

## 7.11: Exercises

### 7.3: Chemical Equations

1. From the statement “nitrogen and hydrogen react to produce ammonia,” identify the reactants and the products.

**Answer**

reactants = nitrogen ( $\text{N}_2$ ) and hydrogen ( $\text{H}_2$ ); products = ammonia ( $\text{NH}_3$ )

2. From the statement “sodium metal reacts with water to produce sodium hydroxide and hydrogen,” identify the reactants and the products.

**Answer**

reactants = sodium ( $\text{Na}$ ) and water ( $\text{H}_2\text{O}$ ); products = sodium hydroxide ( $\text{NaOH}$ ) and hydrogen ( $\text{H}_2$ )

3. From the statement “magnesium hydroxide reacts with nitric acid to produce magnesium nitrate and water,” identify the reactants and the products.

**Answer**

reactants = magnesium hydroxide ( $\text{Mg}(\text{OH})_2$ ) and nitric acid ( $\text{HNO}_3$ ); products = magnesium nitrate ( $\text{Mg}(\text{NO}_3)_2$ ) and water ( $\text{H}_2\text{O}$ )

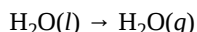
4. From the statement “propane reacts with oxygen to produce carbon dioxide and water,” identify the reactants and the products.

**Answer**

reactants = propane ( $\text{C}_3\text{H}_8$ ) and oxygen ( $\text{O}_2$ ); products = carbon dioxide ( $\text{CO}_2$ ) and water ( $\text{H}_2\text{O}$ )

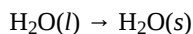
5. Chemical equations can also be used to represent physical processes. Write a chemical equation for the boiling of water, including the proper phase labels.

**Answer**



6. Chemical equations can also be used to represent physical processes. Write a chemical equation for the freezing of water, including the proper phase labels.

**Answer**



### 7.4: Balancing Chemical Equations

7. What does it mean to say an equation is balanced? Why is it important for an equation to be balanced?

**Answer**

An equation is balanced when the same number of each element is represented on the reactant and product sides. Equations must be balanced to accurately reflect the law of conservation of matter.

8. Explain why  $4 \text{Na(s)} + 2 \text{Cl}_2\text{(g)} \rightarrow 4 \text{NaCl(s)}$  should not be considered a proper chemical equation.

**Answer**

It does not have the lowest possible whole number coefficients.

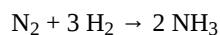
9. Explain why  $\text{H}_2\text{(g)} + \frac{1}{2} \text{O}_2\text{(g)} \rightarrow \text{H}_2\text{O(l)}$  should not be considered a proper chemical equation.

**Answer**

It has a fractional coefficient.

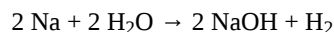
10. Write and balance the chemical equation described by [Exercise 1](#).

**Answer**



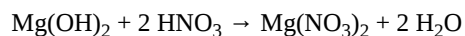
11. Write and balance the chemical equation described by [Exercise 2](#).

**Answer**



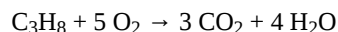
12. Write and balance the chemical equation described by [Exercise 3](#).

**Answer**



13. Write and balance the chemical equation described by [Exercise 4](#). The formula for propane is  $\text{C}_3\text{H}_8$ .

**Answer**



14. Balance the following equations:

- a.  $\text{NaClO}_3 \rightarrow \text{NaCl} + \text{O}_2$
- b.  $\text{N}_2 + \text{H}_2 \rightarrow \text{N}_2\text{H}_4$
- c.  $\text{Al} + \text{O}_2 \rightarrow \text{Al}_2\text{O}_3$
- d.  $\text{C}_2\text{H}_4 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2$

**Answer**

- a.  $2 \text{NaClO}_3 \rightarrow 2 \text{NaCl} + 3 \text{O}_2$
- b.  $\text{N}_2 + 2 \text{H}_2 \rightarrow \text{N}_2\text{H}_4$
- c.  $4 \text{Al} + 3 \text{O}_2 \rightarrow 2 \text{Al}_2\text{O}_3$
- d.  $\text{C}_2\text{H}_4 + 2 \text{O}_2 \rightarrow 2 \text{CO}_2 + 2 \text{H}_2$

