



Predicting Product of Reactions

Video Workbook with Dr. B

More guides at
www.breslyn.org

Be warned that this can be a challenging topic!

If you can [identify the types of chemical reactions](#), the next step is to be able to predict the products when given only reactants.

To be successful:

- Watch the video [Predicting Types of Reactions](#).
- Do the 20 practice problems and check your work! Watch the video solutions if you're stuck.
- Practice with the other types of reactions.

Note: Equations in this guide may not be balanced.

 [Predicting Chemical Reactions](#)

 [Types of Chemical Reactions](#)

Important!

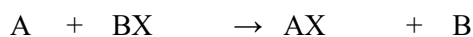
- It isn't possible to predict the products for all reactions.
- You must know how to find and balance ionic charge!

 [Finding the Charge on Ions](#)

Single Displacement

There are two primary types of Single Displacement Reactions.

Metal replacement reactions occur when a more reactive metal replaces a less reactive metal in a compound. Here A is the more reactive metal.



Example: $Zn(s) + CuCl_2(aq) \rightarrow ZnCl_2(aq) + Cu(s)$
([video](#))

Practice 1: Predict the products of $Fe(s) + CuSO_4(aq) \rightarrow$

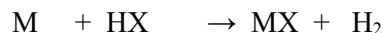
Practice 2: Predict the products of $Cu(s) + AgNO_3(aq) \rightarrow$

Answers

1: Fe will replace the Cu. The products of the reaction will be $FeSO_4(aq)$ + $Cu(s)$. ([video](#))

2: Cu will replace the Ag. The products of the reaction will be $Cu(NO_3)_2(aq)$ + $Ag(s)$. You may have also predicted $CuNO_3$, although $Cu(NO_3)_2$ is more likely. ([video](#))

Hydrogen replacement reactions occur when a metal reacts with an acid to produce hydrogen gas (H_2) and a salt (metal and non-metal).



Example: $Zn(s) + HCl(aq) \rightarrow ZnCl_2 + H_2(g)$
([video](#))

Practice 1: Predict the products of $Mg(s) + HCl(aq) \rightarrow$

Practice 2: Predict the products of $Zn(s) + HNO_3(aq) \rightarrow$

Answers

1: Mg will replace the H. There products of the reaction will be $MgCl_2(aq)$ + $H_2(g)$. ([video](#))

2: Zn will replace the H. There products of the reaction will be $Zn(NO_3)_2(aq)$ + $H_2(g)$.

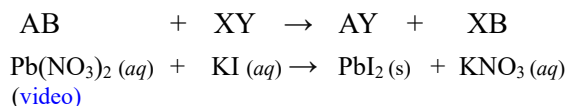
It is possible to write equations that follow this pattern that don't actually occur. The [Activity Series](#) can be used to determine if a Single Displacement reaction actually will take place.



Double Displacement

There are three primary types of Double Displacement reactions.

Precipitation Reactions result in the formation of a solid from two aqueous solutions.



Practice 1: Predict the products of $Ba(NO_3)_2 + Na_2SO_4$

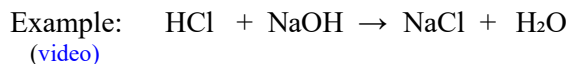
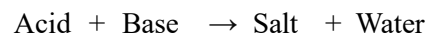
Practice: Predict the products of $NaOH(aq) + CuSO_4(aq)$

Answers

1: Ba and Na will switch places. The products will be $BaSO_4(s)$ and $NaNO_3(aq)$. If you check on a solubility table, you can see $BaSO_4$ is insoluble and will be a solid. Therefore it is the precipitate in the rxn.

2: Na and Cu will switch places. The products will be $Na_2SO_4(aq)$ and $Cu(OH)_2(s)$. The $Cu(OH)_2$ is insoluble and is the precipitate. [\(video\)](#)

Acid-Base (Neutralization) Reactions involve an acid and a base reacting to form a salt and water.



