

10.E: Chemical Reactions (Exercises)

The following questions are related to the material covered in this chapter.

10.1-10.3: The Chemical Equation

1. From the statement “nitrogen and hydrogen react to produce ammonia,” identify the reactants and the products.
2. From the statement “sodium metal reacts with water to produce sodium hydroxide and hydrogen,” identify the reactants and the products.
3. From the statement “magnesium hydroxide reacts with nitric acid to produce magnesium nitrate and water,” identify the reactants and the products.
4. From the statement “propane reacts with oxygen to produce carbon dioxide and water,” identify the reactants and the products.
5. Write and balance the chemical equation described by Exercise 1.
6. Write and balance the chemical equation described by Exercise 2.
7. Write and balance the chemical equation described by Exercise 3.
8. Write and balance the chemical equation described by Exercise 4. The formula for propane is C_3H_8 .
9. Balance: $__ NaClO_3 \rightarrow __ NaCl + __ O_2$
10. Balance: $__ N_2 + __ H_2 \rightarrow __ N_2H_4$
11. Balance: $__ Al + __ O_2 \rightarrow __ Al_2O_3$
12. Balance: $__ C_2H_4 + __ O_2 \rightarrow __ CO_2 + __ H_2O$
13. How would you write the balanced chemical equation in Exercise 10 if all substances were gases?
14. How would you write the balanced chemical equation in Exercise 12 if all the substances except water were gases and water itself were a liquid?

Answers

1. reactants: nitrogen and hydrogen; product: ammonia
- 2.
3. reactants: magnesium hydroxide and nitric acid; products: magnesium nitrate and water
- 4.
5. $N_2 + 3H_2 \rightarrow 2NH_3$
- 6.
7. $Mg(OH)_2 + 2HNO_3 \rightarrow Mg(NO_3)_2 + 2H_2O$
- 8.
9. $2NaClO_3 \rightarrow 2NaCl + 3O_2$
- 10.
11. $4Al + 3O_2 \rightarrow 2Al_2O_3$
- 12.
13. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

10.4: Composition, Decomposition, and Combustion Reactions

1. Which is a composition reaction and which is not?
 - a. $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$
 - b. $CaO + CO_2 \rightarrow CaCO_3$
2. Which is a composition reaction and which is not?
 - a. $H_2 + Cl_2 \rightarrow 2HCl$
 - b. $2HBr + Cl_2 \rightarrow 2HCl + Br_2$
3. Which is a composition reaction and which is not?
 - a. $2SO_2 + O_2 \rightarrow 2SO_3$

- b. $6\text{C} + 3\text{H}_2 \rightarrow \text{C}_6\text{H}_6$
4. Which is a composition reaction and which is not?
- a. $4\text{Na} + 2\text{C} + 3\text{O}_2 \rightarrow 2\text{Na}_2\text{CO}_3$
- b. $\text{Na}_2\text{CO}_3 \rightarrow \text{Na}_2\text{O} + \text{CO}_2$
5. Which is a decomposition reaction and which is not?
- a. $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
- b. $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
6. Which is a decomposition reaction and which is not?
- a. $3\text{O}_2 \rightarrow 2\text{O}_3$
- b. $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$
7. Which is a decomposition reaction and which is not?
- a. $\text{Na}_2\text{O} + \text{CO}_2 \rightarrow \text{Na}_2\text{CO}_3$
- b. $\text{H}_2\text{SO}_3 \rightarrow \text{H}_2\text{O} + \text{SO}_2$
8. Which is a decomposition reaction and which is not?
- a. $2\text{C}_7\text{H}_5\text{N}_3\text{O}_6 \rightarrow 3\text{N}_2 + 5\text{H}_2\text{O} + 7\text{CO} + 7\text{C}$
- b. $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$
9. Which is a combustion reaction and which is not?
- a. $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$
- b. $2\text{Fe}_2\text{S}_3 + 9\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3 + 6\text{SO}_2$
10. Which is a combustion reaction and which is not?
- a. $\text{CH}_4 + 2\text{F}_2 \rightarrow \text{CF}_4 + 2\text{H}_2$
- b. $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
11. Which is a combustion reaction and which is not?
- a. $\text{P}_4 + 5\text{O}_2 \rightarrow 2\text{P}_2\text{O}_5$
- b. $2\text{Al}_2\text{S}_3 + 9\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3 + 6\text{SO}_2$
12. Which is a combustion reaction and which is not?
- a. $\text{C}_2\text{H}_4 + \text{O}_2 \rightarrow \text{C}_2\text{H}_4\text{O}_2$
- b. $\text{C}_2\text{H}_4 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_4\text{Cl}_2$
13. Is it possible for a composition reaction to also be a combustion reaction? Give an example to support your case.
14. Is it possible for a decomposition reaction to also be a combustion reaction? Give an example to support your case.
15. Complete and balance each combustion equation.
- a. $\text{C}_4\text{H}_9\text{OH} + \text{O}_2 \rightarrow ?$
- b. $\text{CH}_3\text{NO}_2 + \text{O}_2 \rightarrow ?$
16. Complete and balance each combustion equation.
- a. $\text{B}_2\text{H}_6 + \text{O}_2 \rightarrow ?$ (The oxide of boron formed is B_2O_3 .)
- b. $\text{Al}_2\text{S}_3 + \text{O}_2 \rightarrow ?$ (The oxide of sulfur formed is SO_2 .)
- c. $\text{Al}_2\text{S}_3 + \text{O}_2 \rightarrow ?$ (The oxide of sulfur formed is SO_3 .)

