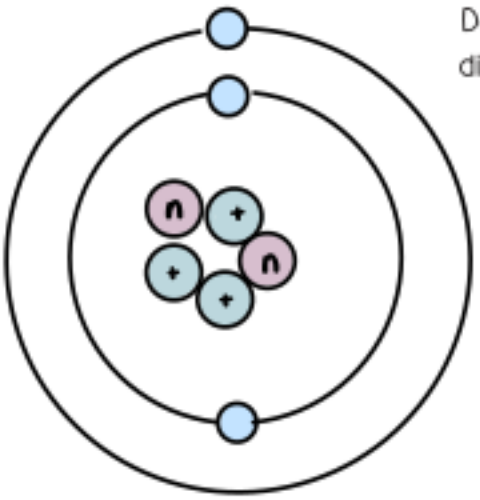
GCE AS Chem

atomic structure



↳ The idea of atoms was first proposed by the ancient Greek philosopher Democritus around 400 BCE. Scientists later developed atomic theory through discoveries made by John Dalton, J. J. Thomson, and Ernest Rutherford.

Mass number/ nucleon number = number of protons + number of neutrons

Atomic number = number of protons

Isotopes = atoms of the same element with same atomic number but different mass number

Relative atomic mass weighted mean mass of all isotope of an element compare with 1/12th the mass of carbon 12

Relative isotopic mass weighted means mass of an isotope of an element compared with 1/12th the mass of carbon-12

$$\text{Relative atomic mass} = \frac{(\text{Isotope 1 atomic number} \times \% \text{ abundance}) + (\text{Isotope 2 atomic number} \times \% \text{ abundance})}{100}$$

A sample of potassium has the following composition.

Isotope	^{39}K	^{40}K	^{41}K
% abundance	93.22	0.12	6.66

Calculate the relative atomic mass of this sample of potassium, giving your answer to **two** decimal places. (2)

$$\frac{(39 \times 93.222) + (40 \times 0.12) + (41 \times 6.66)}{100}$$

$= 39.1344$

$= 39.13$

A sample of potassium is known to consist of isotopes with mass numbers 39 and 41.

The relative atomic mass of this sample of potassium is 39.1.

Calculate the percentage abundance of each isotope. (2)

$$\frac{39 \times x + 41(100 - x)}{100} = 39.1$$

$$\frac{39x + 4100 - 41x}{100} = 39.1$$

$39x + 4100 - 41x = 3910$

$4100 - 3910 = 41x - 39x$

$190 = 2x$

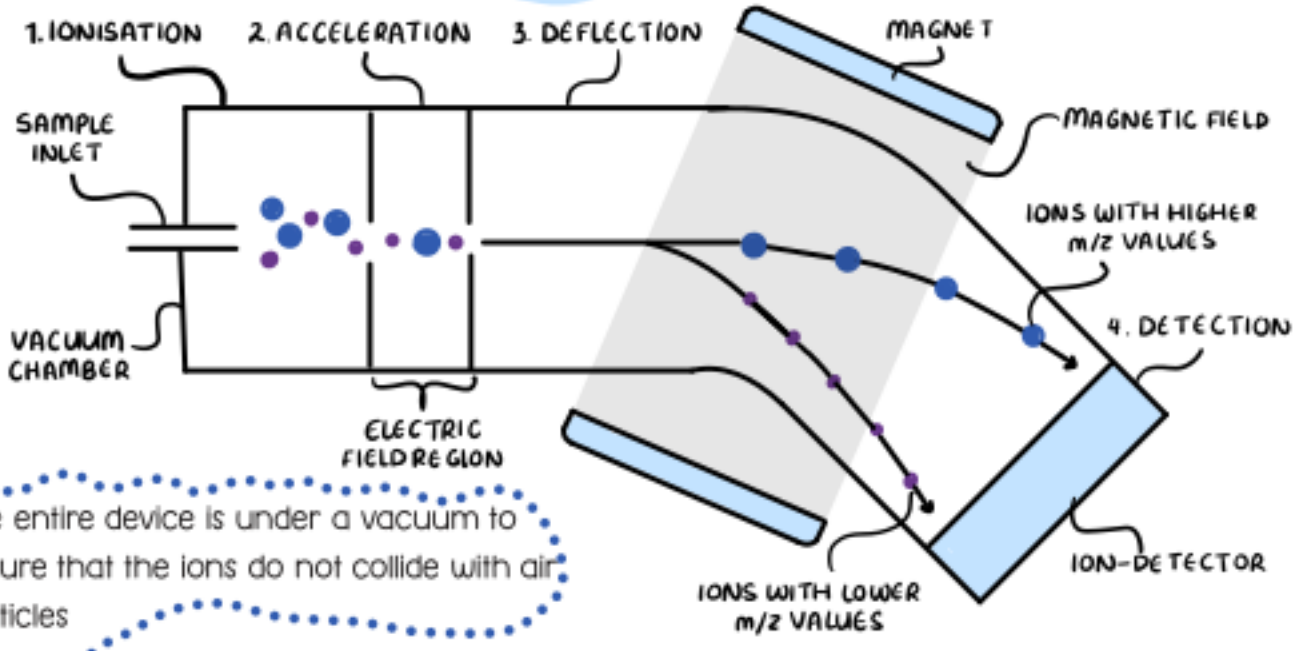
$x = \frac{190}{2} = 95$

% K-39 = 95%

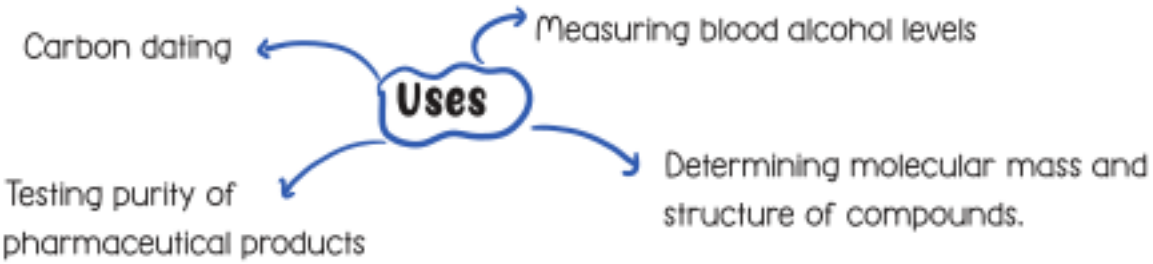
% K-41 = 100 - 95 = 5%

mass spectrometry

To calculate the relative atomic mass accurately
To measure the mass-to-charge ratio of ions.



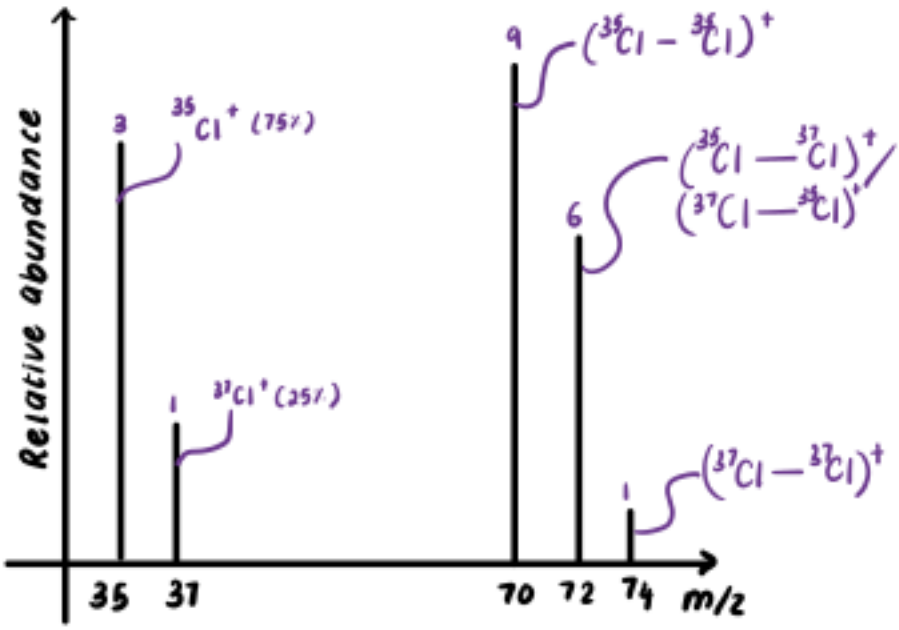
The entire device is under a vacuum to ensure that the ions do not collide with air particles



Process

1. Ionisation — vaporised sample (atoms/molecules) are bombarded with a beam of high energy electrons knocking out electrons from the atom in sample to form positive ions.
2. Acceleration — ions are accelerated by an electric field to give them the same kinetic energy
3. Deflection — ions pass through a magnetic field which deflects based on their mass-to-charge ratio. Lighter ions deflect more. Higher the mass, the lower deflection. Higher the charge, higher the deflection
4. Detection — ions strike a detector, generation a current. The signal strength is proportional to the number of ions of each type.

mass spectrum of chlorine



When a sample of diatomic chlorine molecules (Cl_2) enters the mass spectrometer, the molecules are ionised by removal of an electron, forming a molecular ion (Cl_2^+). The molecular ion has a mass equal to the combined mass of its constituent atoms. However, the molecular ion is not stable, so some molecules become fragmented into their atomic components.

The mass spectrum therefore contains two types of peaks:

- Peaks due to atomic isotopes = these represent the different isotopes of chlorine, ^{35}Cl and ^{37}Cl.
- Peaks due to molecular ions = these represent Cl_2^+ molecules containing different combinations of isotopes.

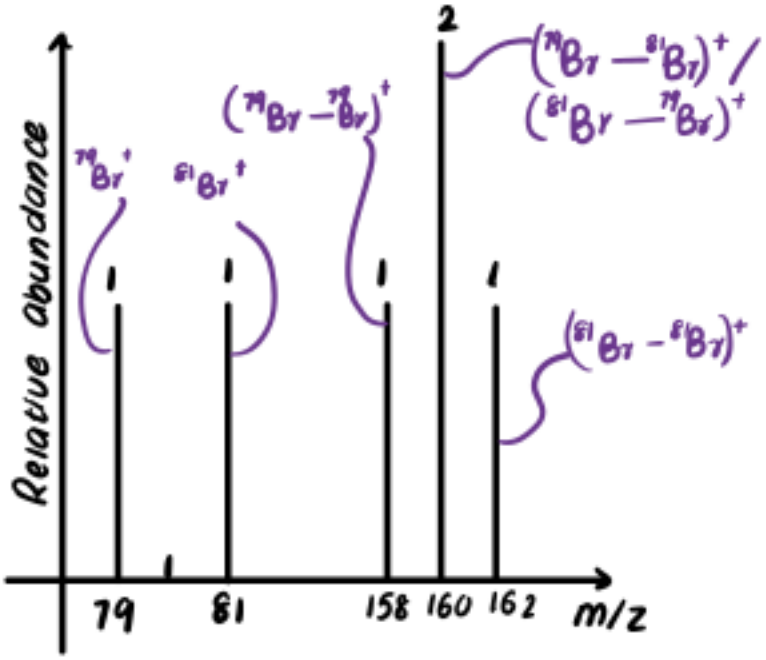
1. First, find the isotope ratio
Chlorine has two isotopes:
^{35}Cl = 75%
^{37}Cl = 25%
So their ratio is:
75 : 25 = 3 : 1
That means if you imagine 4 chlorine atoms, about 3 are ^{35}Cl and 1 is ^{37}Cl.

2. Now think about Cl_2 molecules
Each chlorine molecule contains two chlorine atoms.
Each atom can be either ^{35}Cl or ^{37}Cl.
So there are three possible combinations:
^{35}Cl–^{35}Cl
Both atoms are ^{35}Cl.
Probability: ¾ × ¾ = 9/16
^{35}Cl– ^{37}Cl
One atom is ^{35}Cl and the other is ^{37}Cl.
There are two ways this can happen:
^{35}Cl– ^{37}Cl
^{37}Cl–^{35}Cl
So, ¾ × ¼ × 2 = 6/16
That's why your working has the ×2.
^{37}Cl– ^{37}Cl
Both atoms are ^{37}Cl.
Probability:
¼ × ¼ = 1/16

peak ratio
^{35}Cl — $^{35}Cl^+$ ⇒ ¾ × ¾ = 9/16
^{37}Cl — $^{35}Cl^+$ ⇒ ¾ × ¼ × 2 = 6/16
^{37}Cl — $^{37}Cl^+$ ⇒ ¼ × ¼ = 1/16

3. Therefore, the peak ratio is
You get:
9/16 : 6/16 : 1/16
Since they all have the same denominator, simply remove the /16:
9 : 6 : 1
So the three molecular-ion peaks for chlorine have a peak ratio of 9 : 6 : 1.
And the peaks occur at:
70 : 72 : 74
because:
^{35}Cl + ^{35}Cl = 70
^{35}Cl + ^{37}Cl = 72
^{37}Cl + ^{37}Cl = 74

Mass spectrum of bromine



1. First, find the isotope ratio
Bromine has two isotopes:
^{79}Br = 50%
^{81}Br = 50%
So the isotope ratio is:
50 : 50 = 1 : 1
That means if you imagine 2 bromine atoms, 1 is ^{79}Br and 1 is ^{81}Br.

2. Now think about Br_2 molecules
Each bromine molecule contains two bromine atoms.
Each atom can be either ^{79}Br or ^{81}Br.
So there are three possible combinations:

^{79}Br–$^{79}Br^+$
Both atoms are ^{79}Br.
Probability: ½ × ½ = ¼

^{79}Br–$^{81}Br^+$
One atom is ^{79}Br and the other is ^{81}Br.
There are two ways this can happen:
^{79}Br–^{81}Br
^{81}Br–^{79}Br
So: ½ × ½ × 2 = ½

^{81}Br–$^{81}Br^+$
Both atoms are ^{81}Br.
Probability: ½ × ½ = ¼

peak ratio
$^{79}Br - ^{79}Br^+$ ⟶ ½ × ½ = ¼
$^{79}Br - ^{81}Br^+$ ⟶ ½ × ½ × 2 = ½
$^{81}Br - ^{81}Br^+$ ⟶ ½ × ½ = ¼

3. Therefore, the peak ratio is
¼ : ½ : ¼
Convert everything to quarters:
¼ : 2/4 : ¼
So: 1 : 2 : 1
Therefore, the three molecular-ion peaks of bromine have a peak ratio of 1 : 2 : 1.
And their m/z values are:
^{79}Br + ^{79}Br = 158
^{79}Br + ^{81}Br = 160
^{81}Br + ^{81}Br = 162
So you get:
m/z 158 : 160 : 162 = 1 : 2 : 1

Both graphs must be memorised

electronic configuration



1st quantum shell
2nd quantum shell
3rd quantum shell
4th quantum shell

quantum shells

defined as energy levels of an atom

All electrons in a quantum shell have similar but not identical energies

electrons in the first quantum shells have the lowest energy for that element

each quantum shell, apart from the first, is further divided into subshells of slightly different energy levels

1st quantum shell	Only 1 subshell
2nd quantum shell	2 subshells
3rd quantum shell	3 subshells
4th quantum shell	4 subshells

Orbitals

An orbital is a region in an atom which can hold up to two electrons with opposite spins

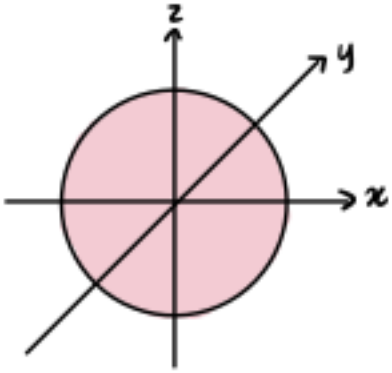
Each subshell contains on orbital

The S subshell has one orbital, and thus can hold up to $2e^-$

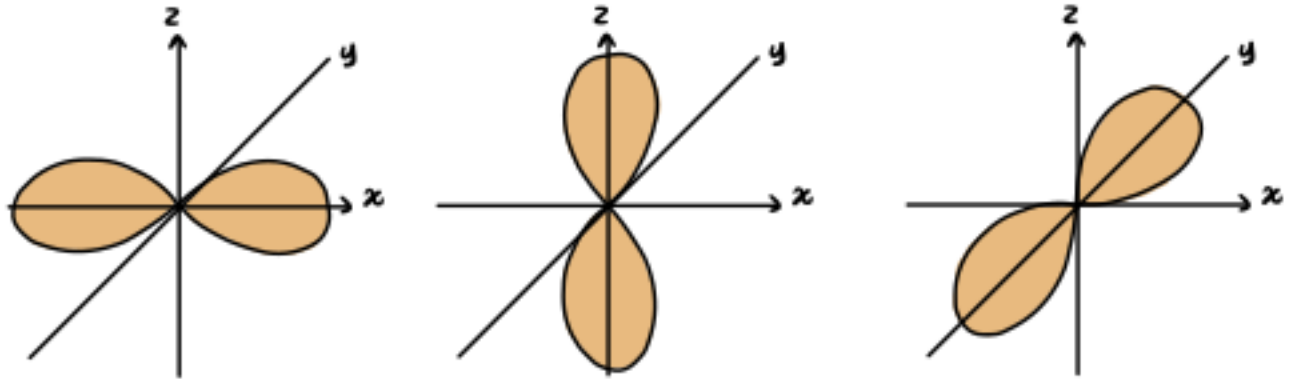
The P subshell has three orbitals, and thus can hold up to $6e^-$

The d subshell has five orbitals, and thus can hold up to $10e^-$

The f subshell has seven orbitals, and thus can hold up to $14e^-$



S orbital → Spherical shape



p-orbitals dumb-bell shaped

electronic configurations

H = $1s^1$
He = $1s^2$
Li = $1s^2 2s^1$
Be = $1s^2 2s^2$
B = $1s^2 2s^2 2p^1$
C = $1s^2 2s^2 2p^2$
N = $1s^2 2s^2 2p^3$
O = $1s^2 2s^2 2p^4$
F = $1s^2 2s^2 2p^5$
Ne = $1s^2 2s^2 2p^6$
Na = $1s^2 2s^2 2p^6 3s^1$
Mg = $1s^2 2s^2 2p^6 3s^2$

Al = $1s^2 2s^2 2p^6 3s^2 3p^1$
Si = $1s^2 2s^2 2p^6 3s^2 3p^2$
P = $1s^2 2s^2 2p^6 3s^2 3p^3$
S = $1s^2 2s^2 2p^6 3s^2 3p^4$
Cl = $1s^2 2s^2 2p^6 3s^2 3p^5$
Ar = $1s^2 2s^2 2p^6 3s^2 3p^6$
K = $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
Ca = $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
Sc = $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$
Ti = $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$
V = $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$

using the electronic configuration, we can find the group and period of any element

the period is the highest occupied energy level

The group is the total no. Of electrons in the highest occupied energy level

ex :- $^{35}B = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$

period = 4

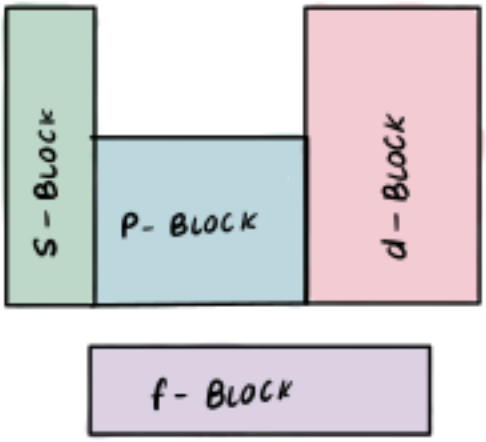
group (2+5) = 7

Q. How many orbitals are there, in total, in the first three quantum shells

1st quantum shell ⟶ 1s
2nd quantum shell ⟶ 2s 2p
3rd quantum shell ⟶ 3s 3p 3d

total = 3(1) + 2(3) + 1(5)
= 14 orbitals

s ⟶ 1 orbital
p ⟶ 3 orbitals
d ⟶ 5 orbitals

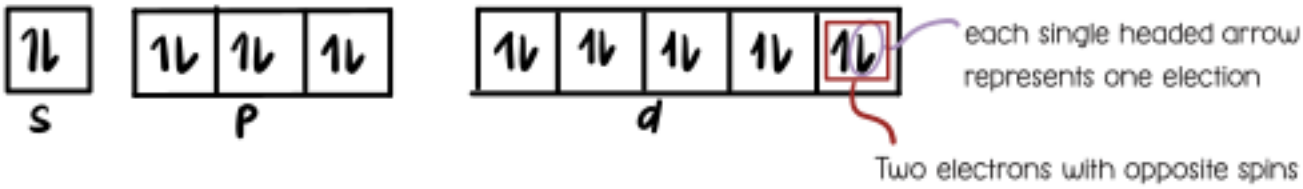


configuration related to the noble gases:

all noble gases have filled S and P orbitals and so are used as references to shorten the electronic configurations of elements

Ne = $1s^2\ 2s^2\ 2p^6$
Na = [Ne] $3s^1$
P = [Ne] $3s^2\ 3p^3$
K = [Ar] $4s^1$
Zn = [Ar] $4s^1\ 3d^{10}$

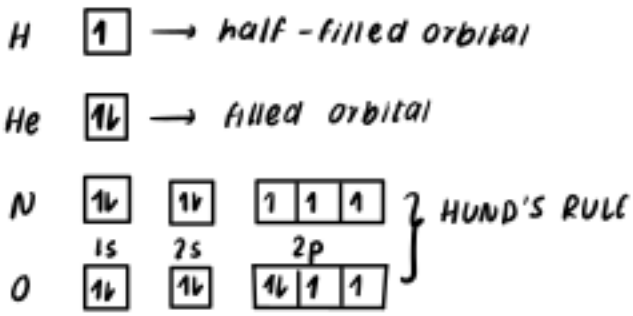
box notation



aufbau principle electrons are adapted to the lowest energy until all elections one accommodated

Paul's exclusion two elections cannot occupy the same orbita unless they have the opposite spin

Hund's rule electrons will occupy the orbitals singly before pairing



Correct electronic configuration of d-orbitals elements

Cr = [Ar] $4s^2\ 3d^4$ ✗ ⇒ stability of half filled d-orbitals
[Ar] $4s^1\ 3d^5$ ✓

Cu = [Ar] $4s^2\ 3d^9$ ✗ ⇒ stability of filled d-orbitals
[Ar] $4s^1\ 3d^{10}$ ✓

When these atoms form cations, the 4S electrons are removed before the 3d electrons

Note that electrons are removed from the highest quantum shell regardless of the filling order

isoelectronic configuration

Different elements or ions but same electronic configurations

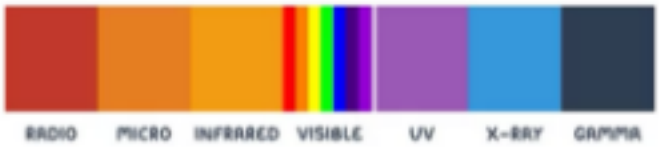
eg :- F^- = $1s^2\ 2s^2\ 2p^6$
O^{2-} = $1s^2\ 2s^2\ 2p^6$
Ne = $1s^2\ 2s^2\ 2p^6$
Na^+ = $1s^2\ 2s^2\ 2p^6$
Mg^{2+} = $1s^2\ 2s^2\ 2p^6$

Atomic emission spectra

Electromagnetic Spectrum

Electromagnetic (EM) radiation is energy transmitted as electromagnetic waves.

