

Quantitative chemistry

State the numbers of atoms for each element in H_2O .

Conservation of mass and balanced chemical equations

Quantitative chemistry

State the number of atoms for each element in NH_3 .

Conservation of mass and balanced chemical equations

Quantitative chemistry

State the number of atoms in $\text{Ca}(\text{OH})_2$.

Conservation of mass and balanced chemical equations

Quantitative chemistry

State the number of atoms for each element in $\text{Ca}(\text{OH})_2$.

Conservation of mass and balanced chemical equations

Quantitative chemistry

Balance $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$.

Conservation of mass and balanced chemical equations

Quantitative chemistry

Balance $\text{Cl}_2 + \text{KI} \rightarrow \text{KCl} + \text{I}_2$.

Conservation of mass and balanced chemical equations

Quantitative chemistry

What is the relative formula mass of a compound?

Relative formula mass

Quantitative chemistry

What is the relative formula mass of H_2SO_4 ?

Relative formula mass

Quantitative chemistry

What is the relative formula mass of Na_2CO_3 ?

Relative formula mass

Quantitative chemistry

What is the relative formula mass of $\text{Ca}(\text{OH})_2$?

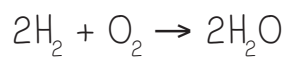
Relative formula mass

Nitrogen = 1, Hydrogen = 3.

Hydrogen = 2, Oxygen = 1.

Calcium = 1, Oxygen = 2, Hydrogen = 2.

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$\text{H} = 1 \times 2 = 2;$
 $\text{S} = 32;$
 $\text{O} = 16 \times 4 = 64;$
 $2 + 32 + 64 = 98$

The sum of the relative atomic masses of the atoms in the compound.

$\text{Ca} = 40;$
 $\text{O} = 16 \times 2 = 32;$
 $\text{H} = 1 \times 2 = 2;$
 $40 + 32 + 2 = 74$

$\text{Na} = 23 \times 2 = 46;$
 $\text{C} = 12;$
 $\text{O} = 16 \times 3 = 48;$
 $46 + 12 + 48 = 106$

Quantitative chemistry

Explain why some reactions may seem to involve a change in mass?

Mass changes when a reactant or product is a gas

Quantitative chemistry

Describe the mass changes that occur when a metal reacts with oxygen in a non-enclosed system.

Mass changes when a reactant or product is a gas

Quantitative chemistry

Describe the mass changes that occur during the thermal decomposition of metal carbonates in a non-enclosed system.

Mass changes when a reactant or product is a gas

Quantitative chemistry

Define uncertainty.

Chemical measurements

Quantitative chemistry

How do you calculate the range of a set of measurements?

Chemical measurements

Quantitative chemistry

What does a large range of a set of measurements about the mean signify?

Chemical measurements

Quantitative chemistry

What is the formula to calculate the uncertainty about the mean.

Chemical measurements

Quantitative chemistry

What are chemical amounts measured using?

Moles (HT)

Quantitative chemistry

What is the symbol for the mole?

Moles (HT)

Quantitative chemistry

How is the relative formula mass of a substance linked to the mole?

Moles (HT)

When a metal reacts with oxygen the mass of the metal oxide will be more than the mass of the metal because of the addition of oxygen gas.

In a non-enclosed system one of the reactants or products may be a gas and its mass has not been measured.

Uncertainty is the amount of error in your measurements.

When a metal carbonate decomposes the mass of the products will appear less than the mass of the reactants because carbon dioxide gas is given off.

A large range suggest the measurements are imprecise and there is a large uncertainty about the results.

The range is the highest repeat value minus the lowest repeat value.

Moles

Uncertainty = range / 2.

The mass of 1 mole of a substance is equal to its relative formula mass in grams.
E.g. Mr of carbon = 12; therefore 1 mole of carbon has a mass of 12g.

Mol

Quantitative chemistry

Compare the number of particles in one mole of carbon (C) with the number of particles in one mole of carbon dioxide (CO₂).

