

# Edexcel Chemistry GCSE

## Topic 1 - Key Concepts in Chemistry

### Flashcards

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What are the three ideas in John Dalton's theory about the atom?



# What are the three ideas in John Dalton's theory about the atom?

- Atoms cannot be created, divided or destroyed.
- Atoms of the same element are exactly the same and atoms of different elements are different.
- Atoms join with other atoms to make new substances.



What discovery caused the original Dalton model of an atom to change?



What discovery caused the original Dalton model of an atom to change?

The discovery of subatomic particles.



# How did JJ Thomson discover the electron?



# How did JJ Thomson discover the electron?

Thomson experimented with a cathode ray tube.

The beam moved towards the positively charged plate so he knew that the particles must have a negative charge.



Describe the atomic model proposed by  
JJ Thomson





Describe the atomic model proposed by JJ Thomson

Plum pudding model.

Negatively charged electrons scattered through a positively charged material.



What did Ernest Rutherford discover from his gold foil experiment?



# What did Ernest Rutherford discover from his gold foil experiment?

He shot a beam of positively charged particles at sheet of gold foil.

- Most of the particles passed straight through suggesting that atoms were mostly empty space.
- A few particles were deflected and a few bounced directly back showing that there must be a tiny, dense and positively-charged nucleus.



# Describe Rutherford's new model of the atom



Describe Rutherford's new model of the atom

- Mass is concentrated in the central nucleus.
- Mostly empty space.
- Electrons travel in random paths around the nucleus.



# Describe the structure of an atom



Describe the structure of an atom

Small central nucleus made up of protons and neutrons.

Electrons orbit (move around) the nucleus in shells.



What is the radius of the nucleus? How large is it compared to the radius atom?





What is the radius of the nucleus? How large is it compared to the radius atom?

The radius of the nucleus is  $1 \times 10^{-14}$  m.

This is 1/10000 of the atomic radius.



What are the relative masses of protons,  
neutrons and electrons?



What are the relative masses of protons, neutrons and electrons?

Proton: 1

Neutron: 1

Electron:  $1/1836$



What are the relative charges of protons,  
neutrons and electrons?



What are the relative charges of protons, neutrons and electrons?

Proton: +1

Neutron: 0

Electron: -1



Why do atoms contain equal numbers of protons and electrons?



# Why do atoms contain equal numbers of protons and electrons?

Atoms are stable with no overall charge.

Protons are positively charged and electrons are negatively charged. For the charges to balance, the number of protons and electrons must be equal.



Where is the mass of an atom concentrated?





Where is the mass of an atom concentrated?

In the nucleus.



What does the atomic number of an atom represent?



What does the atomic number of an atom represent?

The number of protons.



What does the mass number of an atom mean?



What does the mass number of an atom mean?

The mass number is the number of protons and neutrons found in the nucleus of an atom.



Fill in the blank:

‘Atoms of the same element have the same number of \_\_\_\_\_ in the nucleus and this is unique to that element’



Fill in the blank: 'Atoms of the same element have the same number of \_\_\_\_\_ in the nucleus and this is unique to that element'

Protons



# What is an isotope?





## What is an isotope?

Isotopes are atoms with the same number of protons (so they are the same element) but a different number of neutrons.

Isotopes of an element have the same atomic number but different mass numbers.



Boron has the atomic number 5 and the mass number 11. How many protons, electrons and neutrons does Boron have?



Boron has the atomic number 5 and the mass number 11. How many protons, electrons and neutrons does Boron have?

5 protons

5 electrons

6 neutrons



Why is the relative atomic mass not always a whole number?



Why is the relative atomic mass not always a whole number?

Different isotopes of the same element have different mass numbers. The relative atomic mass is an average of the masses of all these isotopes.



What two values would be required to calculate the relative atomic mass of chlorine?  
(higher only)



What two values would be required to calculate the relative atomic mass of chlorine?

Mass numbers and relative abundances of all the isotopes of chlorine.



How did Mendeleev arrange the elements in his periodic table?





# How did Mendeleev arrange the elements in his periodic table?

Elements arranged with increasing atomic masses.

Elements with similar properties put into groups (due to periodic trends in chemical properties).

Switched the position of some elements.

Gaps left for undiscovered elements.



How was Mendeleev able to predict the properties of new elements?



How was Mendeleev able to predict the properties of new elements?