The electromagnetic spectrum is the complete range of electromagnetic radiation arranged by frequency or wavelength.



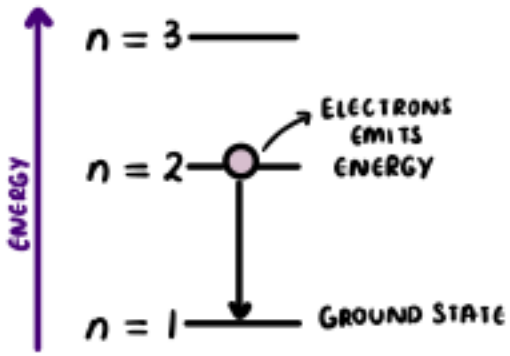
Across the spectrum:

- Frequency and energy increase.
- Wavelength decreases.

Order of the electromagnetic spectrum (lowest → highest frequency):

- Radio waves → Microwaves → Infrared → Visible light → Ultraviolet → X-rays → Gamma rays

Electron Energy Levels



- Electrons occupy fixed energy levels, also known as electron shells or quantum shells.
- In the ground state, electrons occupy the lowest possible energy levels.
- When an atom absorbs energy, electrons move to higher energy levels, becoming excited.
- Excited electrons are unstable and return to lower energy levels by emitting electromagnetic radiation.

- The energy levels are discrete, meaning electrons can only exist in specific energy levels and not between them.

Emission Spectra

An emission spectrum is produced when excited electrons fall from a higher to a lower energy level, emitting light of specific frequencies. It appears as bright coloured lines on a dark background.



- Each line corresponds to a particular electron transition.
- Every element has a unique arrangement of electrons, so each produces a unique emission spectrum.

Electrons are first excited from the ground state (n = 1).

When they return to lower energy levels, they emit radiation with specific frequencies.

Within each series, the spectral lines become closer together (converge) as the frequency increases, because the energy levels become closer together at higher values of n.

Emission Spectra as Evidence for Quantum Shells

- Electrons exist only in fixed energy levels (shells) around the nucleus.
- Each shell has a fixed amount of energy.
- Electrons move between shells by absorbing or emitting electromagnetic radiation.
- Since the energy differences are fixed, the emitted or absorbed radiation has a specific frequency.
- The presence of distinct spectral lines, rather than a continuous spectrum, shows that electrons cannot exist between energy levels.
- Electrons move from one energy level to another by making a quantum jump, with no intermediate energy state.

periodicity

Any property with a general trend in the periodic Table

ionisation Energy (IE)

the amount of energy required to remove one mole of electrons from one mole of gaseous atom to form mole of gaseous ion

1^{st} IE : $A(g) \longrightarrow A^{+}(g) + e^{-}$
2^{nd} IE : $A^{+}(g) \longrightarrow A^{2+}(g) + e^{-}$
3^{rd} IE : $A^{2+}(g) \longrightarrow A^{3+}(g) + e^{-}$

factors affecting IE

nuclear charge

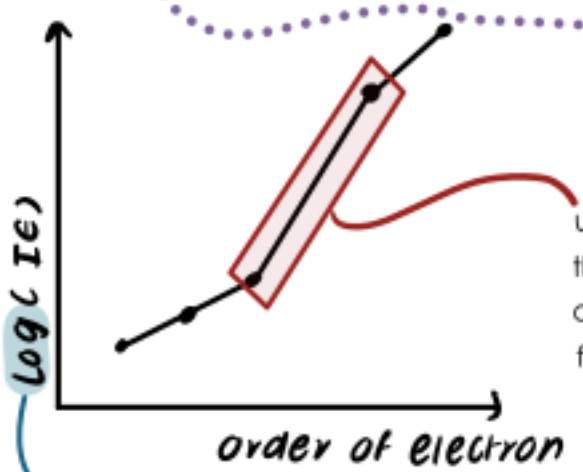
more protons= greater Nuclear change = more positively charged nucleus = more strongly elections attracted to the electrons increasing IE

atomic radius

Larger atomic radius = outer electrons further away from nucleus= weaker attractions between nucleus and electrons decreasing IE

Shielding (electron-electron repulsion)

As the number of Shells increases between The valence electron and positive nucleus shielding from both within an orbit and from inner electrons increases decreasing IE



when reaching a new inner electron shell, there is a big increase in IE because the attraction to the nucleus is much greater for inner shell

Successive ionisation energies increase by very large numbers. A log scare compresses large values and makes jumps easier to compare

Successive ionization energies provide evidence for the existence of quantum shells and the group which the element belongs.

IE trend across the period

increase in nuclear charge as number of protons increases

The Electron is removed from same quantum shell, with approximately same distance of the nucleus hence similar atomic radius

shielding by inner Shell electrons Remains the same as electrons are being added to the same shell

effect from Nuclear charge is significant therefore IE increases

IE trend down the group

increase in nuclear charge as number of protons increases

atomic radius increases, the distance between the nucleus and the outermost electron increases

electron shells increases down the group hence shielding from inner electrons increases

effects from shielding and atomic radius are significant therefore IE decreases

Specific trends in period 2:

Q: Why is there a slight decrease in IE between Be and B?

- As $Be = 1s^2\ 2s^2$ & $B = 1s^2\ 2s^2\ 2p_x^1$
- The outermost electron in B is in a 2p subshell.
- This is further away from the nucleus.
- So is less strongly attracted to it.

Q: Why is there a slight decrease in IE between N and O?

$N = 1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^1$ & $O = 1s^2\ 2s^2\ 2p_x^2\ 2p_y^1\ 2p_z^1$

- In nitrogen, the electron being removed is from a singly occupied 2p orbital.
- That electron is unpaired.
- More energy is required to remove an unpaired electron than a paired electron.
- This is due to the spin-pair repulsion between paired electrons.
- So less ionisation energy is needed to remove it.

Specific trends in period 3:

Q: Why is there a slight decrease in IE between Mg and Al?

As $Mg = 1s^2\ 2s^2\ 2p^6\ 3s^2$ & $Al = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p_x^1$

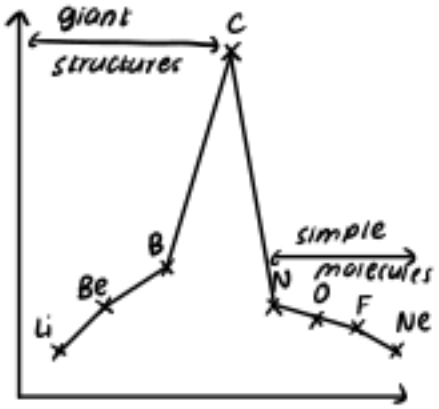
- The outermost electron in Al is being removed from a 3p subshell.
- This is further away from the nucleus.
- So is less strongly attracted to it.
- 3p electrons are higher in energy.
- They are also slightly shielded by the inner electrons.

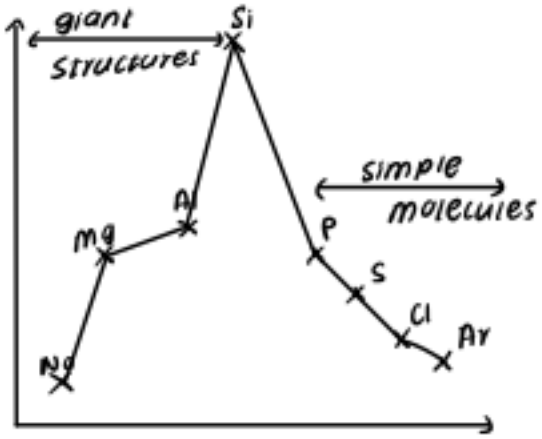
Q: Why is there a slight decrease in IE between P and S?

$P = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p_x^1\ 3p_y^1\ 3p_z^1$ & $S = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p_x^2\ 3p_y^1\ 3p_z^1$

- In phosphorus, the electron being removed is from a singly-occupied p orbital.
- While in sulfur, the electron being removed is paired.
- More energy is required to remove an unpaired electron than a paired electron.
- This is because there already is repulsion between paired electrons.
- So less ionisation energy is needed to remove it.

melting Temperatures





Na, Mg, Al, Li, Be, B **metallic bonding** = strong bonding between cations and anions

Si, C **giant covalent structures** = many strong covalent bonds

Cl, S, P, N, O, F **simple molecules** = weak intermolecular forces of attraction

Ar, Ne **monoatomic** = weak London forces

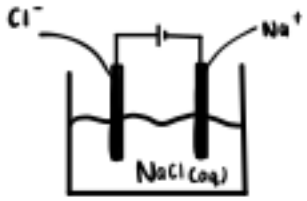
ionic substances

↳ electrostatic Forces of attraction between cations and anions in a lattice

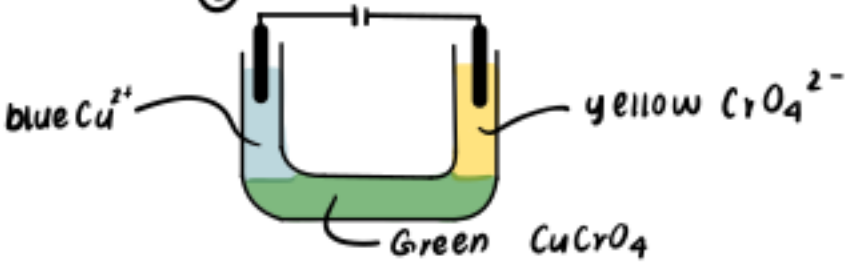


Evidence for existence of ions

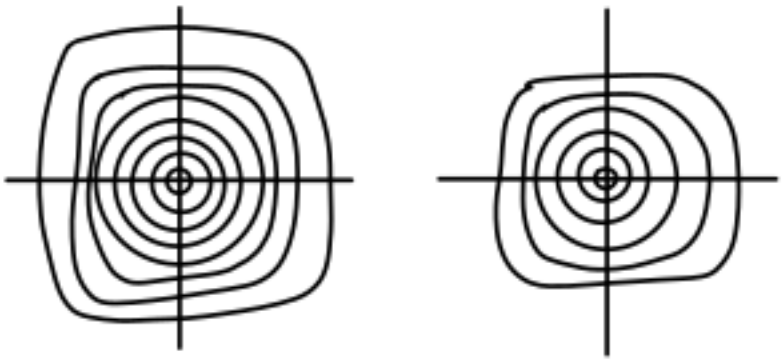
① electrolysis



② Electric current



③ electron density Maps using X-rays



electron density maps show the likelihood of finding electron in a region. The contours are lines of equal electron density.

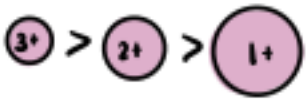
Ionic radii is the measure of the size of an ion

- Ionic radii increases with increasing negative charge
- Ionic radii decreases with increasing positive charge

Cations (positive ions)
High charge = small radius

Anions (negative ions)
High charge = large radius

Charge density = amount of charge per unit volume



Q. Why is melting point MgO greater than KI

Ionic bonds in MgO are much stronger than in KI, as Mg^{2+} was a higher charge density related to having a smaller side and higher change than K^+ so attraction forces are stronger. Also O^{2-} has a higher charge density related to having a smaller size and higher charge than I^- requiring much more energy to overcome these forces of attractions.

Q. Why is melting point of NaCl is than less KCl

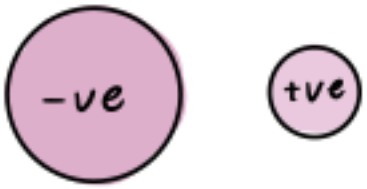
Ionic bonds in NaCl are stronger than in KCl as Na^+ has a higher change density related to having a smaller size than K^+ so attraction forces are stronger, requiring more energy to overcome them

polarisation of ions

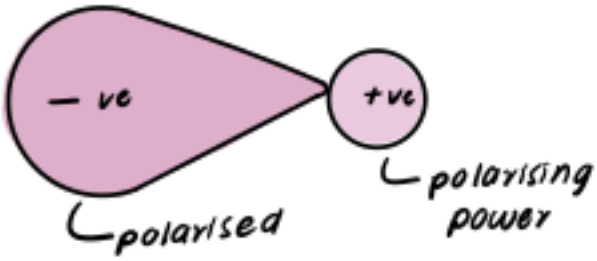
polarisation is the distortion of the electron density of an anion

Polarisation is also referred to as tailing or as covalent effect

ionic compound



polarised ionic bond

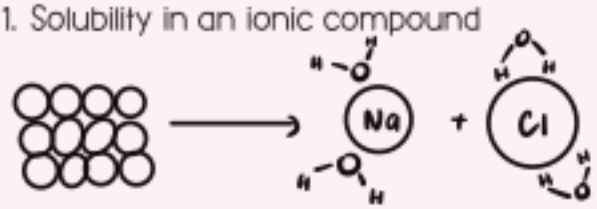


In an ionic lattice, the positive ion will attract the elections of the union, distorting the electron density of the anions

this polarization of anions creates some degree of sharing electrons between the nuclei = some degree of covalent character

Physical properties of ionic compounds

1. Solubility in an ionic compound



The energy required to break apart the lattice structure and the separate the ions, can in some instances be supplied by the hydration of the separated ions produced. Both cations and anions are attracted to water molecules because of the polarity that water molecules possesses

2. High melting points due to strong attraction between ions in the lattice

3.Brittleness layers slide over each other when stress is applied, therefore, particles with same charge come into contact they repel and the crystal breaks.

4. Electrical conductivity ionic compounds in solid state cannot conduct electricity as ions are not mobile. But ion in molten or liquid solutions as the ions are mobile, they can conduct electricity

Covalent bonding

The electrostatic attraction between two nuclei of the bonded atoms and the shared pair of electrons

formed when atomic orbital containing a single electron overlaps with another atomic orbital which also contains a single electron of another atom



σ bond (end-to-end overlap)



π bond (side-to-side overlap)

- π bonds cannot be formed until a σ bond is formed. Therefore, π bonds are seen in triple or double bonds
- π bands cannot be formed by s-orbitals
- π bonds are weaker than σ bonds

Bond strength — the amount of energy required break one mole of bond in gaseous state

Bond length — distance between the nuclei of two covalently bonded atoms

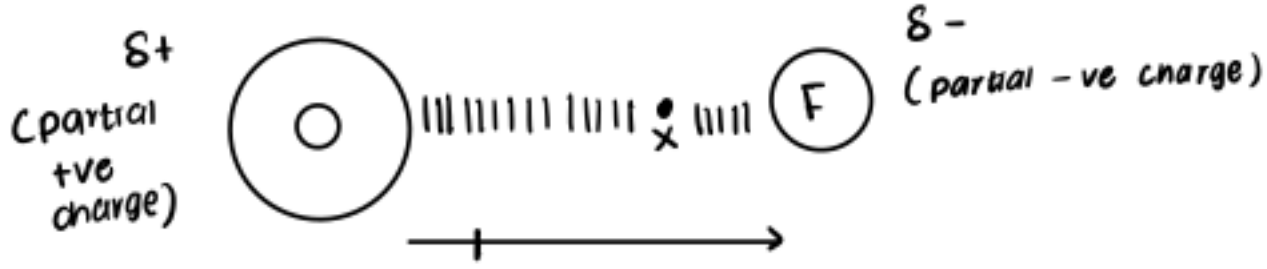
The shorter the bond greater the bond strength

Electronegativity

The ability of an atom to attract a bonding pair of electrons

- Increases across the period
- Decreases down the group

Fluorine is the most electronegative. Therefore, it attracts the bonding pair of electrons mine than oxygen.



Polar covalent bond	a type of covalent bond between two atoms where the bonding electrons are unequally distributed, because of this, one atom carries a partial positive charge and the other a partial negative charge

$H^{\delta+}—Cl^{\delta-}$ $H^{\delta+}—F^{\delta-}$ $Cl—Cl$ non-polar

distribution of electron density

Non-polar



$Cl—\overset{\cdot}{\underset{\times}{}}—Cl$

When two atoms of the same elements are bonding, the distribution of electron density is symmetrical around the nuclei because the electronegative of both atoms is equal.

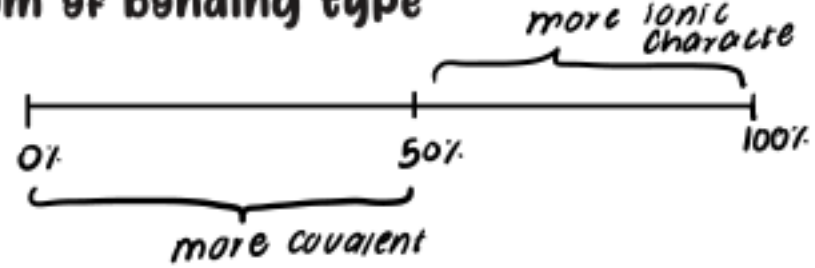
Polar bond

$H^{\delta+}—\overset{\cdot}{\underset{\times}{}}—Cl^{\delta-}$



the distribution of electron density is asymmetrical when the two atoms have different electronegativities. Therefore bond is polar

continuum of bonding type



electronegativity difference

- PURE IONIC
- POLARISED IONIC
- POLAR COVALENT
- PURE COVALENT

If the electronegativity difference is:

Zero= non-polar

Less than 1.7 more covalent character

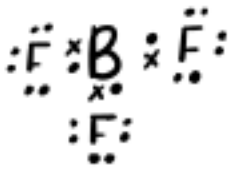
More than 1.7 more ionic character

Discrete (simple) molecules

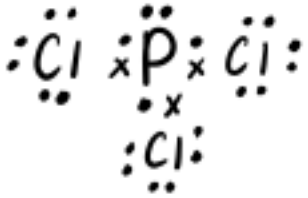
The octet rule states that atoms tend to gain, lose or share electrons in order to achieve 8 electrons in their outer Shell, giving them the stable electron configuration of a noble gas

However there are some atoms that are stable with fewer electrons than 8 electrons such as Be and B. Elements from period 3 and beyond can hold more than 8 electrons

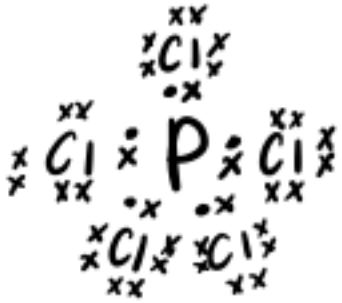
① BF_3



② PCl_3



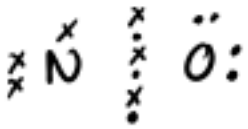
③ PCl_5



④ SF_6

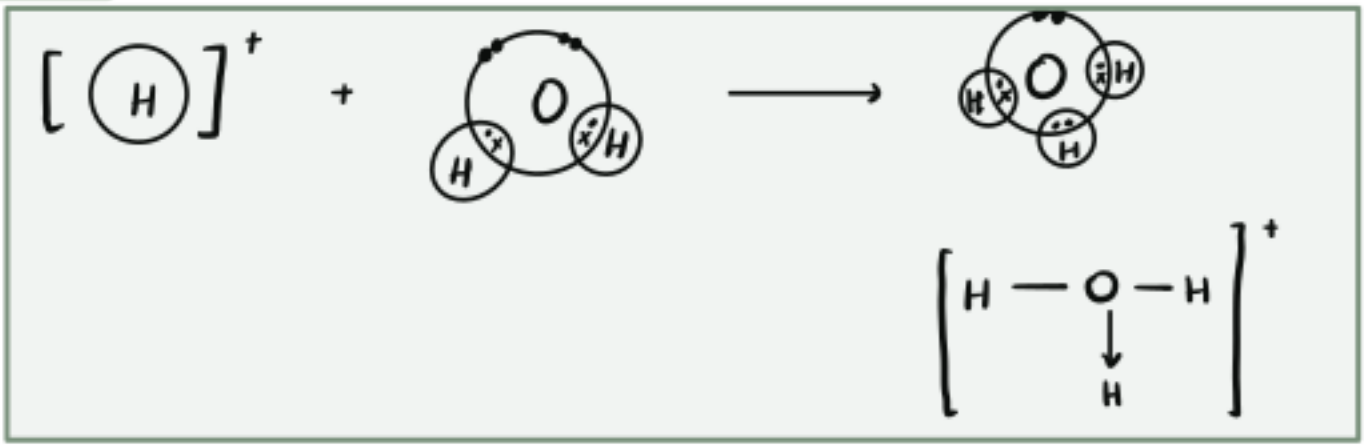


⑤ NO



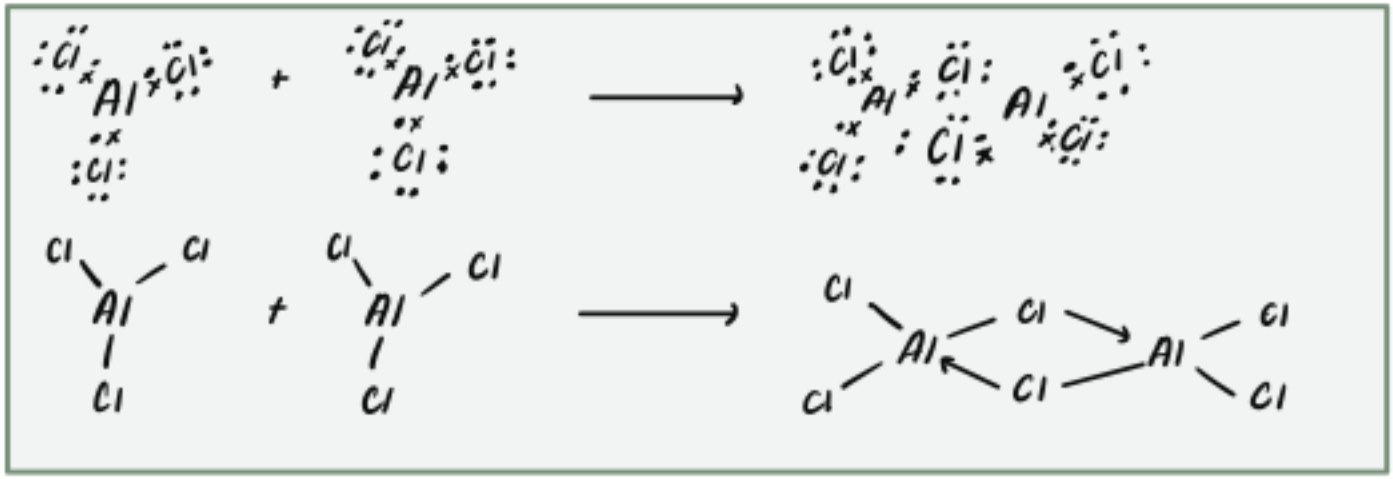
Dative covalent bond

Formed when an empty orbital of one atom overlap with an orbital containing a lone pair of electron of another atom.



