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CHAPTER 20 STUDY GUIDE FOR CONTENT MASTERY

Section 20.2 Balancing Redox Equations

In your textbook, read about balancing equations by using the oxidation number method.

Answer the following questions.

1. Why couldn't the oxidation number method be used for balancing the following equation?

$KI(aq) + Pb(NO_3)_2(aq) \rightarrow PbI_2(s) + KNO_3(aq)$

The equation is not redox. No oxidation numbers change, so the method could not be used.

2. The conventional method of balancing equations can be used to balance redox equations also. Why is it easier to use the oxidation number method to balance redox equations such as $Zn(s) + MnO_2(s) + H_2O(l) \rightarrow Zn(OH)_2(s) + Mn_2O_3(s)$?

In many redox equations, the same element appears in several different substances or has several different oxidation numbers. Oxygen, for example, would be difficult to balance in the above equation using the conventional method of balancing equations.

3. Why might you sometimes use a combination of the oxidation number method and the conventional method to balance a redox equation?

After using the oxidation number method to balance the redox part of the equation, the conventional method can be used to balance other elements present.

4. If you are balancing an ionic redox equation, why is it important to know whether the reaction takes place in an acidic solution? How might your answer change if the reaction takes place in a basic solution?

After balancing the redox part of the equation, if the solution is acidic, hydrogen ions and water molecules are added to the equation to balance any oxygen atoms. If the solution is basic, hydroxide ions and water molecules are added to balance oxygen atoms.

5. What would be the advantage of using a net ionic equation to represent a redox reaction?

Spectator ions are eliminated, leaving only the substances that undergo change.

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Section 20.2 *continued*

Write the numbers *1* through *5* to place in order the steps used to balance an equation by the oxidation number method.

2 6. Determine the oxidation number of each element shown in the equation.

3 7. Draw a line connecting the atoms involved in oxidation and another line connecting the atoms involved in reduction.

5 8. If necessary, use the conventional method of balancing equations to balance all atoms and charges.

4 9. Use coefficients in front of formulas in the equation to balance the number of electrons transferred in the redox part of the reaction.

1 10. Write a chemical equation, showing all reactants and products in the reaction.

In your textbook, read about balancing net ionic redox equations by the oxidation number method.

Balance the following equations, using the oxidation number method for the redox part of the equation. If you need to, use the conventional method to balance the rest of the equation. Show your work.

11. $N_2(g) + H_2(g) \rightarrow NH_3(g)$

−3

$N_2(g) + H_2(g) \rightarrow NH_3(g)$

3(+1) = +3

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

12. $S_8(s) + Cu(s) \rightarrow Cu_2S(s)$

−2

$S_8(s) + Cu(s) \rightarrow Cu_2S(s)$

2(+1) = +2

$S_8(s) + 16Cu(s) \rightarrow 8Cu_2S(s)$

13. $NO_3^-(aq) + Zn(s) \rightarrow Zn(OH)_4^{2-}(aq) + NH_3(aq)$ in a basic solution

−8

$NO_3^-(aq) + Zn(s) \rightarrow Zn(OH)_4^{2-}(aq) + NH_3(aq)$

4(+2) = +8

$NO_3^-(aq) + 4Zn(s) + 7OH^-(aq) + 6H_2O(l) \rightarrow 4Zn(OH)_4^{2-}(aq) + NH_3(aq)$

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CHAPTER 20 STUDY GUIDE FOR CONTENT MASTERY

Section 20.3 Half-Reactions

In your textbook, read about half-reactions.

In the space at the left, write *true* if the statement is true; if the statement is false, change the italicized word or phrase to make it true.

true 1. A *species* is any kind of chemical unit involved in a process.

three 2. Glucose and sucrose are different types of sugars. A solution of glucose, sucrose, and water contains exactly *two* different species.

redox 3. A half-reaction is part of a *decomposition* reaction.

oxidation 4. When magnesium reacts with oxygen, $Mg \rightarrow Mg^{2+} + 2e^-$ is the *reduction* half of the reaction.

true 5. A species that undergoes *oxidation* will donate electrons to any atom that accepts them.

ion 6. A species can be a molecule, an atom, or an *electron*.

electrons 7. Balancing equations by half-reaction is based on the number of *atoms* transferred.

true 8. Balancing half-reactions involves balancing *both atoms and charge*.

ions 9. In writing an equation in ionic form, ionic compounds are written as *molecules*.

an acidic 10. The half-reaction $SO_2 + H_2O + 2e^- \rightarrow SO_4^{2-} + 4H^+$ shows that the reaction takes place in *a basic* solution.