15. Balance the following equations:

- a.  $\text{PCl}_5(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{POCl}_3(\text{l}) + \text{HCl}(\text{aq})$
- b.  $\text{Cu}(\text{s}) + \text{HNO}_3(\text{aq}) \rightarrow \text{Cu}(\text{NO}_3)_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{NO}(\text{g})$
- c.  $\text{H}_2(\text{g}) + \text{I}_2(\text{s}) \rightarrow \text{HI}(\text{s})$
- d.  $\text{Fe}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{Fe}_2\text{O}_3(\text{s})$
- e.  $\text{Na}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{NaOH}(\text{aq}) + \text{H}_2(\text{g})$
- f.  $(\text{NH}_4)_2\text{Cr}_2\text{O}_7(\text{s}) \rightarrow \text{Cr}_2\text{O}_3(\text{s}) + \text{N}_2(\text{g}) + \text{H}_2\text{O}(\text{g})$
- g.  $\text{P}_4(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow \text{PCl}_3(\text{l})$
- h.  $\text{PtCl}_4(\text{s}) \rightarrow \text{Pt}(\text{s}) + \text{Cl}_2(\text{g})$

#### Answer

- a.  $\text{PCl}_5(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{POCl}_3(\text{l}) + 2 \text{HCl}(\text{aq})$
- b.  $3 \text{Cu}(\text{s}) + 8 \text{HNO}_3(\text{aq}) \rightarrow 3 \text{Cu}(\text{NO}_3)_2(\text{aq}) + 4 \text{H}_2\text{O}(\text{l}) + 2 \text{NO}(\text{g})$
- c.  $\text{H}_2(\text{g}) + \text{I}_2(\text{s}) \rightarrow 2 \text{HI}(\text{s})$
- d.  $4 \text{Fe}(\text{s}) + 3 \text{O}_2(\text{g}) \rightarrow 2 \text{Fe}_2\text{O}_3(\text{s})$
- e.  $2 \text{Na}(\text{s}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{NaOH}(\text{aq}) + \text{H}_2(\text{g})$
- f.  $(\text{NH}_4)_2\text{Cr}_2\text{O}_7(\text{s}) \rightarrow \text{Cr}_2\text{O}_3(\text{s}) + \text{N}_2(\text{g}) + 4 \text{H}_2\text{O}(\text{g})$
- g.  $\text{P}_4(\text{s}) + 6 \text{Cl}_2(\text{g}) \rightarrow 4 \text{PCl}_3(\text{l})$
- h.  $\text{PtCl}_4(\text{s}) \rightarrow \text{Pt}(\text{s}) + 2 \text{Cl}_2(\text{g})$

#### 16. Balance the following equations:

- a.  $\text{Ag}(\text{s}) + \text{O}_2(\text{g}) + \text{H}_2\text{S}(\text{g}) \rightarrow \text{Ag}_2\text{S}(\text{s}) + \text{H}_2\text{O}(\text{l})$
- b.  $\text{P}_4(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{P}_4\text{O}_{10}(\text{s})$
- c.  $\text{Pb}(\text{s}) + \text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g}) \rightarrow \text{Pb}(\text{OH})_2(\text{s})$
- d.  $\text{Fe}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Fe}_3\text{O}_4(\text{s}) + \text{H}_2(\text{g})$
- e.  $\text{Sc}_2\text{O}_3(\text{s}) + \text{SO}_3(\text{l}) \rightarrow \text{Sc}_2(\text{SO}_4)_3(\text{s})$
- f.  $\text{Ca}_3(\text{PO}_4)_2(\text{s}) + \text{H}_3\text{PO}_4(\text{aq}) \rightarrow \text{Ca}(\text{H}_2\text{PO}_4)_2(\text{aq})$
- g.  $\text{Al}(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Al}_2(\text{SO}_4)_3(\text{s}) + \text{H}_2(\text{g})$
- h.  $\text{TiCl}_4(\text{s}) + \text{H}_2\text{O}(\text{g}) \rightarrow \text{TiO}_2(\text{s}) + \text{HCl}(\text{g})$