Mendeleev left gaps in his periodic table. He used the properties of elements next to these gaps to predict the properties of undiscovered elements.



Mendeleev's table lacked some amount of accuracy in the way he'd ordered his elements. Why was this?



Mendeleev's table lacked some amount of accuracy in the way he'd ordered his elements. Why was this?

Isotopes were poorly understood at the time.

Protons and neutrons had not yet been discovered.



How are elements arranged in the modern periodic table?



How are elements arranged in the modern periodic table?

In order of increasing atomic number.



Fill in the blank:  
'Elements in the same group (column)  
have similar \_\_\_\_\_'





Fill in the blank: 'Elements in the same group (column) have similar \_\_\_\_\_'

Chemical properties



Why do elements in the same column  
have similar chemical properties?



Why do elements in the same column have similar chemical properties?

Same number of outer shell electrons.

Number of outer shell electrons determines how an atom reacts.



What does the period (row) number tell you about all the elements in that period?



What does the period (row) number tell you about all the elements in that period?

Elements in the same period have the same number of electron shells.

e.g. all elements in period 4 have 4 shells of electrons.



What does group (column) number tell you about all the elements in that group?



What does group (column) number tell you about all the elements in that group?

All elements in the same group have the same number of outer electrons.

e.g. all elements in group 2 have 2 electrons in their outer shell



On which side of the periodic table are the metals positioned?





On which side of the periodic table are the metals positioned?

Left hand side.



What determines whether an element is a metal or non-metal?



What determines whether an element is a metal or non-metal?

Atomic structures of the elements.



What is the maximum number of electrons allowed in each of the first 3 shells?



What is the maximum number of electrons allowed in each of the first 3 shells?

1st shell: 2

2nd shell: 8

3rd shell: 8



# When are atoms most stable?



When are atoms most stable?

When they have full electron shells.



The atomic number of Na is 11.  
What is the electron configuration of Na?





The atomic number of Na is 11.

What is the electron configuration of Na?

2, 8, 1



How is the electron configuration of an element related to its position in the periodic table?



# How is the electron configuration of an element related to its position in the periodic table?

Diagram:

The number of rings is the period.

The number of electrons in the outer ring is the group.

The total number of electrons is the atomic number.

Number (e.g. sodium, 2.8.1):

Sodium has 3 shells as there are 3 numbers.

The last number is the number of outer shell electrons / the group.

The sum of the digits is the atomic number.



# What is an ionic bond?



# What is an ionic bond?

A bond between a metal and non-metal involving the transfer of electrons.



In terms of electrons, describe what happens to the metal and non-metal when an ionic bond forms



In terms of electrons, describe what happens to the metal and non-metal when an ionic bond forms

The metal atom loses electrons to become a positively charged ion (cation).

The non-metal gains electrons to become a negatively charged ion (anion).



# What is an ion?





# What is an ion?

An ion is an atom or group of atoms with a positive or negative charge.



If an ion is positively charged, has it lost or gained electrons?



If an ion is positively charged, has it lost or gained electrons?

It has lost electrons. There are fewer negatively charged electrons to cancel out the charge of the positive protons. This means the overall charge becomes positive.



$\text{Na}^+$  has the atomic number 11 and the mass number 23. How many protons, neutrons and electrons are in this ion?



$\text{Na}^+$  has the atomic number 11 and the mass number 23. How many protons, neutrons and electrons are in this ion?

Protons: 11

Electrons: 10

Neutrons: 12



$O^{2-}$  has the atomic number 8 and the mass number 16. How many protons, neutrons and electrons are in this ion?



$O^{2-}$  has the atomic number 8 and the mass number 16. How many protons, neutrons and electrons are in this ion?

Protons: 8

Electrons: 10

Neutrons: 8



Why do elements in groups 1, 2, 6 and 7 readily form ions?





Why do elements in groups 1, 2, 6 and 7 readily form ions?

So they become more stable and achieve the electron structure of the noble gases (group 8).



What type of ions do elements in group 1 and 2 form?



What type of ions do elements in group 1 and 2 form?

Cations (positive)

- Group 1 metals will form 1+ ions
- Group 2 metals will form 2+ ions



What type of ions do elements in groups 6 and 7 form?



What type of ions do elements in groups 6 and 7 form?

They are non-metals so form anions (negative)

- Group 6 will form 2- ions
- Group 7 will form 1- ions



What does it mean if an ionic compound ends in -ide?



