Topic: Year 10 Chemical Changes - Acids

Duration: 7 lessons

Composite:

Key vocabulary:

Acid
Base
Alkali
Ion
Indicator
Neutralisation
Burette
Pipette
Titration
Ionic
Excess
Concentration
Precipitate
Strong
Weak
Conical flask

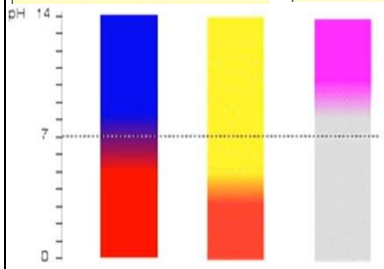
Core Knowledge in this unit:

Learn these formulae !

H_2SO_4	sulphuric acid
HCl	hydrochloric acid
HNO_3	nitric acid

Learn these formulae !

$NaOH$	sodium hydroxide
KOH	potassium hydroxide
$Ca(OH)_2$	calcium hydroxide



Litmus Methyl Orange Phenolphthalein

Solubility Rules:

All nitrates, sodium, potassium and ammonium salts are soluble.

There are extra rules for chlorides, sulfates, hydroxides and carbonates.

METAL + ACID → SALT + HYDROGEN

e.g. $Zn_{(s)} + H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)} + H_{2(g)}$

METAL OXIDE + ACID → SALT + WATER

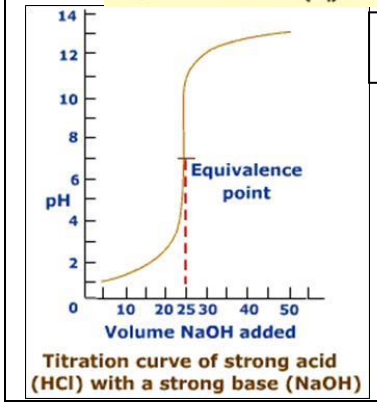
e.g. $CuO_{(s)} + H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + H_2O_{(l)}$

METAL CARBONATE + ACID → SALT + WATER + CARBON DIOXIDE

e.g. $MgCO_{3(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$

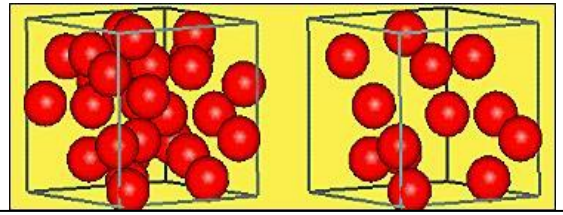
METAL HYDROXIDE + ACID → SALT + WATER

e.g. $NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$



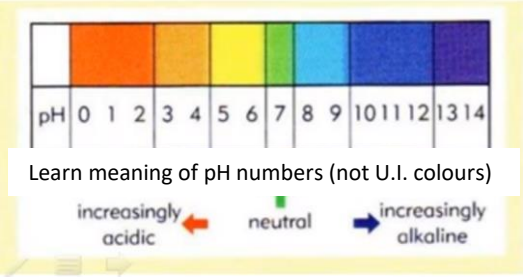
Titration curve of strong acid (HCl) with a strong base (NaOH)

The change in pH when a base is added to a strong acid.

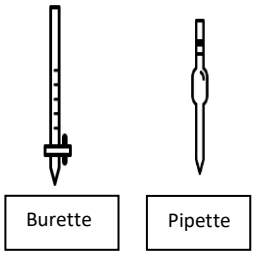


High concentration Low concentration (dilute)

Powerful Knowledge components critical to commit to long term memory:



Learn meaning of pH numbers (not U.I. colours)



Burette Pipette

Acid - A source of hydrogen ions in solution.

Alkali - A source of hydroxide ions in solution. A base that dissolves in water

Indicator - A substance which changes colour in acids and alkalis.

Concentration - a measure of how many particles are in a given volume.

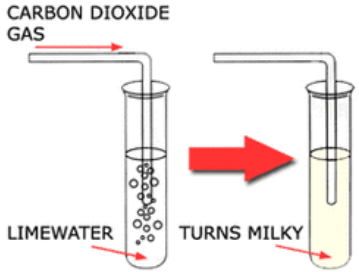
Base – the chemical opposite of an acid.

Neutralisation - reaction between an acid and a base which produces water.

Precipitate - an insoluble salt.

Strong acid/alkali – Fully dissociates in solution releasing all H^+/OH^- ions.

Weak acid/alkali – Slightly dissociates in solution not releasing all H^+/OH^- ions.