#### Answer

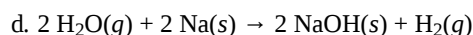
- a.  $4 \text{Ag}(\text{s}) + \text{O}_2(\text{g}) + 2 \text{H}_2\text{S}(\text{g}) \rightarrow 2 \text{Ag}_2\text{S}(\text{s}) + 2 \text{H}_2\text{O}(\text{l})$
- b.  $\text{P}_4(\text{s}) + 5 \text{O}_2(\text{g}) \rightarrow \text{P}_4\text{O}_{10}(\text{s})$
- c.  $2 \text{Pb}(\text{s}) + 2 \text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g}) \rightarrow 2 \text{Pb}(\text{OH})_2(\text{s})$
- d.  $3 \text{Fe}(\text{s}) + 4 \text{H}_2\text{O}(\text{l}) \rightarrow \text{Fe}_3\text{O}_4(\text{s}) + 4 \text{H}_2(\text{g})$
- e.  $\text{Sc}_2\text{O}_3(\text{s}) + 3 \text{SO}_3(\text{l}) \rightarrow \text{Sc}_2(\text{SO}_4)_3(\text{s})$
- f.  $\text{Ca}_3(\text{PO}_4)_2(\text{s}) + 4 \text{H}_3\text{PO}_4(\text{aq}) \rightarrow 3 \text{Ca}(\text{H}_2\text{PO}_4)_2(\text{aq})$
- g.  $2 \text{Al}(\text{s}) + 3 \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Al}_2(\text{SO}_4)_3(\text{s}) + 3 \text{H}_2(\text{g})$
- h.  $\text{TiCl}_4(\text{s}) + 2 \text{H}_2\text{O}(\text{g}) \rightarrow \text{TiO}_2(\text{s}) + 4 \text{HCl}(\text{g})$

#### 17. Write a balanced molecular equation describing each of the following chemical reactions.

- a. Solid calcium carbonate is heated and decomposes to solid calcium oxide and carbon dioxide gas.
- b. Gaseous butane,  $\text{C}_4\text{H}_{10}$ , reacts with diatomic oxygen gas to yield gaseous carbon dioxide and water vapor.
- c. Aqueous solutions of magnesium chloride and sodium hydroxide react to produce solid magnesium hydroxide and aqueous sodium chloride.
- d. Water vapor reacts with sodium metal to produce solid sodium hydroxide and hydrogen gas.

#### Answer

- a.  $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
- b.  $2 \text{C}_4\text{H}_{10}(\text{g}) + 13 \text{O}_2(\text{g}) \rightarrow 8 \text{CO}_2(\text{g}) + 10 \text{H}_2\text{O}(\text{g})$
- c.  $\text{MgCl}_2(\text{aq}) + 2 \text{NaOH}(\text{aq}) \rightarrow \text{Mg}(\text{OH})_2(\text{s}) + 2 \text{NaCl}(\text{aq})$



18. Write a balanced equation describing each of the following chemical reactions.

- Solid potassium chlorate,  $\text{KClO}_3$ , decomposes to form solid potassium chloride and diatomic oxygen gas.
- Solid aluminum metal reacts with solid diatomic iodine to form solid  $\text{Al}_2\text{I}_6$ .
- When solid sodium chloride is added to aqueous sulfuric acid, hydrogen chloride gas and aqueous sodium sulfate are produced.
- Aqueous solutions of phosphoric acid and potassium hydroxide react to produce aqueous potassium dihydrogen phosphate ( $\text{H}_2\text{PO}_4^-$ ) and liquid water.

**Answer**

- $2 \text{KClO}_3(s) \rightarrow 2 \text{KCl}(s) + 3 \text{O}_2(g)$
- $2 \text{Al}(s) + 3 \text{I}_2(s) \rightarrow \text{Al}_2\text{I}_6(s)$
- $2 \text{NaCl}(s) + \text{H}_2\text{SO}_4(aq) \rightarrow 2 \text{HCl}(g) + \text{Na}_2\text{SO}_4(aq)$
- $\text{H}_3\text{PO}_4(aq) + \text{KOH}(aq) \rightarrow \text{KH}_2\text{PO}_4(aq) + \text{H}_2\text{O}(l)$

19. Colorful fireworks often involve the decomposition of barium nitrate and potassium chlorate and the reaction of the metals magnesium, aluminum, and iron with oxygen.