Answers

1. a. not composition
b. composition
- 2.
3. a. composition
b. composition
- 4.
5. a. not decomposition
b. decomposition
- 6.

7. a. not decomposition
b. decomposition
- 8.
9. a. combustion
b. combustion
- 10.
11. a. combustion
b. combustion
- 12.
13. Yes; $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ (answers will vary)
- 14.
15. a. $\text{C}_4\text{H}_9\text{OH} + 6\text{O}_2 \rightarrow 4\text{CO}_2 + 5\text{H}_2\text{O}$
b. $4\text{CH}_3\text{NO}_2 + 3\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O} + 2\text{N}_2$

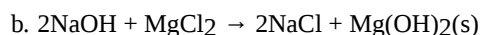
10.5 - 10.6: Types of Chemical Reactions - Single and Double Displacement Reactions

1. What are the general characteristics that help you recognize single-replacement reactions?
2. What are the general characteristics that help you recognize double-replacement reactions?
3. Assuming that each single-replacement reaction occurs, predict the products and write each balanced chemical equation.
 - a. $\text{Zn} + \text{Fe}(\text{NO}_3)_2 \rightarrow ?$
 - b. $\text{F}_2 + \text{FeI}_3 \rightarrow ?$
4. Assuming that each single-replacement reaction occurs, predict the products and write each balanced chemical equation.
 - a. $\text{Li} + \text{MgSO}_4 \rightarrow ?$
 - b. $\text{NaBr} + \text{Cl}_2 \rightarrow ?$
5. Assuming that each single-replacement reaction occurs, predict the products and write each balanced chemical equation.
 - a. $\text{Sn} + \text{H}_2\text{SO}_4 \rightarrow ?$
 - b. $\text{Al} + \text{NiBr}_2 \rightarrow ?$
6. Assuming that each single-replacement reaction occurs, predict the products and write each balanced chemical equation.
 - a. $\text{Mg} + \text{HCl} \rightarrow ?$
 - b. $\text{HI} + \text{Br}_2 \rightarrow ?$
7. Use the periodic table or the activity series to predict if each single-replacement reaction will occur and, if so, write a balanced chemical equation.
 - a. $\text{FeCl}_2 + \text{Br}_2 \rightarrow ?$
 - b. $\text{Fe}(\text{NO}_3)_3 + \text{Al} \rightarrow ?$
8. Use the periodic table or the activity series to predict if each single-replacement reaction will occur and, if so, write a balanced chemical equation.
 - a. $\text{Zn} + \text{Fe}_3(\text{PO}_4)_2 \rightarrow ?$
 - b. $\text{Ag} + \text{HNO}_3 \rightarrow ?$
9. Use the periodic table or the activity series to predict if each single-replacement reaction will occur and, if so, write a balanced chemical equation.
 - a. $\text{NaI} + \text{Cl}_2 \rightarrow ?$
 - b. $\text{AgCl} + \text{Au} \rightarrow ?$
10. Use the periodic table or the activity series to predict if each single-replacement reaction will occur and, if so, write a balanced chemical equation.
 - a. $\text{Pt} + \text{H}_3\text{PO}_4 \rightarrow ?$
 - b. $\text{Li} + \text{H}_2\text{O} \rightarrow ?$ (Hint: treat H_2O as if it were composed of H^+ and OH^- ions.)
11. Assuming that each double-replacement reaction occurs, predict the products and write each balanced chemical equation.
 - a. $\text{Zn}(\text{NO}_3)_2 + \text{NaOH} \rightarrow ?$
 - b. $\text{HCl} + \text{Na}_2\text{S} \rightarrow ?$

