CHAPTER 4 Review

Reflecting on Chapter 4

Summarize this chapter in the format of your choice. Here are a few ideas to use as guidelines.

- Distinguish between chemical reactions and nuclear reactions.
- Summarize guidelines for balancing chemical equations.
- Summarize the different types of chemical reactions.
- Summarize the types of nuclear decay.
- Explain why knowing the solubility of compounds is important to predicting double displacement reactions.
- Summarize guidelines for balancing nuclear equations
- Describe how to use the activity series of metals and the activity series of halogens.

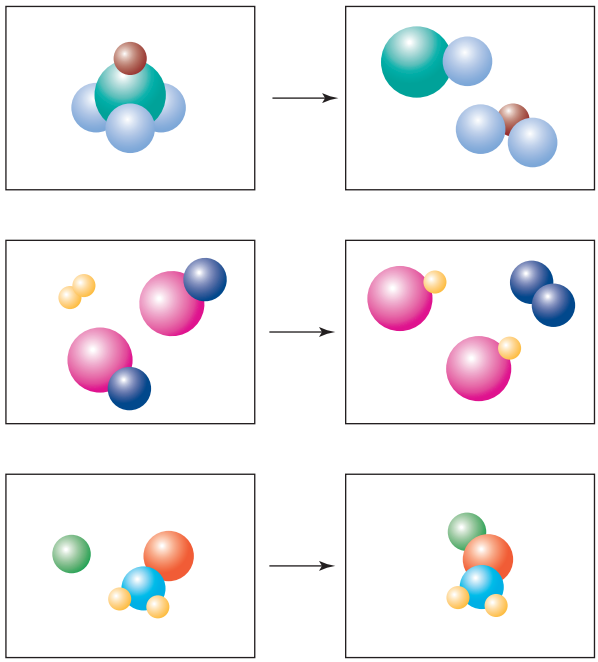
Reviewing Key Terms

For each of the following terms, write a sentence that shows your understanding of its meaning.

activity series
alpha (α) particle emission
balanced chemical equation
beta particle
beta (β) decay
chemical equations
chemical reactions
combustion reaction
decomposition reaction
double displacement reaction
gamma (γ) radiation
incomplete combustion
law of conservation of mass
neutralization reactions
nuclear equation
nuclear fission
nuclear fusion
nuclear reactions
precipitate
product
reactant
single displacement reactions
skeleton equation
synthesis reaction
word equation

Knowledge/Understanding

1. How can you tell if a chemic.al reaction has occurred?
2. Explain why the mixing of red paint with white paint does not constitute a chemical reaction, even though the "product" has a different appearance.
3. Explain how balancing a chemical equation satisfies the law of conservation of mass.
4. Copy each chemical equation into your notebook, and balance it.
   (a) $PdCl_{2(aq)} + HNO_{3(aq)} \rightarrow Pd(NO_3)_{2(aq)} + HCl_{(aq)}$
   (b) $Cr_{(s)} + HCl_{(aq)} \rightarrow CrCl_{2(aq)} + H_{2(g)}$
   (c) $FeO_{(s)} + O_{2(g)} \rightarrow Fe_2O_{3(s)}$
5. What type of chemical reaction is illustrated in each diagram below?



6. Classify each reaction as synthesis, decomposition, single displacement, double displacement, or combustion. Also, balance each chemical equation.
   (a) $H_{2(g)} + CuO_{(s)} \rightarrow Cu_{(s)} + H_2O_{(g)}$
   (b) $Ag_{(s)} + S_{8(s)} \rightarrow Ag_2S_{(s)}$
   (c) $C_4H_{8(g)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)}$
   (d) $NH_{3(g)} + HCl_{(g)} \rightarrow NH_4Cl_{(s)}$
   (e) $Mg_{(s)} + O_{2(g)} \rightarrow MgO_{(s)}$
   (f) $RbCl_{(s)} + O_{2(g)} \rightarrow RbClO_{4(s)}$
   (g) $Cu_2S_{(s)} + O_{2(g)} \rightarrow Cu_2O_{(g)} + SO_{2(g)}$
7. Why is the solubility chart useful for analyzing double displacement reactions?
8. Nitrogen dioxide is a component of smog. It is produced in an automobile engine's combustion chamber. When exposed to sunlight, nitrogen dioxide forms nitrogen monoxide and oxygen. What type of reaction is this?