Difference between covalent bond and dative covalent: in a covalent band the electrons are from each atom whereas in dative covalent bonds the electrons shared are from same single atom.

through dative covalent bonding, two chlorine atoms donate their lone pairs to each of the aluminum atoms to form a dimer

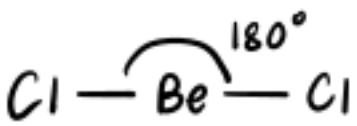


electron pair repulsion theory

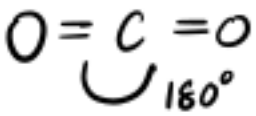
the shape of a molecule or ion is caused by repulsion between both one pair and band pairs
the electron pairs grange themselves around the central atom into a position of minimum repulsion
Lone pair-lone pair repulsion > lone pair - bond pair repulsion > bond pair - bond pair repulsion

shapes of molecules

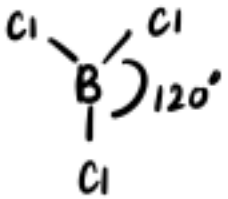
① LINEAR MOLECULES



bond angle = 180°
2 bond pairs
0 lone pairs

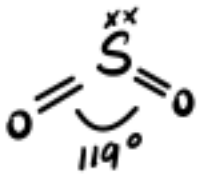


② TRIGONAL PLANAR



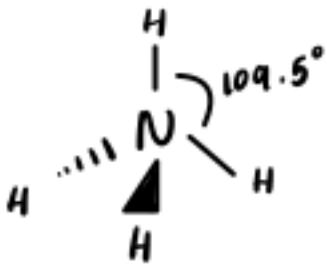
bond angle = 120°
3 bond pairs
0 lone pairs

③ V-SHAPED



bond angle = 119°
2 bond pairs
1 lone pair

④ TETRAHEDRAL



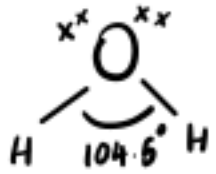
bond angle = 109.5°
4 bond pairs
0 lone pair

⑤ TRIGONAL PYRAMIDAL



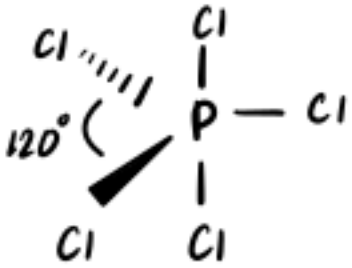
bond angle = 107°
3 bond pairs
1 lone pair

⑥ V-SHAPED



bond angle = 104.5°
2 bond pairs
2 lone pairs

⑦ TRIGONAL BIPYRAMIDAL



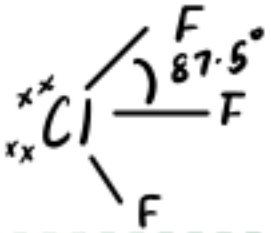
bond angle = 120°
5 bond pairs
0 lone pairs

⑧ SEESAW



bond angle = 102°
4 bond pairs
1 lone pair

⑨ DISTORTED T



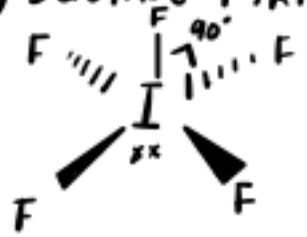
bond angle = 87.5°
3 bond pairs
2 lone pairs

⑩ OCTAHEDRAL



bond angle = 90°
6 bond pairs
0 lone pair

⑪ SQUARE PYRAMIDAL



bond angle = 90°
5 bond pairs
1 lone pair

⑫ SQUARE PLANAR



4 bond pairs
2 lone pairs
bond angle = 90°

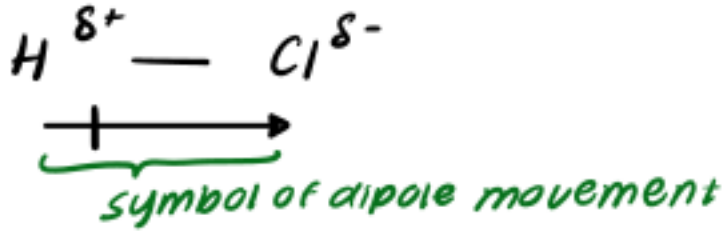
molecule polarity

dipole- When two charges of equal magnitude but opposite signs are separated by a small distance

in a covalent bond, bonded elections drift towards the more electronegative atom and that results in a separation of charge.

- If the dipoles reinforce one another, the molecule will possess an overall Dipole and is said to be polar.
- If the dipoles cancel aut one another due to an even distribution of charge, the resulting molecule will have no overall dipole and is said to be non polar

in some molecules, the bonds are polar however dipoles cancel out as the molecule is symmetrical. The molecule is asymmetrical when there is a lone pair



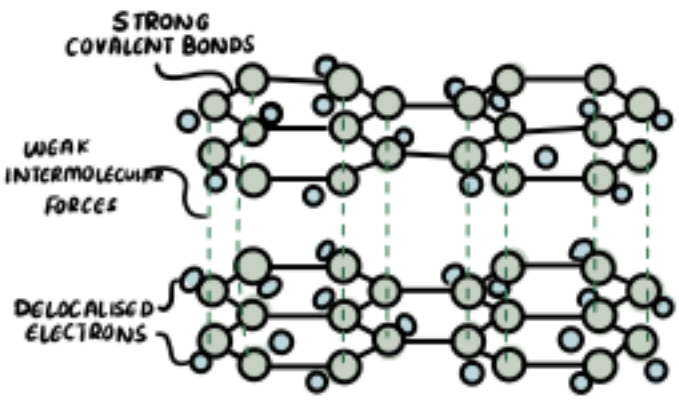
Giant covalent structures

Diamond

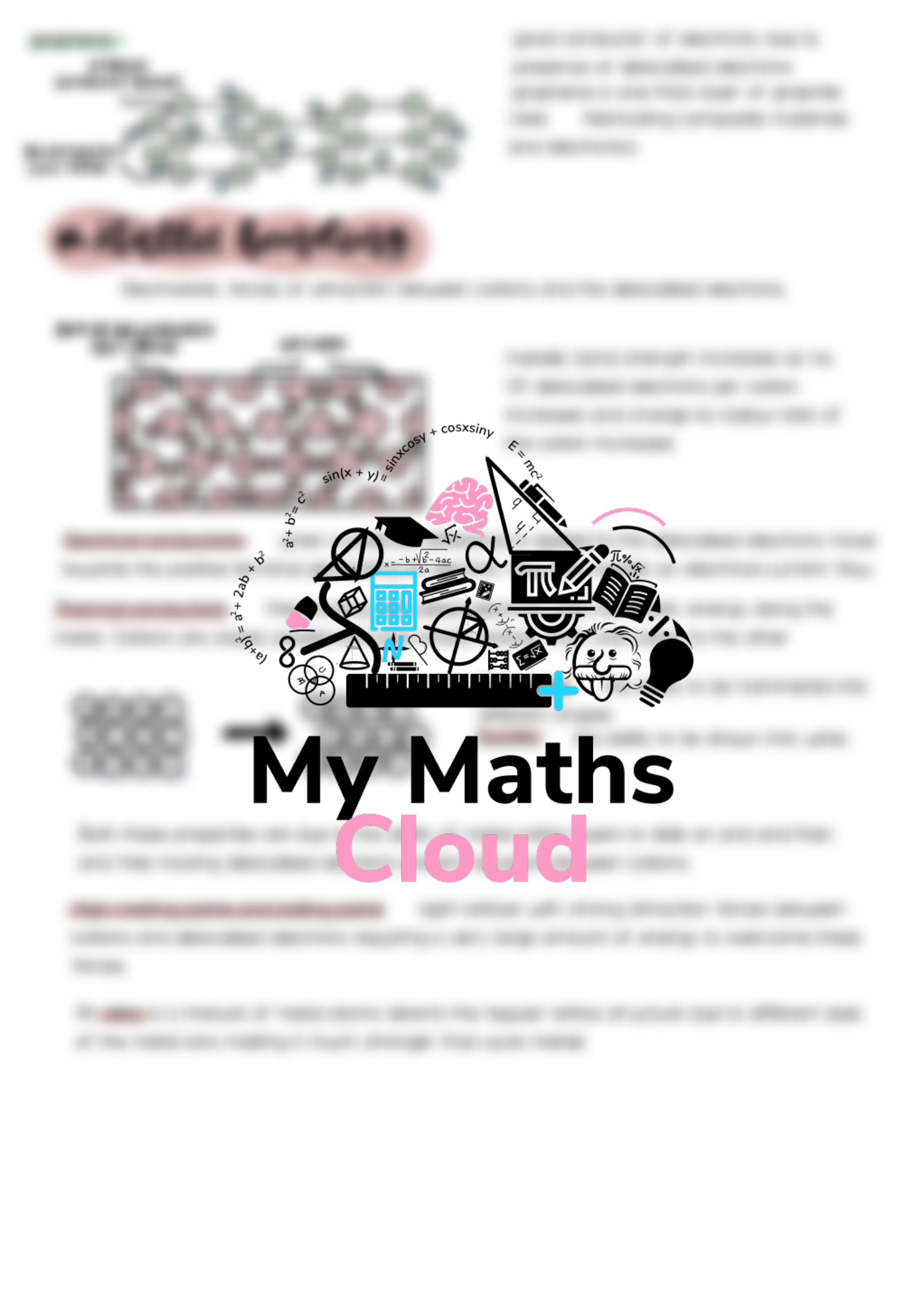


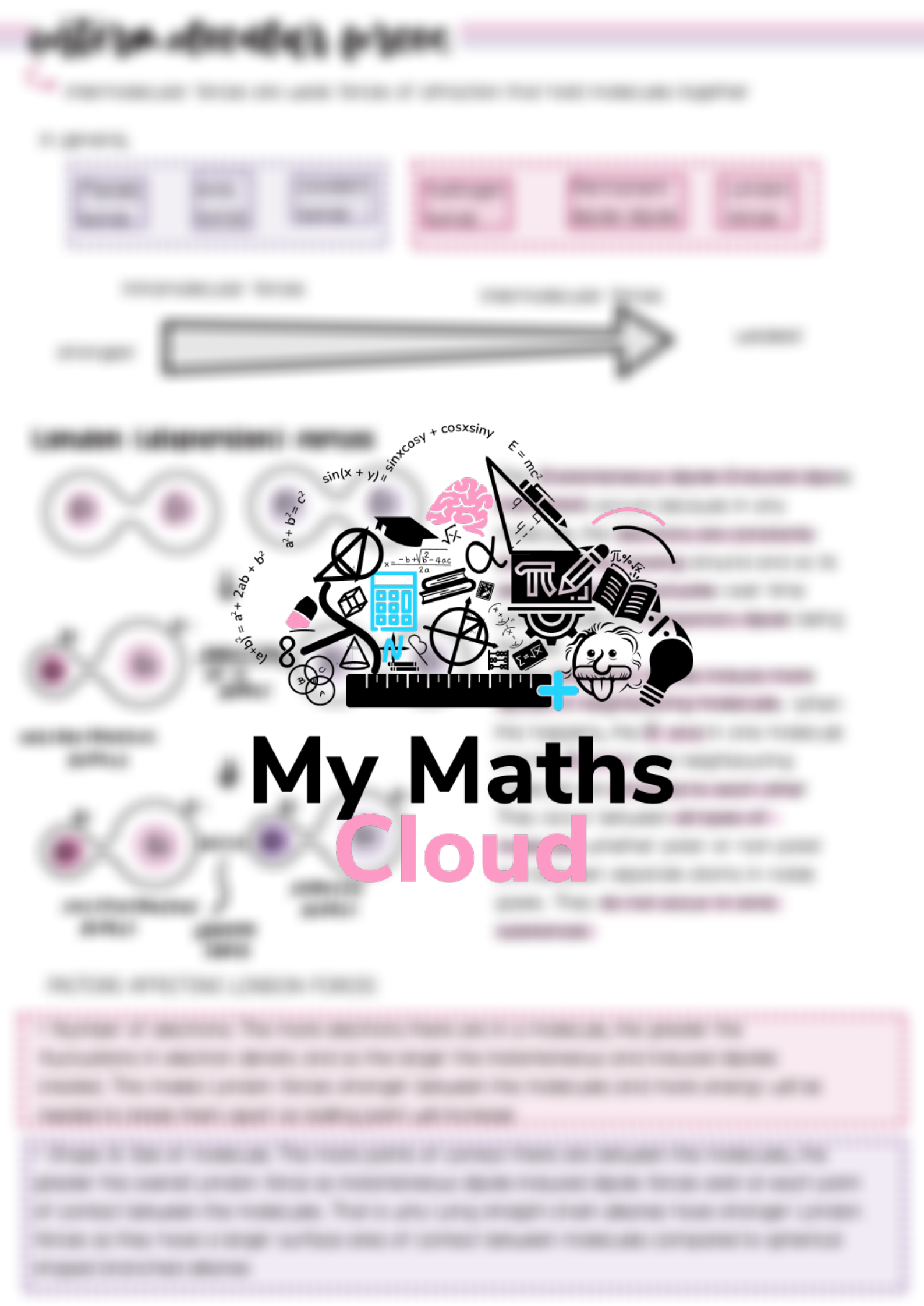
Each carbon atom is bonded to 4 other carbon atoms forming a giant 3D tretranearal arrangement with many strong covalent bonds (hard material).
Does not conduct electricity as there are no delocalised electrons.
Have high melting and boiling point as huge amount of energy is needed to break huge no. Of strong covalent bonds for melting and boiling to occur

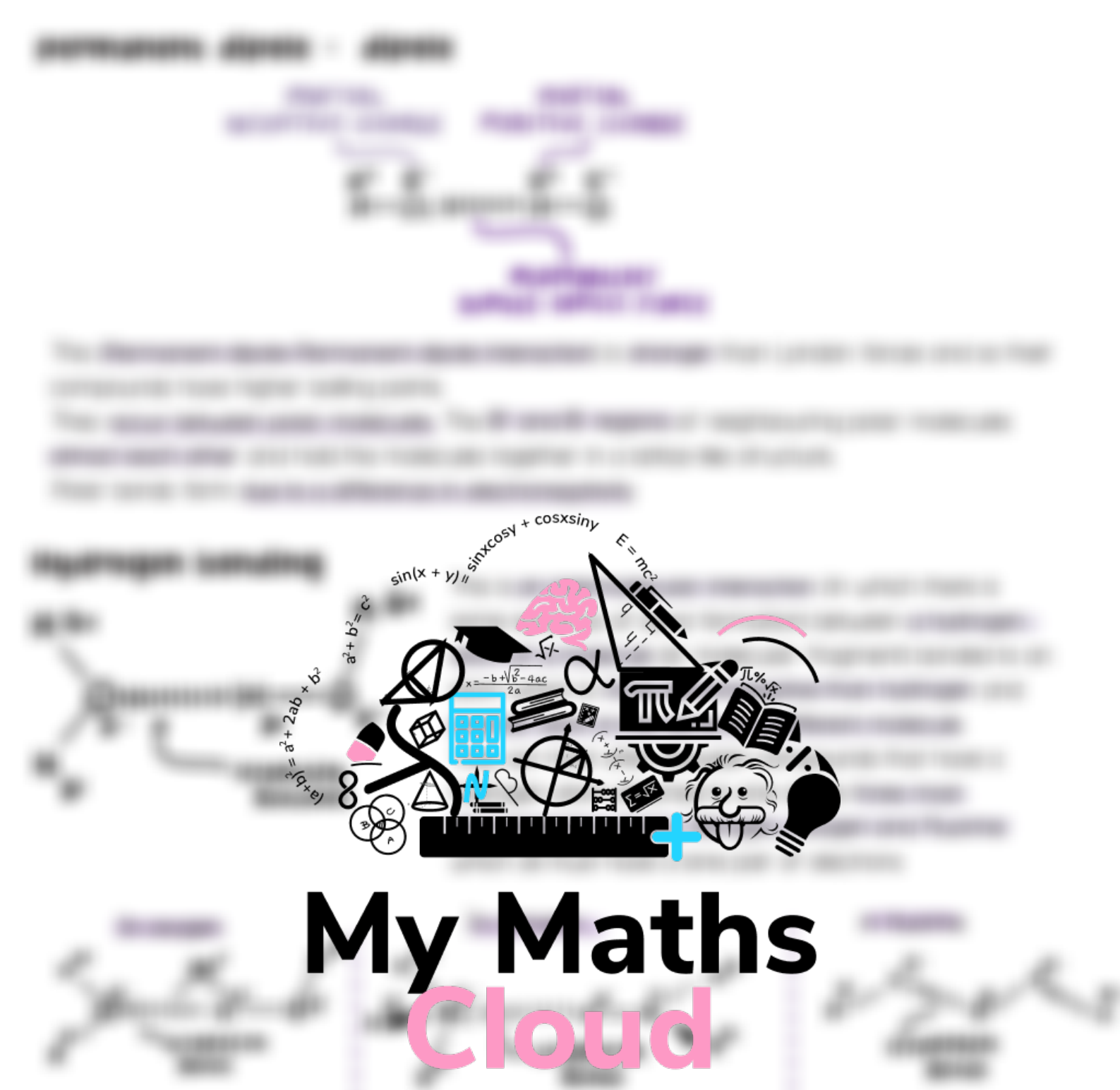
Graphite

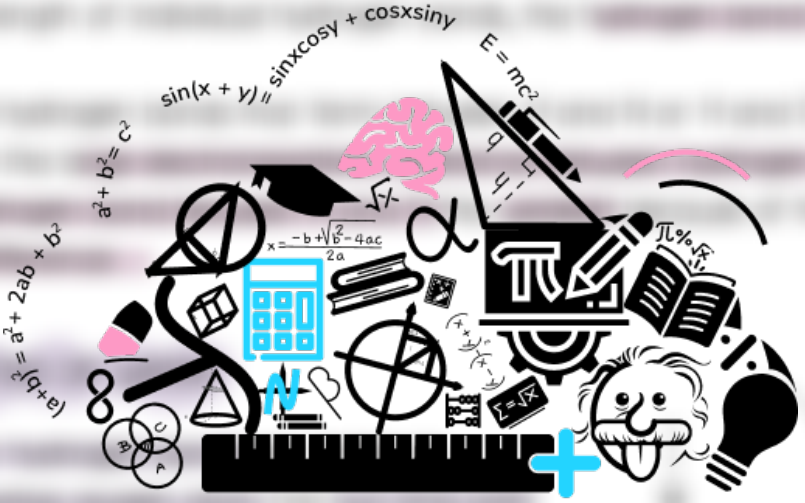


each carbon is attached to three other carbon forming interlocking hexagonal rings.
Conducts electricity due to presence of delocalised electrons which are free to move when influenced by potential differences.
Soft material because of weak intermolecular forces between the layers allowing the layers to side over each other.
very high melting point due to strong covalent bonds


sin(x + y) = sinxcosy + cosxsiny
E = mc²
a² + b² = c²
(a+b)² = a² + 2ab + b²
My Maths
Cloud


sin(x + y) = sinxcosy + cosxsiny
E = mc²
a² + b² = c²
(a+b)² = a² + 2ab + b²
My Maths
Cloud


