Assignment: Unit Review: Redox

SCH4UE_06 - 07

1. What is the oxidation number of :

a. Cr in the dichromate ion, $Cr_2O_7^{-2}$?
b. Cl atom in $KClO_3$?
c. C in $C_2O_4^{-2}$ and in CO_2
d. Cl in CF_2Cl_2

2. Name the species being oxidized, reduced, oxidizing agent, and the reducing agent in the following reaction:

a. $IO_3^{-1}{}_{(aq)} + 5\ I^{-1}{}_{(aq)} + 6\ H^{+1}{}_{(aq)} \longrightarrow 3\ I_{2(s)} + 3\ H_2O_{(l)}$

b. $NO_3^{-1}{}_{(aq)} + 4\ Zn_{(s)} + 7OH^{-1}{}_{(aq)} + 6H_2O \longrightarrow 4\ Zn(OH)_4^{-1}{}_{(aq)} + NH_{3\ (aq)}$

3. Balance the following redox reaction in a basic solution:

a. $Cr_2O_7^{-2}{}_{(aq)} + Bi^{+3}{}_{(aq)} \longrightarrow Cr^{+3}{}_{(aq)} + BiO_3^{-1}{}_{(aq)}$
b. $MnO_4^{-1}{}_{(aq)} + SO_3^{-1}{}_{(aq)} \longrightarrow MnO_{2(s)} + SO_4^{-2}{}_{(aq)}$
c. $Br_{2(aq)} \longrightarrow BrO_3^{-1}{}_{(aq)} + Br^{-1}{}_{(aq)}$ (What name is given to this type of reaction?)
d. $P_{(s)} + PO_4^{-3}{}_{(aq)} \longrightarrow HPO_3^{-2}{}_{(aq)}$
e. $Cr_2O_7^{-2}{}_{(aq)} + C_2O_4^{-2}{}_{(aq)} \longrightarrow Cr^{+3}{}_{(aq)} + CO_{2(g)}$
f. $CrO_4^{-2}{}_{(aq)} + Cl^{-1}{}_{(aq)} \longrightarrow Cr^{+3}{}_{(aq)} + ClO_3^{-1}{}_{(aq)}$
g. $CN^{-1}{}_{(aq)} + MnO_4^{-1}{}_{(aq)} \longrightarrow CNO^{-1}{}_{(aq)} + MnO_{2(s)}$
h. $SeO_3^{-2}{}_{(aq)} + Cl_{2(g)} \longrightarrow SeO_4^{-2}{}_{(aq)} + Cl^{-1}{}_{(aq)}$

4. Will the reactions proceed? Explain. (Use E^0 values to explain)

a. $Cl_{2\ (g)} + Br^{-1}{}_{(aq)} \longrightarrow 2Cl^{-1}{}_{(aq)} + Br_{2(l)}$
b. $Al^{+3} + Hg \longrightarrow Al + Hg^{+2}$

5. Which of $K_{(s)}$ or $Cu_{(s)}$ would you expect to be a stronger reducing agent? Why? (Think of the reactivity table and the Standard reduction potential table.)

6. Why can SO_2 act as either an oxidant or a reducing agent? (Think of possible oxidation numbers of S.)

7. A person's blood alcohol, C_2H_5OH, can be measured by reaction a sample of blood plasma with potassium dichromate in acid solution according to the unbalanced reaction:

$$Cr_2O_7^{-2}{}_{(aq)} + C_2H_5OH_{(aq)} \longrightarrow Cr^{+3}{}_{(aq)} + CO_{2(g)}$$

a. Balance the reaction in acidic solution.
b. If 35.46 cm^3 of 0.04961 mol dm^{-3} $Cr_2O_7^{-2}{}_{(aq)}$ is required to react completely with 25.00 g blood plasma, what is the mass percent of alcohol in the blood?