12. Assuming that each double-replacement reaction occurs, predict the products and write each balanced chemical equation.
 - a. $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2 + \text{HNO}_3 \rightarrow ?$
 - b. $\text{Na}_2\text{CO}_3 + \text{Sr}(\text{NO}_2)_2 \rightarrow ?$
13. Assuming that each double-replacement reaction occurs, predict the products and write each balanced chemical equation.
 - a. $\text{Pb}(\text{NO}_3)_2 + \text{KBr} \rightarrow ?$
 - b. $\text{K}_2\text{O} + \text{MgCO}_3 \rightarrow ?$
14. Assuming that each double-replacement reaction occurs, predict the products and write each balanced chemical equation.
 - a. $\text{Sn}(\text{OH})_2 + \text{FeBr}_3 \rightarrow ?$
 - b. $\text{CsNO}_3 + \text{KCl} \rightarrow ?$
15. Use the solubility rules to predict if each double-replacement reaction will occur and, if so, write a balanced chemical equation.
 - a. $\text{Pb}(\text{NO}_3)_2 + \text{KBr} \rightarrow ?$
 - b. $\text{K}_2\text{O} + \text{Na}_2\text{CO}_3 \rightarrow ?$
16. Use the solubility rules to predict if each double-replacement reaction will occur and, if so, write a balanced chemical equation.
 - a. $\text{Na}_2\text{CO}_3 + \text{Sr}(\text{NO}_2)_2 \rightarrow ?$
 - b. $(\text{NH}_4)_2\text{SO}_4 + \text{Ba}(\text{NO}_3)_2 \rightarrow ?$
17. Use the solubility rules to predict if each double-replacement reaction will occur and, if so, write a balanced chemical equation.
 - a. $\text{K}_3\text{PO}_4 + \text{SrCl}_2 \rightarrow ?$
 - b. $\text{NaOH} + \text{MgCl}_2 \rightarrow ?$
18. Use the solubility rules to predict if each double-replacement reaction will occur and, if so, write a balanced chemical equation.
 - a. $\text{KC}_2\text{H}_3\text{O}_2 + \text{Li}_2\text{CO}_3 \rightarrow ?$
 - b. $\text{KOH} + \text{AgNO}_3 \rightarrow ?$

Answers

1. One element replaces another element in a compound.
- 2.
3. a. $\text{Zn} + \text{Fe}(\text{NO}_3)_2 \rightarrow \text{Zn}(\text{NO}_3)_2 + \text{Fe}$
b. $3\text{F}_2 + 2\text{FeI}_3 \rightarrow 3\text{I}_2 + 2\text{FeF}_3$
- 4.
5. a. $\text{Sn} + \text{H}_2\text{SO}_4 \rightarrow \text{SnSO}_4 + \text{H}_2$
b. $2\text{Al} + 3\text{NiBr}_2 \rightarrow 2\text{AlBr}_3 + 3\text{Ni}$
- 6.
7. a. No reaction occurs.
b. $\text{Fe}(\text{NO}_3)_3 + \text{Al} \rightarrow \text{Al}(\text{NO}_3)_3 + \text{Fe}$
- 8.
9. a. $2\text{NaI} + \text{Cl}_2 \rightarrow 2\text{NaCl} + \text{I}_2$
b. No reaction occurs.
- 10.
11. a. $\text{Zn}(\text{NO}_3)_2 + 2\text{NaOH} \rightarrow \text{Zn}(\text{OH})_2 + 2\text{NaNO}_3$
b. $2\text{HCl} + \text{Na}_2\text{S} \rightarrow 2\text{NaCl} + \text{H}_2\text{S}$
- 12.
13. a. $\text{Pb}(\text{NO}_3)_2 + 2\text{KBr} \rightarrow \text{PbBr}_2 + 2\text{KNO}_3$
b. $\text{K}_2\text{O} + \text{MgCO}_3 \rightarrow \text{K}_2\text{CO}_3 + \text{MgO}$
- 14.
15. a. $\text{Pb}(\text{NO}_3)_2 + 2\text{KBr} \rightarrow \text{PbBr}_2(\text{s}) + 2\text{KNO}_3$
b. No reaction occurs.
- 16.
17. a. $2\text{K}_3\text{PO}_4 + 3\text{SrCl}_2 \rightarrow \text{Sr}_3(\text{PO}_4)_2(\text{s}) + 6\text{KCl}$



10.7 - 10.9: RedOx Reactions

1. Is the reaction $2\text{K}(\text{s}) + \text{Br}_2(\text{l}) \rightarrow 2\text{KBr}(\text{s})$

an oxidation-reduction reaction? Explain your answer.

2. Is the reaction $\text{NaCl}(\text{aq}) + \text{AgNO}_3(\text{aq}) \rightarrow \text{NaNO}_3(\text{aq}) + \text{AgCl}(\text{s})$

an oxidation-reduction reaction? Explain your answer.