9. Write a balanced chemical equation corresponding to each word equation.
   (a) The reaction between aqueous sodium hydroxide and iron(III) nitrate produces a precipitate.
   (b) Powdered antimony reacts with chlorine gas to produce antimony trichloride.
   (c) Mercury(II) oxide is prepared from its elements.
   (d) Ammonium nitrite decomposes into nitrogen gas and water.
   (e) Aluminum metal reacts with a solution of zinc sulfate to produce aluminum sulfate and metallic zinc.

10. Consider the unbalanced chemical equation corresponding to the formation of solid lead(II) chromate, $PbCrO_4$:
$Pb(NO_3)_{2(aq)} + K_2CrO_{4(aq)} \rightarrow PbCrO_{4(s)} + KNO_{3(aq)}$
   (a) What type of chemical reaction is this?
   (b) Balance the equation.

11. In general, what is formed when an oxide of a non-metal reacts with water? Give an example.

12. In general, what is formed when an oxide of a metal reacts with water? Give an example.

13. Complete and balance each nuclear equation. Then classify the reaction.
   (a) ${}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He +$ ____
   (b) ${}^{239}_{92}U \rightarrow$ ____ $+ {}^{0}_{-1}\beta$
   (c) ${}^{239}_{93}Np \rightarrow {}^{239}_{94}Pu +$ ____
   (d) ${}^{238}_{92}U \rightarrow {}^{234}_{90}Th +$ ____ $+ 2{}^{0}_{0}\gamma$

14. Write the product(s) for each reaction. If you predict that there will be no reaction, write "NR." Balance each chemical equation.
   (a) $BaCl_{2(aq)} + Na_2CO_{3(aq)} \rightarrow$
   (b) $Fe_{(s)} + CuSO_{4(aq)} \rightarrow$
   (c) $C_2H_{2(g)} + O_{2(g)} \rightarrow$
   (d) $PCl_{5(s)} \rightarrow$ ____ $+ Cl_{2(g)}$
   (e) $Mg_{(s)} + Fe_2O_3 \rightarrow$
   (f) $Ca_{(s)} + Cl_{2(g)} \rightarrow$

15. Iron often occurs as an oxide, such as Fe_2O_3. In the steel industry, Fe_2O_3 is reacted with carbon monoxide to produce iron metal and carbon dioxide. Write the balanced chemical equation for this reaction, and classify it.

16. Calcium chloride is often used to melt ice on roads and sidewalks, or to prevent it from forming. Calcium chloride can be made by reacting hydrochloric acid with calcium carbonate. Write the balanced chemical equation corresponding to this reaction, and classify it.

Inquiry

17. An American penny is composed of a zinc core clad in copper. Some of the copper is filed away, exposing the zinc, and placed in a solution of hydrochloric acid. Describe what will occur.

18. What will happen to a silver earring that is accidentally dropped into toilet bowl cleaner that contains hydrochloric acid?

Communication

19. Explain why it is advisable to store chemicals in tightly sealed bottles out of direct sunlight.

20. Why is smoking not allowed near an oxygen source? What would happen if a match were struck in an oxygen-rich atmosphere?

21. Even if a smoker is very careful not to let a lighted cigarette come in contact with liquid gasoline, why is it very dangerous to smoke when refuelling an automobile?

22. Solutions that have been used to process film contain silver ions, $Ag^{+}_{(aq)}$.
   (a) Explain how you could recover the silver, in the form of an ionic compound.
   (b) How could you recover the silver as silver metal?

Making Connections

23. Calcium oxide, CaO (lime), is used to make mortar and cement.
   (a) State two reactions that could be used to make lime. Classify each reaction, based on the types of reactions studied in this chapter.
   (b) In construction, cement is prepared by mixing the powdered cement with water. Write the chemical equation that represents the reaction of calcium oxide with water. Why are we cautioned not to expose skin to dry cement mix *and* wet cement? It may help you to know that bases are often corrosive. They can burn exposed skin.