What does it mean if an ionic compound ends in -ide?

The compound contains 2 elements.



What does it mean if an ionic compound ends in -ate?





What does it mean if an ionic compound ends in -ate?

The compound contains at least three elements, one of which is oxygen.



Describe the structure of an ionic compound



Describe the structure of an ionic compound

Lattice structure.

Regular arrangement of ions.

Ions held together by strong electrostatic forces between ions with opposite charges.



What is the chemical formula of sodium oxide, formed from  $\text{Na}^+$  and  $\text{O}^{2-}$ ?



What is the chemical formula of sodium oxide, formed from  $\text{Na}^+$  and  $\text{O}^{2-}$ ?



Charges must balance so 2 sodium ions are required.



What is the chemical formula of magnesium hydroxide, formed from  $\text{Mg}^{2+}$  and  $\text{OH}^-$ ?



What is the chemical formula of magnesium hydroxide, formed from  $\text{Mg}^{2+}$  and  $\text{OH}^-$ ?



Charges must balance so 2 hydroxide ions are required.



# What is a covalent bond?





# What is a covalent bond?

A bond formed when an electron pair is shared between two atoms.



What forms as a result of covalent bonding?



What forms as a result of covalent bonding?

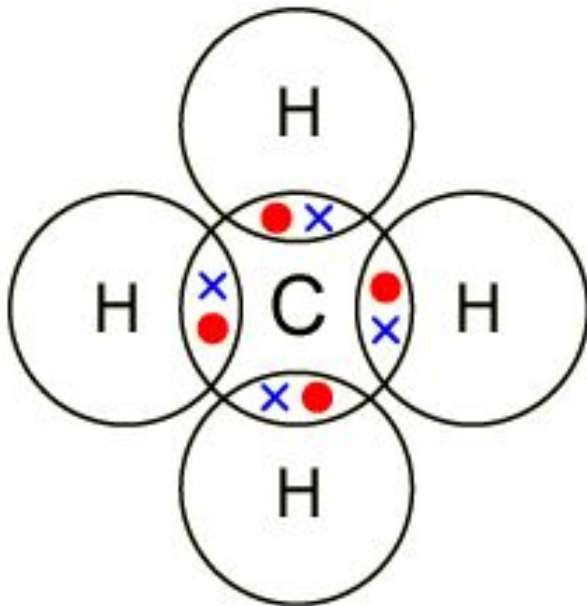
A molecule



Draw a dot and cross diagram for the formation of methane ( $\text{CH}_4$ )



Draw a dot and cross diagram for the formation of methane ( $\text{CH}_4$ )



True or false?  
'Covalent bonds are weak'



True or false?

‘Covalent bonds are weak’

**FALSE**

Covalent bonds are strong



Which is smaller, an atom or a molecule?





Which is smaller, an atom or a molecule?

An atom.

Simple molecules consist of atoms joined by strong covalent bonds within the molecule.



# Why do ionic compounds have high melting points?



Why do ionic compounds have high melting points?

Strong electrostatic attraction between the positive and negative ions requires a lot of energy to overcome.



# When do ionic compounds conduct electricity? Why?



# When do ionic compounds conduct electricity? Why?

When molten or aqueous (dissolved in water) because the ions are charged and free to move. When solid, the ions are fixed in an ionic lattice so can't move.



Why do simple molecular compounds have low melting and boiling points?



Why do simple molecular compounds have low melting and boiling points?

They have weak intermolecular forces (forces between molecules) which only require a little energy to overcome.



Do simple molecular compounds  
conduct electricity? Why / why not?





Do simple molecular compounds conduct electricity?  
Why / why not?

No because there are no charged particles.



Do giant covalent structures have a high melting point? Explain your answer.



Do giant covalent structures have a high melting point? Explain your answer.

Yes because they have lots of strong covalent bonds which require a lot of energy to break



# How do metals conduct electricity and heat?



# How do metals conduct electricity and heat?

The positive ions are fixed in a sea of delocalised electrons. These electrons are free to move and carry charge / energy.



True or false?  
'Metals are insoluble in water'



True or false?

‘Metals are insoluble in water’

TRUE



Name two giant covalent structures  
formed from carbon atoms





Name two giant covalent structures formed from carbon atoms

Graphite

Diamond



# Describe the structure of graphite



## Describe the structure and properties relating to graphite

Each carbon atom bonded to 3 other carbon atoms.

