

SURREY SUPPLEMENT: REDOX REACTIONS AND STOICHIOMETRY

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

- $\text{Zn} + \text{NO}_3^- \longrightarrow \text{Zn}^{2+} + \text{NH}_4^+$
- $\text{ReO}_2 + \text{Cl}_2 \longrightarrow \text{HReO}_4 + \text{Cl}^-$
- $\text{HNO}_2 + \text{MnO}_4^- \longrightarrow \text{NO}_3^- + \text{Mn}^{2+}$
- $\text{Cu} + \text{NO}_3^- \longrightarrow \text{Cu}^{2+} + \text{NO}$

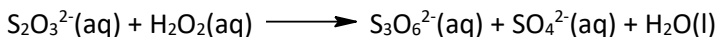
2) Balance the following oxidation-reduction equations. All reactions occur in basic solutions.

- $\text{S}_2\text{O}_3^{2-} + \text{OCl}^- \longrightarrow \text{SO}_4^{2-} + \text{Cl}^-$
- $\text{NiO}_2 + \text{Fe} \longrightarrow \text{Ni(OH)}_2 + \text{Fe(OH)}_3$
- $\text{SbH}_3 + \text{H}_2\text{O} \longrightarrow \text{Sb(OH)}_4^- + \text{H}_2$
- $\text{P}_4 \longrightarrow \text{PH}_3 + \text{HPO}_3^{2-}$

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

- $\text{Pb} + \text{PbO}_2 + \text{SO}_4^{2-} \longrightarrow \text{PbSO}_4$  (acidic solution)
- $\text{CrI}_3 + \text{Cl}_2 \longrightarrow \text{CrO}_4^{2-} + \text{IO}_4^- + \text{Cl}^-$  (basic solution)
- $\text{XO}_2^+ + \text{YO}^+ \longrightarrow \text{X}_2\text{O}_4^{3-} + \text{Y}^- + \text{Y}_3\text{O}_7^{2-}$  (basic solution)
- $\text{Z}_2\text{O}_3 + \text{X(CN)}_6^{3-} \longrightarrow \text{Z}^- + \text{O}_2 + \text{X}^{3+} + \text{NO}_2 + \text{CO}_2$  (acidic conditions)
- $\text{Sn}^{4+} + \text{X(CNO)}_4^{2-} \longrightarrow \text{Sn}^{2+} + \text{XO}_2^{3+} + \text{CO}_3^{2-} + \text{NO}$  (basic conditions)
- $\text{C}_7\text{H}_8 + \text{MnO}_4^- \longrightarrow \text{C}_7\text{H}_6\text{O}_2 + \text{MnO}_2 + \text{Mn}^{2+}$  (basic conditions)

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



Which substance is the oxidizing agent?

5) Iodine ( $\text{I}_2$ ) reacts with thiosulfate ( $\text{S}_2\text{O}_3^{2-}$ ) in acidic solution to form iodide ( $\text{I}^-$ ) and tetrathionate ( $\text{S}_4\text{O}_6^{2-}$ ). Calculate the volume in mL of 0.100 M  $\text{Na}_2\text{S}_2\text{O}_3$  needed to react with 7.50 g of  $\text{I}_2$ .

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

1) (acidic solution balancing)

- a)  $4\text{Zn} + \text{NO}_3^- + 10\text{H}^+ \longrightarrow 4\text{Zn}^{2+} + \text{NH}_4^+ + 3\text{H}_2\text{O}$   
 b)  $3\text{Cl}_2 + 2\text{ReO}_2 + 4\text{H}_2\text{O} \longrightarrow 6\text{Cl}^- + 2\text{HReO}_4 + 6\text{H}^+$   
 c)  $5\text{HNO}_2 + 2\text{MnO}_4^- + \text{H}^+ \longrightarrow 5\text{NO}_3^- + 2\text{Mn}^{2+} + 3\text{H}_2\text{O}$   
 d)  $3\text{Cu} + 2\text{NO}_3^- + 8\text{H}^+ \longrightarrow 3\text{Cu}^{2+} + 2\text{NO} + 4\text{H}_2\text{O}$