My Maths
Cloud

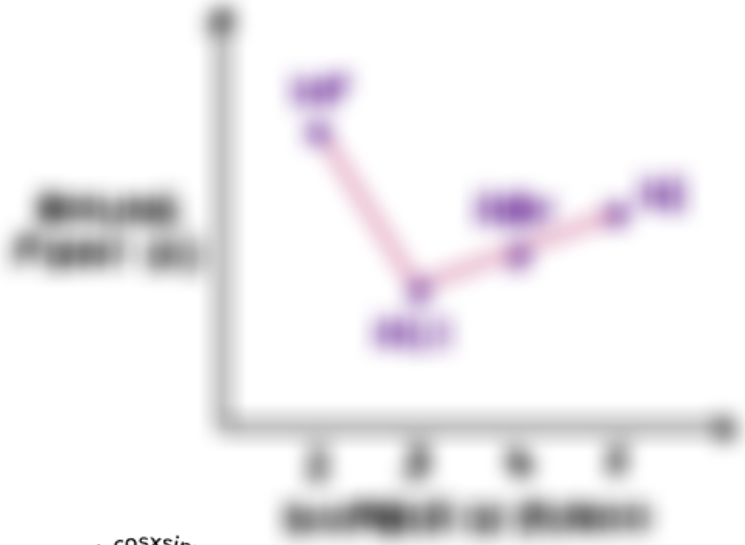


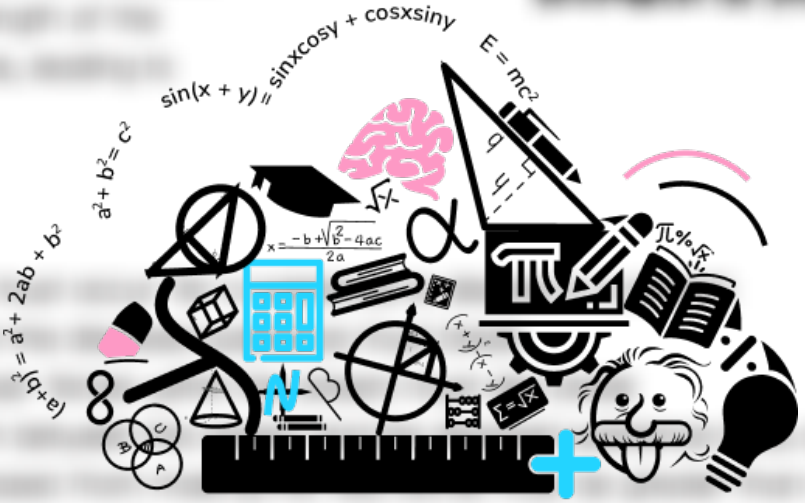
My Maths
Cloud



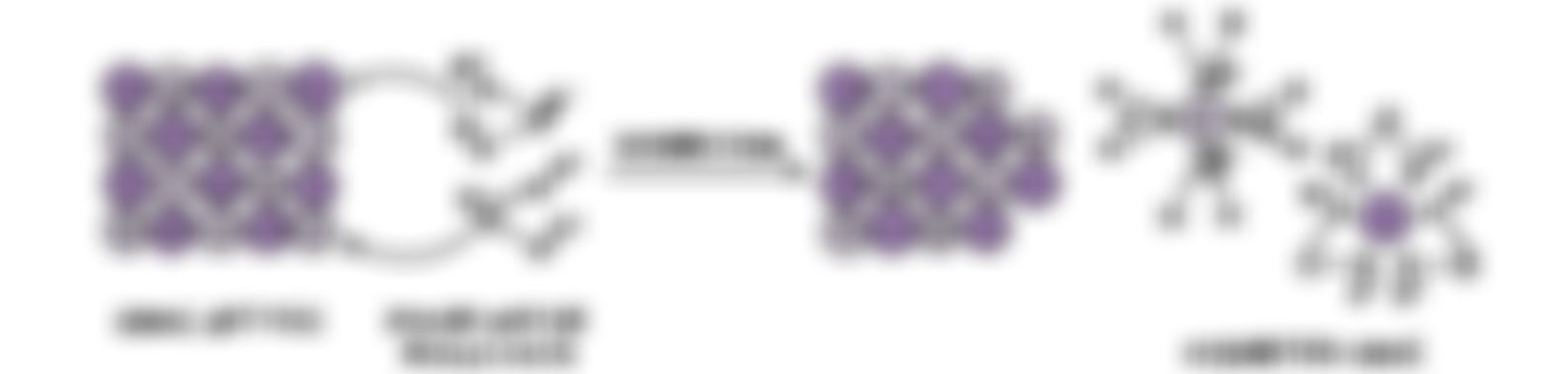


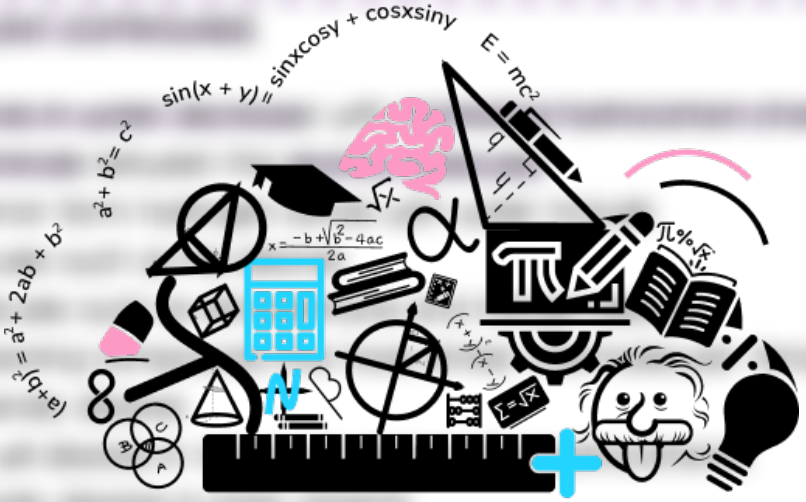
My Maths Cloud





My Maths Cloud

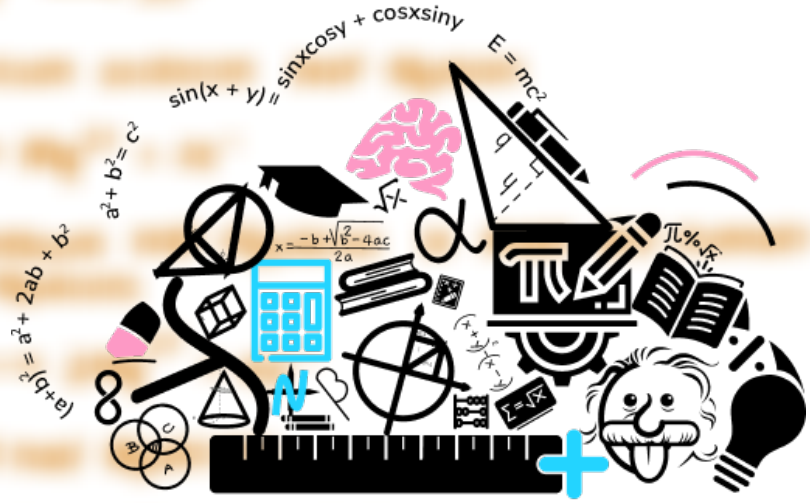




My Maths Cloud



My Maths Cloud



My Maths Cloud

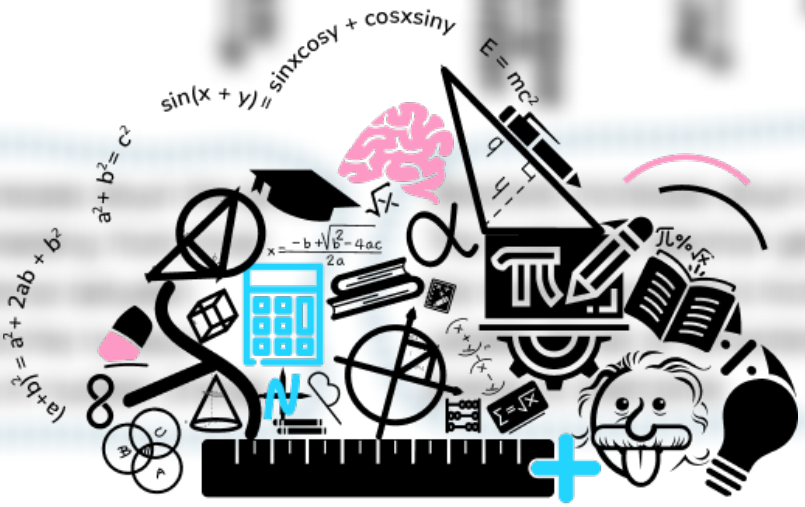
[illegible]

[illegible]

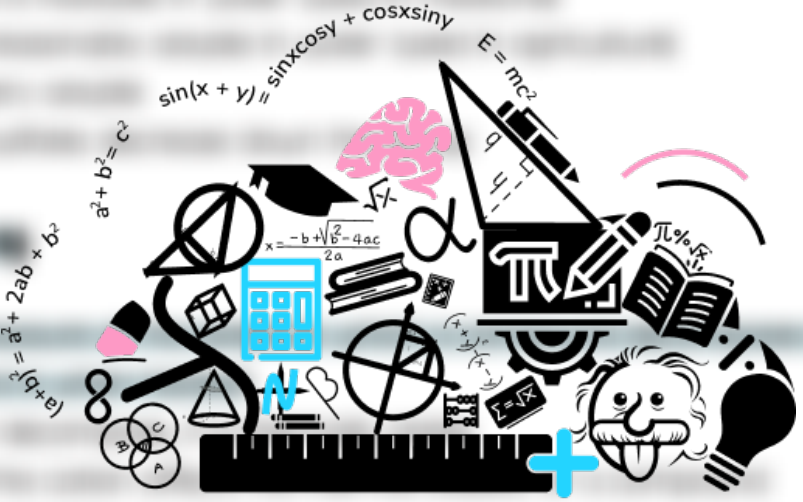
[illegible]



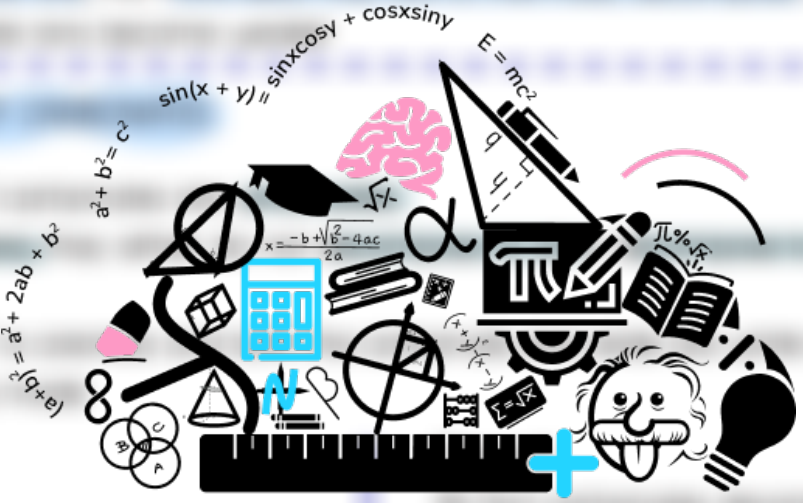
My Maths Cloud



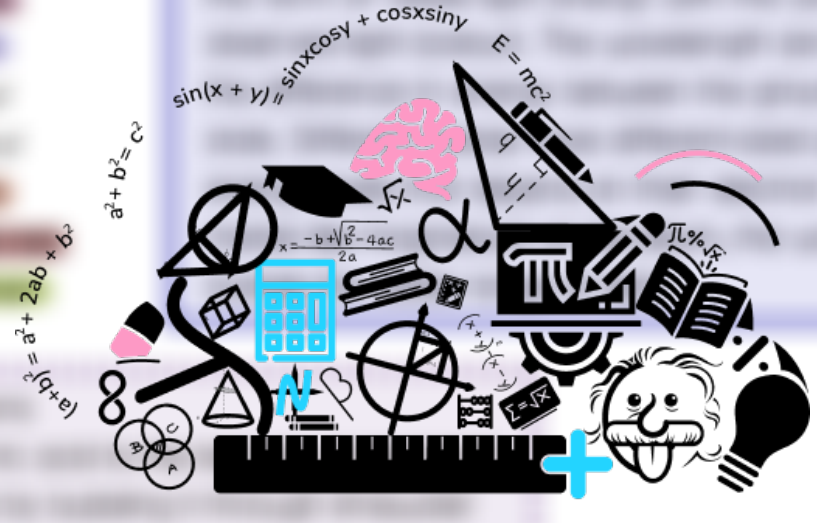
My Maths Cloud



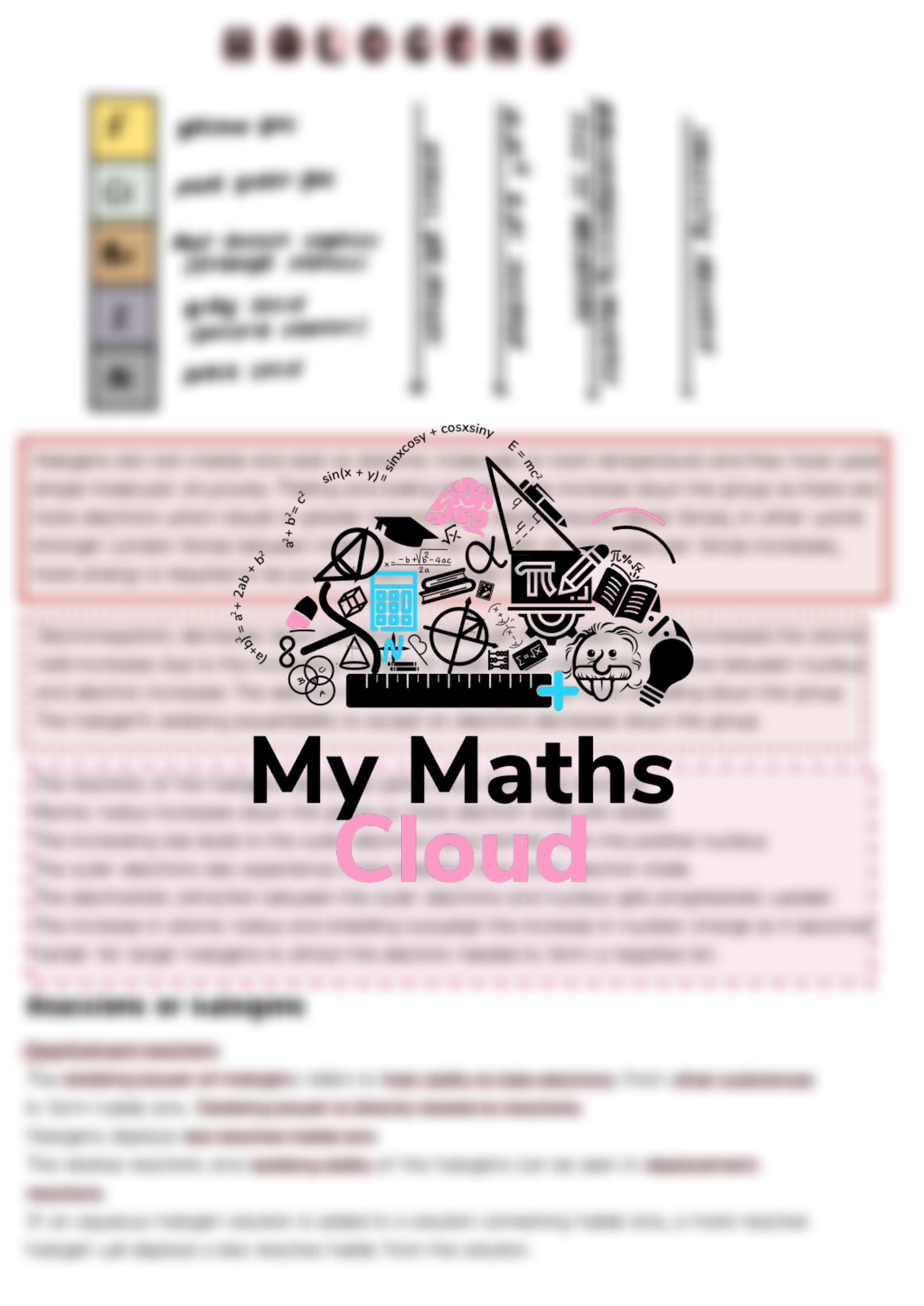
My Maths Cloud



My Maths Cloud

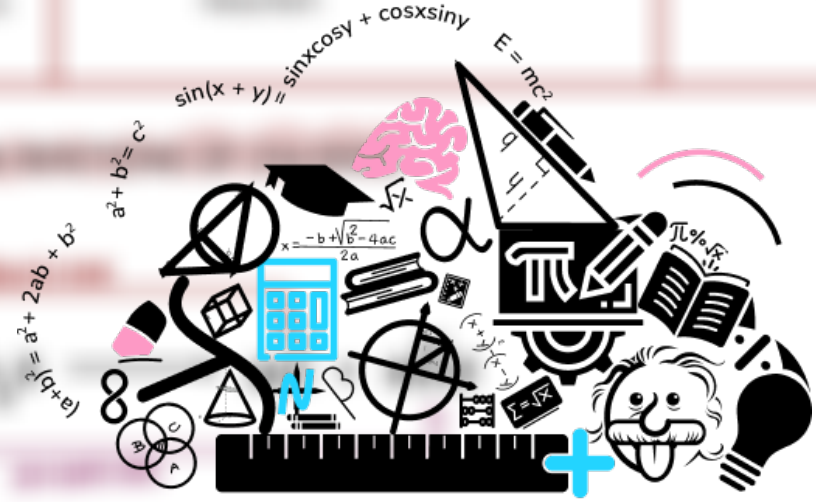


My Maths Cloud

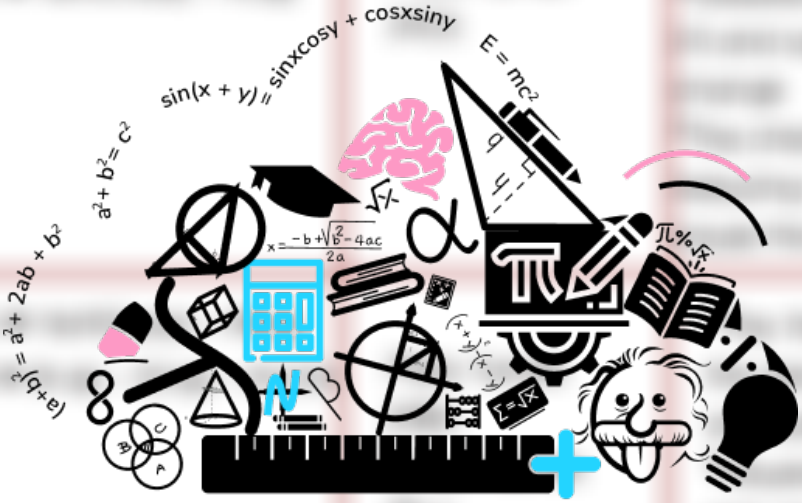

sin(x + y) = sinxcosy + cosxsiny
E = mc²
a² + b² = c²
(a+b)² = a² + 2ab + b²
My Maths
Cloud

The displacing halogen is reduced as it gains an electron to form the halide ion.
The displaced halide is oxidised as it loses an electron to form the halogen molecule.
The *r* are as a halogen will displace any halide ion lower in group 7.

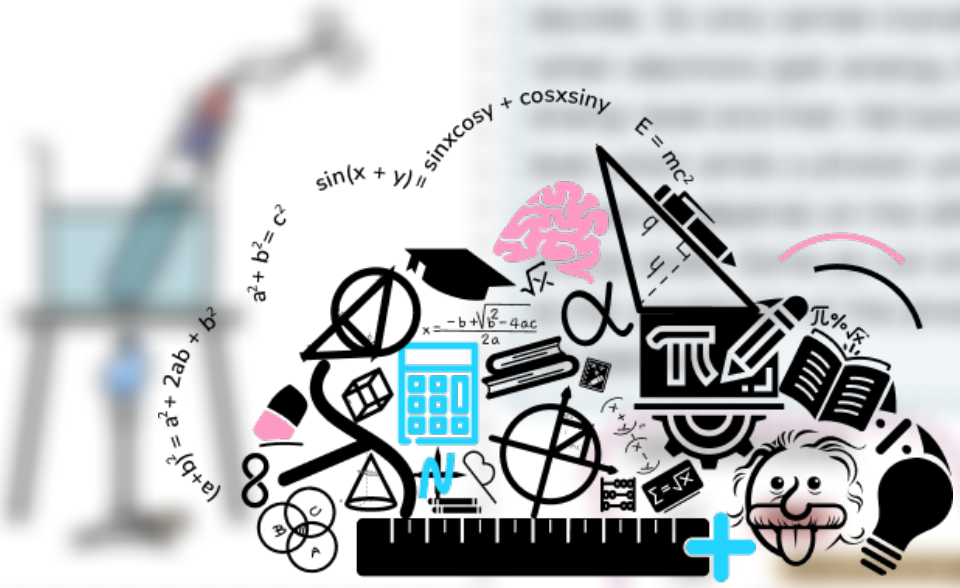
halogen	r = ?	r_2	r_2
chlorine in potassium bromide	no reaction	$Cl_2(aq) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(aq)$ pale cyan to form colourless to orange	$Cl_2(aq) + 2I^-(aq) \rightarrow 2Cl^-(aq) + I_2(aq)$ pale cyan to form colourless to brown
bromine in potassium iodide	no reaction	no reaction	$Br_2(aq) + 2I^-(aq) \rightarrow 2Br^-(aq) + I_2(aq)$ pale cyan to form orange to brown
iodine in potassium bromide	no reaction	no reaction	no reaction



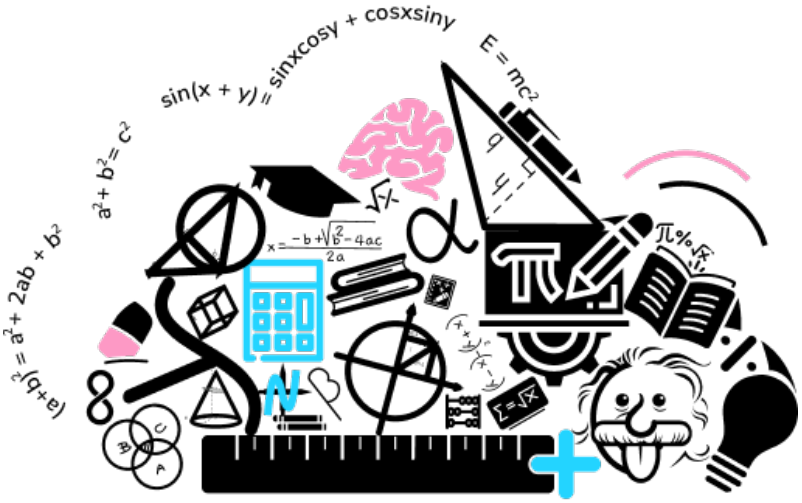
My Maths Cloud


sin(x + y) = sinxcosy + cosxsiny
E = mc²
a² + b² = c²
(a+b)² = a² + 2ab + b²
My Maths
Cloud

