

Act on Your Strategy

Chemical formulas: solid barium hydroxide, $\text{Ba}(\text{OH})_2(\text{s})$; solution of phosphoric acid, $\text{H}_3\text{PO}_4(\text{aq})$; solid barium hydrogen phosphate, $\text{BaHPO}_4(\text{s})$; liquid water, $\text{H}_2\text{O}(\ell)$

Skeleton equation: $\text{Ba}(\text{OH})_2(\text{s}) + \text{H}_3\text{PO}_4(\text{aq}) \rightarrow \text{BaHPO}_4(\text{s}) + \text{H}_2\text{O}(\ell)$

Reactants: 1 Ba^{2+} , 2 OH^- , 3 H, 1 PO_4^{3-}

Products: 1 Ba^{2+} , 1 HPO_4^{2-} , 2 H, 1 O

Insert a 2 in front of the $\text{H}_2\text{O}(\ell)$ to balance the H.

Balanced chemical equation: $\text{Ba}(\text{OH})_2(\text{s}) + \text{H}_3\text{PO}_4(\text{aq}) \rightarrow \text{BaHPO}_4(\text{s}) + 2\text{H}_2\text{O}(\ell)$

The ratio of the coefficients is 1:1:1:2. This is the lowest possible ratio.

Reactants: 1 Ba^{2+} , 2 OH^- , 3 H, 1 PO_4^{3-}

Products: 1 Ba^{2+} , 1 HPO_4^{2-} , 4 H, 2 O

Check Your Solution

The chemical formula for each substance is written correctly. The number of atoms and ions of the elements 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:

$\text{Ba}(\text{OH})_2(\text{s}) + \text{H}_3\text{PO}_4(\text{aq}) \rightarrow \text{BaHPO}_4(\text{s}) + 2\text{H}_2\text{O}(\ell)$.

14. Review Question (page 121)

Your friend has written the following balanced equation for the reaction in which aluminum and chlorine form aluminum(III) chloride:

$\text{Al}(\text{s}) + \text{Cl}(\text{g}) \rightarrow \text{AlCl}(\text{s})$

Is this correct? If not, how would you suggest that your friend correct it?

The equation is not correct. The chemical formulas for chlorine gas and aluminum chloride are incorrect and the equation is not balanced.

The correct balanced chemical equation for this reaction is:

$2\text{Al}(\text{s}) + 3\text{Cl}_2(\text{g}) \rightarrow 2\text{AlCl}_3(\text{s})$

Section 3.2 Synthesis Reactions and Decomposition Reactions**Solutions for Practice Problems****Student Edition page 127****21. Practice Problem (page 127)**

Predict the product that is likely to form in a reaction between lithium and oxygen, and write a balanced chemical equation for the reaction.

What Is Required?

You need to predict the product and write a balanced chemical equation for the reaction between lithium and oxygen.

What Is Given?

You are given the reactants: lithium and oxygen.

Plan Your Strategy

Identify the types of elements involved and predict the product that will form. Write the chemical formula for the product and write a balanced equation for the reaction.

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 and ion is the same in the reactants and products.

Act on Your Strategy

You know this will be a synthesis reaction between a univalent metal and a non-metal to form a binary ionic compound.

The product is predicted to be lithium oxide, $\text{Li}_2\text{O}(\text{s})$.

Skeleton equation: $\text{Li}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{Li}_2\text{O}(\text{s})$

Reactants: 1 Li, 2 O

Products: 2 Li^+ , 1 O^{2-}

Balanced chemical equation: $4\text{Li}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{Li}_2\text{O}(\text{s})$

The ratio of the coefficients is 4:1:2. This is the lowest possible ratio.

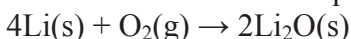
Reactants: 4 Li, 2 O

Products: 4 Li^+ , 2 O^{2-}

Check Your Solution

The overall charge on the compound lithium oxide is zero and the equation is balanced. The product is what would be expected in a synthesis reaction.

The balanced chemical equation for this reaction is:

**22. Practice Problem (page 127)**

Predict the product that is likely to form in a reaction between strontium and fluorine, and write a balanced chemical equation for the reaction.

What Is Required?

You need to predict the product and write a balanced chemical equation for the reaction between strontium and fluorine.

What Is Given?

You are given the reactants: strontium and fluorine.

Plan Your Strategy

Identify the types of elements involved and predict the product that will form. Write the chemical formula for the product and write a balanced chemical equation for the reaction.

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 and ion is the same in the reactants and products.

Act on Your Strategy

You know this will be a synthesis reaction between a univalent metal and a non-metal to form a binary ionic compound.

