

Section 3.2 Synthesis Reactions and Decomposition Reactions
Solutions for Selected Review Questions
Student Edition page 136

7. Review Question (page 136)

Predict whether each compound would form an acid or a base in a reaction with water.

- | | |
|------------------------|--------------------|
| a. dinitrogen trioxide | c. sulfur trioxide |
| b. lithium oxide | d. calcium oxide |

- | | |
|---------|---------|
| a. acid | c. acid |
| b. base | d. base |

15. Review Question (page 136)

If you wanted to generate lithium oxide, what are two decomposition reactions you could try?

Heat solid lithium carbonate: $\text{Li}_2\text{CO}_3(\text{s}) \rightarrow \text{Li}_2\text{O}(\text{s}) + \text{CO}_2(\text{g})$

Heat solid lithium hydroxide: $2\text{LiOH}(\text{s}) \rightarrow \text{Li}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\text{g})$

Section 3.3 Combustion Reactions
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41. Practice Problem (page 141)

Write the chemical equation for the complete combustion of heptane, $\text{C}_7\text{H}_{16}(\text{l})$.

What Is Required?

You need to write a balanced chemical equation for the complete combustion of heptane.

What Is Given?

You are given the reactant: heptane

You are given the type of reaction: complete combustion

Plan Your Strategy

Identify the reactants.

Identify the product.

Write the balanced equation.

Check to make sure that the ratio of the coefficients is the lowest possible ratio.

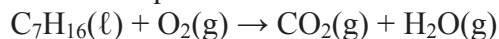
Check to make sure that the number of each kind of atom is the same in the reactants and products.

Act on Your Strategy

Reactants: heptane, $\text{C}_7\text{H}_{16}(\text{l})$, and oxygen, $\text{O}_2(\text{g})$

Products: carbon dioxide, $\text{CO}_2(\text{g})$, and water vapour, $\text{H}_2\text{O}(\text{g})$

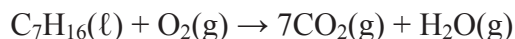
Skeleton equation:



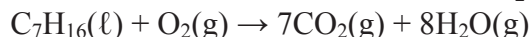
Reactants: 7 C, 16 H, 2 O

Products: 1 C, 2 H, 3 O

Insert the coefficient 7 in front of the $\text{CO}_2(\text{g})$ to balance the C:

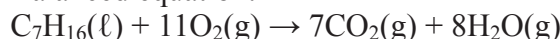


Insert the coefficient 8 in front of the $\text{H}_2\text{O}(\text{g})$ to balance the H:



Insert the coefficient 11 in front of the $\text{O}_2(\text{g})$ to balance the O.

Balanced equation:



The ratio of the coefficients is 1:11:7:8. This is the lowest possible ratio.

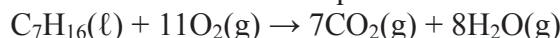
Reactants: 7 C, 16 H, 22 O

Products: 7 C, 16 H, 22 O

Check Your Solution

The products are correct for the complete combustion of a hydrocarbon. The chemical formula for each substance is written correctly. The number of atoms of each element is equal on both sides of the equation. The coefficients are written in the lowest possible ratio.

The balanced chemical equation for this reaction is:



42. Practice Problem (page 141)

Write the balanced equation for the complete combustion of nonane, $\text{C}_9\text{H}_{20}(\ell)$.

What Is Required?

You need to write a balanced chemical equation for the complete combustion of nonane.

What Is Given?

You are given the reactant: nonane

You are given the type of reaction: complete combustion

Plan Your Strategy

Identify the reactants.

Identify the products.

Write the balanced equation.

Check to make sure that the ratio of the coefficients is the lowest possible ratio.

Check to make sure that the number of each kind of atom is the same in the reactants and products.

Act on Your Strategy

Reactants: nonane, $\text{C}_9\text{H}_{20}(\ell)$, and oxygen, $\text{O}_2(\text{g})$

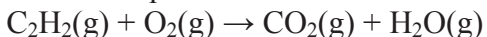
Products: carbon dioxide, $\text{CO}_2(\text{g})$, and water vapour, $\text{H}_2\text{O}(\text{g})$

Act on Your Strategy

Reactants: ethyne, $\text{C}_2\text{H}_2(\text{g})$, and oxygen, $\text{O}_2(\text{g})$

Products: carbon dioxide, $\text{CO}_2(\text{g})$, and water vapour, $\text{H}_2\text{O}(\text{g})$

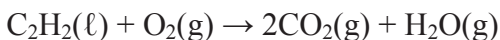
Skeleton equation:



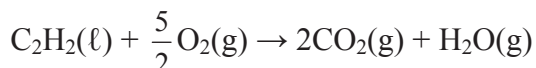
Reactants: 2 C, 2 H, 2 O

Products: 1 C, 2 H, 3 O

Insert the coefficient 2 in front of the $\text{CO}_2(\text{g})$ to balance the C:

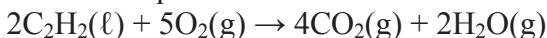


Insert the coefficient $\frac{5}{2}$ in front of the $\text{O}_2(\text{g})$ to balance the O:



Multiply each coefficient by 2 to clear the fraction.

Balanced equation:



The ratio of the coefficients is 2:5:4:2. This is the lowest possible ratio.

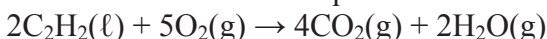
Reactants: 4 C, 4 H, 10 O

Products: 4 C, 4 H, 10 O

Check Your Solution

The products are correct for the complete combustion of a hydrocarbon. The chemical formula for each substance is written correctly. The number of atoms of each element is equal on both sides of the equation. The coefficients are written in the lowest possible ratio.

The balanced chemical equation for this reaction is:

**44. Practice Problem (page 141)**

Write the balanced equation for the complete combustion of benzene, $\text{C}_6\text{H}_6(\text{l})$.

What Is Required?

You need to write a balanced chemical equation for the complete combustion of benzene.

What Is Given?

You are given the reactant: benzene

You are given the type of reaction: complete combustion

Plan Your Strategy

Identify the reactants.

Identify the products.

Write the balanced equation.

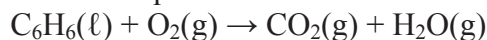
Check to make sure that the ratio of the coefficients is the lowest possible ratio.
Check to make sure that the number of each kind of atom is the same in the reactants and products.

Act on Your Strategy

Reactants: benzene, $\text{C}_6\text{H}_6(\ell)$, and oxygen, $\text{O}_2(\text{g})$

Products: carbon dioxide, $\text{CO}_2(\text{g})$, and water vapour, $\text{H}_2\text{O}(\text{g})$

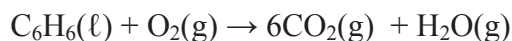
Skeleton equation:



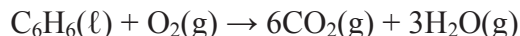
Reactants: 6 C, 6 H, 2 O

Products: 1 C, 2 H, 3 O

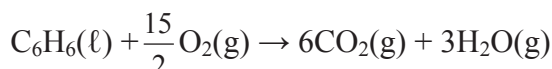
Insert the coefficient 6 in front of the $\text{CO}_2(\text{g})$ to balance the C:



Insert the coefficient 3 in front of the $\text{H}_2\text{O}(\text{g})$ to balance the H:

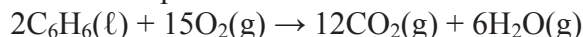


Insert the coefficient $\frac{15}{2}$ in front of the $\text{O}_2(\text{g})$ to balance the O:



Multiply each coefficient by 2 to clear the fraction.

Balanced equation:



The ratio of the coefficients is 2:15:12:6. This is the lowest possible ratio.

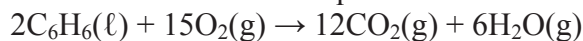
Reactants: 12 C, 12 H, 30 O

Products: 12 C, 12 H, 30 O

Check Your Solution

The products are correct for the complete combustion of a hydrocarbon. The chemical formula for each substance is written correctly. The number of atoms of each element is equal on both sides of the equation. The coefficients are written in the lowest possible ratio.

The balanced chemical equation for this reaction is:



45. Practice Problem (page 141)

Write the balanced equation for the complete combustion of octane, $\text{C}_8\text{H}_{18}(\ell)$.