Practice 1: Predict the products of $HBr(aq) + KOH(aq)$

Practice 2: Predict the products of $HNO_3(aq) + Ca(OH)_2(aq)$

Answers

1: HBr is an acid, KOH is a base. The products will be KBr and H_2O .

2: HNO_3 is an acid, $Ca(OH)_2$ is a base. The products will be $Ca(NO_3)_2(aq)$ and $H_2O(l)$. [\(video\)](#)

*Acids often start with H.
Bases often end in OH (the OH is bonded to a metal).*

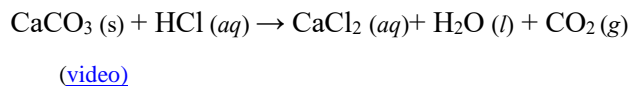
Gas Producing Reactions

For the reaction: $CaCO_3(l) + HCl(aq) \rightarrow$

It seems like you should get $CaCl_2(aq) + H_2CO_3(aq)$

But $H_2CO_3(aq)$ will decompose into $H_2O(l)$ and $CO_2(g)$.

So the final reaction is:



Practice for Gas Producing Reactions

1. Predict the products for $MgCO_3(s) + HCl(aq) \rightarrow$

Answers

1: The Mg and H switch places to give $MgCl_2 + H_2CO_3$. The H_2CO_3 then decomposes into H_2O and CO_2 .

The final reaction is:

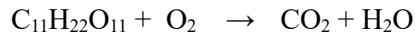
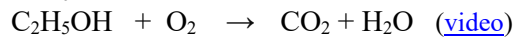
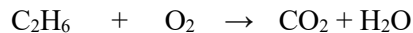
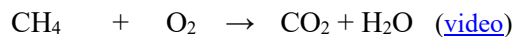
$$MgCO_3(s) + HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$$

For Precipitation Reactions we can tell if the reaction takes place by determining if one of the products is insoluble (and will be a solid). We can use a [solubility chart or the solubility rules](#) to make that determination.

Combustion (organic) Reactions

When we have a hydrocarbon (C_xH_y) react with O_2 we always get CO_2 and H_2O .

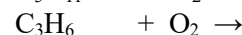
Examples of Combustion Reactions



Note that combustion reactions are exothermic so we could write $+energy$ or $+heat$ in the products.

Combustion Reactions Practice

Practice: Predict the products of the following:

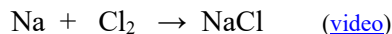


Answer: Each will give CO_2 and H_2O as products with the exception of $C + O_2 \rightarrow CO_2$.

Combination/Synthesis Reactions

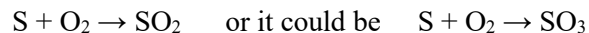
These can be difficult. Sometimes you can rely on memory or common sense. Other times ionic charge can be helpful.

For Combination/Synthesis reactions two or more reactants combine to form one product



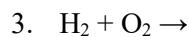
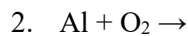
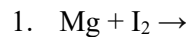
When dealing with ionic compounds (like $NaCl$) you need to [balance the ionic charge](#).

For covalent compounds (two or more [non-metals bonding](#)) it isn't as straightforward.



Practice

Predict the products of the following:



Answers

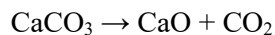
1. The products are MgI_2 .
2. The products are Al_2O_3 . (video)
3. The products are likely H_2O . (video)

Decomposition Reactions

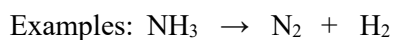
Probably the most difficult.

Decomposition Reactions

While simple to recognize as decomposition reactions, many are challenging to predict. For example:



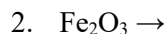
Often you can predict the products if you should also know the [common diatomic gases](#) (H_2 , N_2 , O_2 , F_2 , Cl_2 , Br_2 , I_2).



Note that most decomposition reactions require heat to occur. This means they will be endothermic rxns.