Answers to Practice Problems and Short Answers to Section Review Questions

Practice Problems: **1.(a)** calcium + fluorine (reactants) → calcium fluoride (product) **(b)** barium chloride + hydrogen sulfate → hydrogen chloride + barium sulfate **(c)** calcium carbonate + carbon dioxide + water → calcium hydrogen carbonate **(d)** hydrogen peroxide → water + oxygen **(e)** sulfur dioxide + oxygen → sulfur trioxide **2.** Sugar → ethanol + carbon dioxide **3.(a)** $Zn_{(s)} + Cl_{2(g)} \rightarrow ZnCl_{2(s)}$ **(b)** $Ca_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2(aq)} + H_{2(g)}$ **(c)** $Ba_{(s)} + S_{(s)} \rightarrow BaS_{(s)}$ **(d)** $Pb(NO_3)_{2(aq)} + Mg_{(s)} \rightarrow Mg(NO_3)_{2(aq)} + Pb_{(s)}$ **4.(a)** $CO2_{(g)} + CaO_{(s)} \rightarrow CaCO_{3(s)}$ **(b)** $Al_{(s)} + O_{2(g)} \rightarrow Al_2O_{3(s)}$ **(c)** $Mg_{(s)} + O_{2(g)} \rightarrow MgO_{(s)}$ **5.(a)** $S_{(s)} + O_{2(g)} \rightarrow SO_{2(g)}$ **(b)** $P_{4(s)} + 5O_{2(g)} \rightarrow P_4O_{10(s)}$ **(c)** $H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}$ **(d)** $SO_{2(g)} + H_2O_{(l)} \rightarrow H_2SO_{3(aq)}$ **6.(a)** balanced **(b)** $2HgO_{(s)} \rightarrow 2Hg_{(l)} + O_{2(g)}$ **(c)** $H_2O_{2(aq)} \rightarrow 2H_2O_{(l)} + O_{2(g)}$ **(d)** balanced **7.(a)** $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$ **(b)** $BaCl_{2(aq)} + Na_2SO_{4(aq)} \rightarrow NaCl_{(aq)} + BaSO_{4(s)}$ **8.** $P_{4(s)} + 5O_{2(g)} \rightarrow P_4O_{10(s)}$; $P_4O_{10(s)} + 6H_2O_{(l)} \rightarrow 4H_3PO_{4(aq)}$ **9.(a)** $As_4S_{6(s)} + 9O_{2(g)} \rightarrow As_4O_{6(s)} + 6SO_{2(g)}$ **(b)** $Sc_2O_{3(s)} + 3H_2O_{(l)} \rightarrow 2Sc(OH)_{3(s)}$ **(c)** $C_2H_5OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$ **(d)** $2C_4H_{10(g)} + 9O_{2(g)} \rightarrow 8CO_{(g)} + 10H_2O_{(g)}$ **10.(a)** $2K + Br_2 \rightarrow 2KBr$ **(b)** $H_2 + Cl_2 \rightarrow 2HCl$ **(c)** $Ca + Cl_2 \rightarrow CaCl_2$ **(d)** $Li + O_2 \rightarrow LiO_2$ **11.(a)** products are Fe_2O_3, FeO **(b)** possible products: V_2O_5, VO, V_2O_3, VO_2 **(c)** possible products: TiO_2, TiO, Ti_2O_3 **12.(a)** $K_2O + H_2O \rightarrow 2KOH$ **(b)** $MgO + H_2O \rightarrow Mg(OH)_2$ **(c)** $SO_2 + H_2O \rightarrow H_2SO_3$ **13.** $NH_{3(g)} + HCl_{(g)} \rightarrow NH_4Cl_{(s)}$ **14.** Hg, O_2 **15.(a)** $2HI \rightarrow H_2 + I_2$ **(b)** $2Ag_2O \rightarrow 4Ag + O_2$ **(c)** $2AlCl_3 \rightarrow 2Al + 3Cl_2$ **(d)** $MgO \rightarrow Mg + O_2$ **16.