What Is Required?

You need to write a balanced chemical equation for the complete combustion of octane.

What Is Given?

You are given the reactant: octane

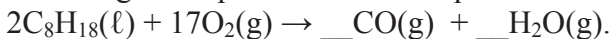
You are given the type of reaction: complete combustion

What Is Given?

You are given the reactant: octane

You are given the type of reaction: incomplete combustion

You are given a partial chemical equation:



You know the products: $\text{CO}(\text{g})$ and $\text{H}_2\text{O}(\text{g})$

Plan Your Strategy

Identify the information that is missing in the given partial chemical equation.

Begin balancing the equation from the known information in the partial equation.

Complete the balancing of the equation knowing what products could form.

Check to make sure that the ratio of the coefficients is the lowest possible ratio.

Check to make sure that the number of each kind of atom is the same in the reactants and products.

Act on Your Strategy

For the equation to balance, the coefficient in front of $\text{H}_2\text{O}(\text{g})$ must be 18. This leads to the conclusion that the second product must contain the remaining oxygen. The other product must contain $34 - 18 = 16$ oxygen atoms. The missing product is $16\text{CO}(\text{g})$. This balances the carbon atoms.

Balanced equation: $2\text{C}_8\text{H}_{18}(\ell) + 17\text{O}_2(\text{g}) \rightarrow 16\text{CO}(\text{g}) + 18\text{H}_2\text{O}(\text{g})$

The ratio of the coefficients is 2:17:16:18. This is the lowest possible ratio.

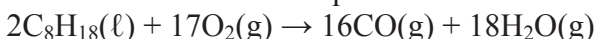
Reactants: 16 C, 36 H, 34 O

Products: 16 C, 36 H, 34 O

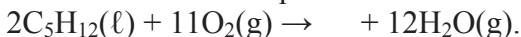
Check Your Solution

The chemical formula for each substance is written correctly. The number of atoms of each element is equal on both sides of the equation. The coefficients are written in the lowest possible ratio.

The balanced chemical equation for this reaction is:

**47. Practice Problem (page 141)**

Write the balanced equation for the incomplete combustion of pentane:

**What Is Required?**

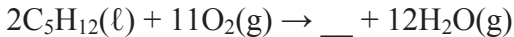
You need to write a balanced chemical equation for the incomplete combustion of pentane based upon the given partial equation.

What Is Given?

You are given the reactant: pentane

You are given the type of reaction: incomplete combustion

You are given a partial chemical equation:



You know the possible products are C(s) and CO(g).

Plan Your Strategy

Identify the information that is missing in the given partial chemical equation. Begin balancing the equation from the known information in the partial equation.

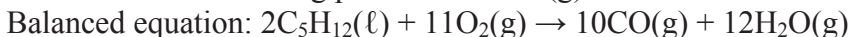
Complete the balancing of the equation.

Check to make sure that the ratio of the coefficients is the lowest possible ratio.

Check to make sure that the number of each kind of atom is the same in the reactants and products.

Act on Your Strategy

For the equation to balance, the unknown product must contain 10 C atoms and 10 O atoms. The missing product is 10CO(g).



The ratio of the coefficients is 2:11:10:12. This is the lowest possible ratio.

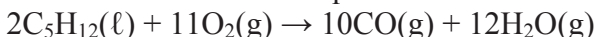
Reactants: 10 C, 24 H, 22 O

Products: 10 C, 24 H, 22 O

Check Your Solution

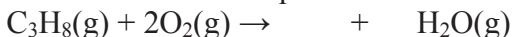
The chemical formula for each substance is written correctly. The number of atoms of each element is equal on both sides of the equation. The coefficients are written in the lowest possible ratio.

The balanced chemical equation for this reaction is:



48. Practice Problem (page 141)

Write the balanced equation for the incomplete combustion of propane:



What Is Required?

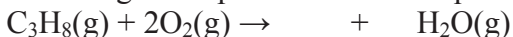
You need to write a balanced chemical equation for the incomplete combustion of propane based upon the given partial equation.

What Is Given?

You are given the reactant: propane

You are given the type of reaction: incomplete combustion

You are given a partial chemical equation:



You know the possible products: C(s) and CO(g)

Plan Your Strategy

Identify the information that is missing in the given partial chemical equation. Begin balancing the equation from the known information in the partial equation.