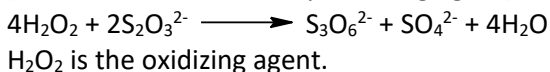
2) (basic solution balancing)

- a)  $4\text{ClO}^- + \text{S}_2\text{O}_3^{2-} + 2\text{OH}^- \longrightarrow 4\text{Cl}^- + 2\text{SO}_4^{2-} + \text{H}_2\text{O}$   
 b)  $2\text{Fe} + 3\text{NiO}_2 + 6\text{H}_2\text{O} \longrightarrow 2\text{Fe}(\text{OH})_3 + 3\text{Ni}(\text{OH})_2$   
 c)  $\text{SbH}_3 + 3\text{H}_2\text{O} + \text{OH}^- \longrightarrow \text{Sb}(\text{OH})_4^- + 3\text{H}_2$   
 d)  $\text{P}_4 + 2\text{H}_2\text{O} + 4\text{OH}^- \longrightarrow 2\text{PH}_3 + 2\text{HPO}_3^{2-}$

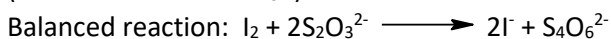
3) (given conditions balancing)

- a) (acidic)  $\text{Pb} + \text{PbO}_2 + 4\text{H}^+ + 2\text{SO}_4^{2-} \longrightarrow 2\text{PbSO}_4 + 2\text{H}_2\text{O}$   
 b) (basic)  $64\text{OH}^- + 27\text{Cl}_2 + 2\text{CrI}_3 \longrightarrow 2\text{CrO}_4^{2-} + 6\text{IO}_4^- + 54\text{Cl}^- + 32\text{H}_2\text{O}$   
 c) (basic)  $2\text{XO}_2^+ + 10\text{YO}^+ + 22\text{OH}^- \longrightarrow \text{X}_2\text{O}_4^{3-} + \text{Y}^- + 3\text{Y}_3\text{O}_7^{2-} + 11\text{H}_2\text{O}$  (One of many possible answers)  
 d) (acidic)  $14\text{Z}_2\text{O}_3 + 2\text{X}(\text{CN})_6^{3-} + 8\text{H}_2\text{O} \longrightarrow 2\text{X}^{3+} + 12\text{NO}_2 + 12\text{CO}_2 + \text{O}_2 + 28\text{Z}^- + 16\text{H}^+$  (One of many possible answers)  
 e) (basic)  $25\text{Sn}^{4+} + 56\text{OH}^- + 2\text{X}(\text{CNO})_4^{2-} \longrightarrow 25\text{Sn}^{2+} + 2\text{XO}_3^{3-} + 8\text{CO}_3^{2-} + 8\text{NO} + 28\text{H}_2\text{O}$   
 f) (basic)  $2\text{H}_2\text{O} + 4\text{MnO}_4^- + 3\text{C}_7\text{H}_8 \longrightarrow 3\text{C}_7\text{H}_6\text{O}_2 + 3\text{Mn}^{2+} + 3\text{MnO}_2 + 10\text{OH}^-$  (One of many possible answers)

4) (balance reaction, identify oxidizing agent)



5) (reaction of  $\text{I}_2$  and  $\text{S}_2\text{O}_3^{2-}$ )



moles of  $\text{I}_2 = 7.50 \text{ g} / 253.8 \text{ g/mol} = 2.955 \times 10^{-2} \text{ mol } \text{I}_2 = 29.55 \text{ mmol } \text{I}_2$

moles of  $\text{S}_2\text{O}_3^{2-}$  needed =  $2 \times 2.955 \times 10^{-2} = 5.910 \times 10^{-2} = 59.10 \text{ mmol } \text{S}_2\text{O}_3^{2-}$  and volume of 0.100 M

$\text{Na}_2\text{S}_2\text{O}_3$  needed = 591 mL