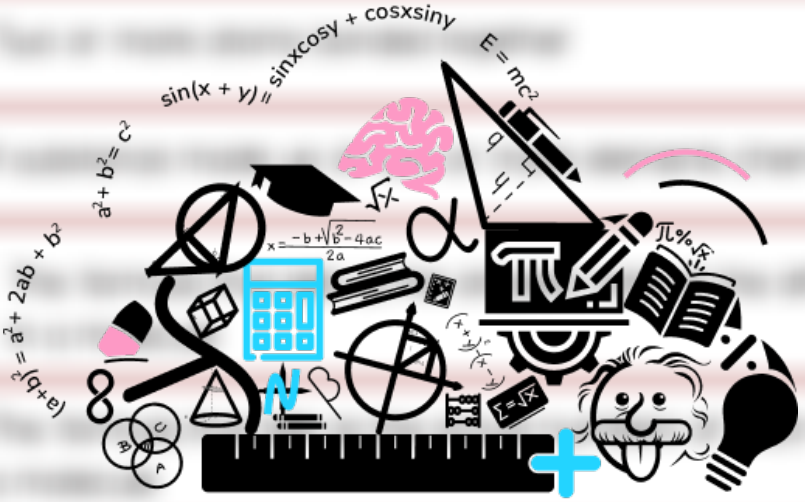
My Maths Cloud



My Maths Cloud



My Maths Cloud



My Maths Cloud

Formulae



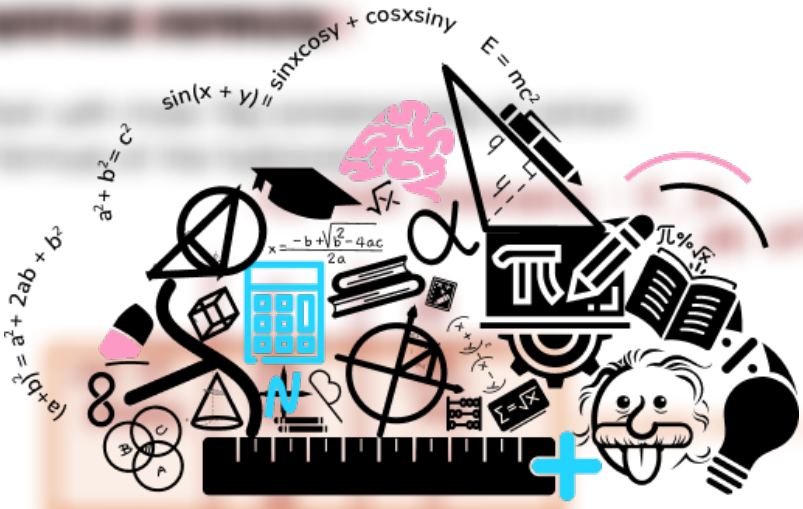
My Maths Cloud



My Maths Cloud



My Maths Cloud



My Maths Cloud



My Maths Cloud



My Maths Cloud



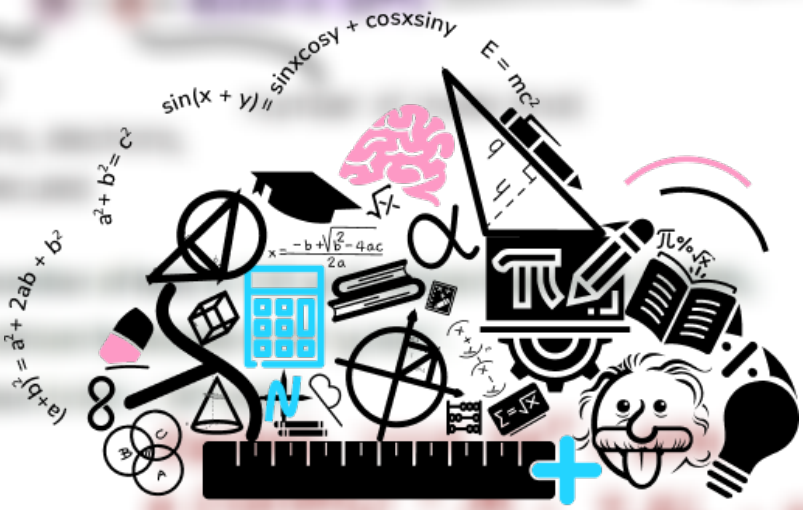
My Maths Cloud



My Maths Cloud

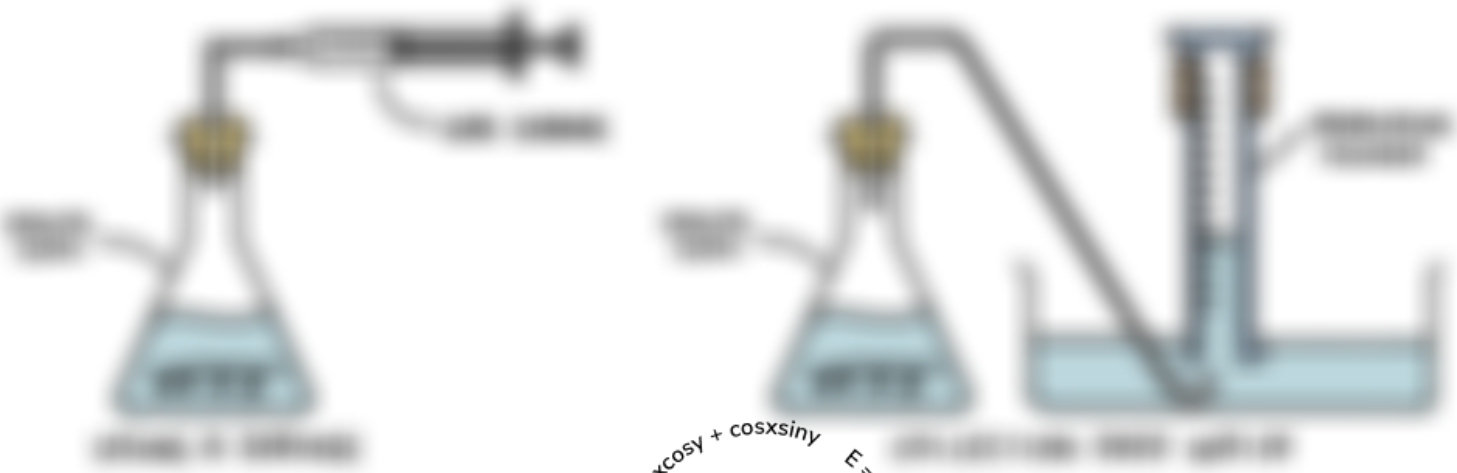
calculating using zeds

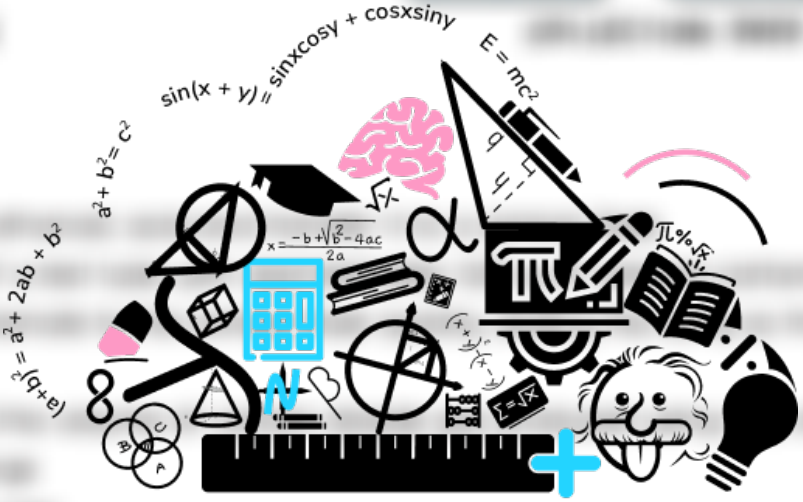
calculating using hoogahs's constants



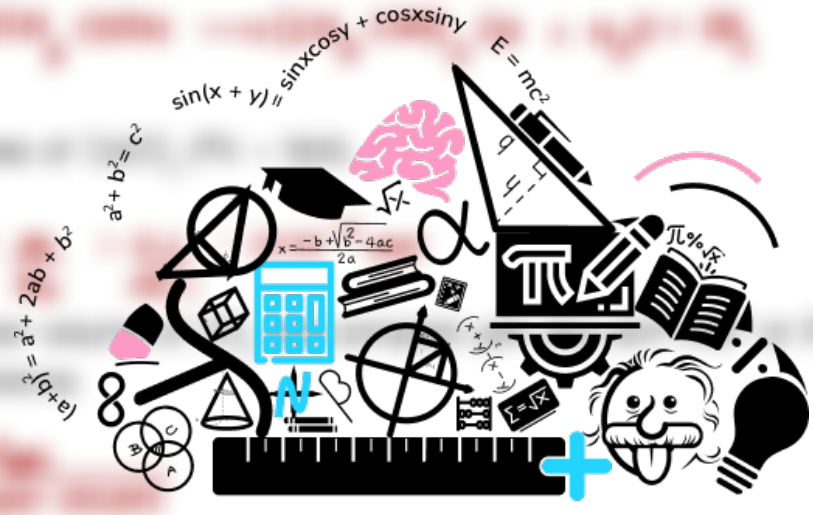
My Maths Cloud

GCSE PRACTICAL 01: Finding the molar volume of a gas





My Maths Cloud



My Maths Cloud

(b) Calculate the 75^{th} of the ordered liquid.

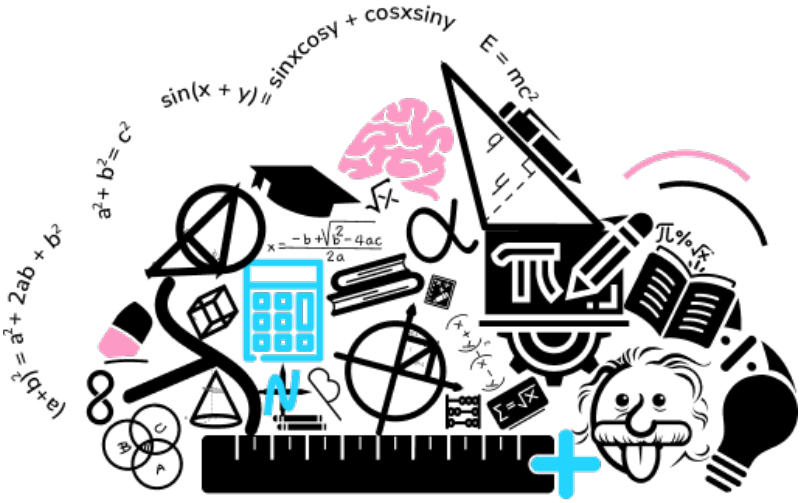
$$\text{Ans} = \frac{\text{Ans}}{\text{Ans}} = \frac{\text{Ans}}{\text{Ans}} = \text{Ans} \times \text{Ans}^{-1}$$

(c) A student uses the over-under method to collect CO_2.

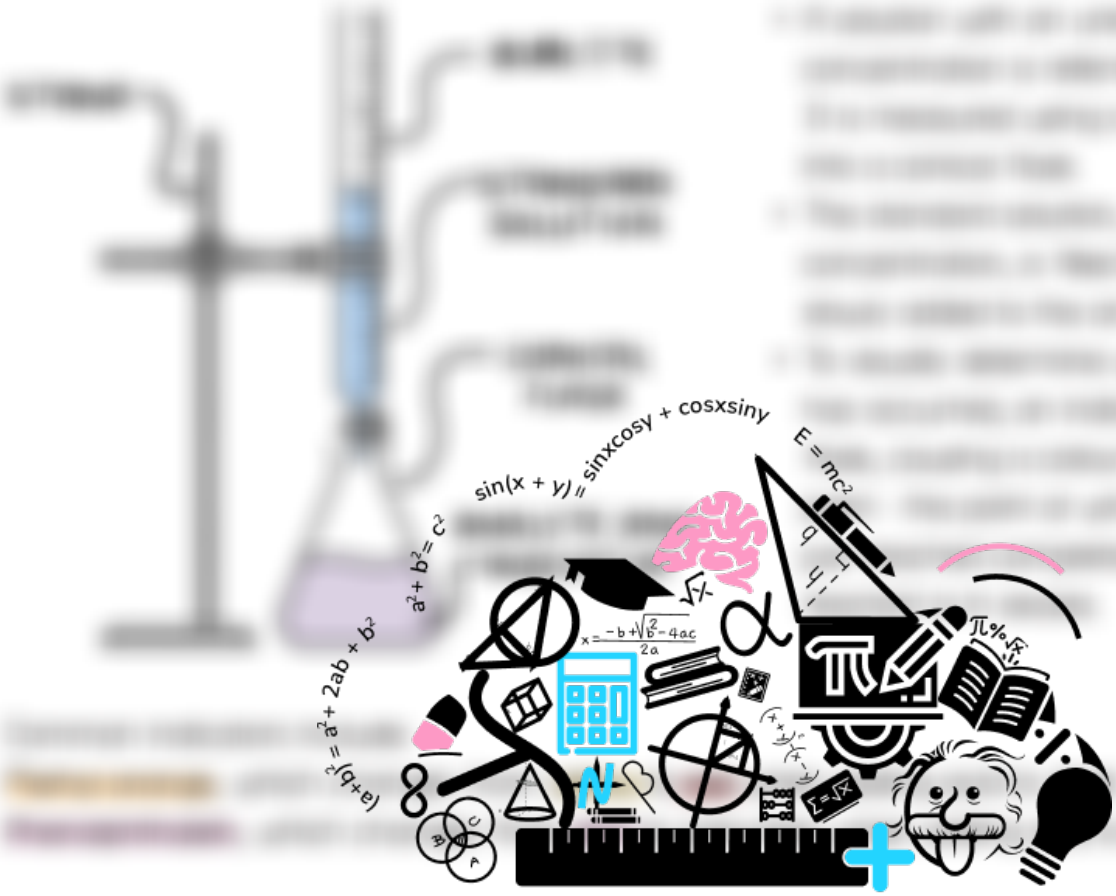
(i) State two sources of error specific to this method and the effect of each on the calculated molar volume.

CO_2 dissolves slightly in water causing the volume of the gas to decrease hence molar volume becomes too low.

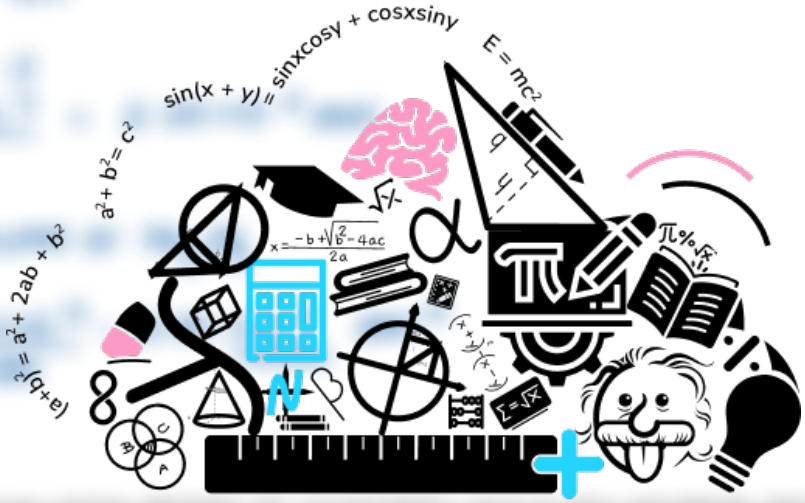
water level would have been difficult to read accurately due to uneven surface and water vapour is also present in the cylinder which is not recorded causing the volume to be too low hence molar volume becomes too low.



My Maths Cloud



My Maths Cloud



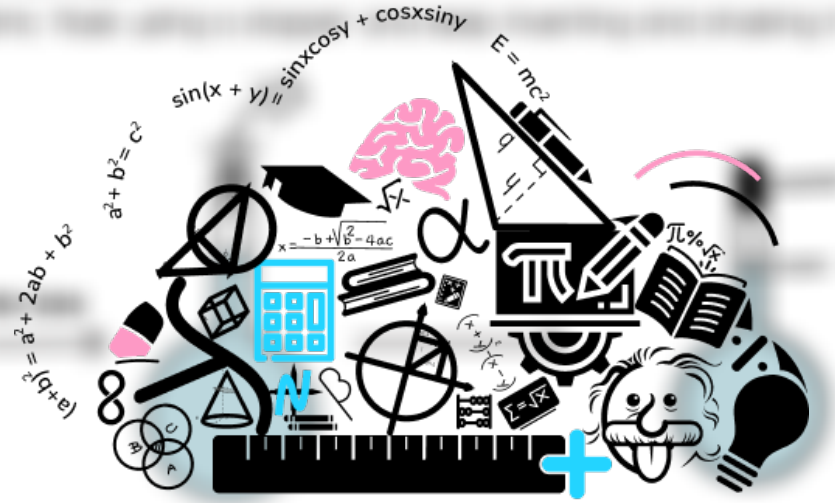
My Maths Cloud

CCEA PRACTICAL 01 & 03: Titrations and standard solutions

STANDARD SOLUTION PROCEDURE

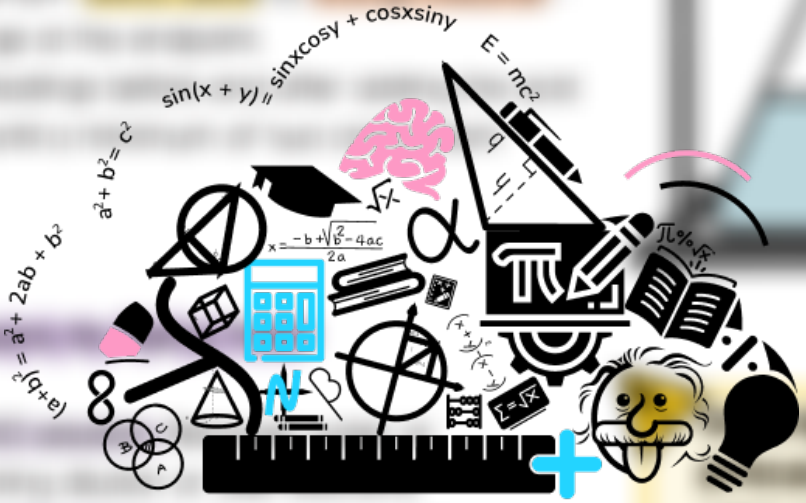
- Dissolve the solid in a beaker with distilled water. The amount of water added depends on the desired concentration of the standard solution.
- Stir the mixture using a glass rod until the solid is dissolved in the water.
- Using a funnel, transfer the solution to a volumetric flask.
- After transferring, wash the beaker with distilled water and transfer these washings to the volumetric flask.
- Using a pipette, continue adding distilled water to the volumetric flask until the bottom of the meniscus is up to the mark.
- Shake the volumetric flask using a stopper or parafilm and inverting and shaking it to mix the solution.





My Maths Cloud

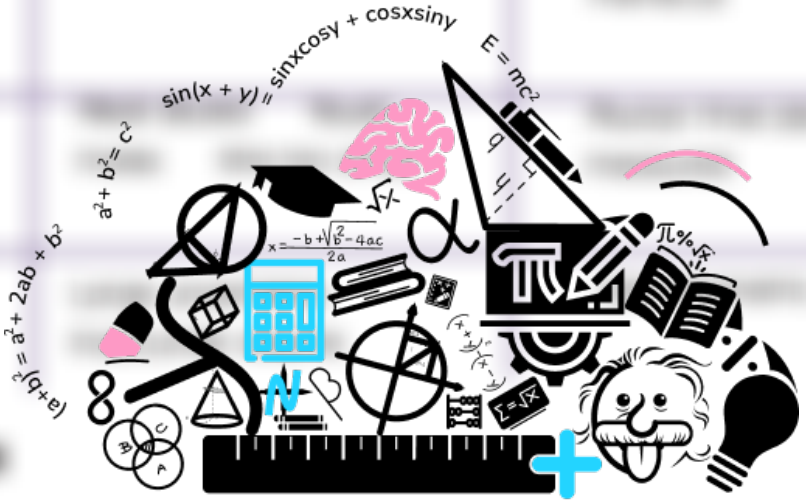




My Maths Cloud

Common errors

Error	Effect	How to minimise
Bubble not in touch with axis	Axis divided into wrong range	Ensure bubble with solution to be used
Turned left in bubble during iteration	Drops fail in reading the key	Remove turned before starting
An bubble in an space	Bubble disappears then run into the run range	Purple tap bubble to remove bubbles
Handles error reading bubble	Incorrect time returns	Read on eye level, read bottom of meniscus
Bubble not in touch with axis	Wrong	Ensure that bubble just touches axis
Reading in the wrong place	Incorrect	Read at eye level

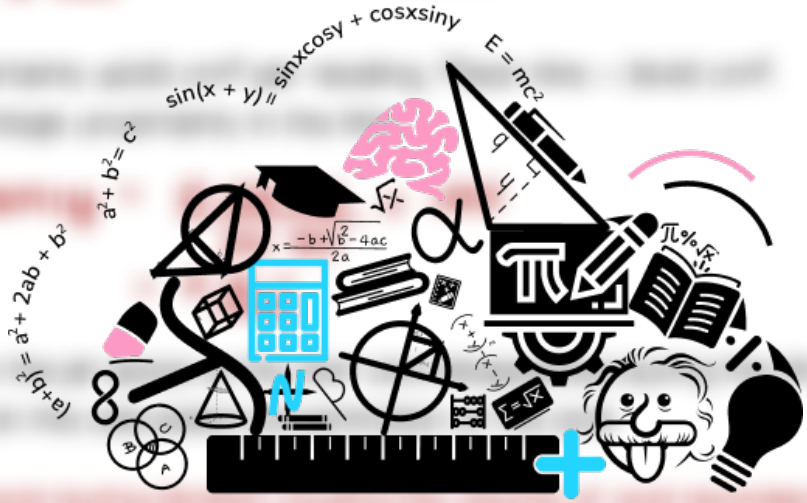


My Maths Cloud

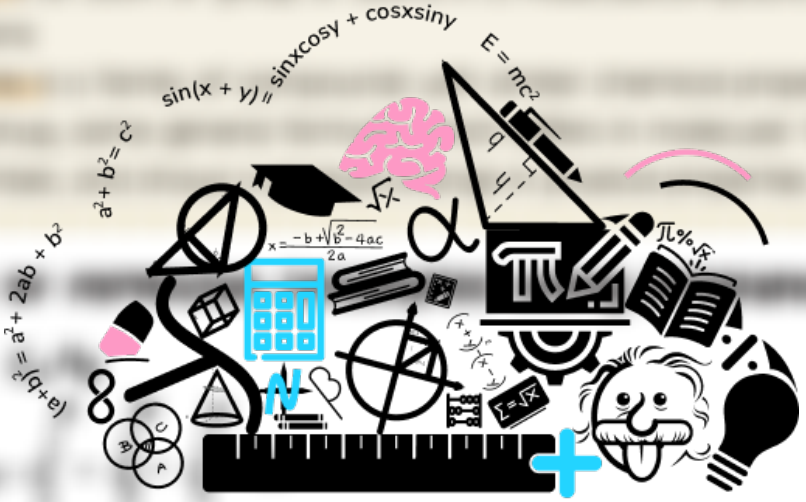
Exam questions

Q. A student observes [illegible] and calculates [illegible]

Q. Identify [illegible]



My Maths Cloud

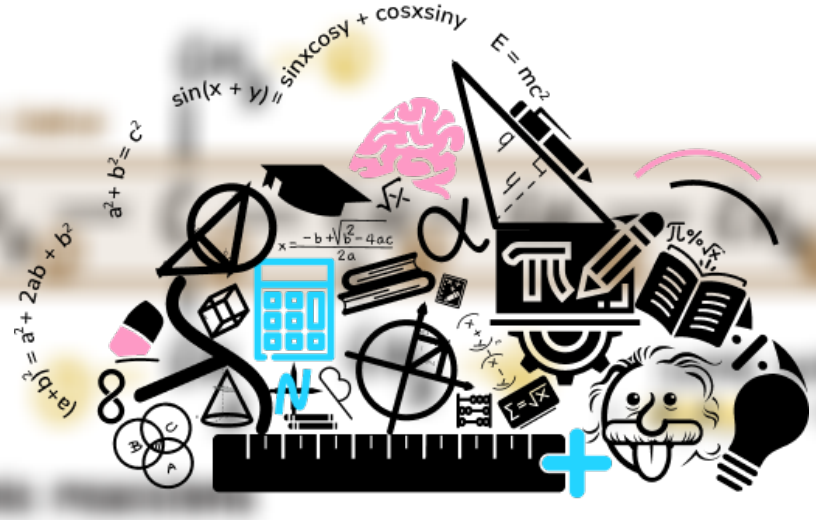


My Maths Cloud

naming organic compounds (IUPAC)

1. Find the longest continuous carbon chain, this gives a prefix
2. Number the chain in a direction that gives the functional group the smallest possible number
3. If there is more than one long chain, then choose the one with the most side chains
4. Determine the name and the position number of any side chain or functional group
5. Side chains and functional groups are added as prefixes before the name
6. The compounds with functional group in double or triple bonds, as there is no need to mention its position
7. Use the "di-", "tri-" or "tetra-" to state there are multiple identical functional groups

prefixes	
1	meth-
2	eth-
3	prop-
4	but-
5	pent-
6	hex-
7	hept-
8	oct-
9	non-
10	dec-



My Maths Cloud

types of organic reactions

- **Oxidation** is reaction in which a compound loses electrons, increases its oxygen content or decreases its hydrogen content
- **Substitution** is reaction in which one atom or group of atoms in a molecule is replaced by another atom or group
- **Oxidation reaction** is reaction in which a compound loses electrons, increases its oxygen content or decreases its hydrogen
- **Reduction reaction** is reaction in which a compound gains electrons, decreases its oxygen content or gains hydrogen
- **Free radical** is species which has an unpaired electron
- **Electrophile** is species that is attracted to a region of high electron density such as a double bond
- **Heterolytic fission** breaking of a covalent bond where bonding electrons are taken by one of the atoms to form ion
- **Homolytic fission** the breaking of a covalent bond where each of the bonding electrons leaves with one of forming two free radicals
- **Polymerisation** is reaction in which a large number of small molecules (monomers) react together to form very large molecule called a polymer

hazards and risks

A **hazard** is something that could cause harm to a user.

