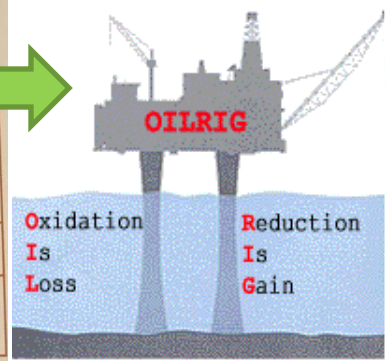


START

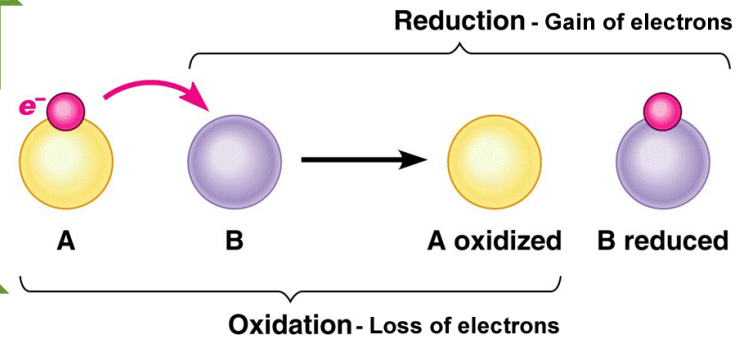
Order of reactivity	Reaction with water	Reaction with dilute acid
potassium	fizz, giving off hydrogen gas, leaving an alkaline solution of metal hydroxide	explode
sodium		
lithium		
calcium		
magnesium		
aluminium	very slow reaction	fizz, giving off hydrogen gas and forming a salt
zinc		
iron		
tin	slight reaction with steam	react slowly with warm acid
lead		
copper	no reaction, even with steam	no reaction
silver		
gold		



Name of acid	Formula	Formula of ion	Name of salt
Hydrochloric acid	HCl	Cl <sup>-</sup>	Chloride
Sulphuric acid	H <sub>2</sub> SO <sub>4</sub>	SO <sub>4</sub> <sup>-2</sup>	Sulphate
Nitric acid	HNO <sub>3</sub>	NO <sub>3</sub> <sup>-</sup>	Nitrate
Phosphoric acid	H <sub>3</sub> PO <sub>4</sub>	PO <sub>4</sub> <sup>-3</sup>	Phosphate

Key words:  
**Oxidation:** loss of electrons (reacted with oxygen)  
**Reduction:** gain of electrons  
**Displacement reaction:** When a more reactive metal swaps places with a less reactive metal

Metal + water → metal hydroxide + hydrogen  
 Metal + acid → metal salt + hydrogen



**What affect how reactive something is?**  
 Metals: The less electrons to lose and the further away from the nucleus as the attractive force from the nucleus is less, electrons are easier to lose so the metal is more reactive.  
 Non-metals: The less electrons to gain and the closer to the nucleus means the attractive force is greater.

- Metals become oxidised
- Non-metals such as oxygen become reduced when they form an ionic bond
- In this case it has also formed an oxide because it has reacted with oxygen
- Metals react easily with oxygen so often are found in oxide compounds
- If we want to remove the oxygen we need to find a more reactive metal to displace the metal

Sometimes we can't extract a metal using carbon as carbon forms another compound. When you react carbon with tungsten oxide it forms tungsten carbide. So instead we react it with hydrogen in a process called electrolysis which requires electricity.

### 1. Reactivity Series of Metals

Potassium	
Sodium	
Calcium	
Magnesium	
Aluminium	
<i>Carbon</i>	
Zinc	
Iron	
Tin	
Lead	
<i>Hydrogen</i>	
Copper	
Silver	
Gold	
Platinum	

(elements in italics, though non-metals, have been included for comparison)

