   f) (basic) $2H_2O + 4MnO_4^- + 3C_7H_8 \longrightarrow 3C_7H_6O_2 + 3Mn^{2+}\ MnO_2 + 10OH^-$ (One of many possible answers)

4) (balance reaction, identify oxidizing agent)
   $4H_2O_2 + 2S_2O_3^{2-} \longrightarrow S_3O_6^{2-} + SO_4^{2-} + 4H_2O$
   H_2O_2 is the oxidizing agent.

5) (reaction of I_2 and $S_2O_3^{2-}$)
   Balanced reaction: $I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$
   moles of I_2 = 7.50 g/253.8 g/mol = 2.955×10^{-2} mol I_2 = 29.55 mmol I_2
   moles of $S_2O_3^{2-}$ needed = $2 \times 2.955 \times 10^{-2} = 5.910 \times 10^{-2}$ = 59.10 mmol $S_2O_3^{2-}$ and volume of 0.100 M $Na_2S_2O_3$ needed = 591 mL