8. A reaction involves two reactants: $Fe_{(s)}$ and $Cl_{2(g)}$. Which is the oxidant and which is the reducing agent? How do you know? (Think of O.N)

9. Write the overall electrochemical reaction for the cell described by the shorthand notation:

$$Al_{(s)} \mid Al^{+3}{}_{(aq)} \mid\mid O_{2(g)}, H^{+1}{}_{(aq)}, H_2O_{2(aq)} \mid Pt$$

10. Referring to the Standard Reduction Potential Table in the Data Book, arrange the following species in increasing order of their strengths as reducing agents and explain your reasoning:

a. $H_{2(g)}$, $Cu_{(s)}$, $Na_{(s)}$
b. $Cd_{(s)}$, $Fe_{(s)}$, $Zn_{(s)}$

11. A cell is constructed using the following overall electrochemical reaction:

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

Is this a spontaneous reaction under standard conditions? Why or why not? (SRP (Cd^{+2}) = – 0.40)

12. Why is an electrolyte necessary in an electrochemical cell?

13. Why is corrosion faster in the presence of salts or acids/

14. Electrolysis of a molten metal chloride having the molecular formula MCl_3, where M is the metal, using a current of 6.50 A for 1397 seconds deposits 1.41 g of the metal. What is the metal?

15. Write the shorthand cell notation for the redox reaction:

a. $Cr_2O_7^{-2}{}_{(aq)} + 6Br^{-1}{}_{(aq)} + 14\ H^{+1}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 3\ Br_{2(l)} + 7\ H_2O_{(l)}$

b. $NO_{(g)} + 2H_2O_{(l)} + Fe^{+3}{}_{(aq)} \longrightarrow NO_3^{-1}{}_{(aq)} + 4\ H^{+1}{}_{(aq)} + Fe_{(s)}$

c. Draw the Galvanic cell for the reaction in 15. (a) above, and label all the relevant parts of the cell

16. A surface is to be electroplated with calcium, Ca, metal by electrolyzing molten $CaCl_2$.
(a)If a surface is made the cathode in an electrolytic cell, how long, in minutes, will it take to deposit a layer of $Ca_{(s)}$ 0.015 mm thick on an object having a surface area of 80.0 cm^2, using a current of 0.12 A? The density of calcium metal is 1.55 g /cm^3 .
(b) Why can calcium not be reduced from an aqueous solution of $CaCl_2$?

17. How long, in minutes, will it take to electroplate 1.00 g $Ni_{(s)}$ from a solution of $NiCl_{3(aq)}$ using a current of 2.00 A?

18. Iron in food, in the form of Fe^{+3}, reacts with ascorbic acid (vitamin C),$C_6H_8O_6$, to form dehydroascorbic acid,$C_6\ H_6\ O_6$.
(i) Write an ionic half-equation to show the conversion of ascorbic acid to dehydroascorbic acid in aqueous solution.
(ii) In the other ionic half-equation Fe^{+3} is converted to Fe^{+2}. Deduce the overall equation for the reaction of $C_6H_8O_6$ and Fe^{+3}.

19. (a) Electrolysis can be used to obtain chlorine from molten sodium chloride. Write an equation for the reaction occurring at each electrode and describe the two different ways in which electricity is conducted when the cell is in operation.

(b) In one experiment involving the electrolysis of molten sodium chloride, 0.1 mol of chlorine was formed. Deduce, giving a reason, the amount of sodium formed at the same time.

(c) In another experiment involving the electrolysis of molten sodium chloride, the time of the electrolysis was halved and the current increased from 1 amp to 5 amp, compared to the experiment in (b). Deduce the amount of chlorine formed, showing your working.
(d) If dilute aqueous sodium chloride is electrolyzed, a different product is obtained at each electrode. Identify the product formed at each electrode and write an equation showing its formation.
(f) Explain the term *standard electrode potential* of an element.

20. Balance the following using oxidation numbers:

a. $Cr_2O_7^{-2}{}_{(aq)} + SO_3^{-2}{}_{(aq)} + H^{+1}{}_{(aq)} \longrightarrow Cr^{+3}{}_{(aq)} + SO_4^{-2}{}_{(aq)} + H_2O_{(l)}$

b. $MnO_4^{-1}{}_{(aq)} + VO^{+2}{}_{(aq)} + H_2O \longrightarrow MnO_{2\ (s)} + VO_2^{+1}{}_{(aq)} + H^{+1}$

21. Electrolysis of molten CaF_2 produces $Ca_{(s)}$ at the cathode and $F_{2(g)}$ at the anode. Electrolysis of $CaF_{2(aq)}$ produces neither of these products. Explain these observations.

22. Use Standard Reduction Potential table to arrange:

a. Ag^{+1} , Na^{+1}, H^{+1} in increasing oxidizing strength. (b) Ag, Na, H in increasing reducing strength.