Moles (HT)

Quantitative chemistry

What is the value of the Avogadro constant?

Moles (HT)

Quantitative chemistry

What is the formula that links the number of moles, relative formula (or atomic) mass and mass in grams?

Moles (HT)

Quantitative chemistry

How many moles are there in 44g of H₂O?

Moles (HT)

Quantitative chemistry

Calculate the mass of 0.4mol of CO₂.

Moles (HT)

Quantitative chemistry

Describe the following equation in terms of moles: $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$.

Amounts of substances in equations (HT)

Quantitative chemistry

What is the formula to calculate the percentage mass of an element in a compound?

Amounts of substances in equations (HT)

Quantitative chemistry

Describe how you would balance an equation using the masses of the products and reactants.

Using moles to balance equations (HT)

Quantitative chemistry

12g of magnesium (Mg) react with 8g of oxygen (O₂) to produce 20g of magnesium oxide (MgO). Write a balanced equation for the reaction.

Using moles to balance equations (HT)

Quantitative chemistry

What is a limiting reactant?

Limiting reactants (HT)

6.02×10^{23} per mole

The number of particles in one mole of carbon is equal to the number of particles in one mole of carbon dioxide.

Number of moles = $44 / (1 \times 2) + 16$;
Number of moles = $44 / 18$;
Number of moles = 2.4 mol

Number of moles = mass in grams / Mr of the substance

1 mole of magnesium reacts with 2 moles of hydrochloric acid to form 1 mole of magnesium chloride and 1 mole of hydrogen.

Rearrange the equation; mass = number of moles x Mr of the substance; mass = $0.4 \times (12 + (16 \times 2))$; mass = 0.4×44 ; mass = 17.6g

Divide the mass of each substance by its relative formula mass to find the number of moles of each substance. Divide the number of moles of each substance by the smallest number of moles in the reaction. If the any of the numbers are not whole numbers, multiply all the numbers so that they become whole numbers.

Percentage mass of an element in a compound = $(\text{Ar} \times \text{number of atoms of the element} / \text{Mr of the compound}) \times 100$

The limiting reactant limits the amount of product made in a reaction.

Number of moles of magnesium = $12 / 24 = 0.5$ moles
Number of moles of oxygen = $8 / 32 = 0.25$ moles.
Number of moles of MgO = $20 / 40 = 0.5$ moles.
Divide each substance by the smallest number of moles in the reaction (oxygen = 0.25);
Mg = $0.5 / 0.25 = 2$; $\text{O}_2 = 0.25 / 0.25 = 1$; MgO = $0.5 / 0.25 = 2$. The balanced equation for the reaction is:
 $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$

Quantitative chemistry

Why is it common to use an excess of one of the reactants in a chemical reaction?

Limiting reactants (HT)

Quantitative chemistry

What does the mass of a product formed in a chemical reaction depend upon?

Limiting reactants (HT)

Quantitative chemistry

What is a solution?

Concentration of solutions

Quantitative chemistry

What is a solute?

Concentration of solutions

Quantitative chemistry

What is a solvent?

Concentration of solutions

Quantitative chemistry

What is the formula to calculate the concentration of a solution?

Concentration of solutions

Quantitative chemistry

How many cm^3 in 1 dm^3 ?

Concentration of solutions

Quantitative chemistry

What is the concentration of a salt solution when 20g of salt is dissolved in 500 cm^3 of water?

Concentration of solutions

Quantitative chemistry

Explain how the concentration of the solution is related to the mass of the solute and the volume of the solvent (HT).

Concentration of solutions

Chemical changes

What are the products when metals react with oxygen?

Metal oxides

The mass of the limiting reactant.

To ensure that the other reactants involved are used up.

The solid part of a solution which has been dissolved.

A solution consists of a solute (solid) dissolved in a solvent (liquid).

Concentration = mass of the solute (g) / volume of solvent (dm³).

The liquid part of the solution.

Convert 500cm³ into 0.5 dm³. Concentration = mass of solute / volume of solvent; concentration = 20 / 0.5 = 40g/dm³

1000cm³ = 1 dm³

Metal oxides.