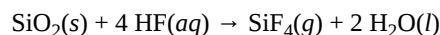
- Write the formulas of barium nitrate and potassium chlorate.
- The decomposition of solid potassium chlorate leads to the formation of solid potassium chloride and diatomic oxygen gas. Write an equation for the reaction.
- The decomposition of solid barium nitrate leads to the formation of solid barium oxide, diatomic nitrogen gas, and diatomic oxygen gas. Write an equation for the reaction.
- Write separate equations for the reactions of the solid metals magnesium, aluminum, and iron with diatomic oxygen gas to yield the corresponding metal oxides. (Assume the iron oxide contains  $\text{Fe}^{3+}$  ions.)

**Answer**

- $\text{Ba}(\text{NO}_3)_2$ ;  $\text{KClO}_3$
- $2 \text{KClO}_3(s) \rightarrow 2 \text{KCl}(s) + 3 \text{O}_2(g)$
- $2 \text{Ba}(\text{NO}_3)_2(s) \rightarrow 2 \text{BaO}(s) + 2 \text{N}_2(g) + 5 \text{O}_2(g)$
- $2 \text{Mg}(s) + \text{O}_2(g) \rightarrow 2 \text{MgO}(s)$ ;  $4 \text{Al}(s) + 3 \text{O}_2(g) \rightarrow 2 \text{Al}_2\text{O}_3(s)$ ;  $4 \text{Fe}(s) + 3 \text{O}_2(g) \rightarrow 2 \text{Fe}_2\text{O}_3(s)$

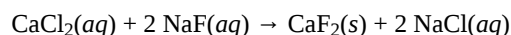
20. Aqueous hydrogen fluoride (hydrofluoric acid) is used to etch glass and to analyze minerals for their silicon content. Hydrogen fluoride will also react with sand (silicon dioxide). Write a balanced equation for the reaction of solid silicon dioxide with hydrofluoric acid to yield gaseous silicon tetrafluoride and liquid water.

**Answer**



21. The mineral fluorite (calcium fluoride) occurs extensively in Illinois. Solid calcium fluoride can also be prepared by the reaction of aqueous solutions of calcium chloride and sodium fluoride, yielding aqueous sodium chloride as the other product. Write a balanced equation for this reaction.

**Answer**



22. A novel process for obtaining magnesium from sea water involves several reactions. Write a balanced chemical equation for each step of the process.
- The first step is the decomposition of solid calcium carbonate from seashells to form solid calcium oxide and gaseous carbon dioxide.
  - The second step is the formation of solid calcium hydroxide as the only product from the reaction of the solid calcium oxide with liquid water.
  - Solid calcium hydroxide is then added to the seawater, reacting with dissolved magnesium chloride to yield solid magnesium hydroxide and aqueous calcium chloride.
  - The solid magnesium hydroxide is added to a hydrochloric acid solution, producing dissolved magnesium chloride and liquid water.
  - Finally, the magnesium chloride is melted and electrolyzed to yield liquid magnesium metal and diatomic chlorine gas.

**Answer**

- $\text{CaCO}_3(s) \rightarrow \text{CaO}(s) + \text{CO}_2(g)$
- $\text{CaO}(s) + \text{H}_2\text{O}(l) \rightarrow \text{Ca}(\text{OH})_2(s)$
- $\text{Ca}(\text{OH})_2(s) + \text{MgCl}_2(aq) \rightarrow \text{Mg}(\text{OH})_2(s) + \text{CaCl}_2(aq)$
- $\text{Mg}(\text{OH})_2(s) + 2 \text{HCl}(aq) \rightarrow \text{MgCl}_2(aq) + 2 \text{H}_2\text{O}(l)$
- $\text{MgCl}_2(l) \rightarrow \text{Mg}(l) + \text{Cl}_2(g)$

### 7.5: Classifying Chemical Reactions

23. What are the general characteristics that help you recognize single-replacement reactions?

**Answer**

The reactants have an element and a compound which combine to form a new element and a new compound.

24. What are the general characteristics that help you recognize double-replacement reactions?

**Answer**

Two compounds (typically ionic) switch partners to form two new compounds.