### 2. Formulae of Some Common Ions

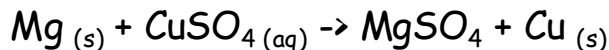
Positive ions		Negative ions	
Name	Formula	Name	Formula
Hydrogen	H <sup>+</sup>	Chloride	Cl <sup>-</sup>
Sodium	Na <sup>+</sup>	Bromide	Br <sup>-</sup>
Silver	Ag <sup>+</sup>	Fluoride	F <sup>-</sup>
Potassium	K <sup>+</sup>	Iodide	I <sup>-</sup>
Lithium	Li <sup>+</sup>	Hydroxide	OH <sup>-</sup>
Ammonium	NH <sub>4</sub> <sup>+</sup>	Nitrate	NO <sub>3</sub> <sup>-</sup>
Barium	Ba <sup>2+</sup>	Oxide	O <sup>2-</sup>
Calcium	Ca <sup>2+</sup>	Sulfide	S <sup>2-</sup>
Copper(II)	Cu <sup>2+</sup>	Sulfate	SO <sub>4</sub> <sup>2-</sup>
Magnesium	Mg <sup>2+</sup>	Carbonate	CO <sub>3</sub> <sup>2-</sup>
Zinc	Zn <sup>2+</sup>		
Lead	Pb <sup>2+</sup>		
Iron(II)	Fe <sup>2+</sup>		
Iron(III)	Fe <sup>3+</sup>		
Aluminium	Al <sup>3+</sup>		

When we extract a metal using carbon from its ore we call this reduction of oxide by carbon. The metal oxide is heated up with carbon and if carbon is higher in the reactivity series displacement happens and carbon dioxide is formed in the place of the metal oxide.

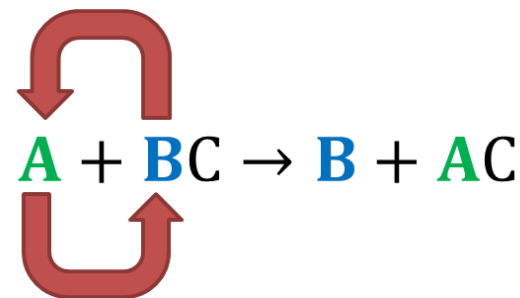
Metals are found in ores in rocks where they are in a compound with oxygen. Silver, gold and platinum are never found in an ore, as they are very unreactive.

Displacement reaction:

Magnesium + copper(II) sulphate → magnesium sulphate + copper



- A more reactive metal swaps places with a less reactive metal.
- You can work out whether a metal will displace another by looking at the reactivity series, if it is higher up it will displace a less reactive metal



Acid + oxide (base)  $\rightarrow$  salt + water

Acid + hydroxide (alkali)  $\rightarrow$  salt + water

Acid + carbonate  $\rightarrow$  salt + water + carbon dioxide

When an acid reacts with an alkali it give  $H^+$  ions, the alkali  $OH^-$  ions and  $H_2O$  is formed.

pH is a measurement of the concentration of  $H^+$  ions in a solution. At pH7 the concentration of  $H^+$  and  $OH^-$  is equal so the solution is 'neutral.'

Acid + alkali = neutral

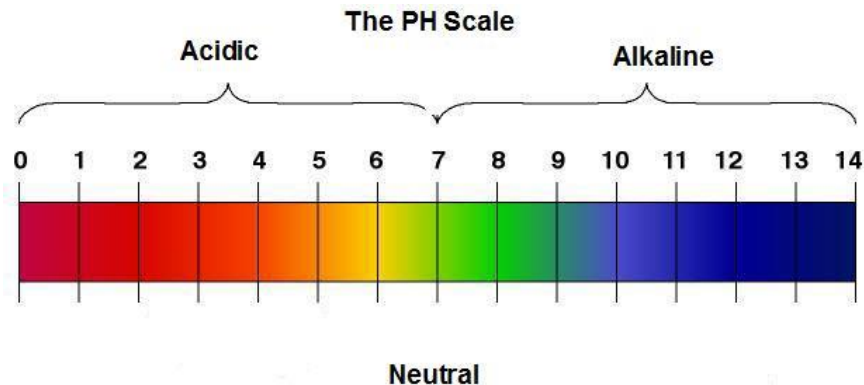
You can measure pH using universal indicator of a pH probe

**Key words:**

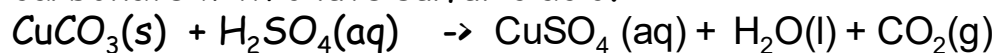
**Acids:** pH of less than 7, form  $H^+$  (hydrogen) ions when in solution (dissolved in water - aq).