The more solute added for a given volume the higher the concentration of a solution. The more solvent added for a given mass of solute the lower the concentration of the solution.

Chemical changes

What type of reactions occur when metals react with oxygen?

Metal oxides

Chemical changes

Define oxidation with reference to oxygen.

Metal oxides

Chemical changes

Define reduction with reference to oxygen.

Metal oxides

Chemical changes

What do metals form when they react with other substances?

The reactivity series

Chemical changes

What is the reactivity of a metal related to?

The reactivity series

Chemical changes

Put zinc, lithium, potassium, copper, iron, calcium, sodium and magnesium in order of reactivity (most reactive first).

The reactivity series

Chemical changes

Which two non-metals are often placed in the reactivity series.

The reactivity series

Chemical changes

Write out the reactivity series including the two non-metals.

The reactivity series

Chemical changes

What type of reaction occurs between a reactive metal and a less reactive metal compound?

The reactivity series

Chemical changes

What is the general equation to show the reaction of metal with water.

The reactivity series

Oxidation occurs when a substance gains oxygen.

Oxidation.

Metals form positive ions.

Reduction occurs when a substance loses oxygen.

Potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper.

The reactivity of a metal is related to the ease by which it can form ions (lose electrons).

Potassium, sodium, lithium, calcium, magnesium, carbon, zinc, iron, hydrogen and copper

Carbon and hydrogen.

Metal + water → metal hydroxide + hydrogen.

A displacement reaction.

Chemical changes

Write out a balanced equation to show the reaction between sodium and water.

The reactivity series

Chemical changes

What is the general equation to show the reaction of metal with acid.

The reactivity series

Chemical changes

How are most metals found in the Earth?

Extraction of metals and reduction

Chemical changes

What is a metal ore?

Extraction of metals and reduction

Chemical changes

Why is gold found as a metal in the Earth?

Extraction of metals and reduction

Chemical changes

How can iron, zinc and copper be extracted from their oxides?

Extraction of metals and reduction

Chemical changes

Identify which substances have been oxidised and which substances have been reduced in the following equation:
$$2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2$$

Extraction of metals and reduction

Chemical changes

Define oxidation with reference to electrons.

Oxidation and reduction in terms of electrons (HT)

Chemical changes

Define reduction with reference to electrons.

Oxidation and reduction in terms of electrons (HT)

Chemical changes

Write out the ionic equation for the following displacement reaction:
$$\text{Fe} + \text{CuSO}_4 \rightarrow \text{FeSO}_4 + \text{Cu}$$

Oxidation and reduction in terms of electrons (HT)

Metal + acid → salt + water.



A metal compound which is mined.

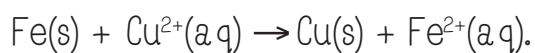
Metals are usually found as compounds in the Earth.

These metals are extracted from their oxides by reduction with carbon. This works because these metals are less reactive than carbon.

Because it is unreactive and does not form compounds.

Oxidation is electron loss.

Iron oxide (Fe_2O_3) is reduced (loses oxygen). Carbon (C) is oxidised (gains oxygen).



Reduction is electron gain.

Chemical changes

Define the term spectator ion.

Oxidation and reduction in terms of electrons (HT)

Chemical changes

What are the spectator ions in the following equation:



Oxidation and reduction in terms of electrons (HT)

Chemical changes

Write out the half equations for the following reaction:



Oxidation and reduction in terms of electrons (HT)

Chemical changes

What are the products of a reaction between most metals and acid?

Reactions of acids with metals

Chemical changes

Describe the type of reaction that occurs between metals and acids.

Reactions of acids with metals

Chemical changes

Which substances are oxidised in the reaction between metals and acids?

Reactions of acids with metals

Chemical changes

Which substances are reduced in the reaction between metals and acids?

Reactions of acids with metals

Chemical changes

Define alkali.

Neutralisation of acids and salt production

Chemical changes

Define base.