The product is predicted to be strontium fluoride, $\text{SrF}_2(\text{s})$.

Skeleton equation: $\text{Sr}(\text{s}) + \text{F}_2(\text{g}) \rightarrow \text{SrF}_2(\text{s})$

Reactants: 1 Sr, 2 F

Products: 1 Sr^{2+} , 2 F^-

Balanced chemical equation: $\text{Sr}(\text{s}) + \text{F}_2(\text{g}) \rightarrow \text{SrF}_2(\text{s})$

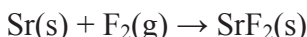
The ratio of the coefficients is 1:1:1. This is the lowest possible ratio.

The skeleton and balanced equations are the same.

Check Your Solution

The overall charge on the compound strontium fluoride is zero and the equation is balanced. The product is what would be expected in a synthesis reaction.

The balanced chemical equation for this reaction is:

**23. Practice Problem (page 127)**

Predict the product that is likely to form in a reaction between iron and bromine, and write a balanced chemical equation for the reaction.

What Is Required?

You need to predict the product and write a balanced chemical equation for the reaction between iron and bromine.

What Is Given?

You are given the reactants: iron and bromine.

Plan Your Strategy

Identify the types of elements involved and predict the most likely product that will form.

Determine whether the metal involved, iron, is multivalent and, if so, determine its possible charges.

Write the chemical formula for the products and write balanced chemical equations for the reactions.

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

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

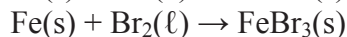
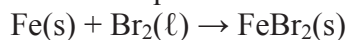
Act on Your Strategy

You know this will be a synthesis reaction between a multivalent metal and a non-metal to form a binary ionic compound.

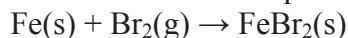
The possible charges on multivalent iron are Fe^{2+} and Fe^{3+} .

The predicted products are solid iron(II) bromide, $\text{FeBr}_2(\text{s})$, and solid iron(III) bromide, $\text{FeBr}_3(\text{s})$.

Skeleton equations:



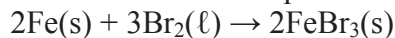
Balanced chemical equation for solid iron(II) bromide:



Reactants: 1 Fe, 2 Br

Products: 1 Fe^{2+} , 2 Br^-

Balanced chemical equation for solid iron(III) bromide:



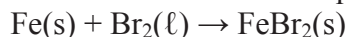
Reactants: 2 Fe, 6 Br

Products: 2 Fe^{3+} , 6 Br^-

Check Your Solution

The overall charges on the compounds iron(II) bromide and iron(III) bromide are zero and each equation is balanced. The products are what would be expected in synthesis reactions.

The balanced chemical equation for solid iron(II) bromide is:



The balanced chemical equation for solid iron(III) bromide is:



24. Practice Problem (page 127)

Predict the product that is likely to form in a reaction between phosphorus and hydrogen, forming gaseous phosphorus trihydride, and write a balanced chemical equation for the reaction.

What Is Required?

You need to write the balanced chemical equation for the reaction between phosphorus and hydrogen, forming gaseous phosphorus trihydride.

What Is Given?

You are given the reactants: phosphorus and hydrogen.

You are given the product: phosphorus trihydride.

Plan Your Strategy

Identify the types of elements involved in the reaction.

Write the chemical formula for the products and write a balanced chemical equation for the reaction.

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

You know this will be a synthesis reaction between two non-metals to form a binary molecular compound.

The product is phosphorus trihydride, $\text{PH}_3(\text{g})$.

Skeleton equation: $\text{P}(\text{s}) + \text{H}_2(\text{g}) \rightarrow \text{PH}_3(\text{g})$

Reactants: 1 P, 2 H

Products: 1 P, 3 H

Balanced chemical equation: $2\text{P}(\text{s}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{PH}_3(\text{g})$

The ratio of the coefficients is 2:3:2. This is the lowest possible ratio.

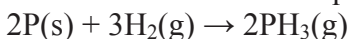
Reactants: 2 P, 6 H

Products: 2 P, 6 H

Check Your Solution

The equation is balanced. The product is what would be expected in a synthesis reaction.

The balanced chemical equation for this reaction is:

**25. Practice Problem (page 127)**

Predict the product that is likely to form in a reaction between calcium and iodine, and write a balanced chemical equation for the reaction.

What Is Required?

You need to predict the product and write a balanced chemical equation for the reaction between calcium and iodine.

What Is Given?

You are given the reactants: calcium and iodine.

Plan Your Strategy

Identify the types of elements involved and predict the product that will form.

Write the chemical formula for the product and write a balanced chemical equation for the reaction.

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 and ion is the same in the reactants and products.