$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

Acid-alkali neutralisation ionic equation

Links to previous and future topics

KS2 Materials

KS3 Elements, compounds and reactivity (Yr7)

KS3 Separations & Mixtures (Yr7)

KS3 Particles & Solutions (Yr7)

KS3 Solutions & Mixtures (Yr8)

KS4 States of Matter & Mixtures (Chem)

KS4 Chemical Changes

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Following written practical method	Collaborating with peers in practical	Describing transitions in pH curve	Questions levelled 1 to 9	Many industries use products of these reactions e.g. paints and pigments, fertilisers etc.

CULTURAL CAPITAL:

Acids and alkalis handled at home and future work can be very dangerous and need to be handled carefully following hazard symbol and instruction advice.

Newspaper article 'My face melted when drain cleaner exploded'

https://www.dailyecho.co.uk/news/8253292.my-face-melted-when-drain-cleaner-exploded/

SEND:

- Opening activity/theme is Knowledge Recall to ensure learner buy in
- Opportunities for retrieval practice and building on prior knowledge using Knowledge Recall.
- Multi-sensory approach using reading, listening, watching, doing practicals, talking, observing demonstrations…
- Repetition of key vocabulary in every lesson
- Curriculum time allocated for the explicit teaching of key vocabulary
- Skills ordered logically and sequenced with an increase in complexity

Topic: Year 10 Chemical Changes - Electrolysis

Duration: lessons

Composite:

Key Vocabulary:

Electrolyte
Electrolysis
Inert
Cathode
Anode
Cation
Cathode
Decomposition
Ion
Oxidation
Reduction
Ionic

Core Knowledge in this unit:

Oxidation
Is
Loss of electrons
Reduction
Is
Gain of electrons

Positively charged ions move to the negative electrode.

Metal ions and hydrogen ions are positively charged, so metals or hydrogen gas are produced at the negative electrode.

Negatively charged ions move to the positive electrode.

Non-metal ions such as oxide ions and chloride ions are negatively charged, so gases such as oxygen or chlorine are produced at the positive electrode.

Method for working out what is produced:

- Split the substance into its ions and the water present if in solution
- Hydrogen is only produced at the cathode when a more reactive metal is present
- If a halogen is present then that is always produced at the anode
- If no halogen is present the water produces oxygen instead

Powerful Knowledge components critical to commit to long term memory:

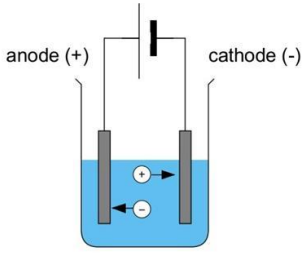
Electrolyte – ionic compounds in the molten state or in solution

Electrolysis – a process in which direct current is used to decompose (break apart) an electrolyte

Cations – positively charged ions

Anions – negatively charged ions

Inert - unreactive



Ions are attracted to an oppositely charged electrode

Electrolyte	Electrodes	Reduction Reaction at Cathode (-)	Oxidation Reaction at Anode (+)
Copper chloride solution	Carbon	$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$
Sodium chloride solution	Carbon	$2H^+(aq) + 2e^- \rightarrow H_2(g)$	$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$
Sodium sulphate solution	Carbon	$2H^+(aq) + 2e^- \rightarrow H_2(g)$	$4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$
Water acidified with sulfuric acid	Carbon	$2H^+(aq) + 2e^- \rightarrow H_2(g)$	$4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$
Molten lead bromide	Carbon	$Pb^{2+}(l) + 2e^- \rightarrow Pb(s)$	$2Br^-(l) \rightarrow Br_2(l) + 2e^-$
Copper sulfate solution	Carbon	$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	$4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$
Copper sulfate solution	Copper	$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	$Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

Links to previous and future topics

KS2 Materials

KS3 Elements, compounds and reactivity (Yr7)

KS3 Separations & Mixtures (Yr7)

KS3 Particles & Solutions (Yr7)

KS3 Solutions & Mixtures (Yr8)

KS4 States of Matter & Mixtures

KS4 Chemical Changes

KS4 Obtaining and using metals

KS4 Transition metals, alloys and corrosion

KS5 Acid-Base Redox Reactions

KS5 Redox and Electrode Potentials

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
CULTURAL CAPITAL:				
SEND				

Topic: KS4: Topic 4 Extracting metals and Equilibria – Obtaining and using metals (C)	**Duration: 4 lessons**	**Composite: Unit test**

Key vocabulary:	**Core knowledge Components** **Powerful knowledge components crucial to commit to long term memory (in red box)**	**Links to previous and future topics**

Reactivity, Displacement, Tendency, Salt, Electrons, Ions, Cations, Oxidised, Reduction, Ore, Extraction, Electrolysis, Recycling, Lifetime assessment (LTA) Reversible, Reactants, Products, Dynamic equilibrium, Rate, Haber Process, Catalyst, Temperature, Pressure

1. Know the products of a reaction between metal and water. Products are a metal hydroxide (forming an alkaline solution) and hydrogen gas.