**Base:** solids that react with an acid. E.g. metals, metal oxides, metal carbonates

**Alkali:** a base that dissolves in water (soluble base - aq), form  $OH^-$  (hydroxide) ions in solution. pH of greater than 7.



The salt copper sulfate can be made by reacting copper carbonate with dilute sulfuric acid.



1 Add insoluble copper oxide to sulfuric acid and stir. Warm gently on a tripod and gauze (do not boil).

2 The solution turns blue as the reaction occurs, showing that copper sulfate is being formed. Excess black copper oxide can be seen.

3 When the reaction is complete, filter the solution to remove excess copper oxide.

4 You can evaporate the water so that crystals of copper sulfate start to form. Stop heating when you see the first crystals appear at the edge of the solution. Then leave for the rest of the water to evaporate off slowly. This will give you larger crystals. Any small excess of solution on the crystals can be removed by dabbing between filter papers (do not touch the solution), then leaving to dry.

### Making copper sulphate

- pour a sulphuric acid into a beaker
- add a small amount of copper carbonate to the acid and stir until the fizzing stops
- continue to add small amounts of copper carbonate to the acid and each time stir until any fizzing stops
- filter the mixture to remove the excess copper carbonate
- pour the filtrate (copper sulphate solution) into an evaporating basin and heat to evaporate a small amount of the water
- leave the copper sulphate solution to crystallise
- remove the crystals from the solution remaining and dry the crystals

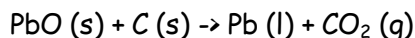
- When potassium reacts with oxygen it forms potassium oxide. What type of bond forms?
- Potassium is in group 1 and oxygen is in group 6:
  - How many electrons does potassium need to lose to get a full outer shell?
  - How many electrons does oxygen need to gain to get a full outer shell?
  - How many potassium atoms will bind to 1 oxygen atom?
- Write a balanced equation for the reaction:
- Oxidation is where electrons are lost, which atom has been oxidised, potassium or oxygen?
- Reduction is where atom gains electrons, which atom has been reduced, potassium or oxygen?

Complete the word equations and complete a balanced symbol equation for the following displacement reactions

- Magnesium oxide + calcium → calcium oxide + magnesium
- Silver oxide + magnesium → magnesium oxide + silver
- Lead oxide + lithium → lithium oxide + lead
- Calcium oxide + magnesium → Calcium oxide + magnesium
- Potassium oxide + calcium → Potassium oxide + calcium
- Copper oxide + sodium → sodium oxide + copper
- Metals are often found in an ore e.g. copper oxide, suggest using ideas about the reactivity series how scientists could extract copper from its ore:
- Recall the different ways you would know a reaction had taken place
- Aluminium reacts with oxygen to make aluminium oxide which forms a protective layer on top of the aluminium. Explain why this means aluminium can be used outside
- Explain why silver and gold are used to make jewellery
- Identify and justify which metal would be best for water pipes in your home
- Explain why potassium, lithium and sodium are stored in oil

Complete the work equation:

- Iron + Copper Sulphate →
- Copper + Silver Nitrate →
- Sodium + Zinc Carbonate →



- What is a metal ore?
- Explain the factors that are considered before a metal is extracted from its ore
- Balance the reaction
- In the **reactants** has Pb been reduced or oxidised?
- In the **reactants** has O been reduced or oxidised?
- In the **products** has Pb been reduced or oxidised?
- In the **products** has C been reduced or oxidised?
- Explain using ideas about the reactivity series why this reaction has occurred
- Write a word equation for the extraction of copper from its ore
- After the reaction has copper been reduced or oxidised?
- After the reaction has carbon been reduced or oxidised?
- Explain how copper can be extracted from its ore:

Complete the word equations

- Sodium carbonate + Hydrochloric acid →
- Potassium hydroxide + Sulphuric acid →
- Copper carbonate + Sulphuric acid →
- Calcium carbonate + Hydrochloric acid →
- Sodium hydroxide + Nitric acid →

- Explain how you make copper sulphate
- Explain the difference between an acid, alkali and a base
- How do you measure pH?
- Explain what happens when an acid and alkali react
- Explain the difference between a strong and a weak acid
- Explain the difference between a concentrated and dilute acid
- Explain how weak acids react in water
- Explain how strong acids react in water
- Explain the relationship between concentration and pH