A **risk** is the chance of a hazard causing harm.

Risk assessment is the identification of the hazards involved in undertaking such a procedure and the control measures needed to reduce the risk from those hazards.



Corrosive

Alkalis can dilute acids and alkalis. Use concentrated solutions in a small scale.



Irritant

Avoid skin, spills OR they are immediately.



Toxic

Avoid inhaling fumes and mouth. Use in fume cupboard.



Flammable

Keep away from naked flames.



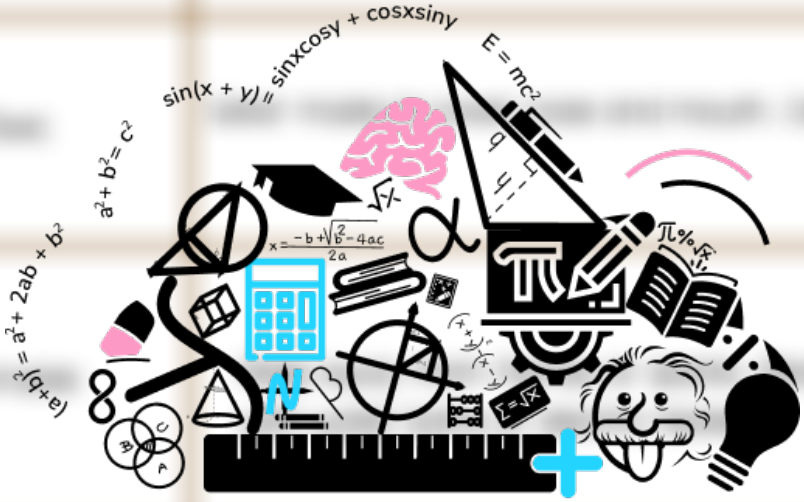
Health hazard

Can cause cancer. Avoid contact by wearing gloves and eye goggles.

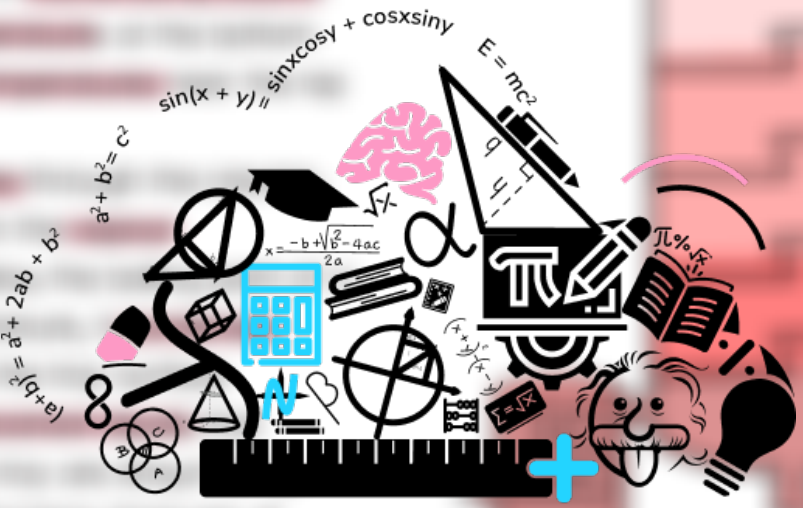


Harmful to environment

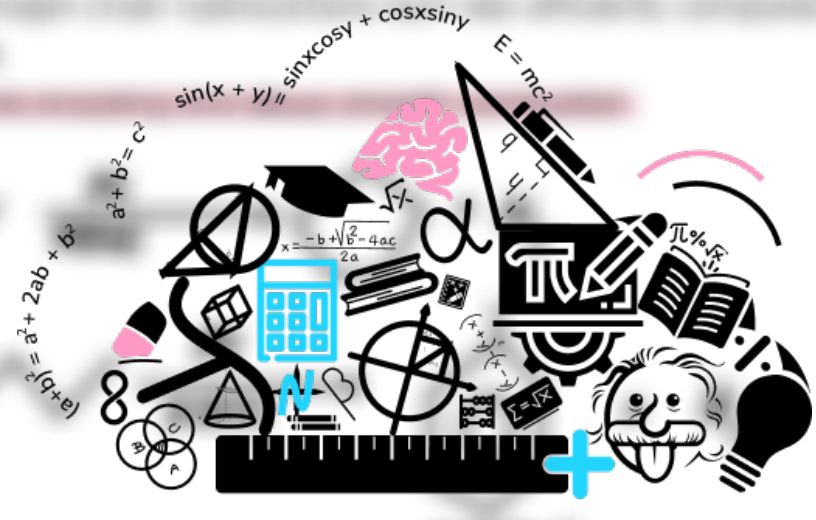
Store in a sealed labelled container. Recycle chemicals instead of disposal.



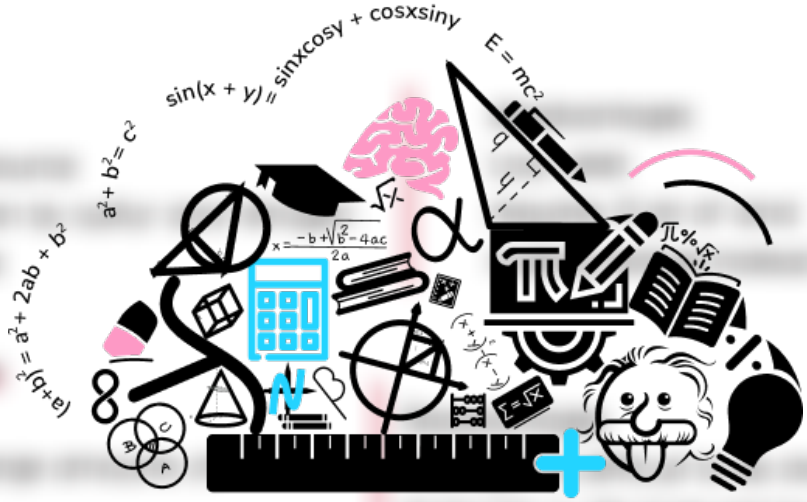
My Maths Cloud



My Maths Cloud

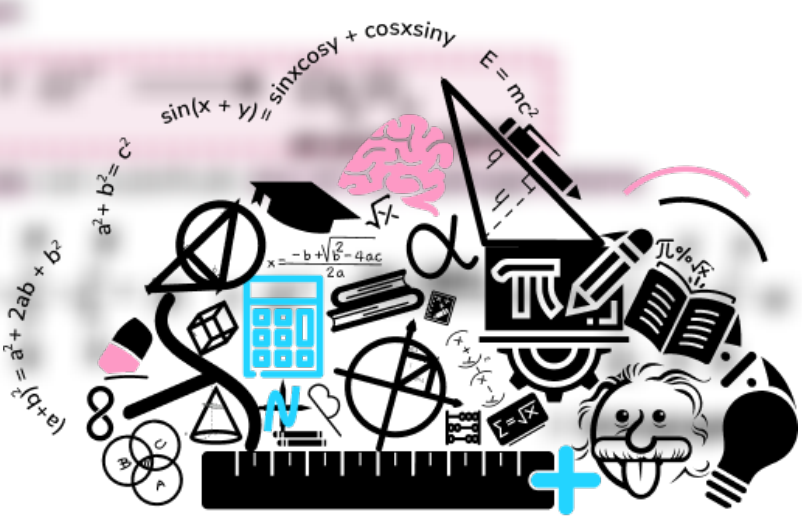


My Maths Cloud



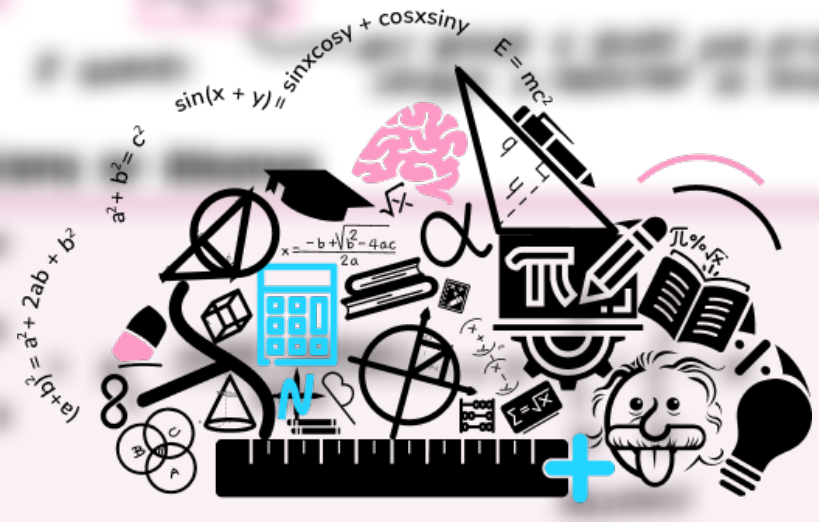
My Maths Cloud



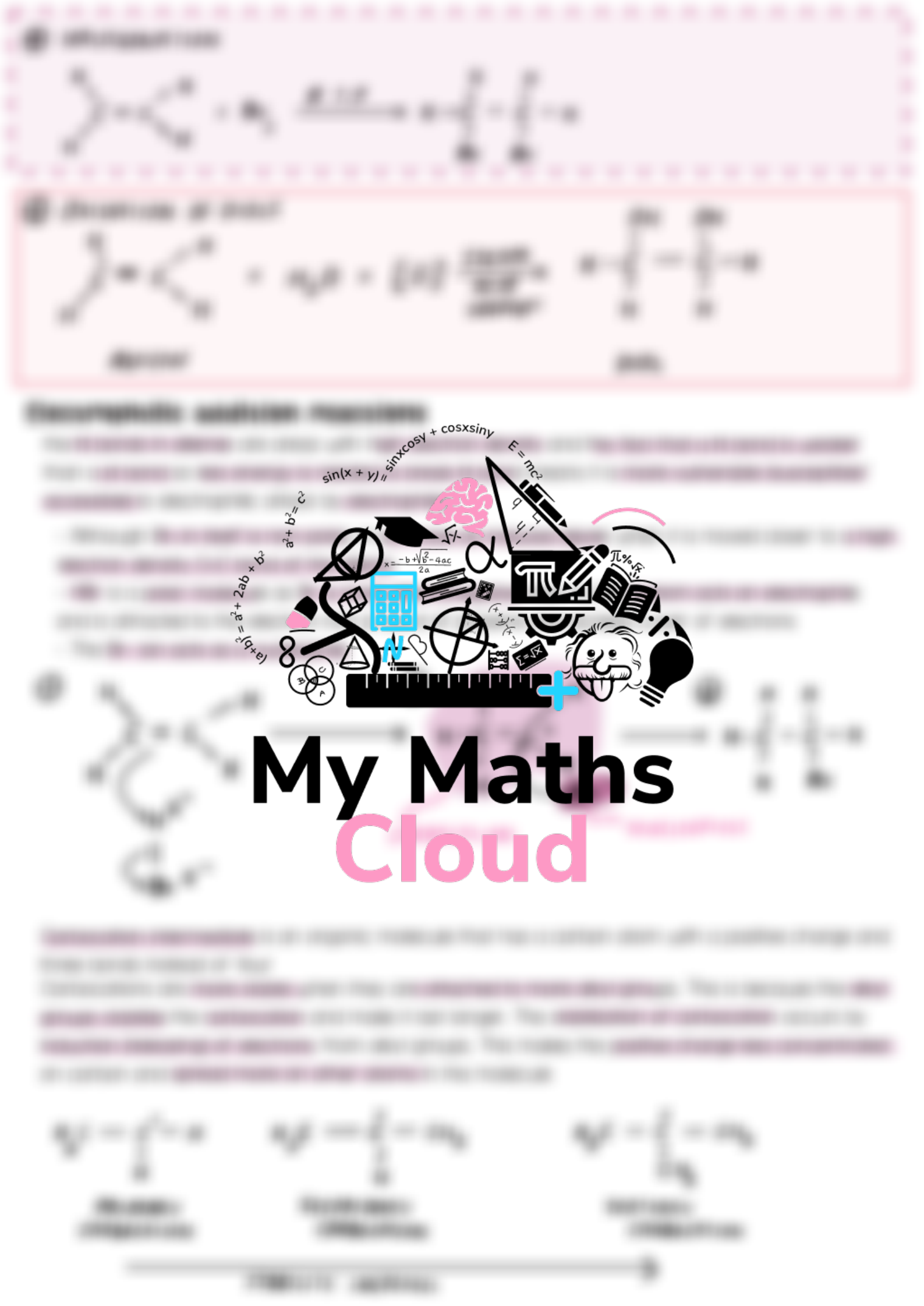


My Maths Cloud

My Maths Cloud



My Maths Cloud

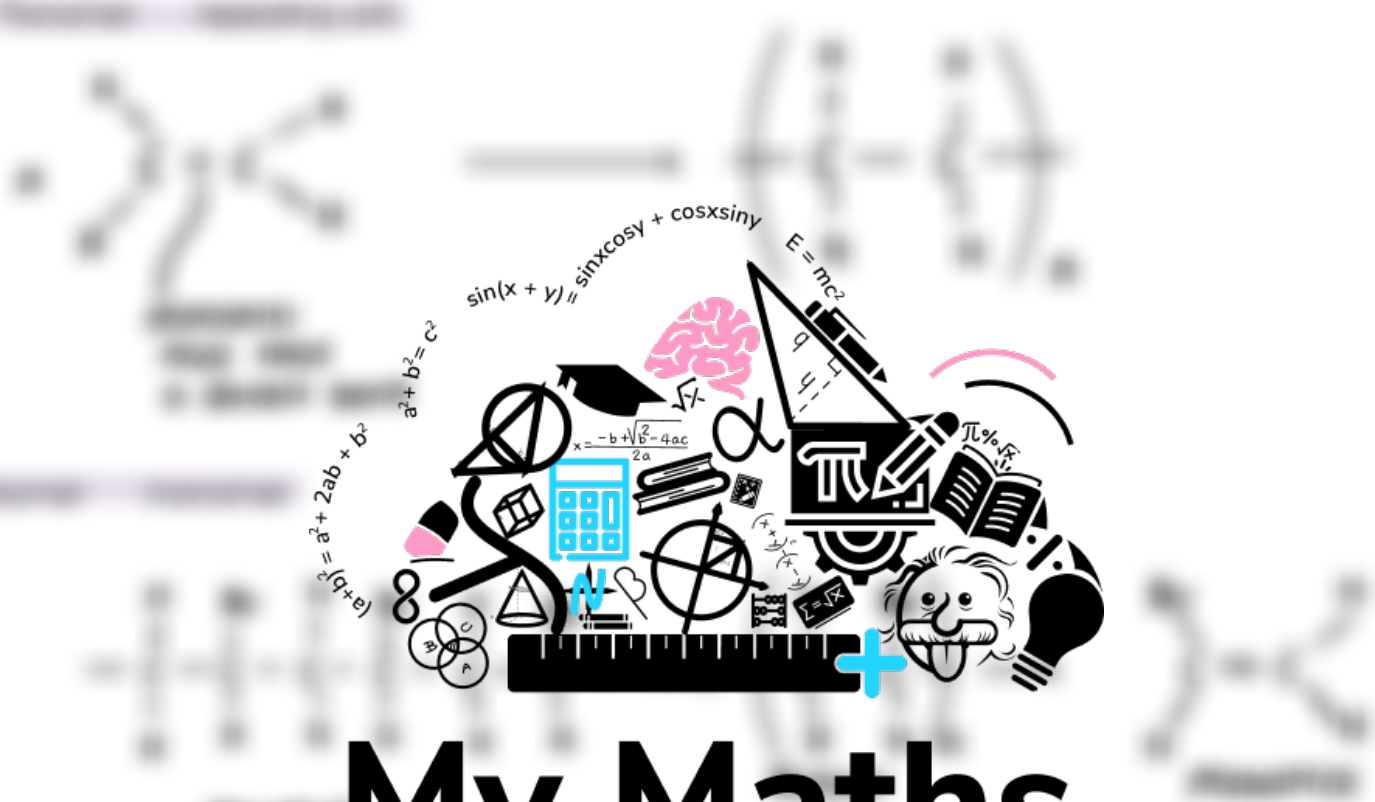

My Maths
Cloud

POLYMERISATION

A polymer is a long chain made and made up of many repeating units called monomers, usually. Hence,

addition polymerisation

Addition polymerisation is the reaction in which many monomers containing, at least one C=C double bond form long chains of polymers as the only product.



Processes also polymerisation

Plastics are non-biodegradable,

Landfill Sites

Advantages

- Cheap and simple method of disposal.
- Can be used for plastics that are difficult to recycle.

Disadvantages

- Landfill sites eventually become full.
- Plastics remain in the ground for many years because they are non-biodegradable.
- Landfill contributes useful materials.

Recycling Plastics

Advantages

- Conserves non-renewable crude oil resources.
- Reduces the amount of waste sent to landfill.
- Reduces environmental pollution.

Disadvantages

- Plastics must be sorted before recycling.
- Sorting and processing can be expensive.
- Not all plastics can be recycled.

Incineration (Burning Plastics)

Advantages

+ Reduces the volume of waste.
+ Produces heat energy that can be used to generate electricity.

Disadvantages

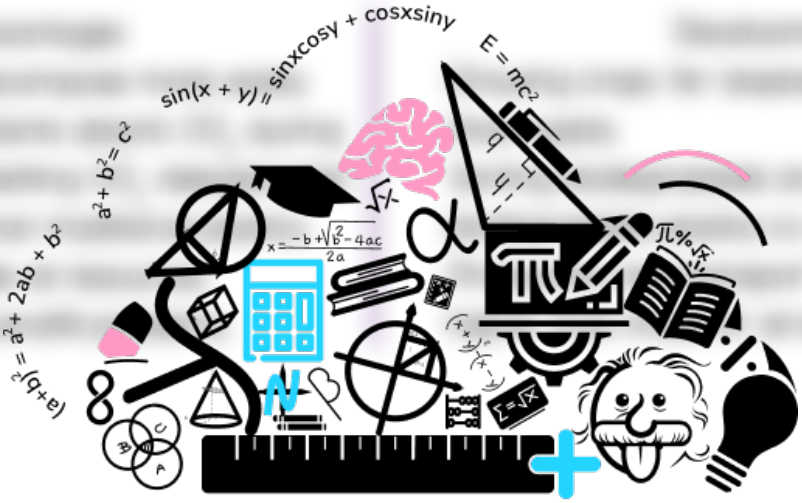
+ Produces carbon dioxide, contributing to global warming.
+ Can release toxic gases such as CO and HCl.
+ Requires air pollution or emissions to neutralise acidic gases before release into the environment.

Emphasis

Plastics must be biodegradable by incorporating starch products such as starch.

They can be broken down naturally by microorganisms.

Advantages	Disadvantages
Biodegradable – decomposes naturally by microorganisms.	Requires crops for cellulose, may reduce
Carbon neutral – plants absorb CO₂ during	
photosynthesis, offsetting	
Plastic substitutes from	is difficult
Help conserve crude	plastic uses are often
Reduces long-term	



My Maths Cloud

Halogenoalkanes

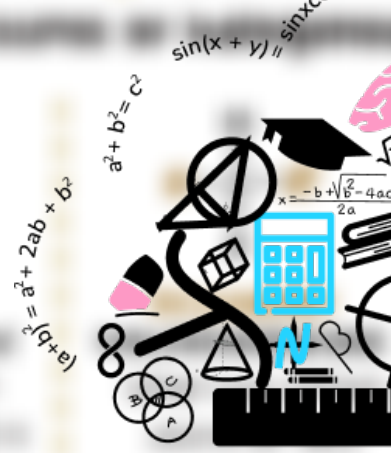
A halogenoalkane is a [redacted] where one or more hydrogen atoms in an alkane have been replaced by halogen atoms like fluorine, chlorine, bromine, or iodine.

To name a halogenoalkane, we use prefixes like [redacted] to indicate the type and number of halogen atoms.