In your textbook, read about identifying half-reactions.

For each of the following reactions, write the oxidation and reduction half-reactions. Identify each half-reaction as either oxidation or reduction. Then list the spectator ions that are present in the reaction. If no spectator ions are present, write *none*.

11. $Ca(s) + Al(NO_3)_3(aq) \rightarrow Al(s) + Ca(NO_3)_2(aq)$
$Ca \rightarrow Ca^{2+} + 2e^-$, oxidation; $Al^{3+} + 3e^- \rightarrow Al$, reduction; NO_3^-

12. $NO_2(g) + NaOH(aq) \rightarrow NaNO_2(aq) + NaNO_3(aq) + H_2O(l)$
$NO_2 \rightarrow NO_3^- + 1e^-$, oxidation; $NO_2 + 1e^- \rightarrow NO_2^-$, reduction; Na^+

13. $HCl(aq) + KMnO_4(aq) \rightarrow KCl(aq) + MnCl_2(aq) + Cl_2(g) + H_2O(l)$
$2Cl^- \rightarrow Cl_2 + 2e^-$, oxidation; $MnO_4^- + 5e^- \rightarrow Mn^{2+}$, reduction; Cl^-, K^+

14. $H_3PO_3(aq) + HNO_3(aq) \rightarrow H_3PO_4(aq) + NO(g) + H_2O(l)$
$PO_3^{3-} \rightarrow PO_4^{3-} + 2e^-$, oxidation; $NO_3^- + 3e^- \rightarrow NO$, reduction; H^+

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Section 20.3 *continued*

In your textbook, read about balancing equations using half-reactions.

Use your answers from questions 11–13 to help you balance these equations. Show your work.

15. $Ca(s) + Al(NO_3)_3(aq) \rightarrow Al(s) + Ca(NO_3)_2(aq)$
$3(Ca \rightarrow Ca^{2+} + 2e^-)$; $2(Al^{3+} + 3e^- \rightarrow Al)$
$3Ca \rightarrow 3Ca^{2+} + 6e^-$
$2Al^{3+} + 6e^- \rightarrow 2Al$
$3Ca(s) + 2Al(NO_3)_3(aq) \rightarrow 2Al(s) + 3Ca(NO_3)_2(aq)$

16. $NO_2(g) + NaOH(aq) \rightarrow NaNO_2(aq) + NaNO_3(aq) + H_2O(l)$
$NO_2 \rightarrow NO_3^- + 1e^-$; $NO_2 + 1e^- \rightarrow NO_2^-$
$NO_2 \rightarrow NO_3^- + 1e^-$
$NO_2 + 1e^- \rightarrow NO_2^-$
$2NO_2(g) + 2NaOH(aq) \rightarrow NaNO_2(aq) + NaNO_3(aq) + H_2O(l)$

17. $HCl(aq) + KMnO_4(aq) \rightarrow KCl(aq) + MnCl_2(aq) + Cl_2(g) + H_2O(l)$
$5(2Cl^- \rightarrow Cl_2 + 2e^-)$; $2(MnO_4^- + 5e^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O)$
$10Cl^- \rightarrow 5Cl_2 + 10e^-$
$2MnO_4^- + 10e^- + 16H^+ \rightarrow 2Mn^{2+} + 8H_2O$
$16HCl(aq) + 2KMnO_4(aq) \rightarrow 2KCl(aq) + 2MnCl_2(aq) + 5Cl_2(g) + 8H_2O(l)$

Balance the following equations, assuming all reactions take place in an acidic solution. Remember that charge, as well as atoms, must be balanced. Show your work.

18. $NO_3^-(aq) + H_2S(g) \rightarrow S(s) + NO(g)$
$2(NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O)$; $3(S^{2-} \rightarrow S + 2e^-)$
$2NO_3^- + 8H^+ + 6e^- \rightarrow 2NO + 4H_2O$
$3S^{2-} \rightarrow 3S + 6e^-$
$2H^+(aq) + 2NO_3^-(aq) + 3H_2S(g) \rightarrow 3S(s) + 2NO(g) + 4H_2O(l)$

19. $Cr_2O_7^{2-}(aq) + I^-(aq) \rightarrow Cr^{3+}(aq) + I_2(s)$
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$; $3(2I^- \rightarrow I_2 + 2e^-)$
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$
$6I^- \rightarrow 3I_2 + 6e^-$
$Cr_2O_7^{2-}(aq) + 6I^-(aq) + 14H^+(aq) \rightarrow 2Cr^{3+}(aq) + 3I_2(s) + 7H_2O(l)$