Layers of hexagonal rings of carbon atoms.

Weak intermolecular forces between layers.

One delocalised electron per carbon atom.



# Describe and explain the properties of graphite



## Describe and explain the properties of graphite

Graphite is soft / slippery because there are only weak intermolecular forces between layers which allow the layers to slide over one another.

Graphite conducts electricity because there is one delocalised electron per carbon atom. The delocalised electrons are mobile charges.



# Describe the structure of diamond



Describe the structure of diamond

All carbon atoms are covalently bonded to four other carbon atoms.

No delocalised electrons.



# Describe the properties of diamond





Describe the properties of diamond

Very hard.

Very high melting point.

Doesn't conduct electricity as there are no charged particles.



# What are the uses of graphite? Why?



What are the uses of graphite? Why?

Electrodes because graphite conducts electricity and has a high melting point.

Lubricant because it's slippery (the layers in graphite can slide over each other).



# Why is diamond used in cutting tools?



# Why is diamond used in cutting tools?

It's very hard.



# What is a fullerene?



# What is a fullerene?

A fullerene is a molecule made of carbon, shaped like a closed tube or hollow ball.



Name two fullerenes





Name two fullerenes

Graphene

$C_{60}$  (buckminsterfullerene)



What are the properties of the fullerene  
 $C_{60}$ ?



# What are the properties of the fullerene $C_{60}$ ?

- Slippery due to weak intermolecular forces.
- Low melting point.
- Spherical.
- Strong covalent bonds between carbon atoms in a molecule.
- Large surface area.



# What are the properties of graphene?



# What are the properties of graphene?

- High melting point due to covalent bonding between carbon atoms.
- Conducts electricity because it has delocalised electrons.



# Why is graphene useful in electronics?



## Why is graphene useful in electronics?

It is extremely strong and has delocalised electrons which are free to move and carry charge.

It is only one atom thick as it is a single layer of graphite.



What is a polymer? Name a polymer





What is a polymer? Name a polymer

Long chain molecules formed from many monomers.

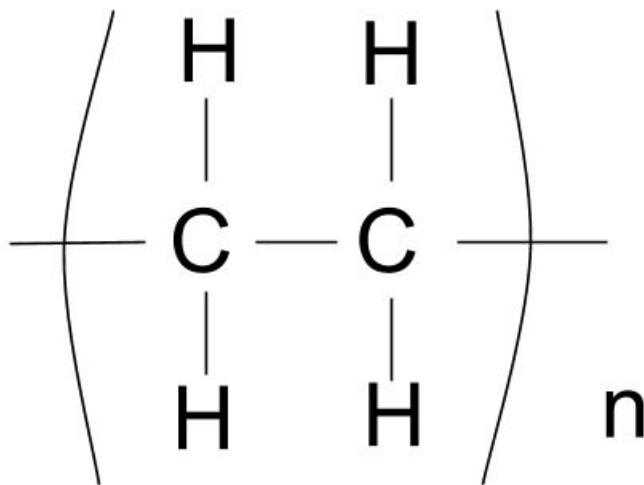
E.g. poly(ethene)



Draw the structure of poly(ethene)



Draw the structure of poly(ethene)



What bond is formed between carbon atoms in polymer molecules?



What bond is formed between carbon atoms in polymer molecules?

Covalent bonds



# What are the properties of metals?



## What are the properties of metals?

- High melting point.
- High density.
- Good conductors of electricity.
- Malleable and ductile.
- Generally shiny.



# Explain why metals are malleable





# Explain why metals are malleable

The atoms are arranged in uniform rows which can slide over one another.



# Explain why metals can conduct electricity



# Explain why metals can conduct electricity

The electrons in the metal are charges that can move.



# What are the properties of non-metals?



# What are the general properties of non-metals?

- Low boiling points.
- Poor conductors of electricity.
- Brittle when solid.



List the limitations of the following models when representing ionic compounds: dot and cross, 2D diagrams and 3D diagrams



List the limitations of the following models when representing ionic compounds: dot and cross, 2D diagrams and 3D diagrams

- Dot and cross - no lattice structure or ionic bonds.
- 2D diagrams - only shows one layer, doesn't show formation of ions.
- 3D diagrams - shows spaces between the ions, doesn't show charges.