General Formula of Halogenoalkanes: [redacted]



[redacted]



My Maths Cloud

Polarity of halogenoalkanes

In halogenoalkanes, the [redacted] because [redacted] have a [redacted] than carbon. This causes [redacted], making the carbon atom [redacted] and the [redacted].



- Going down Group 7 of the periodic table, the [redacted].
- This results in a [redacted].
- Bond polarity: [redacted].
- This makes the [redacted].

- The [redacted] and the [redacted] is determined by the [redacted]
- The [redacted] down group.
- Therefore, the [redacted] the ones because [redacted]
- The [redacted] is [redacted] and the [redacted]
- The [redacted]

Reasoning near or explanation

- [redacted]
- [redacted]
- The rate of hydrolysis depends on the [redacted] strength.



A [redacted] precipitate.

The colour of the precipitate can help to identify the original halogenoalkane.

1. [redacted]
2. [redacted]
3. [redacted]

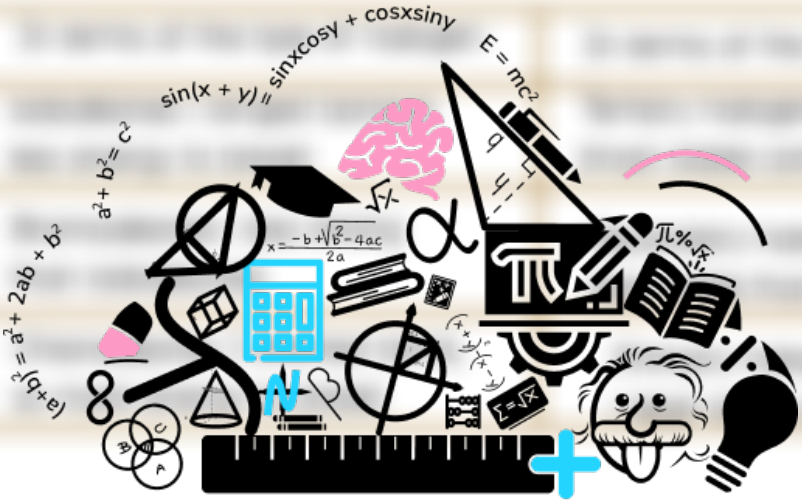
The reactivity of halogenoalkanes also depends on whether they are primary, secondary, or tertiary. The general trend in reactivity is tertiary > secondary > primary.

The trend is observed in nucleophilic substitution reactions, where the rate of reaction increases from primary to tertiary halogenoalkanes.

The reason for this trend is related to the stability of the carbocation intermediate formed during the reaction.

- Tertiary halogenoalkanes – Form the most stable carbocations due to increased electron-donating alkyl groups, which stabilise the positive charge.
- Secondary halogenoalkanes – Form less stable carbocations than tertiary but more stable than primary.
- Primary halogenoalkanes – Form the least stable carbocations, as they have the least number of electron-donating alkyl groups.

Reactivity	It varies, so they have a ...	It varies, so they are unstable
Trend	Tertiary > secondary > primary	Tertiary > halogenoalkanes are more reactive than ...
Less than	...	... halogenoalkanes ... than tertiary ...
Because	...	... halogenoalkanes ... carbocations



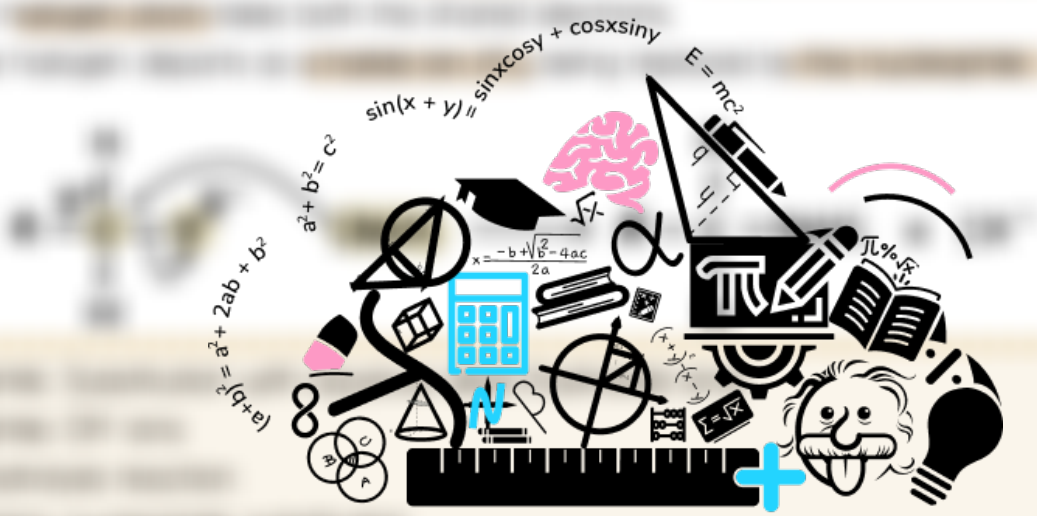
My Maths Cloud

Nucleophilic substitution

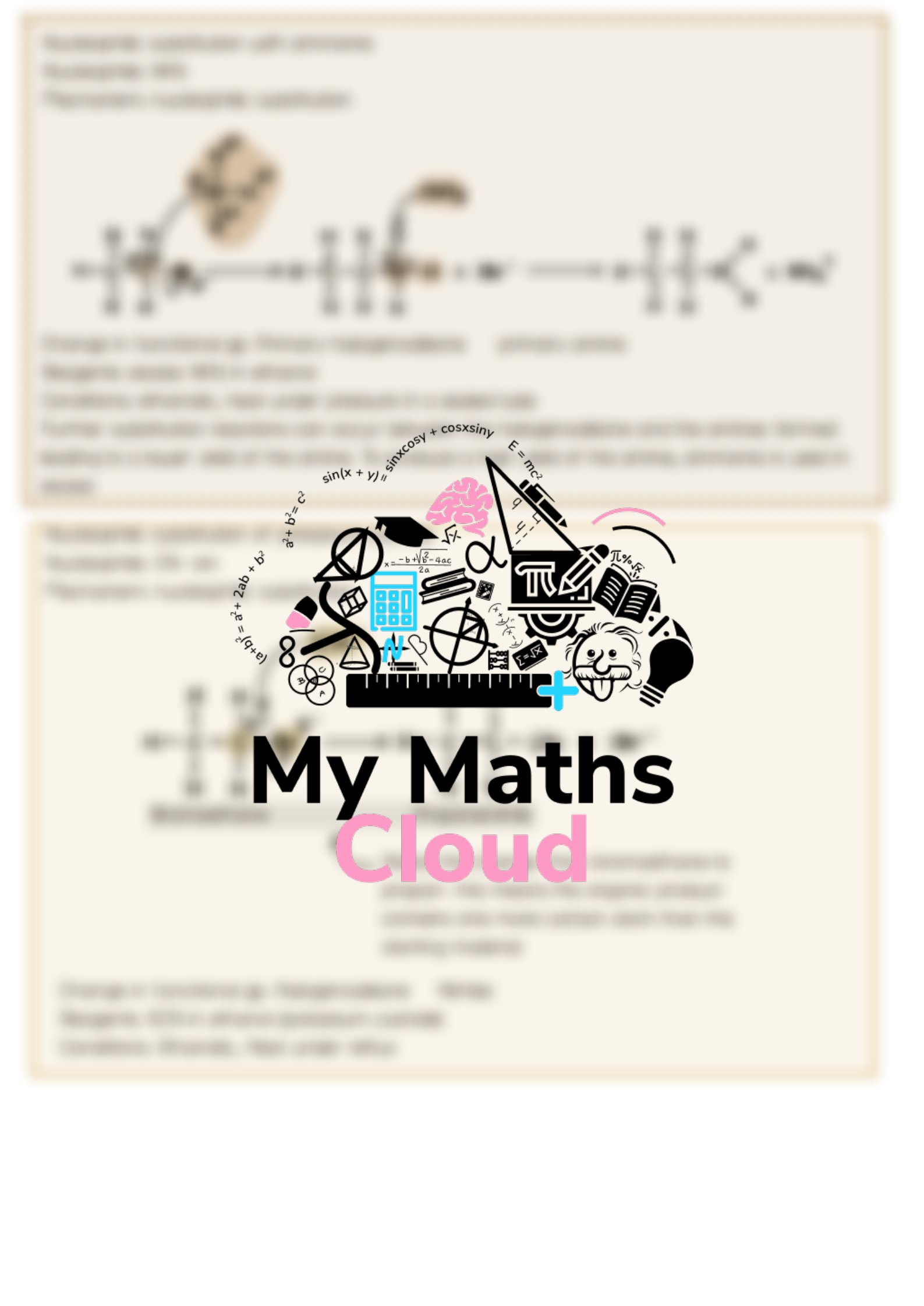
A nucleophilic substitution reaction is a reaction in which a nucleophile attacks a positive atom and brings a pair of electrons with it.

The key steps are:

- A nucleophile (Nu:) approaches the δ+ atom, which has a partially positive charge.
- The nucleophile donates its lone pair of electrons to the δ+ carbon, forming a new covalent bond.
- The original bond between the δ+ carbon and the leaving group breaks heterolytically, as the leaving group takes both the bonding electrons.
- The halogen departs as a halide ion (X⁻), taking a pair of electrons with it.



My Maths Cloud


sin(x + y) = sinxcosy + cosxsiny
E = mc²
a² + b² = c²
(a+b)² = a² + 2ab + b²
My Maths
Cloud



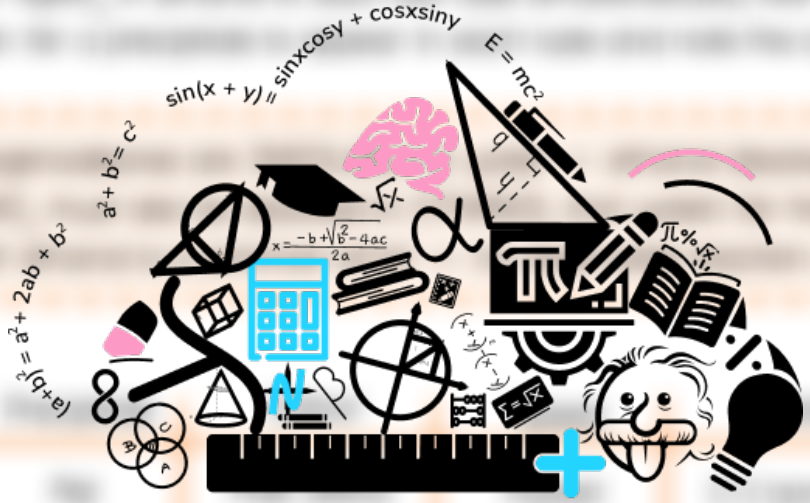
My Maths Cloud

CCEA PRACTICAL 6.4: Rate of hydrolysis of halogenoalkanes

Procedure

- Set up three test tubes. Add 1 cm³ of ethanol to each + 4 drops decane. Put halogenoalkane (Prep. are insoluble in water).
- Add 3 drops of a different halogenoalkane to each tube: 1- chlorobutane, 1-bromobutane, 1-iodobutane.
- Place all three test tubes in a water bath at 60°C together with a test tube of 10 mol dm⁻³ $HgNO_3$ dissolved in ethanol.
- Mixy all tubes to reach the same temperature in 5 minutes.
- Quickly add 1 cm³ of $HgNO_3$ in ethanol to each test tube simultaneously, start stopwatch.
- Record the time taken for a precipitate to form in each tube and note the colour.





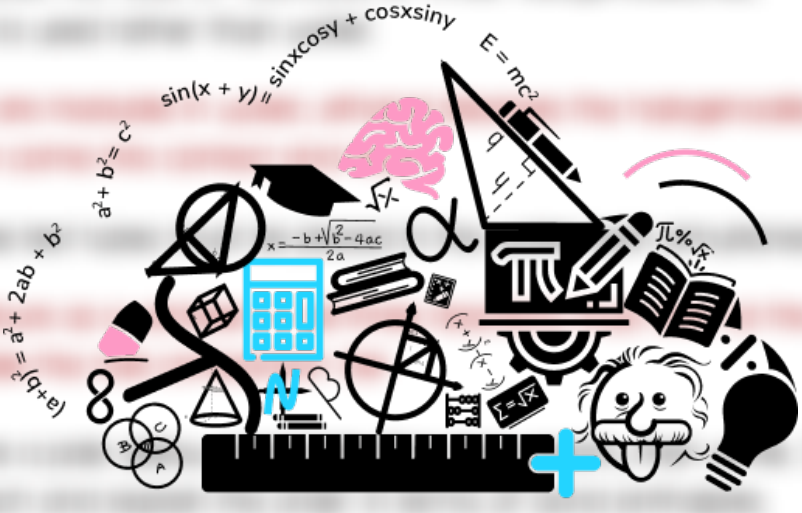
My Maths Cloud

Observations

Halogenoalkane	Time taken for precipitate to form	Colour of precipitate
1-chlorobutane	4	Cream
1-bromobutane	2	Cream
1-chloroiodane	1	Yellow

Common errors

Error	Effect	How to minimise
Using $HgNO_3$ in water instead of ethanol	No reaction — halogenoalkane molecules in water	Ensure use $HgNO_3$ dissolved in ethanol
Not water bath 60°C placed in both simultaneously	Temperature comparison invalid — unfair test	Place all three in both on the same bench
Temperature of water bath varies	Time comparison meaningless	Use thermometer both, monitor temperature
$HgNO_3$ added in different times	Invalid fair test, results	Add in all three tubes simultaneously, start stopwatch at moment of addition

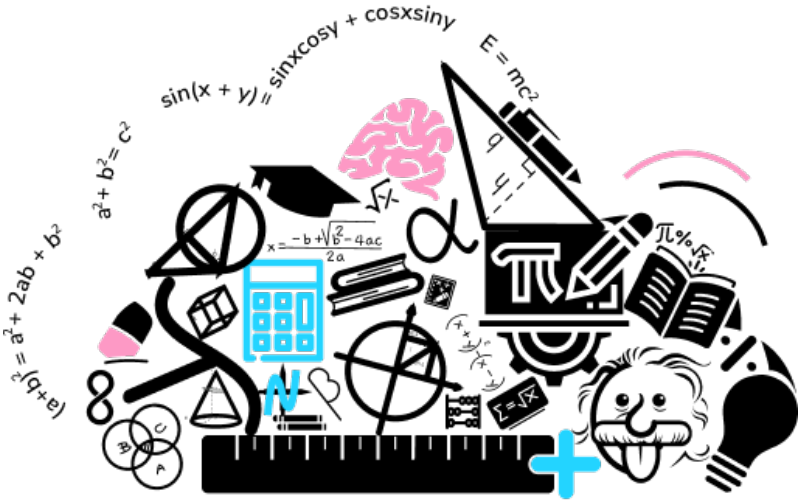

sin(x + y) = sinxcosy + cosxsiny
E = mc²
a² + b² = c²
(a+b)² = a² + 2ab + b²
My Maths
Cloud

(b) (i) A student uses aqueous $NaHCO_3$ instead of $NaHCO_3$ in ethanoic. Explain this effect on the results

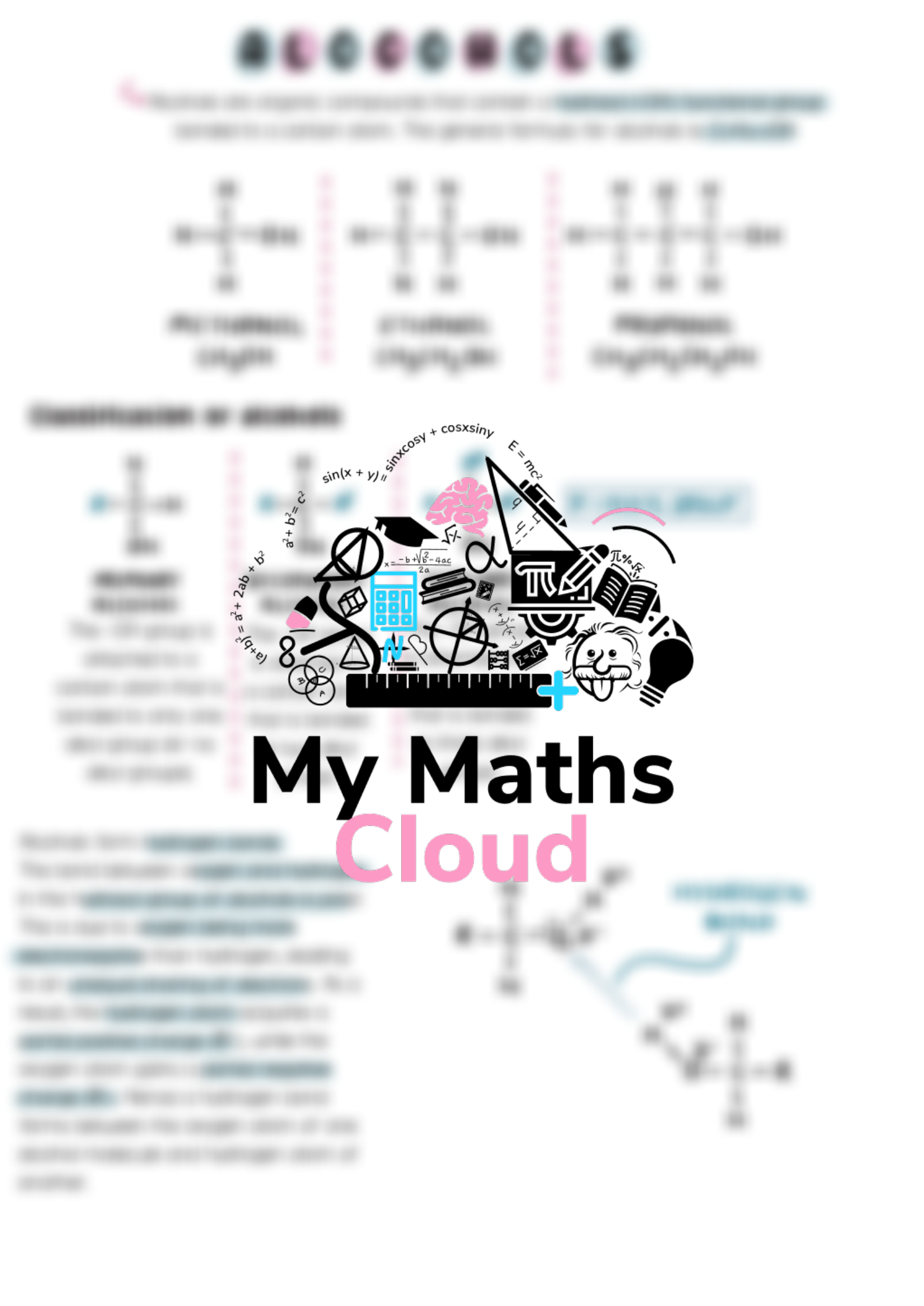
- Halogenoalkanes are insoluble in water
- This results in no / very slow reaction with aqueous $NaHCO_3$
- Hence, no precipitate observed
- Thus, cannot compare rate

(b) State two variables that must be controlled to make the rate comparison a fair test

- temperature same under both temperatures
- concentration/amount of $NaHCO_3$ in ethanol
- concentration/ number of drops of each halogenoalkane
- all times added to $NaHCO_3$ simultaneously



My Maths Cloud


sin(x + y) = sinxcosy + cosxsiny
E = mc²
a² + b² = c²
(a+b)² = a² + 2ab + b²
My Maths
Cloud

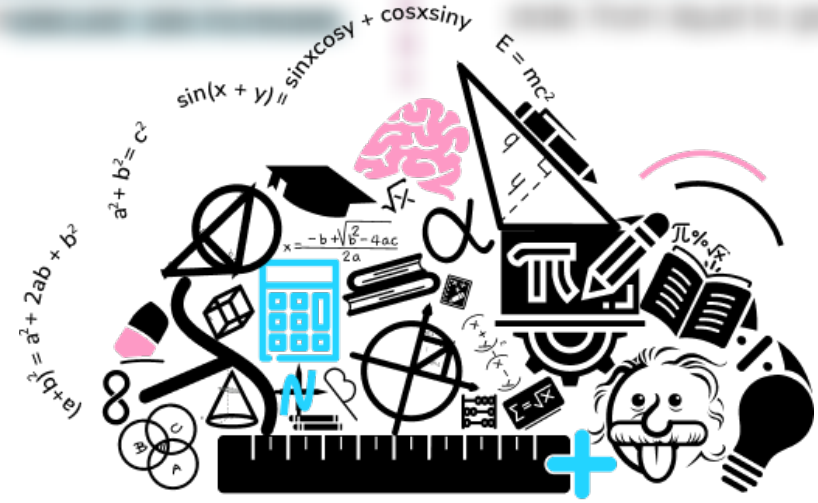
Physical Properties

Boiling Point

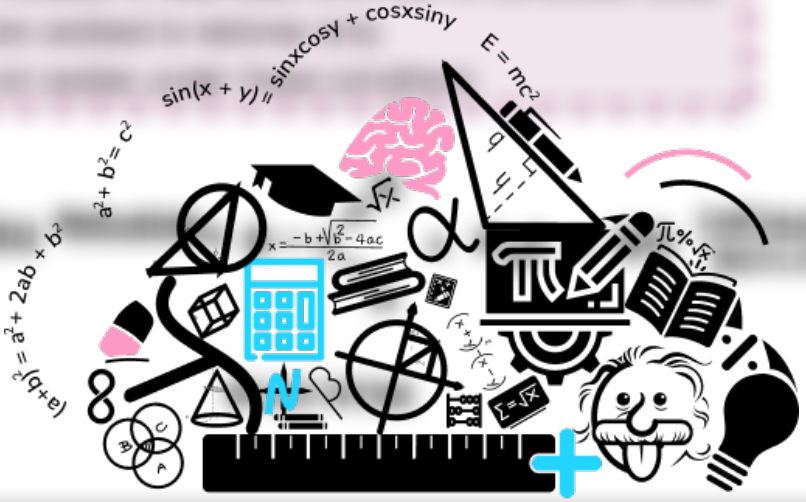
- Alcohols with **simple aromatic groups** (methanol to propanol) **dissolve in water** because they **withdraw groups forming hydrogen bonds** with water molecules.
- In summary, alkenes are insoluble in water due to their lack of polar groups and inability to form hydrogen bonds.
- **Longer alcohols have increasing non-polar hydrocarbon regions** thus interfere with hydrogen water hydrogen bonding.
- So the **solubility of alcohols in water decreases** as their **molecular size increases**.