Decomposition Rxns Practice

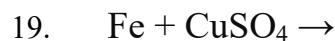
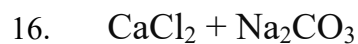
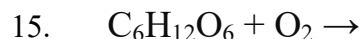
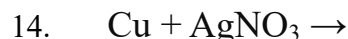
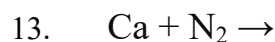
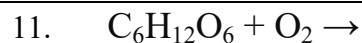
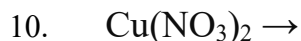
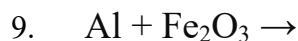
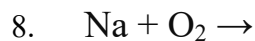
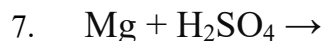
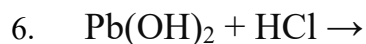
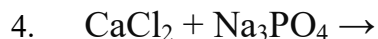
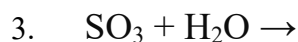
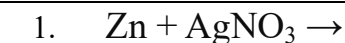
Predict the products of the following:



Answers

1. The products are $\text{K} + \text{Cl}_2$ (vide)
2. The products are $\text{Fe} + \text{O}_2$.
3. The products are likely $\text{H}_2 + \text{O}_2$.

Practice Five Main Reaction Types



Answers



- | | |
|--|---|
| 1. $\text{Zn} + \text{AgNO}_3 \rightarrow \text{Ag} + \text{Zn}(\text{NO}_3)_2$ | 11. $\text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ (video) |
| 2. $\text{C}_2\text{H}_4 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ | 12. $\text{Pb}(\text{NO}_3)_2 + \text{KI} \rightarrow \text{KNO}_3 + \text{PbI}_2$ (s)
(video) |
| 3. $\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$ | 13. $\text{Ca} + \text{N}_2 \rightarrow \text{Ca}_3\text{N}_2$ |
| 4. $\text{CaCl}_2 + \text{Na}_3\text{PO}_4 \rightarrow$
$\text{Ca}_3(\text{PO}_4)_2$ (s) + NaCl | 14. $\text{Cu} + \text{AgNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + \text{Ag}$ (video) |
| 5. $\text{NaBr} + \text{Cl}_2 \rightarrow \text{NaCl} + \text{Br}_2$ | 15. $\text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ (video) |
| 6. $\text{Pb}(\text{OH})_2 + \text{HCl} \rightarrow \text{PbCl}_2$ (s) + H_2O | 16. $\text{CaCl}_2 + \text{Na}_2\text{CO}_3$
$\rightarrow \text{CaCO}_3$ (s) + NaCl |
| 7. $\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$ | 17. $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ |
| 8. $\text{Na} + \text{O}_2 \rightarrow \text{Na}_2\text{O}$ | 18. $\text{C}_2\text{H}_2 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ |
| 9. $\text{Al} + \text{Fe}_2\text{O}_3 \rightarrow \text{Al}_2\text{O}_3 + \text{Fe}$ | 19. $\text{Fe} + \text{CuSO}_4 \rightarrow \text{FeSO}_4 + \text{Cu}$ (video) |
| 10. $\text{Cu}(\text{NO}_3)_2 \rightarrow \text{CuO} + \text{NO}_2 + \text{O}_2$ | 20. $\text{Na}_2\text{CO}_3 + \text{HCl} \rightarrow$
NaCl + $\text{H}_2\text{O} + \text{CO}_2$ |

If your time is extremely limited, watch these videos:

Types of Chemical Reactions: <https://youtu.be/ddY2RQ3ziLo>

Predicting the Products of Chemical Reactions: <https://youtu.be/TeXWuTMLe9M>

Finding Ionic Charge: <https://youtu.be/N4N1Njh7nCo>

Criss-Cross Method for Formula Writing: <https://youtu.be/77LVxv05XKE>

Using the Solubility Table and Chart: <https://youtu.be/snxoegzVnWw>

Using the Activity Series: https://youtu.be/IS3_BAfQT54

Report errors and suggestions to DrB@breslyn.org



www.Breslyn.org