Identify the coefficient required in front of $\text{H}_2\text{O}(\text{g})$.

Complete the balancing of the equation.

Check to make sure that the ratio of the coefficients is the lowest possible ratio.

Check to make sure that the number of each kind of atom is the same in the reactants and products.

Act on Your Strategy

For the equation to balance, the product must contain 64 H atoms. The coefficient in front of H_2O is 32. This accounts for 32 O atoms in the products. There are 2×37 O atoms in the reactants. The remainder of the O atoms, $74 - 32 = 42$ O must be shared between CO_2 and CO .

Balanced equation: $4\text{C}_7\text{H}_{16}(\text{l}) + 37\text{O}_2(\text{g}) \rightarrow 14\text{CO}_2(\text{g}) + 14\text{CO}(\text{g}) + 32\text{H}_2\text{O}(\text{g})$

The ratio of the coefficients is 4:37:14:14:32. This is the lowest possible ratio.

Reactants: 28 C, 64 H, 74 O

Products: 28 C, 64 H, 74 O

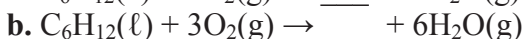
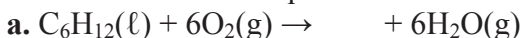
Check Your Solution

The chemical formula for each substance is written correctly. The number of atoms of each element is equal on both sides of the equation. The coefficients are written in the lowest possible ratio.

The balanced chemical equation for this reaction is:

**50. Practice Problem (page 141)**

Write two balanced equations for the incomplete combustion of cyclohexane:

**What Is Required?**

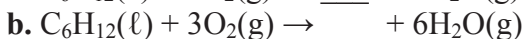
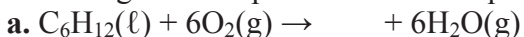
You need to write a balanced chemical equation for the incomplete combustion of cyclohexane based upon the given partial equations.

What Is Given?

You are given the reactant: cyclohexane

You are given the type of reaction: incomplete combustion

You are given two partial chemical equations:



You know the possible products: $\text{C}(\text{s})$ and $\text{CO}(\text{g})$

Plan Your Strategy

Identify the information that is missing in the given partial chemical equation. Begin balancing the equation from the known information in the partial equation.

Complete the balancing of the equation.

Check to make sure that the ratio of the coefficients is the lowest possible ratio.

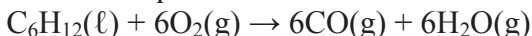
Check to make sure that the number of each kind of atom is the same in the reactants and products.

Act on Your Strategy

The possible products that could balance the equations are C(s) and CO(g).

a. For the equation to balance, the product must contain 6 C atoms and 6 O atoms. The product is 6CO(g).

Balanced equation:



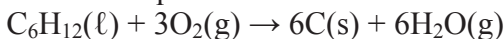
The ratio of the coefficients is 1:6:6:6. This is the lowest possible ratio.

Reactants: 6 C, 12 H, 12 O

Products: 6 C, 12 H, 12 O

b. For the equation to balance, 6 C are needed. The product is 6C(s).

Balanced equation:



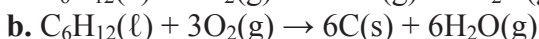
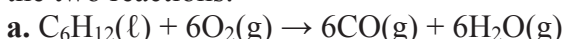
The ratio of the coefficients is 1:3:6:6. This is the lowest possible ratio.

Reactants: 6 C, 12 H, 6 O

Products: 6 C, 12 H, 6 O

Check Your Solution

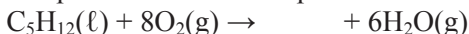
The chemical formula for each substance is written correctly. The number of atoms of each element is equal on both sides of the equation. The coefficients are written in the lowest possible ratio. The balanced chemical equations for the two reactions:

**Section 3.3 Combustion Reactions****Solutions for Selected Review Questions**

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5. Review Question (page 145)

Identify the missing product in the following balanced chemical equation for the complete combustion of pentane:



Since the combustion is complete, the missing product is CO₂(g). 5 C atoms are required on the right side of the equation to balance the reaction.