(a)** $MgCO_3 \rightarrow MgO + CO_2$ **(b)** $CuCO_3 \rightarrow CuO + CO_2$ **17.** $2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$ **18.** $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ **19.** $C_3H_6O + O_2 \rightarrow CO_2 + H_2O$ **20.** $2C_{16}H_{34} + 49O_2 \rightarrow 32CO_2 + 34H_2O$ **21.(a)** $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ **(b)** $Zn + Pb(NO_3)_2 \rightarrow Zn(NO_3)_2 + Pb$ **(c)** $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$ **(d)** $Li + AgNO_3 \rightarrow Ag + LiNO_3$ **(e)** $Pb + H_2SO_4 \rightarrow PbSO_4 + H_2$ **(f)** $2Mg + Pt(OH)_4 \rightarrow 2Mg(OH)_2 + Pt$ **(g)** $Ba + FeCl_2 \rightarrow BaCl_2 + Fe$ **(h)** $Fe + Co(ClO_3)_2 \rightarrow Fe(ClO_3)_3 + Co$ **22.(a)** NR **(b)** $Zn + FeCl_2 \rightarrow ZnCl_2 + Fe$ **(c)** $K + H_2O \rightarrow KOH + H_2$ **(d)** $2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$ **(e)** NR **(f)** NR **(g)** $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$ **(h)** $Mg + SnCl_2 \rightarrow MgCl_2 + Sn$ **23.(a)** NR **(b)** $Cl_2 + 2NaI \rightarrow 2NaCl + I_2$ **24.(a)** $2Pb + 2HCl \rightarrow 2PbCl + H_2$ **(b)** $KI + Br_2 \rightarrow KBr + I_2$ **(c)** NR **(d)** $Ca + H_2O \rightarrow Ca(OH)_2 + H_2$ **(e)** NR **(f)** $Ni + H_2SO_4 \rightarrow NiSO_4 + H_2$ **25.(a)** $Pb(NO_3)_{2(aq)} + 2KI_{(aq)} \rightarrow 2KNO_{3(aq)} + PbI_{2(s)}$ **(b)** NR **(c)** NR **(d)** $Ba(NO_3)_{2(aq)} + Mg(SO_4)_{(aq)} \rightarrow BaSO_{4(s)} + Mg(NO_3)_{2(aq)}$ **26.(a)** $Na_2SO_{3(aq)} + 2HCl_{(aq)} \rightarrow SO_{2(g)} + 2NaCl_{(aq)} + H_2O_{(l)}$ **(b)** $CaS_{(aq)} + H_2SO_{4(aq)} \rightarrow H_2S_{(g)} + CaSO_{4(l)}$ **27.(a)** $HCl_{(aq)} + LiOH_{(aq)} \rightarrow H_2O_{(l)} + LiCl_{(aq)}$ **(b)** $HclO_{4(aq)} + Ca(OH)_{2(aq)} \rightarrow H_2O_{(l)} + Ca(ClO_4)_{2(aq)}$ **(c)** $H_2SO_{4(aq)} + NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + H_2O_{(l)}$ **28.(a)** $BaCl_{2(aq)} + Na_2CrO_{4(aq)} \rightarrow BaCrO_{4(s)} + 2NaCl_{(aq)}$ **(b)** $HNO_{3(aq)} + NaOH_{(aq)} \rightarrow H_2O_{(l)} + NaNO_{3(aq)}$ **(c)** $K_2CO_{3(aq)} + 2HNO_{3(aq)} \rightarrow H_2O_{(l)} + 2KNO_{3(aq)} + CO_{2(g)}$ **29.** [234/90]Th **30.** [222/86]Rn → [4/2]He + [218/82]Pb **31.** [242/94]Pu → [4/2]He + [238/92]U **32.** [144/60]Nd → [4/2]He + [140/58]Ce **33.** [40/19]K → [0/ − 1]e + [40/20]Ca **34.** [47/20]Ca **35.** [73/31]Ga → [0/ − 1]e + [73/32]Ge **36.** [208/83]Bi **37.** 5 **38.** 4 **39.** [27/13]Al+ [4/2]He → [30/15]P + [1/0]n