List the limitations of the following models when representing covalent molecules: dot and cross and ball and stick





List the limitations of the following models when representing covalent molecules: dot and cross and ball and stick

- Dot and cross - doesn't show relative sizes of atoms or intermolecular forces.
- Ball and stick - bonds shown as sticks rather than forces, doesn't show how covalent bonds form.



How do you calculate the relative formula mass of a compound?



How do you calculate the relative formula mass of a compound?

Add together all the relative atomic masses of the atoms in the compound.



What is the empirical formula? What 2 values could be used to calculate the empirical formula of a simple compound?



What is the empirical formula? What 2 values could be used to calculate the empirical formula of a simple compound?

- The empirical formula is the smallest whole number ratio of the atoms of each element in a compound.
- Reacting masses or percentage composition can be used to calculate the empirical formula.



What is the empirical formula for  $\text{Fe}_2\text{O}_4$ ?



What is the empirical formula for  $\text{Fe}_2\text{O}_4$ ?

$\text{FeO}_2$



# What is the molecular formula?





# What is the molecular formula?

Actual number of atoms of each element in a compound.



Describe an experiment to work out the empirical formula of magnesium oxide



# Describe an experiment to work out the empirical formula of magnesium oxide

- Weigh a sample of magnesium.
- Heat the sample in a crucible.
- Weigh the mass of magnesium oxide at the end.
- Calculate the mass of oxygen (this is the increase of mass).
- Calculate the moles of magnesium and oxygen using the experimental mass and relative atomic mass.
- Work out the whole number ratio of the number of moles of magnesium to oxygen.



# What is the law of conservation of mass?



What is the law of conservation of mass?

No matter is lost or gained during a chemical reaction.



If a reaction is carried out in a closed system, what can you say about the total mass of the reaction throughout the experiment?



If a reaction is carried out in a closed system, what can you say about the total mass of the reaction throughout the experiment?

Mass stays constant.



If a reaction is carried out in an open flask and a gas is produced, what can you say about the total mass of the reaction throughout the experiment?





If a reaction is carried out in an open flask and a gas is produced, what can you say about the total mass of the reaction throughout the experiment?

Mass decreases as the gas escapes.



52g of calcium reacts with oxygen to form 79g of calcium oxide. Using the law of conservation of mass, what mass of oxygen is needed?



52g of calcium reacts with oxygen to form 79g of calcium oxide. Using the law of conservation of mass, what mass of oxygen is needed?

$$79 - 52 = 27$$

Mass of oxygen = 27g



What equation links mass, moles and  
relative atomic mass?  
(higher only)



What equation links mass, moles and relative atomic mass? (**higher only**)

Mass (g) = Moles x Relative atomic mass (Mr)



How can you calculate concentration in  $\text{g/dm}^3$ ?



How can you calculate concentration in  $\text{g}/\text{dm}^3$ ?

$$\text{Concentration}(\text{g}/\text{dm}^3) = \text{Mass}(\text{g})/\text{Volume}(\text{dm}^3)$$



What is the Avogadro constant?  
(higher only)





What is the Avogadro constant?  
(higher only)

The number of atoms, molecules or ions in one mole of a given substance.

The value of the constant is  $6.02 \times 10^{23}$ .



What is the mass of 20 moles of calcium carbonate,  $\text{CaCO}_3$ ?  
(higher only)



What is the mass of 20 moles of calcium carbonate,  
 $\text{CaCO}_3$ ?  
(higher only)

Mass (g) = Moles x Relative atomic mass (Mr)

Mr = 100

$20 \times 100 = 2000 \text{ g}$



What formula links the Avogadro  
constant, moles and number of  
particles?  
(higher only)



What formula links the Avogadro constant, moles and number of particles?

(higher only)

Number of particles = Avogadro constant x Moles



How many atoms are in 3 moles of  
copper?  
(higher only)



How many atoms are in 3 moles of copper?  
(higher only)

Number of atoms = Avogadro's constant x Moles

$$= 6.02 \times 10^{23} \times 3$$

$$= 1.81 \times 10^{24}$$



What is a limiting reagent in a chemical reaction?  
(higher only)





What is a limiting reagent in a chemical reaction?  
(higher only)

The chemical that is used up first in a reaction, preventing the formation of more product.

Typically, an excess of one of reactants is used to ensure that the other reactant is completely used up.