   Metal + water -> metal hydroxide + water

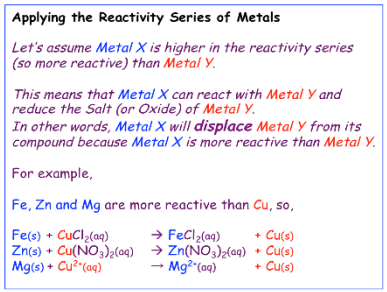
2. Recall that fairly reactive metals react with acids to produce a salt and hydrogen gas.

   Acid + metal → salt + hydrogen

3. Know that the more reactive metals will react with oxygen more quickly and recall the word equation for metals reacting with oxygen:

   Metal + oxygen -> metal oxide

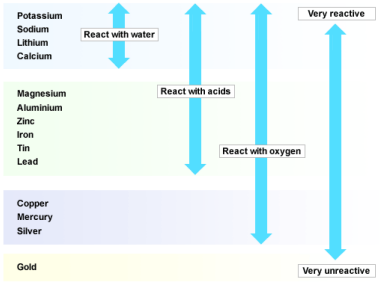
4. Explain how displacement reactions can show which metal is the most reactive.



5. Recall that: most metals are extracted from ores found in the Earth's crust, and unreactive metals are found in the Earth's crust as the uncombined elements.
   - Most metals are found as compounds that require chemical reactions to extract the metal but gold is very unreactive and can be found in the Earth as itself.

6. Recall that the extraction of metals involves reduction of ores
   - Metals less reactive than carbon.
   - Can be extracted from their oxides by reduction with carbon

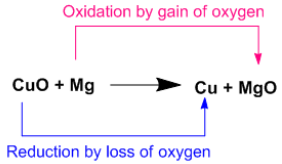
1. **Deduce the relative reactivity of some metals, by their reactions with water, acids and salt solutions.**

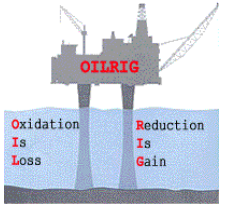


2. **Explain the reactivity series of metals (potassium, sodium, calcium, magnesium, aluminium, (carbon), zinc, iron, (hydrogen), copper, silver, gold) in terms of the reactivity of the metals with water and dilute acids and that these reactions show the relative tendency of metal atoms to form cations.**

- **When metals react with other substances, metal atoms form positive ions (they lose electrons to become cations)**
- **Reactivity of a metal is related to its tendency to form positive ions (cations) more reactive metals can form cations more easily**

3. **Explain oxidation as the gain of oxygen and reduction as the loss of oxygen.**





4. **Explain why the method used to extract a metal from its ore is related to its position in the reactivity series and the cost of the extraction process, illustrated by heating with carbon (including iron) and electrolysis.**

KS3: Elements and compounds, The Periodic Table, Separation Techniques, Metals and Reactivity

KS4: Obtaining & Using Metals, The Periodic Table

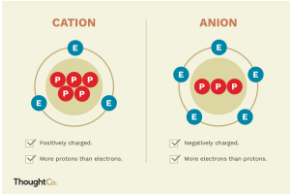
KS3: Elements and compounds, The Periodic Table, Separation Techniques, Metals and Reactivity

KS4: Obtaining & Using Metals, The Periodic Table, Dynamic Equilibria

7. Recall the general word equation for extracting a metal compound from its ore and give an example of a symbol equation.

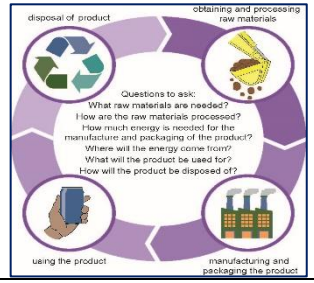
- Metal compound + carbon → metal + carbon dioxide
- $2Fe_2O_3$ (s) + 3C(s) -> 4Fe(l) + $3CO_2$ (g)

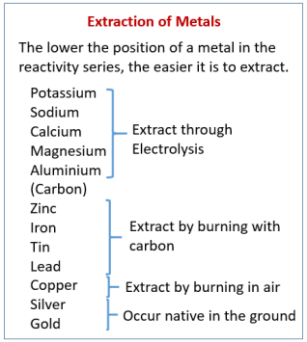
8. Explain how cations and anions are formed.



