Oxidation-Reaction Reactions

1) **What is oxidation?**

2) **What is reduction?**

3) **What are the oxidation numbers in hydrogen peroxide, H_2O_2?**

4) **What are the oxidation numbers in sulfite, SO_3^{2-}?**

5) **What determines whether a chemical reaction is a redox reaction?**

6) **(a) What effect does oxidation have on the oxidation number of a substance?**

   (b) What effect does reduction have on the oxidation number of a substance?

7) **What is the difference between an oxidizing agent and a reducing agent?**

8) **Why are the Group I elements (alkali metals) very strong reducing agents?**

9) **Why are the Group VII elements (halogens) very strong oxidizing agents?**

10) **What is the relationship between the strength of an oxidizing agent and its corresponding reducing agent?**

11) **In the reaction, $O_2 + 4e^- \rightarrow 2O^{2-}$, is O_2 oxidized or reduced?**

12) **In the reaction, $2Na + Cl_2 \rightarrow 2NaCl$, which species is reduced?**

13) **In the reaction, $Mg + F_2 \rightarrow MgF_2$, which species is oxidized?**

14) **In a redox reaction, MnO_4^- is changed to Mn^{2+}. How many electrons must be lost or gained by Mn?**

15) **In a redox reaction, MnO_4^- is changed to MnO_4^{2-}. How many electrons must be lost or gained by Mn?**

16) **In a balanced redox equation, how does the total number of reactant molecules compare with the total number of product molecules?**

17) **What is the strongest reducing agent among the elements?**

18) **What is the strongest oxidizing agent among the elements?**

19) Balance the following redox reaction using the oxidation number method.

$Al + Cu^{2+} \rightarrow Al^{3+} + Cu$

20) Balance the following redox reaction using the oxidation number method.

copper + nitric acid → copper(II) nitrate + nitrogen monoxide + water

Solutions

1) **Oxidation is a chemical reaction in which the atoms or ions of an element acquire a more positive oxidation state by losing electrons.**

2) **Reduction is a chemical reaction in which the atoms or ions of an element acquire a more negative oxidation state by gaining electrons.**

3) $\overset{+1\ \ -1}{H_2O_2}$

4) $\overset{+4\ -6}{\underset{-2}{SO_3^{2-}}}$

5) **Only those reactions in which elements undergo a change in oxidation number (state).**

6) **(a) The oxidation number becomes more positive even though it may remain negative.**

(b) The oxidation number becomes more negative even though it may remain positive.

7) **The oxidizing agent is reduced or acquires a more negative oxidation state and the reducing agent is oxidized or acquires a more positive oxidation state.**

8) **The relatively large atomic radii of the alkali metals results in a weak force of attraction between the positive nuclei and the one valence electron.**

9) **The relatively small atomic radii of the halogens results in a strong force of attraction between the positive nuclei and the seven valence electrons.**

10) **The stronger an oxidizing agent, the weaker its corresponding reducing agent.**

11) **O_2 is reduced because its oxidation state becomes more negative by changing from 0 to -2.**

12) **Cl_2 is reduced because its oxidation state becomes more negative by changing from 0 to -1.**

13) **Mg is oxidized because its oxidation state becomes more positive by changing from 0 to +2.**

14) $\overset{+7\ \ -8}{\underset{\ \ -2}{MnO_4^-}} \rightarrow Mn^{2+}$**, therefore Mn must gain five electrons.**

15) $\overset{+7\ \ -8}{\underset{\ \ -2}{MnO_4^-}} \rightarrow \overset{+6\ \ -8}{\underset{\ \ -2}{MnO_4^{2-}}}$**, therefore Mn must gain one electron.**

16) **As in all chemical reactions, there is no relationship that exists between the number of reactant and product molecules.**

17) **Lithium.**

18) **Fluorine.**

19) $Al + Cu^{2+} \rightarrow Al^{3+} + Cu$

$\overset{0}{Al} + \overset{+2}{Cu^{2+}} \rightarrow \overset{+3}{Al^{3+}} + \overset{0}{Cu}$

oxidation:

$Al \rightarrow Al^{3+} + 3e^-$

reduction:

$Cu^{2+} + 2e^- \rightarrow Cu$

$2Al \rightarrow 2Al^{3+} + \cancel{6e^-}$

$3Cu^{2+} + \cancel{6e^-} \rightarrow 3Cu$

$2Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$

$2Al(s) + 3Cu^{2+}(aq) \rightarrow 2Al^{3+}(aq) + 3Cu(s)$

20) **copper + nitric acid → copper(II) nitrate + nitrogen monoxide + water**

$$Cu + HNO_3 \rightarrow Cu(NO_3)_2 + NO + H_2O$$

+5 -6

0 +1 -2 +2 +5 -2 +2 -2 +1 -2

$$Cu + HNO_3 \rightarrow Cu(NO_3)_2 + NO + H_2O$$

oxidation:

$$Cu \rightarrow Cu^{2+} + 2e^-$$

reduction:

$$N^{5+} + 3e^- \rightarrow N^{2+}$$

$$3Cu \rightarrow 3Cu^{2+} + \cancel{6e^-}$$

$$2N^{5+} + \cancel{6e^-} \rightarrow 2N^{2+}$$

$$3Cu + 2N^{5+} \rightarrow 3Cu^{2+} + 2N^{2+}$$

$$3Cu + 2HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + H_2O$$

$$3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$$

$$3Cu(s) + 8HNO_3(aq) \rightarrow 3Cu(NO_3)_2(aq) + 2NO(g) + 4H_2O(l)$$