Act on Your Strategy

You know this will be a synthesis reaction between a univalent metal and a non-metal to form a binary ionic compound.

The product is predicted to be solid calcium iodide, $\text{CaI}_2(\text{s})$.

Skeleton equation: $\text{Ca}(\text{s}) + \text{I}_2(\text{g}) \rightarrow \text{CaI}_2(\text{s})$

Reactants: 1 Ca, 2 I

Products: 1 Ca^{2+} , 2 I^-

Balanced chemical equation: $\text{Ca(s)} + \text{I}_2\text{(g)} \rightarrow \text{CaI}_2\text{(s)}$

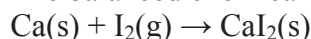
The ratio of the coefficients is 1:1:1. This is the lowest possible ratio.

The skeleton and balanced equations are the same.

Check Your Solution

The overall charge on the compound calcium iodide is zero and the equation is balanced. The product is what would be expected in a synthesis reaction.

The balanced chemical equation for this reaction is:



26. Practice Problem (page 127)

Predict the product that is likely to form in a reaction between tin and oxygen, and write a balanced chemical equation for the reaction.

What Is Required?

You need to predict the most likely product and write a balanced chemical equation for the reaction between tin and oxygen.

What Is Given?

You are given the reactants: tin and oxygen.

Plan Your Strategy

Identify the types of elements involved and predict the most likely product that will form.

Determine whether the metal involved, tin, is multivalent and, if so, determine its possible charges.

Write the chemical formula for the products and write Balanced chemical equations for the reactions.

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

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

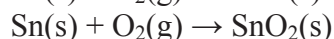
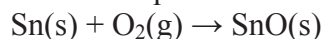
Act on Your Strategy

You know this will be a synthesis reaction between a multivalent metal and a non-metal to form a binary ionic compound.

The possible charges on multivalent tin are Sn^{2+} and Sn^{4+} .

The predicted products are solid tin(II) oxide, SnO(s) , and solid tin(IV) oxide, $\text{SnO}_2\text{(s)}$.

Skeleton equations:



Balanced chemical equation for solid tin(II) oxide: $2\text{Sn(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{SnO(s)}$

Reactants: 2 Sn, 2 O

Products: 2 Sn²⁺, 2 O²⁻

Balanced chemical equation for solid tin(IV) oxide: $\text{Sn(s)} + \text{O}_2\text{(g)} \rightarrow \text{SnO}_2\text{(s)}$

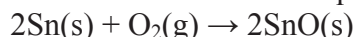
Reactants: 1 Sn, 2 O

Products: 1 Sn⁴⁺, 2 O²⁻

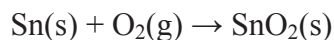
Check Your Solution

The overall charges on the compounds tin(II) oxide and tin(IV) oxide are zero and each equation is balanced. The products are what would be expected in synthesis reactions.

The balanced chemical equation for solid tin(II) oxide is:



The balanced chemical equation for solid tin(IV) oxide is:



27. Practice Problem (page 127)

Predict the product that is likely to form in a reaction between bismuth and sulfur, and write a balanced chemical equation for the reaction.

What Is Required?

You need to predict the product and write a balanced chemical equation for the reaction between bismuth and sulfur.

What Is Given?

You are given the reactants: bismuth and sulfur.

Plan Your Strategy

Identify the types of elements involved and predict the most likely product that will form.

Determine whether the metal involved, bismuth, is multivalent and, if so, determine its possible charges.

Write the chemical formula for the products and write Balanced chemical equations for the reactions.

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 and ion is the same in the reactants and products.

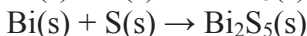
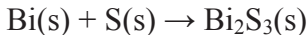
Act on Your Strategy

You know this will be a synthesis reaction between a multivalent metal and a non-metal to form a binary ionic compound.

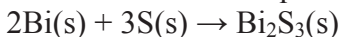
The possible charges on multivalent bismuth are Bi³⁺ and Bi⁵⁺.

The predicted products are solid bismuth(III) sulfide, Bi₂S₃(s), and solid bismuth(V) sulfide, Bi₂S₅(s).

Skeleton equations:



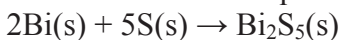
Balanced chemical equation for solid bismuth(III) sulfide:



Reactants: 2 Bi, 3 S

Products: 2 Bi^{3+} , 3 S^{2-}

Balanced chemical equation for solid bismuth(V) sulfide:



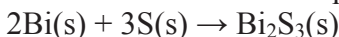
Reactants: 2 Bi, 5 S

Products: 2 Bi^{5+} , 5 S^{2-}

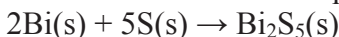
Check Your Solution

The overall charges on the compounds bismuth(III) sulfide and bismuth(V) sulfide are zero and each equation is balanced. The products are what would be expected in synthesis reactions.