25. Classify each of the following reactions as synthesis, decomposition, combustion, single-replacement, or double-replacement.

- $\text{NaCl} + \text{AgNO}_3 \rightarrow \text{AgCl} + \text{NaNO}_3$
- $\text{CaO} + \text{CO}_2 \rightarrow \text{CaCO}_3$
- $2 \text{HBr} + \text{Cl}_2 \rightarrow 2 \text{HCl} + \text{Br}_2$
- $\text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 \rightarrow 6 \text{CO}_2 + 6 \text{H}_2\text{O}$
- $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$

**Answer**

- double-replacement
- synthesis
- single-replacement
- combustion
- decomposition

26. Classify each of the following reactions as synthesis, decomposition, combustion, single-replacement, or double-replacement.

- $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
- $\text{C}_5\text{H}_{12} + 8 \text{O}_2 \rightarrow 5 \text{CO}_2 + 6 \text{H}_2\text{O}$

- c.  $\text{CH}_4 + 2 \text{F}_2 \rightarrow \text{CF}_4 + 2 \text{H}_2$
- d.  $\text{Na}_2\text{O} + \text{CO}_2 \rightarrow \text{Na}_2\text{CO}_3$
- e.  $\text{H}_2\text{SO}_3 \rightarrow \text{H}_2\text{O} + \text{SO}_2$

**Answer**

- a. double-replacement
- b. combustion
- c. single-replacement
- d. synthesis
- e. decomposition

27. Classify each of the following reactions as synthesis, decomposition, combustion, single-replacement, or double-replacement.

- a.  $\text{H}_2 + \text{Cl}_2 \rightarrow 2 \text{HCl}$
- b.  $\text{Na}_2\text{CO}_3 \rightarrow \text{Na}_2\text{O} + \text{CO}_2$
- c.  $\text{Pb}(\text{NO}_3)_2 + \text{H}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + 2 \text{HNO}_3$
- d.  $2 \text{HCl} + \text{Zn} \rightarrow \text{ZnCl}_2 + \text{H}_2$
- e.  $\text{C}_2\text{H}_4 + \text{O}_2 \rightarrow \text{C}_2\text{H}_4\text{O}_2$

**Answer**

- a. synthesis
- b. decomposition
- c. double-replacement
- d. single-replacement
- e. synthesis

28. Classify each of the following reactions as synthesis, decomposition, combustion, single-replacement, or double-replacement.

- a.  $\text{Ca} + \text{Br}_2 \rightarrow \text{CaBr}_2$
- b.  $\text{C}_6\text{H}_{12} + 9 \text{O}_2 \rightarrow 6 \text{CO}_2 + 6 \text{H}_2\text{O}$
- c.  $\text{H}_2\text{O} + \text{C} \rightarrow \text{CO} + \text{H}_2$
- d.  $2 \text{KClO}_3 \rightarrow 2 \text{KCl} + 3 \text{O}_2$
- e.  $\text{Al}(\text{OH})_3 + 3 \text{HBr} \rightarrow \text{AlBr}_3 + 3 \text{H}_2\text{O}$

**Answer**

- a. synthesis
- b. combustion
- c. single-replacement
- d. decomposition
- e. double-replacement

29. Use the following equations to answer the next three questions:

- i.  $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l})$
- ii.  $2 \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{H}_2(\text{g}) + \text{O}_2(\text{g})$
- iii.  $\text{CH}_3\text{OH}(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{g})$

- a. Which equation describes a physical change?
- b. Which equation identifies the reactants and products of a combustion reaction?
- c. Which equation is not balanced?

**Answer**

- a. equation i

- b. equation iii
- c. equation iii

### 7.6: Combustion Reactions

30. Complete and balance each combustion equation.

- a.  $\text{C}_4\text{H}_9\text{OH} + \text{O}_2 \rightarrow ?$
- b.  $\text{CH}_3\text{SH} + \text{O}_2 \rightarrow ?$

#### Answer

- 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.  $\text{CH}_3\text{SH} + 3 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O} + \text{SO}_2$

### 7.7: Solubility Rules for Ionic Compounds

31. Classify each of the following compounds as soluble or insoluble in water.

- a. AgBr
- b.  $\text{Na}_3\text{PO}_4$
- c.  $\text{CaC}_2\text{O}_4$
- d.  $\text{K}_2\text{SO}_4$

#### Answer

- a. insoluble
- b. soluble
- c. insoluble
- d. soluble

32. Classify each of the following compounds as soluble or insoluble in water.

- a.  $\text{Pb}(\text{OH})_2$
- b. SrS
- c.  $\text{AgC}_2\text{H}_3\text{O}_2$
- d.  $\text{Fe}(\text{NO}_3)_2$

#### Answer

- a. insoluble
- b. soluble
- c. soluble
- d. soluble

33. Classify each of the following compounds as soluble or insoluble in water.

- a.  $\text{BaSO}_4$
- b.  $\text{Li}_2\text{CO}_3$
- c. NaOH
- d.  $\text{Hg}_2\text{I}_2$

#### Answer

- a. insoluble
- b. soluble
- c. soluble

d. insoluble

### 7.8: Precipitation Reactions

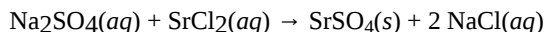
34. Explain what is wrong with this double-replacement reaction:  $\text{NaCl}(aq) + \text{KBr}(aq) \rightarrow \text{NaK}(aq) + \text{ClBr}(aq)$

#### Answer

The cations are combined in one product and the anions are combined in the other. The products each need to have one cation and one anion.

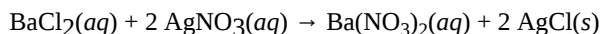
35. Predict the products of and balance this double-replacement reaction:  $\text{Na}_2\text{SO}_4(aq) + \text{SrCl}_2(aq) \rightarrow ?$

#### Answer



36. Predict the products of and balance this double-replacement reaction:  $\text{BaCl}_2(aq) + \text{AgNO}_3(aq) \rightarrow ?$

#### Answer



37. For each of the following reactions, predict the products and write the balanced chemical equation. If no reaction occurs, write "no reaction."

- $\text{Zn}(\text{NO}_3)_2(aq) + \text{NaOH}(aq) \rightarrow ?$
- $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2(aq) + \text{HNO}_3(aq) \rightarrow ?$
- $\text{Na}_2\text{CO}_3(aq) + \text{Sr}(\text{NO}_3)_2(aq) \rightarrow ?$
- $\text{Pb}(\text{NO}_3)_2(aq) + \text{KBr}(aq) \rightarrow ?$

#### Answer

- $\text{Zn}(\text{NO}_3)_2(aq) + 2 \text{NaOH}(aq) \rightarrow \text{Zn}(\text{OH})_2(s) + 2 \text{NaNO}_3(aq)$
- no reaction
- $\text{Na}_2\text{CO}_3(aq) + \text{Sr}(\text{NO}_3)_2(aq) \rightarrow 2 \text{NaNO}_3(aq) + \text{SrCO}_3(s)$
- $\text{Pb}(\text{NO}_3)_2(aq) + 2 \text{KBr}(aq) \rightarrow \text{PbBr}_2(s) + 2 \text{KNO}_3(aq)$

38. For each of the following reactions, predict the products and write the balanced chemical equation. If no reaction occurs, write "no reaction."

- $\text{AgClO}_3(aq) + \text{KI}(aq) \rightarrow ?$
- $\text{K}_2\text{O}(aq) + \text{Na}_2\text{CO}_3(aq) \rightarrow ?$
- $\text{Na}_2\text{CO}_3(aq) + \text{Sr}(\text{NO}_3)_2(aq) \rightarrow ?$
- $(\text{NH}_4)_2\text{SO}_4(aq) + \text{Ba}(\text{NO}_3)_2(aq) \rightarrow ?$

#### Answer

- $\text{AgClO}_3(aq) + \text{KI}(aq) \rightarrow \text{AgI}(s) + \text{KClO}_3(aq)$
- no reaction
- $\text{Na}_2\text{CO}_3(aq) + \text{Sr}(\text{NO}_3)_2(aq) \rightarrow 2 \text{NaNO}_3(aq) + \text{SrCO}_3(s)$
- $(\text{NH}_4)_2\text{SO}_4(aq) + \text{Ba}(\text{NO}_3)_2(aq) \rightarrow 2 \text{NH}_4\text{NO}_3(aq) + \text{BaSO}_4(s)$



39. For each of the following reactions, predict the products and write the balanced chemical equation. If no reaction occurs, write "no reaction."

- $\text{K}_3\text{PO}_4(\text{aq}) + \text{SrCl}_2(\text{aq}) \rightarrow ?$
- $\text{NaOH}(\text{aq}) + \text{MgCl}_2(\text{aq}) \rightarrow ?$
- $\text{KC}_2\text{H}_3\text{O}_2(\text{aq}) + \text{Li}_2\text{CO}_3(\text{aq}) \rightarrow ?$
- $\text{KOH}(\text{aq}) + \text{AgNO}_3(\text{aq}) \rightarrow ?$

**Answer**

- $2 \text{K}_3\text{PO}_4(\text{aq}) + 3 \text{SrCl}_2(\text{aq}) \rightarrow 6 \text{KCl}(\text{aq}) + \text{Sr}_3(\text{PO}_4)_2(\text{s})$
- $2 \text{NaOH}(\text{aq}) + \text{MgCl}_2(\text{aq}) \rightarrow 2 \text{NaCl}(\text{aq}) + \text{Mg}(\text{OH})_2(\text{s})$
- no reaction
- $\text{KOH}(\text{aq}) + \text{AgNO}_3(\text{aq}) \rightarrow \text{KNO}_3(\text{aq}) + \text{AgOH}(\text{s})$

40. For each of the following reactions, predict the products and write the balanced chemical equation. If no reaction occurs, write "no reaction."

- $\text{FeCl}_2(\text{aq}) + \text{AgNO}_3(\text{aq}) \rightarrow ?$
- $\text{BaCl}_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq}) \rightarrow ?$
- $\text{KCl}(\text{aq}) + \text{NaC}_2\text{H}_3\text{O}_2(\text{aq}) \rightarrow ?$
- $\text{Fe}_2(\text{SO}_4)_3(\text{aq}) + \text{Sr}(\text{NO}_3)_2(\text{aq}) \rightarrow ?$

**Answer**

- $\text{FeCl}_2(\text{aq}) + 2 \text{AgNO}_3(\text{aq}) \rightarrow \text{Fe}(\text{NO}_3)_2(\text{aq}) + 2 \text{AgCl}(\text{s})$
- $\text{BaCl}_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq}) \rightarrow \text{BaSO}_4(\text{s}) + 2 \text{NaCl}(\text{aq})$
- no reaction
- $\text{Fe}_2(\text{SO}_4)_3(\text{aq}) + 3 \text{Sr}(\text{NO}_3)_2(\text{aq}) \rightarrow 2 \text{Fe}(\text{NO}_3)_3(\text{aq}) + 3 \text{SrSO}_4(\text{s})$

### 7.9: Acid-Base and Gas Evolution Reactions

41. Write balanced chemical equations for the following neutralization reactions.

- HCl and KOH
- $\text{H}_2\text{SO}_4$  and KOH
- $\text{H}_3\text{PO}_4$  and  $\text{Ni}(\text{OH})_2$

**Answer**

- $\text{HCl} + \text{KOH} \rightarrow \text{KCl} + \text{H}_2\text{O}$
- $\text{H}_2\text{SO}_4 + 2 \text{KOH} \rightarrow \text{K}_2\text{SO}_4 + 2 \text{H}_2\text{O}$
- $2 \text{H}_3\text{PO}_4 + 3 \text{Ni}(\text{OH})_2 \rightarrow \text{Ni}_3(\text{PO}_4)_2 + 6 \text{H}_2\text{O}$

42. Write balanced chemical equations for the following neutralization reactions.

- HBr and  $\text{Fe}(\text{OH})_3$
- $\text{HNO}_2$  and  $\text{Al}(\text{OH})_3$
- $\text{HClO}_3$  and  $\text{Mg}(\text{OH})_2$

**Answer**

- $3 \text{HBr} + \text{Fe}(\text{OH})_3 \rightarrow \text{FeBr}_3 + 3 \text{H}_2\text{O}$
- $3 \text{HNO}_2 + \text{Al}(\text{OH})_3 \rightarrow \text{Al}(\text{NO}_2)_3 + 3 \text{H}_2\text{O}$
- $2 \text{HClO}_3 + \text{Mg}(\text{OH})_2 \rightarrow \text{Mg}(\text{ClO}_3)_2 + 2 \text{H}_2\text{O}$

43. Write a balanced chemical equation for the neutralization reaction between each given acid and base. Include the proper phase labels.

- a.  $\text{HI}(aq) + \text{KOH}(aq) \rightarrow ?$
- b.  $\text{H}_2\text{SO}_4(aq) + \text{Ba}(\text{OH})_2(aq) \rightarrow ?$

**Answer**

- a.  $\text{HI}(aq) + \text{KOH}(aq) \rightarrow \text{KI}(aq) + \text{H}_2\text{O}(l)$
- b.  $\text{H}_2\text{SO}_4(aq) + \text{Ba}(\text{OH})_2(aq) \rightarrow \text{BaSO}_4(s) + 2 \text{H}_2\text{O}(l)$

44. Write a balanced chemical equation for the neutralization reaction between each given acid and base. Include the proper phase labels.

- a.  $\text{HNO}_3(aq) + \text{Fe}(\text{OH})_3(s) \rightarrow ?$
- b.  $\text{H}_3\text{PO}_4(aq) + \text{LiOH}(aq) \rightarrow ?$

**Answer**

- a.  $3 \text{HNO}_3(aq) + \text{Fe}(\text{OH})_3(s) \rightarrow \text{Fe}(\text{NO}_3)_3(aq) + 3 \text{H}_2\text{O}(l)$
- b.  $\text{H}_3\text{PO}_4(aq) + 3 \text{LiOH}(aq) \rightarrow \text{Li}_3\text{PO}_4(aq) + 3 \text{H}_2\text{O}(l)$

45. Write a balanced chemical equation for the neutralization reaction between each given acid and base. Include the proper phase labels.

- a.  $\text{HClO}_3(aq) + \text{Zn}(\text{OH})_2(s) \rightarrow ?$
- b.  $\text{H}_2\text{C}_2\text{O}_4(s) + \text{Sr}(\text{OH})_2(aq) \rightarrow ?$

**Answer**

- a.  $2 \text{HClO}_3(aq) + \text{Zn}(\text{OH})_2(s) \rightarrow \text{Zn}(\text{ClO}_3)_2(aq) + 2 \text{H}_2\text{O}(l)$
- b.  $\text{H}_2\text{C}_2\text{O}_4(s) + \text{Sr}(\text{OH})_2(aq) \rightarrow \text{SrC}_2\text{O}_4(s) + 2 \text{H}_2\text{O}(l)$

46. Write a balanced chemical equation for the following acid-base equations:

- a. HCl gas reacts with solid  $\text{Ca}(\text{OH})_2(s)$ .
- b. A solution of  $\text{Sr}(\text{OH})_2$  is added to a solution of  $\text{HNO}_3$ .
- c. A solution of  $\text{HClO}_4$  is added to a solution of  $\text{LiOH}$ .
- d. Aqueous  $\text{H}_2\text{SO}_4$  reacts with  $\text{NaOH}$ .
- e.  $\text{Ba}(\text{OH})_2$  reacts with HF gas.

**Answer**

- a.  $2 \text{HCl}(g) + \text{Ca}(\text{OH})_2(s) \rightarrow \text{CaCl}_2(aq) + 2 \text{H}_2\text{O}(l)$
- b.  $\text{Sr}(\text{OH})_2(aq) + 2 \text{HNO}_3(aq) \rightarrow \text{Sr}(\text{NO}_3)_2(aq) + 2 \text{H}_2\text{O}(l)$
- c.  $\text{HClO}_4(aq) + \text{LiOH}(aq) \rightarrow \text{LiClO}_4(aq) + \text{H}_2\text{O}(l)$
- d.  $\text{H}_2\text{SO}_4(aq) + 2 \text{NaOH}(aq) \rightarrow \text{Na}_2\text{SO}_4(aq) + 2 \text{H}_2\text{O}(l)$
- e.  $\text{Ba}(\text{OH})_2(aq) + 2 \text{HF}(g) \rightarrow \text{BaF}_2(aq) + 2 \text{H}_2\text{O}(l)$

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