3. In the reaction $2\text{Ca}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{CaO}$

indicate what has lost electrons and what has gained electrons.

4. In the reaction $16\text{Fe}(\text{s}) + 3\text{Sg}(\text{s}) \rightarrow 8\text{Fe}_2\text{S}_3(\text{s})$

indicate what has lost electrons and what has gained electrons.

5. In the reaction $4\text{Li}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{Li}_2\text{O}(\text{s})$

indicate what has been oxidized and what has been reduced.

6. In the reaction $2\text{Ni}(\text{s}) + 3\text{I}_2(\text{s}) \rightarrow 2\text{NiI}_3(\text{s})$

indicate what has been oxidized and what has been reduced.

7. What are two different definitions of oxidation?

8. What are two different definitions of reduction?

9. Assign oxidation numbers to each atom in each substance.

- P_4
- SO_2
- SO_2^{2-}
- $\text{Ca}(\text{NO}_3)_2$

10. Assign oxidation numbers to each atom in each substance.

- PF_5
- $(\text{NH}_4)_2\text{S}$
- Hg
- Li_2O_2 (lithium peroxide)

11. Assign oxidation numbers to each atom in each substance.

- CO
- CO_2
- NiCl_2
- NiCl_3

12. Assign oxidation numbers to each atom in each substance.

- NaH (sodium hydride)
- NO_2
- NO_2^-
- AgNO_3

13. Assign oxidation numbers to each atom in each substance.

- CH_2O
- NH_3
- Rb_2SO_4
- $\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2$

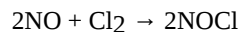
14. Assign oxidation numbers to each atom in each substance.

- C_6H_6
- $\text{B}(\text{OH})_3$

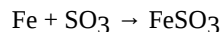
c. Li_2S

d. Au

15. Identify what is being oxidized and reduced in this redox equation by assigning oxidation numbers to the atoms. (In NOCl , assign oxygen's oxidation number first, then chlorine, then solve for nitrogen.)



16. Identify what is being oxidized and reduced in this redox equation by assigning oxidation numbers to the atoms.

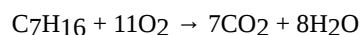


17. Identify what is being oxidized and reduced in this redox equation by assigning oxidation numbers to the atoms. $2\text{KrF}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{Kr} + 4\text{HF} + \text{O}_2$

18. Identify what is being oxidized and reduced in this redox equation by assigning oxidation numbers to the atoms. $\text{SO}_3 + \text{SCl}_2 \rightarrow \text{SOCl}_2 + \text{SO}_2$

19. Identify what is being oxidized and reduced in this redox equation by assigning oxidation numbers to the atoms. $2\text{K} + \text{MgCl}_2 \rightarrow 2\text{KCl} + \text{Mg}$

20. Identify what is being oxidized and reduced in this redox equation by assigning oxidation numbers to the atoms.



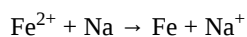
Answers

1. Yes; both K and Br are changing oxidation numbers.
- 2.
3. Ca has lost electrons, and O has gained electrons.
- 4.
5. Li has been oxidized, and O has been reduced.
- 6.
7. loss of electrons; increase in oxidation number
- 8.
9. a. P: 0
b. S: +4; O: -2
c. S: +2; O: -2
d. Ca: 2+; N: +5; O: -2
- 10.
11. a. C: +2; O: -2
b. C: +4; O: -2
c. Ni: +2; Cl: -1
d. Ni: +3; Cl: -1
- 12.
13. a. C: 0; H: +1; O: -2
b. N: -3; H: +1
c. Rb: +1; S: +6; O: -2
d. Zn: +2; C: 0; H: +1; O: -2
- 14.
15. N is being oxidized, and Cl is being reduced.
- 16.
17. O is being oxidized, and Kr is being reduced.
- 18.
19. K is being oxidized, and Mg is being reduced.

Additional Exercises

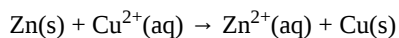
1. What is the difference between a combination reaction and a redox reaction? Are all combination reactions also redox reactions? Are all redox reactions also combination reactions?

2. Are combustion reactions always redox reactions as well? Explain.
3. A friend argues that the equation



is balanced because each side has one iron atom and one sodium atom. Explain why your friend is incorrect.

4. Historically, the first true battery was the Leclanché cell, named after its discoverer, Georges Leclanché. It was based on the following reaction:



Identify what is being oxidized, what is being reduced, and the respective reducing and oxidizing agents.

Answers

1. A combination reaction makes a new substance from more than one reactant; a redox reaction rearranges electrons. Not all combination reactions are redox reactions, and not all redox reactions are combination reactions.
3. Your friend is incorrect because the number of electrons transferring is not balanced.

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