The balanced chemical equation for bismuth(III) sulfide is:



The balanced chemical equation for bismuth(V) sulfide is:



28. Practice Problem (page 127)

Predict the product that is likely to form in a reaction between aluminum and iodine, and write a balanced chemical equation for the reaction.

What Is Required?

You need to predict the product and write a balanced chemical equation for the reaction between aluminum and iodine.

What Is Given?

You are given the reactants: aluminum and iodine.

Plan Your Strategy

Identify the types of elements involved and predict the product that will form.

Write the chemical formula for the product and write a balanced chemical equation for the reaction.

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 and ion is the same in the reactants and products.

Act on Your Strategy

You know this will be a synthesis reaction between a univalent metal and a non-metal to form a binary ionic compound.

The product is predicted to be solid aluminum iodide, $\text{AlI}_3\text{(s)}$.

Skeleton equation: $\text{Al(s)} + \text{I}_2\text{(s)} \rightarrow \text{AlI}_3\text{(s)}$

Reactants: 1 Al, 2 I

Products: 1 Al³⁺, 3 I⁻

Balanced chemical equation: $2\text{Al(s)} + 3\text{I}_2\text{(s)} \rightarrow 2\text{AlI}_3\text{(s)}$

The ratio of the coefficients is 2:3:2. This is the lowest possible ratio.

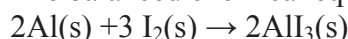
Reactants: 2 Al, 6 I

Products: 2 Al³⁺, 6 I⁻

Check Your Solution

The overall charge on the compound aluminum iodide is zero and the equation is balanced. The product is what would be expected in a synthesis reaction.

The balanced chemical equation for this reaction is:



29. Practice Problem (page 127)

Predict the product that is likely to form in a reaction between silver and oxygen, and write a balanced chemical equation for the reaction.

What Is Required?

You need to predict the product and write a balanced chemical equation for the reaction between silver and oxygen.

What Is Given?

You are given the reactants: silver and oxygen.

Plan Your Strategy

Identify the types of elements involved and predict the product that will form.

Write the chemical formula for the product and write a balanced chemical equation for the reaction.

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 and ion is the same in the reactants and products.

Act on Your Strategy

You know this will be a synthesis reaction between a univalent metal and a non-metal to form a binary ionic compound.

The product is predicted to be solid silver oxide, Ag₂O(s).

Skeleton equation: $\text{Ag(s)} + \text{O}_2\text{(g)} \rightarrow \text{Ag}_2\text{O(s)}$

Reactants: 1 Ag, 2 O

Products: 2 Ag⁺, O²⁻

Balanced chemical equation: $4\text{Ag(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{Ag}_2\text{O(s)}$

The ratio of the coefficients is 4:1:3. This is the lowest possible ratio.

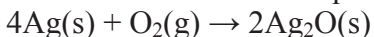
Reactants: 4 Ag, 2 O

Products: 4 Ag⁺, 2 O²⁻

Check Your Solution

The overall charge on the compound silver oxide is zero and the equation is balanced. The product is what would be expected in a synthesis reaction.

The balanced chemical equation for this reaction is:

**30. Practice Problem (page 127)**

Predict the product that is likely to form in a reaction between nitrogen and oxygen, forming nitrogen dioxide, and write a balanced chemical equation for the reaction.

What Is Required?

You need to write a balanced chemical equation for the reaction between nitrogen and oxygen forming nitrogen dioxide.

What Is Given?

You are given the reactants: nitrogen and oxygen.

You are given the product: nitrogen dioxide.

Plan Your Strategy

Write the chemical formula for the product and write a balanced chemical equation for the reaction.

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

You know this will be a synthesis reaction between two non-metals to form a binary molecular compound.

The product is nitrogen dioxide, $\text{NO}_2\text{(g)}$.

Skeleton equation: $\text{N}_2\text{(g)} + \text{O}_2\text{(g)} \rightarrow \text{NO}_2\text{(g)}$

Reactants: 2 N, 2 O

Products: 1 N, 2 O

Balanced chemical equation: $\text{N}_2\text{(g)} + 2\text{O}_2\text{(g)} \rightarrow 2\text{NO}_2\text{(g)}$

The ratio of the coefficients is 1:2:2. This is the lowest possible ratio.

Reactants: 2 N, 4 O

Products: 2 N, 4 O

Check Your Solution

The equation is balanced. The product is what would be expected in a synthesis reaction.

The balanced chemical equation for this reaction is:

