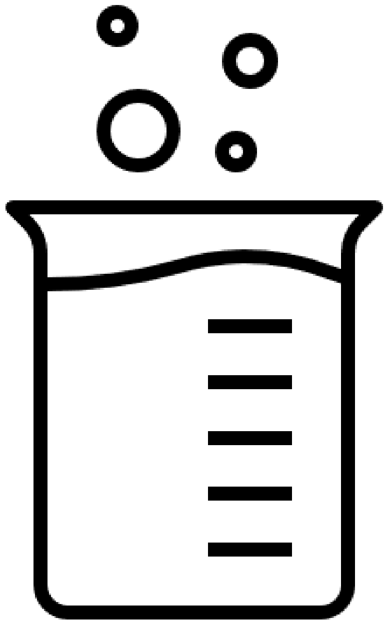
Understanding



Chemical reactions

L1 Word equations and catalysts

Chemical Reactions

Chemical reactions are like magical transformations that happen when substances combine or break apart to create something new. These reactions are all around us, from cooking your favourite meals to powering the engines of cars and even the way plants grow. So, what really happens during a chemical reaction?

In a chemical reaction, the substances you start with are called reactants, and what you end up with are the products. The important part is that the total mass of the reactants is equal to the total mass of the products. This is known as the Law of Conservation of Mass. In simple terms, nothing is created or destroyed during a chemical reaction; it's just rearranged.

Chemical Equations

To represent chemical reactions, scientists use something called chemical equations. These equations are like the ABCs of chemistry, helping us understand what's happening in the reaction. Let's break down a basic chemical equation:

Reactant 1 + Reactant 2 → Product 1 + Product 2

Each substance is represented using its chemical formula. For example, water is H_2O, meaning it consists of two hydrogen (H) atoms and one oxygen (O) atom. So, if hydrogen and oxygen react to form water, we can write it like this:

$2H_2 + O_2 \rightarrow 2H_2O$

In this equation, we see that two molecules of hydrogen gas (H_2) combine with one molecule of oxygen gas (O_2) to produce two molecules of water (H_2O).

States of Matter

In chemical equations, you might see different letters in brackets, like (s), (l), (g), and (aq). These indicate the physical state of the substances involved in the reaction:

(s) stands for solid: These are compact and have a fixed shape, like table salt (NaCl) or ice.
(l) stands for liquid: Liquids have a definite volume but no fixed shape. Water is a common example.
(g) stands for gas: Gases have neither a fixed shape nor a fixed volume. Think of the air you breathe.
(aq) stands for aqueous: This means something is dissolved in water. For example, table salt (NaCl) dissolves in water to form an aqueous solution.

Catalysts

Now, let's talk about catalysts. Catalysts are like the superheroes of chemical reactions. They speed up reactions without getting consumed themselves. Think of them as a magical potion that makes things happen faster. Catalysts work by providing an alternative pathway for the reaction to occur, one that has a lower activation energy. This means that the reactants don't need as much energy to get the reaction going.

For instance, the catalytic converter in your car's exhaust system helps convert harmful gases into less harmful ones, reducing pollution. Without catalysts, many important chemical reactions would be too slow to be useful, like the digestion of food in your body.

Independent practice

1. **Extended writing (paragraph required):** Describe what a chemical equation tells us.
2. What is a chemical reaction, and what are its key components?
3. What is the Law of Conservation of Mass, and why is it important in chemistry?
4. How are reactants and products represented in a chemical equation?
5. Explain the purpose of chemical formulas in chemical equations.
6. Give an example of a chemical equation using water (H2O).
7. What do the abbreviations (s), (l), (g), and (aq) represent in chemical equations?
8. How does a catalyst affect a chemical reaction?
9. Can you provide an everyday example of a catalyst in action?
10. Why is the catalytic converter in a car important?
11. Describe what happens in a chemical reaction when a catalyst is present.
12. What is activation energy, and how does a catalyst lower it?
13. If you have a chemical equation with the reactants on the left and products on the right, what does this arrangement represent?
14. How can you balance a chemical equation, and why is it necessary?
15. Why are chemical equations and understanding reactions important in the real world?

L2 Acids and metals

What's an Acid?
First things first, let's talk about acids. Acids are substances that taste sour and can turn blue litmus paper red. But don't go around tasting them - it's not safe! Acids are all around us, like the citric acid in lemons or the hydrochloric acid in our stomachs that helps with digestion. When acids dissolve in water, they release hydrogen ions (H+), which make them acidic.

Metals and Their Properties:
Metals, on the other hand, are shiny, malleable (they can be hammered into thin sheets), and good conductors of heat and electricity. They include elements like iron, copper, and aluminum. Now, when metals react with acids, something exciting happens!

Reactions of Acids with Metals:
When an acid and a metal come into contact, they react to produce a salt and hydrogen gas. This reaction is known as a metal-acid reaction. Let's break it down step by step:

The metal gives up its electrons (e-) to the hydrogen ions (H^+) from the acid.
This electron transfer forms hydrogen gas (H_2) as a byproduct.
The metal ions (like Fe^{2+} or Cu^{2+}) combine with the negative ions from the acid (like Cl^- or SO_4^{2-}) to form a salt.
Here's a simple equation to illustrate this:

Metal (M) + Acid (HX) -> Salt (MX) + Hydrogen Gas (H_2)

For example, if you drop a piece of magnesium (Mg) into hydrochloric acid (HCl), you'll get magnesium chloride ($MgCl_2$) as the salt and hydrogen gas bubbling up.

Why Do Metals React with Acids?
Metals react with acids because they want to get rid of their outermost electrons. This is like a game of "pass the parcel," but instead of passing a gift, they pass electrons. This process helps the metal reach a more stable electron configuration, and the hydrogen ions in the acid are more than happy to oblige.

Safety Precautions:
Before you try any experiments, safety always comes first! Always wear safety goggles to protect your eyes. Work in a well-ventilated area, and if you're handling corrosive acids, make sure to wear gloves and a lab coat. Also, conduct these experiments under adult supervision or in a school laboratory.

Independent practice

1. **Extended writing (paragraph required):** Describe what acids are and how they react with metals.
2. How can you identify the presence of an acid using a simple test?
3. What are some common characteristics of acids mentioned in the text?
4. Why is it unsafe to taste acids, even though they are known to taste sour?
5. Provide examples of acids that are commonly found in everyday items.
6. What happens when acids dissolve in water, and what ion do they release?
7. Name some metals and describe their properties mentioned in the text.
8. What are the three main characteristics of metals mentioned in the text?
9. Describe the reaction that takes place when a metal reacts with an acid.
10. Explain the step-by-step process of a metal-acid reaction as detailed in the text.
11. Write the chemical equation for the reaction between magnesium and hydrochloric acid, as mentioned in the text.
12. Why do metals react with acids, and what is the significance of this reaction for the metal?
13. What is the role of hydrogen ions in the process of metal-acid reactions?
14. How does the electron transfer in a metal-acid reaction contribute to the formation of hydrogen gas?
15. Why is it essential to follow safety precautions when conducting experiments involving acids and metals, as stated in the text?

L3 Displacement reactions

To understand displacement reactions, let's first talk about atoms. Atoms are like tiny building blocks that make up everything around us, including you! Imagine atoms as the LEGO bricks of the universe. Sometimes, these atoms can swap places in a chemical reaction, and that's where displacement reactions come into play.

Recap

Atoms can join to form molecules, which can be elements or compounds.
Elements are like the purest LEGO bricks - think of them as the basic colours.
Compounds are combinations of different elements, like building a LEGO house using various colours.

Reactants and Products:

In a chemical reaction, you have things called reactants (the starting materials) and products (the end results).
It's like mixing different LEGO bricks to create a new structure.

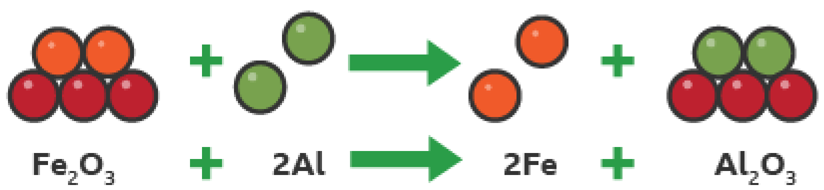
Displacement Reactions:

This happens when one element kicks out another from a compound.
Picture it as one LEGO brick pushing another out of the structure. Displacement reactions are chemical reactions which involve a metal and a compound containing a different metal.

These compounds containing metals and non-metals are called salts. For example, iron (a metal) reacts with copper sulphate (a salt containing copper). In a displacement reaction, a less reactive metal is displaced from its compound by a more reactive metal. There is no reaction between a metal and a salt of the same metal. For example, iron cannot displace iron from iron chloride (a salt).

Let's Look at an Example:
Imagine you have a compound made of two elements, A and B. Now, element C comes along and wants to join the compound. In a displacement reaction, if element C is more 'reactive' than element A, it will push A out of the compound, taking its place. So, now you have a new compound with elements B and C.

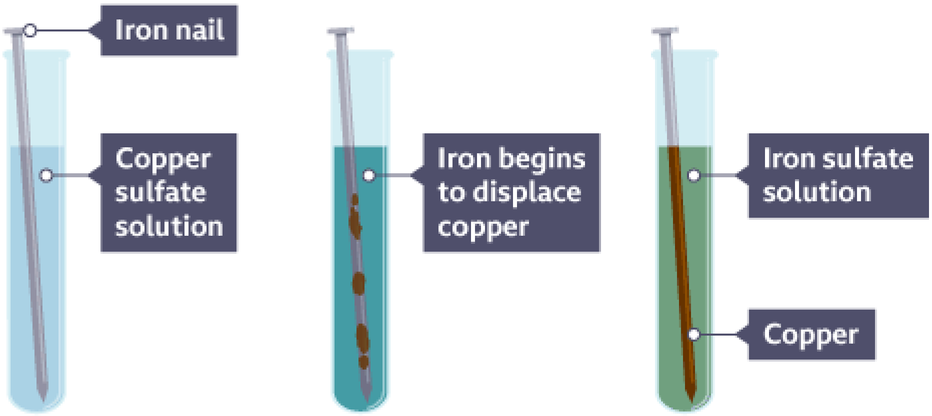
Real-life Example:



iron oxide + aluminium → iron + aluminium oxide

Aluminium is more reactive than iron. This means the aluminium takes the oxygen from the iron oxide to produce aluminium oxide. The iron has been displaced from its compound, so it is not bonded to anything after the reaction.

Reactivity Series:
A series of displacement experiments can be used to put metals in order of reactivity. This involves placing metal pieces in different metal salt solutions. In this diagram, an iron nail is placed in a solution of copper sulphate. The iron displaces the copper and copper builds up on the exterior of the nail.



Iron displaces copper in copper sulphate

The table shows the results of a series of experiments involving four metals and solutions of their salts. A tick shows where there was a visible reaction and a cross shows where there was no visible reaction.

	Magnesium	Zinc	Iron	Copper
Magnesium salt		✗	✗	✗
Zinc salt	✓		✗	✗
Iron salt	✓	✓		✗
Copper salt	✓	✓	✓	
Reactions seen	3	2	1	0

Magnesium displaces three metals, zinc displaces two metals, iron displaces one metal and copper does not displace any of the other three metals.
From the results, it can be concluded that the order of reactivity, starting with the most reactive is:
magnesium
zinc
iron
copper

Let's Recap
Think of displacement reactions as a chemical game of musical chairs. Atoms are constantly moving and rearranging themselves, creating new compounds in the process. Remember, it's not about atoms having feelings or intentions; it's about their chemical properties dictating how they interact.

Independent practice

1. **Extended writing (paragraph required):** What are atoms, and how can we imagine them in the context of displacement reactions?
2. Explain the difference between elements and compounds using the analogy of LEGO bricks.
3. In a chemical reaction, what are reactants and products, and how is it like mixing LEGO bricks to create something new?
4. Define displacement reactions and provide an example using LEGO bricks as an analogy.
5. **Extended writing (paragraph required)**: Why does a displacement reaction occur, and how can we relate it to the LEGO brick analogy?
6. What are salts, and how do they relate to displacement reactions?
7. Explain the concept of reactivity in the context of displacement reactions. How does one metal displace another from a compound?
8. Can you describe a real-life example of a displacement reaction involving iron and aluminium?
9. What is the reactivity series, and how is it determined through displacement experiments?
10. Using the provided table, explain the results of the displacement experiments and how they contribute to establishing the reactivity series.
11. How many metals does magnesium displace, and what does this indicate about its reactivity?
12. Compare the reactivity of zinc, iron, and copper based on the results of the displacement experiments.
13. How is the order of reactivity determined from the results of the displacement experiments?
14. Summarize the concept of displacement reactions using the analogy of a chemical game of musical chairs and the constant movement of atoms.

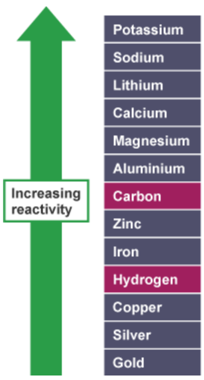
L4 Extraction of metals

Metals are incredible materials that play a crucial role in our everyday lives. From the spoon you use to eat your cereal to the frame of your bike, metals are all around us. But have you ever wondered where these metals come from and how we get them? Well, let's dive into the fascinating world of metals in the Earth and the methods we use to extract them.

Metals in the Earth:
The Earth's crust is like a treasure chest filled with different metals. Some metals, like gold and platinum, can be found in their pure form, just waiting to be discovered. These are called native metals. However, most metals are not found in their pure state; instead, they are combined with other elements in compounds called metal oxides. The metal oxides are found in solid mixtures with other compounds. We call the mixture of metal oxides and other compounds ores. A metal ore is essentially a rock you can dig out of the ground containing the metal oxide.

Methods of Extracting Metals:
Extracting metals from their ores (compounds in which they are found) is a process called metallurgy. There are various methods of extracting metals, and the choice of method depends on factors like the reactivity of the metal and the stability of its compounds.

The diagram shows a simple reactivity series, including carbon and hydrogen. Carbon and hydrogen are often included in a reactivity series as they allow us to predict chemical reactions.



The reactivity series can be split up to show how metals are extracted into three groups:

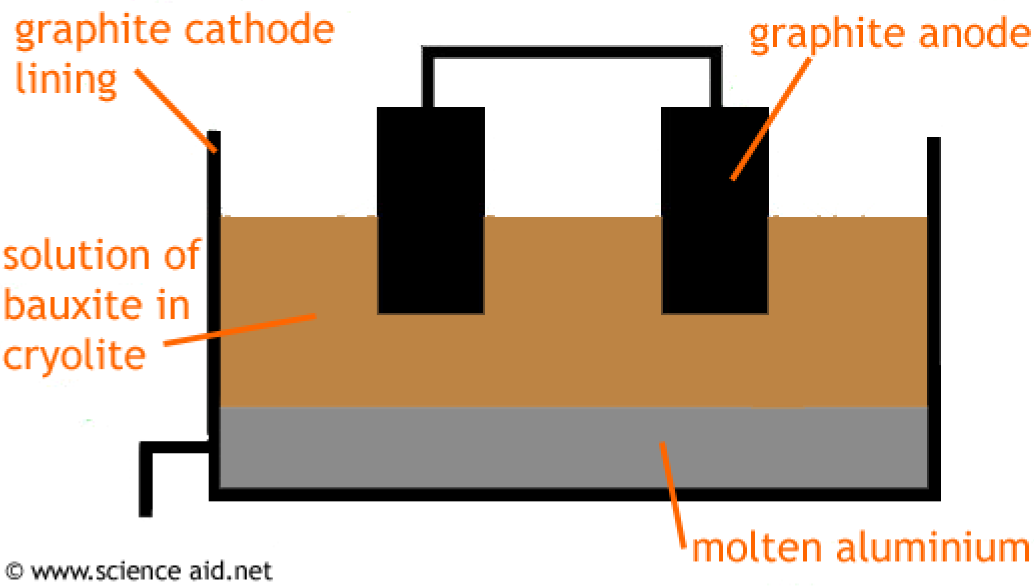
1. Metals which are found in the pure crust.
2. Reduction of metal oxides using carbon.
3. Extraction using electrolysis.

Reduction of Metal Oxides using Carbon:
One common method is the reduction of metal oxides using carbon. Imagine metal oxides as a metal (like iron) bonded with oxygen. To extract the metal, we use carbon (usually in the form of coke, which is a type of coal). Here's a word equation to make it clearer:

Iron Oxide (Metal Oxide) + Carbon → Iron (Metal) + Carbon Dioxide
This process is known as smelting. The carbon takes away the oxygen from the metal oxide, leaving behind the pure metal.

Extraction using Electrolysis:
For metals that are more reactive and have a stronger bond with oxygen, we use a different method called electrolysis. This process involves passing an electric current through a molten metal compound or a solution of the metal compound in water.

For example, let's look at the extraction of aluminium:
Aluminium Oxide (Metal Oxide) → Aluminium (Metal) + Oxygen
This reaction takes place during the electrolysis of molten aluminium oxide.



Independent practice

1. Where can metals be found in their pure form in the Earth's crust, and what are these metals called? **Pure**
2. What is an ore, and how does it relate to the extraction of metals? **Metal within compound**
3. How does the reactivity of a metal influence the method chosen for its extraction? **More reactive than carbon: use electrolysis... less reactive than carbon, use carbon**
4. What is the purpose of carbon in the reduction of metal oxides, and how does the process of reduction using carbon work? **Carbon reduces elements less reactive than itself.**
5. **Extended writing (paragraphs required):** Compare and contrast the methods of extracting metals using carbon reduction and electrolysis. What are the key differences between the two processes?
6. Describe the role of electrolysis in the extraction of metals. Provide an example, such as the extraction of aluminium, and explain the reaction involved.
7. Why is the reactivity series important in understanding the methods of extracting metals?
8. Can you think of some everyday objects made of metals and speculate on the extraction method used to obtain the metals in those objects?
9. How does the stability of a metal's compounds influence the choice of extraction method in metallurgy?

L5 Conservation of mass - Recap

Conservation of Mass:

The conservation of mass is a fundamental principle in chemistry, stating that the total mass of substances involved in a chemical reaction remains constant. In simpler terms, it means that matter cannot be created or destroyed during a chemical process; it only changes its form.

Combustion Reactions:

Let's start with combustion, a process many of us are familiar with, like burning a candle or wood in a fireplace. The most common example is the combustion of hydrocarbons, such as the reaction between methane (CH_4) and oxygen (O_2) to produce carbon dioxide (CO_2) and water (H_2O):

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Here, the number of carbon atoms and oxygen atoms on the left side (reactants) equals the number on the right side (products). This demonstrates the conservation of mass in a combustion reaction.

Thermal Decomposition Reactions:

Next, let's explore thermal decomposition, a process where a substance breaks down into simpler substances upon heating. An example is the decomposition of calcium carbonate ($CaCO_3$) into calcium oxide (Caol) and carbon dioxide (CO_2):

$CaCO3 \rightarrow CaO + CO2$

Oxidation Reactions:

Lastly, oxidation reactions involve the addition of oxygen to a substance or the removal of electrons. One common example is the oxidation of iron (Fe) to form iron oxide (rust), where iron reacts with oxygen:

$4Fe + 3O2 \rightarrow 2Fe2O_3$

As before, the number of atoms on each side of the equation remains the same, showcasing the conservation of mass.

Independent practice

1. What is the conservation of mass? **total mass of substances involved in a chemical reaction remains constant.**
2. Provide an example of a combustion reaction. **Combustion of fuels (methane)/burning fire**
3. Write the balanced equation for the combustion of methane. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
4. Explain what happens during thermal decomposition. **process where a substance breaks down into simpler substances upon heating**
5. Give an example of a thermal decomposition reaction. **Thermal decomposition of calcium carbonate**
6. Write the balanced equation for the thermal decomposition of calcium carbonate. $CaCO_3 \rightarrow CaO + CO_2$
7. What is an oxidation reaction? **oxidation reactions involve the addition of oxygen to a substance or the removal of electrons**
8. Provide an example of an oxidation reaction. **Oxidation of iron into iron oxide**
9. Explain why the conservation of mass is important in chemical reactions. **the number of atoms on each side of the equation remains the same, showcasing the conservation of mass.**
10. If you burn a piece of paper, is the total mass of the ash and smoke different from the original paper? Why or why not? **No, mass has been conserved: nothing has been created or destroyed**
11. What happens to the atoms of the substances involved in a chemical reaction? **The number of atoms remains the same**
12. How does the number of atoms on the left side of a chemical equation compare to the number on the right side? **It is the same**
13. Why is it essential to balance chemical equations? **As mass/atoms are conserved: not created or destroyed**
14. Can you think of a real-life situation where understanding the conservation of mass would be important?