Section Review: **4.1:** **2.(a)** $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$ **(b)** $Na_{(s)} + H_2O_{(l)} \rightarrow H_{2(g)} + NaOH_{(aq)}$ **(c)** $Cu_{(s)} + HNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + NO_{2(g)} + H_2O_{(l)}$ **4.(a)** $4Al_{(s)} + 3O_{2(g)} \rightarrow 42Al_2O_{3(s)}$ **(b)** $2Na_2S_2O_{3(aq)} + I_{2(aq)} \rightarrow 2NaI_{(aq)} + Na_2S_4O_{6(aq)}$ **(c)** $2Al_{(s)} + Fe_2O_{3(s)} \rightarrow Al_2O_{3(s)} + 2Fe_{(s)}$ **(d)** $4NH_{3(g)} + 5O_{2(g)} \rightarrow 4NO_{(g)} + 6H_2O_{(l)}$ **(e)** $Na_2O_{(s)} + (NH_4)_2SO_{4(aq)} + H_2O_{(l)} + NH_{3(aq)}$ **(f)** $C_5H_{12(l)} + 8O_{2(g)} \rightarrow 5CO_{2(g)} + 6H_2O_{(g)}$ **5.** $Fe_{(s)} + CuSO_{4(aq)} \rightarrow Cu_{(s)} + FeSO_{4(aq)}$ **4.2:** **1.(a)** $Be + O_2 \rightarrow BeO$ **(b)** $2Li + Cl_2 \rightarrow 2LiCl$ **(c)** $Mg + N_2 \rightarrow Mg_3N_2$ **(d)** $Ca + Br_2 \rightarrow CaBr_2$ **2.(a)** $2K_2O \rightarrow O_2 + 4K$ **(b)** $2CuO \rightarrow 2Cu + O_2$ **(c)** $2H_2O \rightarrow 2H_2 + O_2$ **(d)** $2Ni_2O_3 \rightarrow 4Ni + 3O_2$ **(e)** $2Ag_2O \rightarrow 4Ag + O_2$ **3.(a)** $Sn(OH)_{4(s)} \rightarrow SnO_{2(s)} + 2H_2O_{(g)}$, decomposition **(b)** $3Cl_2(g) + I_{2(s)} \rightarrow 2ICl_3$ synthesis **(c)** $C_4H_9OH + 6O_2 \rightarrow 5H_2O + 4CO_2$ **5.** $2HgO_{(s)} \rightarrow O_{2(g)} + 2Hg_{(s)}$ decomposition **4.3:** **1.(a)** $Li + H_2O \rightarrow Li_2O + H_2$ **(b)** NR **(c)** $F_2 + 2KI \rightarrow 2KF + I_2$ **(d)** NR **(e)** $Zn + CuSO_4 \rightarrow Cu + ZnSO_4$ **(f)** $K + H_2O \rightarrow K_2O + H_2$ **2.(a)** $NaOH_{(aq)} + Fe(NO_3)_{3(aq)} \rightarrow NaNO_{3(aq)} + Fe(OH)_{3(s)}$ **(b)** $Ca(OH)_{2(aq)} + HCl_{(aq)} \rightarrow CaCl_{2(aq)} + H_2O)_{(l)}$ **(c)** NR **(d)** $K_2CO_{3(s)} + H_2SO_{4(aq)} \rightarrow K_2SO_{4(aq)} + CO_{2(g)} + H_2O_{(l)}$ **3.(b)** $(NH_4)_2SO_{4(aq)} + 2KOH_{(aq)} \rightarrow 2NH_{3(g)} + 2H_2O_{(l)} + K_2SO_{4(aq)}$ **4.(a)** incomplete combustion **(b)** single displacement **(c)** double displacement **(d)** complete combustion **(e)** decomposition **(f)** synthesis **(g)** decomposition **5.4:** **2.(a)** [1/0]n **(b)** [0/ − 1]e **(c)** [222/2]Rn **(d)** [4/2]He **(e)** [236/92]U **(f)** [4/2]He