Neutralisation of acids and salt production

Chemical changes

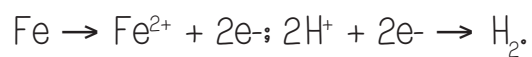
How are acids neutralised?

Neutralisation of acids and salt production



An ion that takes no part in the reaction.

Salt and hydrogen.



Metals

Redox reactions.

Soluble metal hydroxides.

Hydrogen

By reacting with alkalis or bases.

Insoluble metal hydroxides and metal oxides.

Chemical changes

What is the general equation to show the reaction between acids and metal oxides?

Neutralisation of acids and salt production

Chemical changes

What is the general equation to show the reaction between acids and metal hydroxides?

Neutralisation of acids and salt production

Chemical changes

What is the general equation to show the reaction between acids and metal carbonates?

Neutralisation of acids and salt production

Chemical changes

The production of a particular salt depends on which two factors?

Neutralisation of acids and salt production

Chemical changes

Predict the salt formed from a reaction between nitric acid and potassium hydroxide.

Neutralisation of acids and salt production

Chemical changes

Predict the salt formed from a reaction between hydrochloric acid and calcium carbonate.

Neutralisation of acids and salt production

Chemical changes

Predict the salt formed from a reaction between sulfuric acid and copper oxide.

Neutralisation of acids and salt production

Chemical changes

Deduce the formula of magnesium chloride using the ions Mg^{2+} and Cl^- .

Neutralisation of acids and salt production

Chemical changes

Deduce the formula of zinc sulfate using the ions Zn^{2+} and SO_4^{2-} .

Neutralisation of acids and salt production

Chemical changes

Describe how soluble salts can be made.

Soluble salts

Metal hydroxide + acid \rightarrow salt + water.

Metal oxide + acid \rightarrow salt + water.

The acid used and the positive (metallic) ions in the alkali or base.

Metal carbonates + acid \rightarrow salt + water + carbon dioxide (bubbles!)

Calcium chloride.

Potassium nitrate.

MgCl₂.

Copper sulfate.

React an acid with an insoluble substance (e.g. metal, metal oxide, metal hydroxide or metal carbonate). Add the solid till no more reacts. The unreacted powder will be visible in the beaker. Excess acid is filtered off and the solution of the new salt is collected.

ZnSO₄.

Chemical changes

How can salt solutions be used to form solid salts?

Soluble salts

Chemical changes

What ions do acids produce in a aqueous solution?

The pH scale and neutralisation

Chemical changes

What ions do alkalis form in a aqueous solution.

The pH scale and neutralisation

Chemical changes

What does pH mean?

The pH scale and neutralisation

Chemical changes

What is the pH scale a measure of?

The pH scale and neutralisation

Chemical changes

What numbers on the scale represent acids?

The pH scale and neutralisation

Chemical changes

What numbers on the pH scale represent alkalis?

The pH scale and neutralisation

Chemical changes

What does pH 7 represent on the scale?

The pH scale and neutralisation

Chemical changes

Name two ways the pH of a solution can be measured.

The pH scale and neutralisation

Chemical changes

What type of reaction occurs between an acid and an alkali.

The pH scale and neutralisation

H^+ .

Crystallisation.

per Hydrogen.

OH^- .

1 - 6.

The acidity or alkalinity of a solution.

Neutral.

8 - 14.

Neutralisation.

Using a wide range indicator (e.g. universal indicator) or a pH probe.

Chemical changes

Write an ionic equation for the reaction between an acid and an alkali.

The pH scale and neutralisation

Chemical changes

What is a strong acid?

Strong and weak acids (HT)

Chemical changes

Give three examples of strong acids.

Strong and weak acids (HT)

Chemical changes

What is a weak acid?

Strong and weak acids (HT)

Chemical changes

Give three examples of weak acids.

Strong and weak acids (HT)

Chemical changes

Explain the difference between the terms concentrated and dilute acids and weak and strong acids.

Strong and weak acids (HT)

Chemical changes

For a given concentration of an aqueous solution, what is the relationship between the strength of acid and the pH.

Strong and weak acids (HT)

Chemical changes

Describe how the pH scale is linked to the hydrogen ion concentration.

Strong and weak acids (HT)

Chemical changes

What type of compounds can be electrolysed?

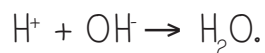
Electrolysis

Chemical changes

What state must the compound be in for electrolysis to take place?

Electrolysis

A strong acid is completely ionised in solution.



A weak acid is only partially ionised in solution.

Hydrochloric, nitric and sulfuric acids.

Dilute and concentrated refer to the amount of substance in a solution (e.g. the number of moles). Weak and strong refer to the amount of ionisation that has occurred.

Ethanol, citric and carbonic acids.

As pH concentration decreases by one unit (e.g. from 5 to 4), the hydrogen ion concentration increases by a factor of ten (e.g. from 10 to 100).

The stronger the acid, the lower the pH.

Molten (liquid) or in an aqueous solution.

Ionic compounds.

Chemical changes

What is an electrolyte?

Electrolysis

Chemical changes

What is the negative electrode called?

Electrolysis

Chemical changes

What is the positive electrode called?

Electrolysis

Chemical changes

What happens when an electric current is passed through an electrolyte?

Electrolysis

Chemical changes

What ions do lead bromide form when melted?

Electrolysis of molten ionic compounds.

Chemical changes

What type of electrodes are used during the electrolysis of lead bromide?

Electrolysis of molten ionic compounds.

Chemical changes

What happens when a molten ionic compound is electrolysed?

Electrolysis of molten ionic compounds.

Chemical changes

What is formed at the positive electrode (anode) during the electrolysis of lead bromide?

Electrolysis of molten ionic compounds.

Chemical changes

What is the ionic equation for the positive electrode (anode)?

Electrolysis of molten ionic compounds.

Chemical changes

What is formed at the negative electrode (cathode) during the electrolysis of lead bromide?

Electrolysis of molten ionic compounds.

Cathode.

Liquids or solutions that are able to conduct electricity.

Positive charged ions move to the negative electrode (cathode). Negatively charged ions move towards the positive electrode (anode). The ions gain or lose electrons at the electrodes producing elements.

Anode.

Inert electrodes.

Pb^{2+} and Br^- .

Bromine.

The metal ions are attracted to the negative electrode (cathode). The non-metal ions are attracted to the positive electrode (anode).

Lead.



Chemical changes

What is the ionic equation for the negative electrode (cathode)?

Electrolysis of molten ionic compounds.

Chemical changes

What ions do zinc chloride form when melted?

Electrolysis of molten ionic compounds.

Chemical changes

Predict the products of the electrolysis of zinc chloride.

Electrolysis of molten ionic compounds.

Chemical changes

How can metals be extracted by electrolysis?

Using electrolysis to extract metals.

Chemical changes

Which type of metals are extracted by electrolysis?

Using electrolysis to extract metals.

Chemical changes

Why is aluminium sometimes called solid electricity?

Using electrolysis to extract metals.

Chemical changes

Describe how aluminium is manufactured.

Using electrolysis to extract metals.

Chemical changes

What is formed at the negative electrode (cathode) during the electrolysis of aluminium oxide?

Using electrolysis to extract metals.

Chemical changes

What is the ionic equation for the negative electrode (cathode) during the electrolysis of aluminium oxide?

Using electrolysis to extract metals.

Chemical changes

What is formed at the positive electrode (anode) during the electrolysis of aluminium oxide?

Using electrolysis to extract metals.

Zn^{2+} and Cl^- .



Metals can be extracted from molten compounds.

Chlorine will be formed at the positive electrode (anode) and zinc will be formed at the negative electrode (cathode).

Large amounts of energy are used in the extraction process to melt the compounds and to produce the electrical current for electrolysis.

Metals which are more reactive than carbon.

Aluminium.

Aluminium is extracted by the electrolysis of a mixture of aluminium oxide and cryolite using carbon as the positive electrode (anode).

Oxygen.



Chemical changes

What is the ionic equation for the positive electrode (anode) during the electrolysis of aluminium oxide?

Using electrolysis to extract metals.

Chemical changes

Why is cryolite used in this process?

Using electrolysis to extract metals.

Chemical changes

Why does the positive electrode (anode) have to be constantly replaced?

Using electrolysis to extract metals.

Chemical changes

What ions are present in all aqueous solutions?

Electrolysis of aqueous solutions

Chemical changes

What affects the ions discharged when an aqueous solution is electrolysed?

Electrolysis of aqueous solutions

Chemical changes

Explain what will be discharged from a negative electrode (cathode) during the electrolysis of an aqueous solution.

Electrolysis of aqueous solutions

Chemical changes

Explain what will be discharged from a positive electrode (anode) during the electrolysis of an aqueous solution.

Electrolysis of aqueous solutions

Chemical changes

What are the ions found in a solution of copper sulfate: $\text{CuSO}_4(\text{aq})$?

Electrolysis of aqueous solutions

Chemical changes

Explain what will happen when an aqueous solution of copper sulfate is electrolysed.

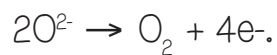
Electrolysis of aqueous solutions

Chemical changes

What are the ions found in a solution of sodium chloride: $\text{NaCl}(\text{aq})$?

Electrolysis of aqueous solutions

To reduce the melting point of aluminium oxide.



H^+ and OH^- .

The oxygen formed at the positive electrode (anode) reacts with the carbon in the electrode.

If the metal ion is less reactive than hydrogen the metal will be formed. Otherwise, hydrogen will be released.

The relative reactivity of the elements involved.

H^+ , OH^- , Cu^{2+} and SO_4^{2-}

Oxygen is produced unless the solution contains halide ions in which event a halogen will be produced.

H^+ , OH^- , Na^+ and Cl^-

Copper is less reactive than hydrogen so copper is formed at the negative electrode (cathode). As copper sulfate contains no halide ions oxygen will be formed at the positive electrode (anode).

Chemical changes

Explain what will happen when an aqueous solution of sodium chloride is electrolysed.

Electrolysis of aqueous solutions

Chemical changes

What happens at the cathode (negative electrode) during electrolysis?

Reactions at electrodes as half equations (HT).

Chemical changes

What type of reaction occurs at the cathode (negative electrode)?

Reactions at electrodes as half equations (HT).

Chemical changes

What happens at the anode (positive electrode) during electrolysis?

Reactions at electrodes as half equations (HT).

Chemical changes

What type of reaction occurs at the anode (positive electrode)?

Reactions at electrodes as half equations (HT).

Chemical changes

Write out the half equations for the electrolysis of copper sulfate solution.

Reactions at electrodes as half equations (HT).

Chemical changes

Write out the half equations for the electrolysis of sodium chloride solution.

Reactions at electrodes as half equations (HT).

Energy changes

What happens to energy in chemical reactions?

Exothermic and endothermic reactions

Energy changes

Compare the energy in the reactants and the products if energy is transferred to the surroundings during the reaction.

Exothermic and endothermic reactions

Energy changes

Compare the energy in the reactants and the products if energy is transferred from the surroundings during the reaction.

Exothermic and endothermic reactions

Positive metal ions or hydrogen gain electrons.

Sodium is more reactive than hydrogen so copper is formed at the negative electrode (cathode). As there are halide ions present in solution (the chloride ions) chlorine gas will be given off at the positive electrode (anode).

Negative non-metal ions lose electrons

Reduction.

At the negative electrode (cathode): $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$. At the positive electrode (anode): $4\text{OH}^- \rightarrow \text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^-$.

Oxidation.

Energy is concerned in chemical reactions.

At the negative electrode (cathode): $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$. At the positive electrode (anode): $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$.

The reactant molecules have less energy than the reactant molecules.

The product molecules have less energy than the reactant molecules.