9. Describe that a life time assessment for a product involves the consideration of the effect on the environment of obtaining the raw materials, manufacturing the product, using the product and disposing of the product when it is no longer useful.

● These are carried out to assess the environmental impact of products in each of these stages:
o Extracting and processing raw materials
o Manufacturing and packaging
o Use and operation during its lifetime
o Disposal at the end of its useful life, including transport and distribution at each stage
● Use of water, resources, energy sources and production of some wastes can be fairly easily quantified
● Allocating numerical values to pollutant effects is less straightforward and requires value judgements, so LTA (life time assessment) is not a purely objective process
● Selective or abbreviated LTAs can be devised to evaluate a product but these can be misused e.g. in support of claims for advertising purposes





● Can only be extracted by reduction of carbon if metal is less reactive - carbon displaces the metal from the ore
● If more reactive than carbon, electrolysis can be used (metals less reactive than carbon can also be extracted this way)
● Electrolysis is expensive due to large amounts of energy needed to melt the compounds and to produce the electrical current (so you wouldn't extract a metal using electrolysis if it could be done more cheaply using carbon)

5. Explain how a metals' relative resistance to oxidation is related to its position in the reactivity series.
● Relative resistance to oxidation is the same as relative resistance to losing electrons / forming positive metal ions
● Less reactive a metal is, the more resistant it is to oxidation, because for a metal to react, it forms a positive metal ion by losing electrons (loss of electrons=oxidation)

6. Evaluate the advantages of recycling metals, including economic implications and how recycling can preserve both the environment and the supply of valuable raw materials.
● Recycling is important to achieve sustainable development
○ Requires less energy to melt and remould metals than it does to extract new metals from their ores
○ Mining ores is bad for the environment as large quarries are created, which produce noise pollution and dust
○ Also, recycling allows for waste metals to be reused, saving money, helping the environment and the supply of valuable raw materials (meaning metal ores will last longer).

7. Evaluate data from a life cycle assessment of a product.

1. Recall that chemical reactions are reversible, the use of the symbol ⇌ in equations and that the direction of some reversible reactions can be altered by changing the reaction conditions.

- **The direction of the reaction can be changed by changing the conditions E.g. if the forwards reaction takes place in hot conditions, lowering the temperature can allow the reverse reaction to take place**

2. Explain what is meant by dynamic equilibrium.

	1. Recall that the ⇌ symbol is used to show that a reaction is reversible. • E.g. The Haber Process: nitrogen + hydrogen ⇌ ammonia 2. Describe the connection between reactants and products during dynamic equilibrium. • During the reaction, the same percentage of reactants and products are formed at the same rate. 3. Identify where the products of the Haber process come from. • nitrogen - extracted from the air • hydrogen - obtained from natural gas 4. Recall the conditions for the Haber process. • **The purified gases (nitrogen and hydrogen) are passed over a catalyst of iron at:** • **a high temperature (about 450 °C) and** • **a high pressure (about 200 atmospheres).**	**3. Describe the formation of ammonia as a reversible reaction between nitrogen and hydrogen and that it can reach a dynamic equilibrium.** • **Ammonia is manufactured using the Haber process. It is used to make nitrogen-based fertilisers. This is a reversible reaction between nitrogen (from the air) and hydrogen (from natural gas) that can reach dynamic equilibrium. The reaction is illustrated below:** **Word equation: Nitrogen + hydrogen ⇌ ammonia** **Formula equation: N_2 (g) + $3H_2$ (g) ⇌ $2NH_3$ (g)**		
Impressive reading	**Impressive speaking**	**Impressive writing**	**Resilience**	**Employability via:**
1 lesson. Reading for information	**Able to explain models of dynamic equilibrium. Explain the need for fertilisers and impact on food availability (culture capital)**	**Structured answers. Plastic bags vs Paper bags**	**Explaining how conditions push reverse changes in line with Chataliers principle (simple terms)**	Product Design involving plastics, ceramics, polymers and composites; material scientist, engineering: composite, chemical, polymer; mining, artist, architect

SEND

- Opening activity/theme is opening slide to ensure learner buy in
- Opportunities for retrieval practice and building on prior knowledge: knowledge recall slide
- Multi-sensory approach using reading, listening, practical work, watching videos, dual-coding, practical work, paired working, observing teacher demonstrations
- Repetition of key vocabulary in every lesson
- Curriculum time allocated for the explicit teaching of key vocabulary
- Skills ordered logically and sequenced with an increase in complexity
- Links to prior learning explicitly highlighted to support non-verbal reasoning
- Texts used/alternative texts available with a consideration to reading age