Solubility

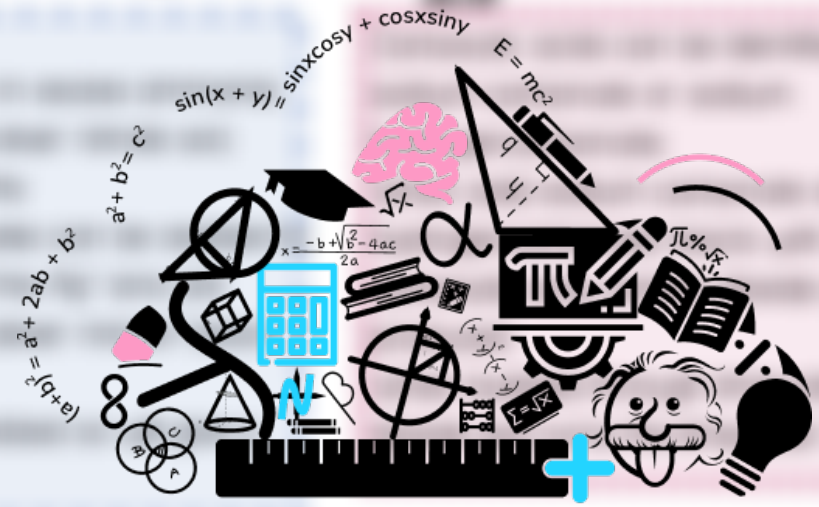
- The **ability of alcohol molecules to withstand forces with each other** leads to **weak solubility** (higher boiling points in comparison to alkenes of similar **molecular size**).
- For example, ethanol is less volatile than ethene, despite having similar molecular masses.
- This is because the **hydrogen bonds** between **alcohol molecules** require **more energy to break** during the change of state from liquid to gas.



My Maths Cloud



My Maths Cloud



My Maths Cloud



My Maths Cloud

1. [redacted]



[redacted]

1. [redacted]
2. [redacted]
3. [redacted]

a. [redacted]
b. [redacted]
c. [redacted]

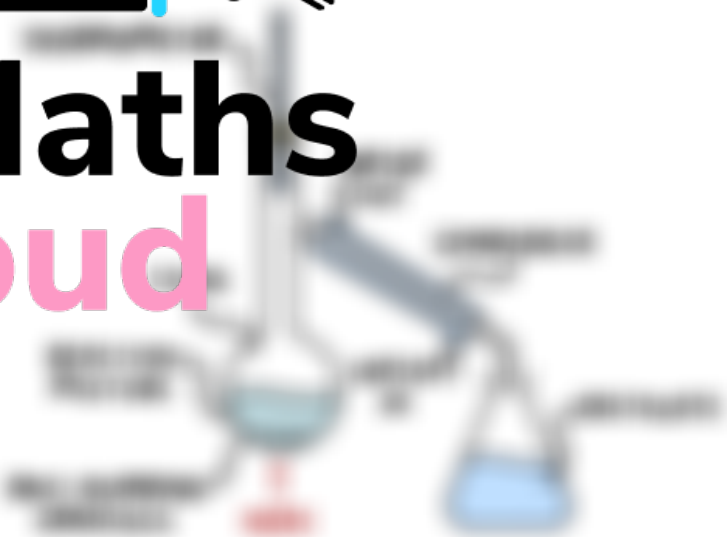
2. [redacted]

[redacted]

1. [redacted]
2. [redacted]
3. [redacted]

a. [redacted]

1. [redacted]
2. [redacted]



My Maths Cloud

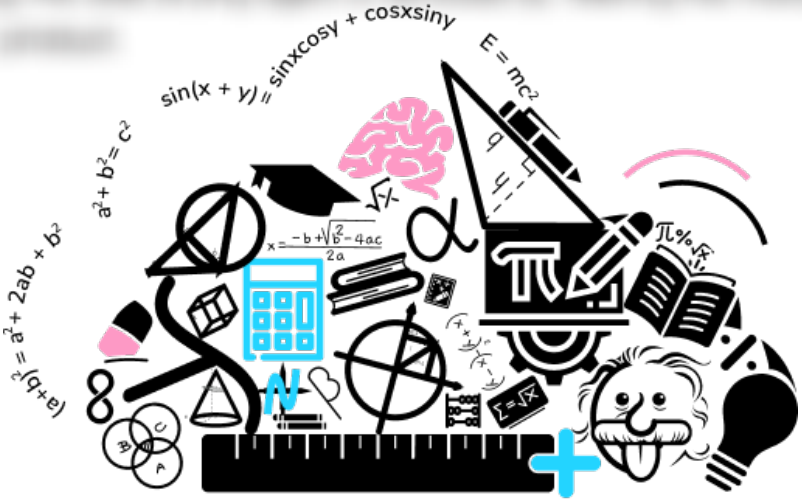
[illegible]



[illegible] - when water is added to a mixture of two organic liquids and an organic solvent in a separating funnel, two immiscible liquids form. The organic liquid product dissolves in the organic layer, while water-soluble impurities dissolve in the aqueous layer. The layers are then drained off separately from the tap at the bottom of the funnel.

[illegible] - Traces of water dissolved in organic products can be removed using drying agents such as anhydrous magnesium sulfate or anhydrous calcium chloride.

[illegible] - After drying, the solid drying agent is removed by filtering the mixture, leaving behind the dry purified organic product.

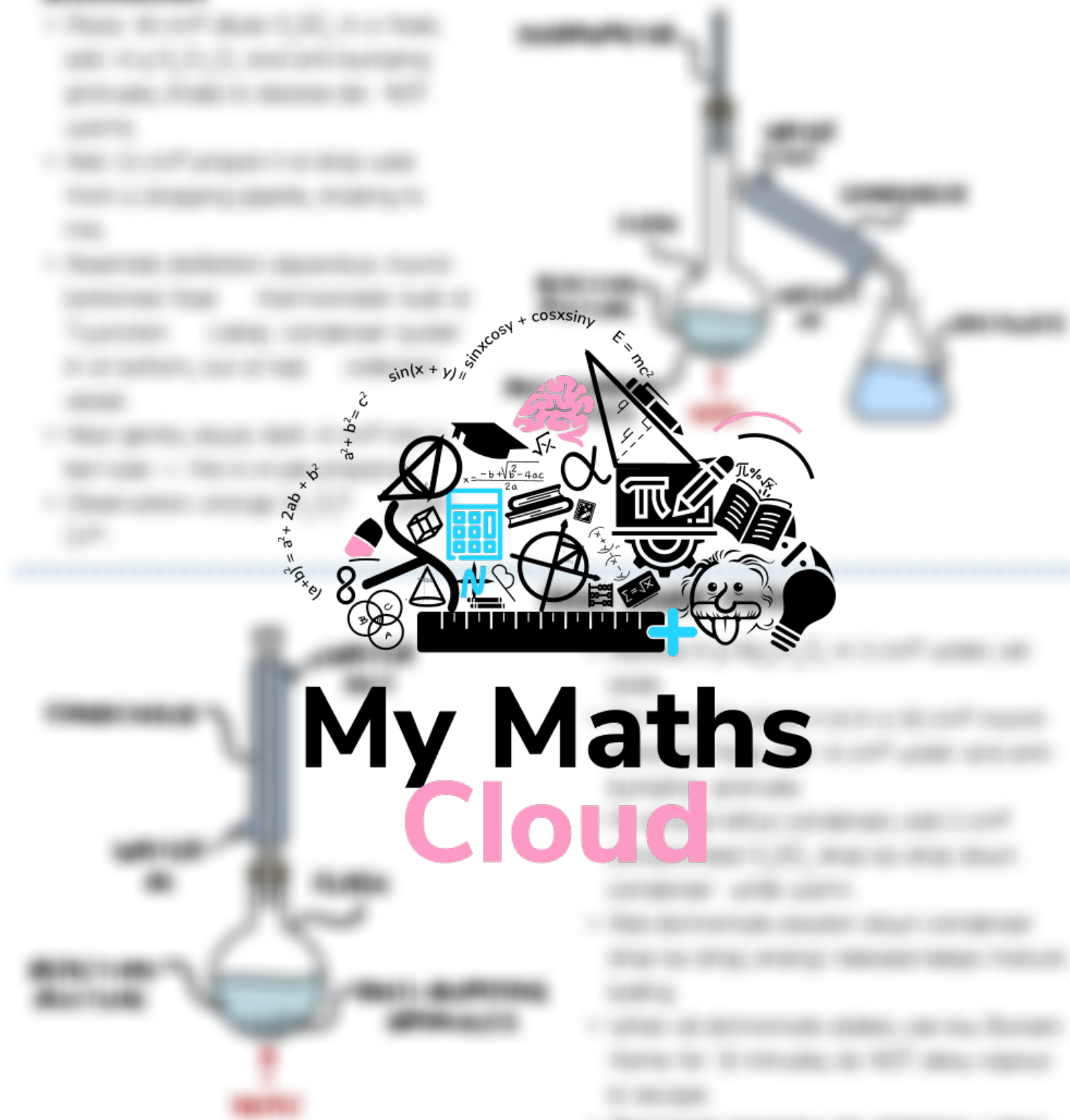


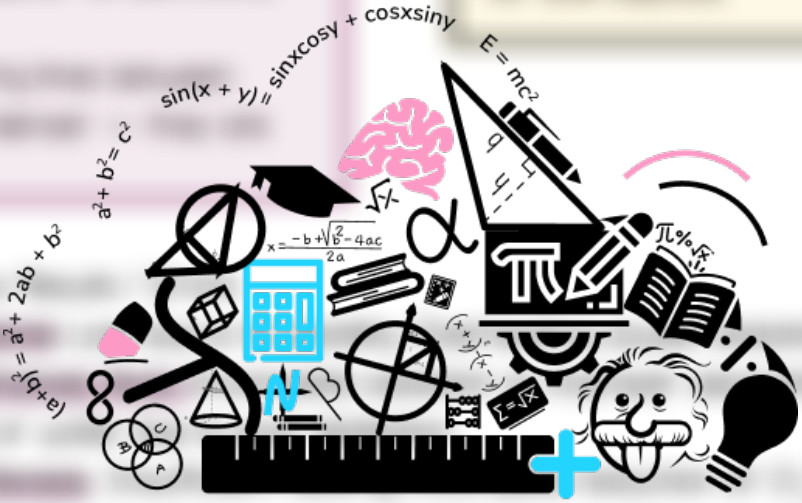
My Maths Cloud

CCEE PRACTICAL 05- Oxidation of alcohol

Aim/Objective

Procedure

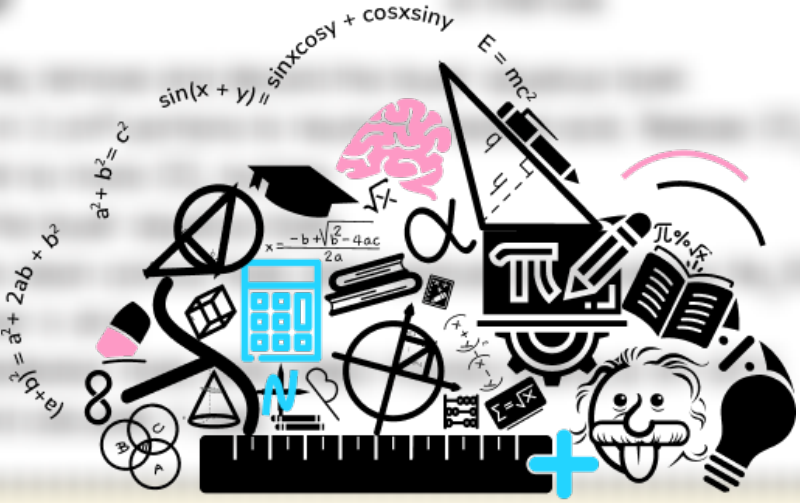




My Maths Cloud

GCSE PRACTICAL 6 :- Chlorination





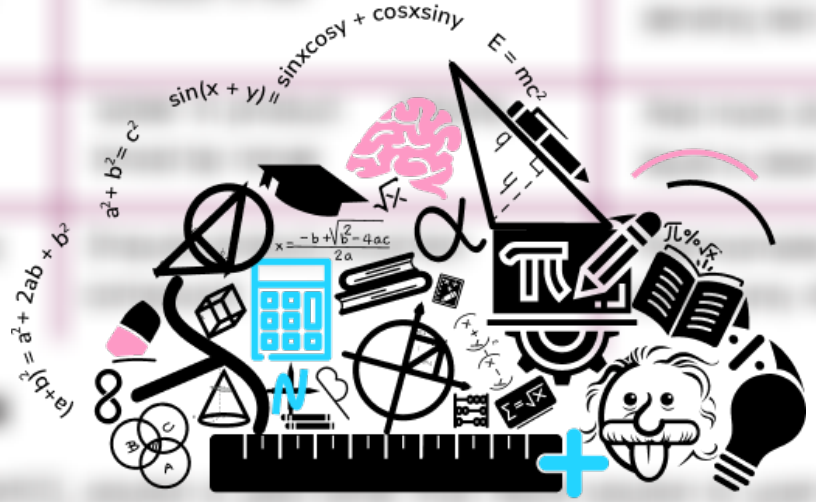
My Maths Cloud

Purpose of certain step

[illegible]	Removes aqueous HCl layer from organic product
[illegible]	Neutralises residual HCl, produces CO_2 (→ release pressure after each addition)
[illegible]	Removes dissolved water from organic layer (→ clear, pale yellow oily liquid)
[illegible]	Removes remaining impurities, collect pure product

Common errors

Error	Effect	How to minimise
Not releasing pressure from funnel	Pressure builds → stopper blown out	Invert and open tap frequently
Discarding the organic layer	Product is lost	Check which layer is aqueous (density test or drop it in water)
Incomplete drying	Cloudy product, low purity	Add more drying agent, until solid no longer clumps
Collecting wrong boiling fraction	Impure product	Collect only at 1 consistent, narrow range (±2°C)



My Maths Cloud

Exam questions

(b) (i) State why $NaHCO_3$ solution is used to wash the organic product.

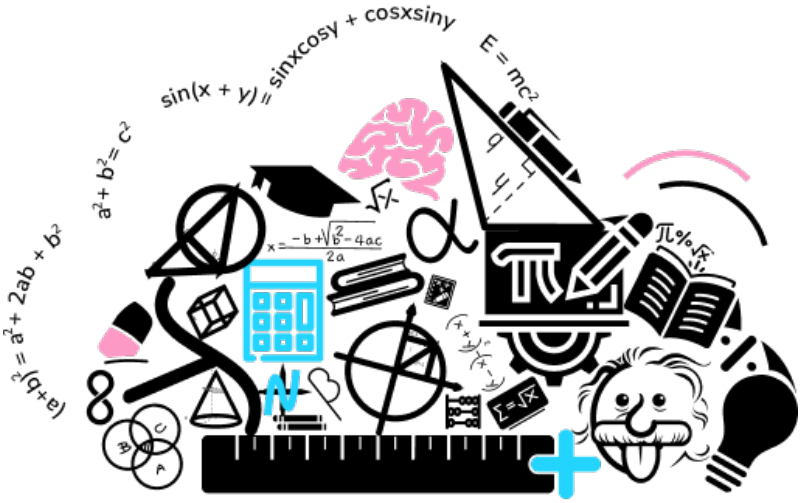
- $NaOH$ is a strong [illegible] which could cause hydrolysis/saponification of ester/product
- $NaHCO_3$ is a mild base that [illegible] HCl without [illegible] the product

(ii) Write the ionic equation for the reaction of $NaHCO_3$ with HCl. Explain why this separating funnel must be inverted and the tap opened regularly.

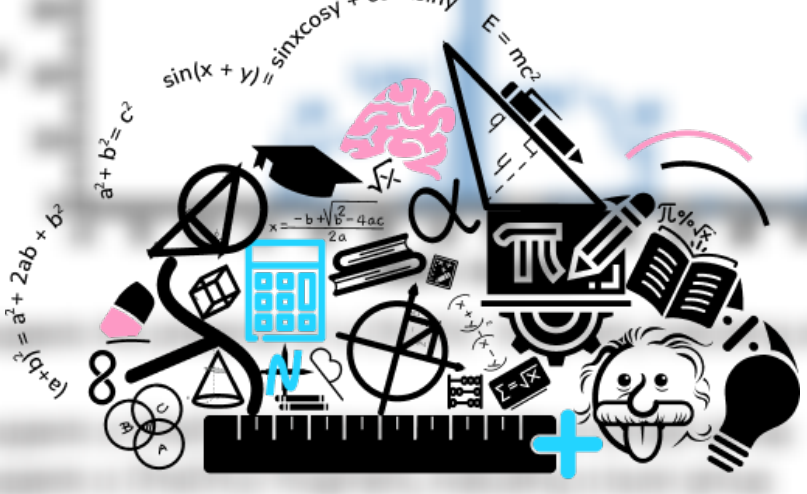
- $H^+ + HCO_3^- \rightarrow H_2O + CO_2$ or $HCl + NaHCO_3 \rightarrow NaCl + H_2O + CO_2$
- CO_2 gas produced increases pressure inside funnel
- opening tap releases pressure to prevent stopper being blown out

(c) (i) 1 mol of 1-methylpropan-2-ol (74) → 96 cm³ used; 0.5 mol of 2-chloro-2-methylpropane (92.5) was collected. Calculate the percentage yield.

[illegible]



My Maths Cloud



My Maths Cloud

[redacted]

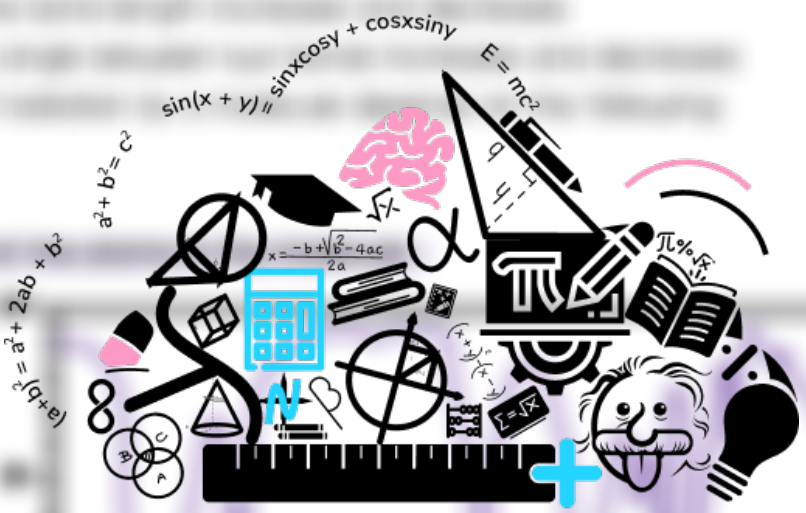
- [redacted]
- [redacted]

[redacted]

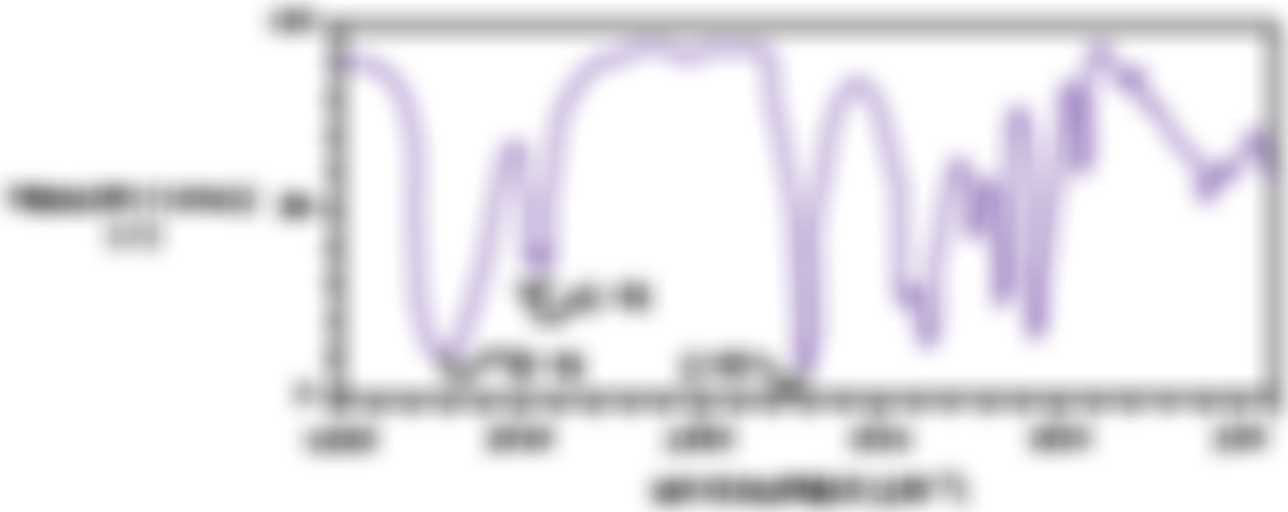
1. [redacted]
2. [redacted]

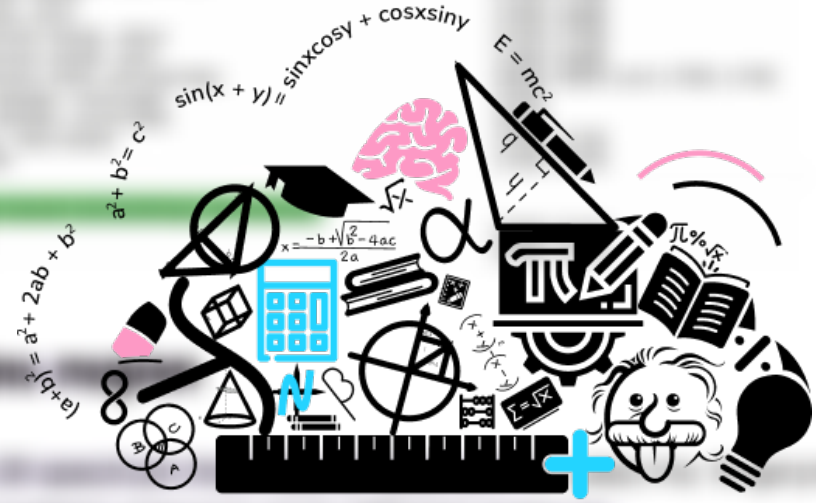
[redacted]

1. [redacted]
2. [redacted]
3. [redacted]

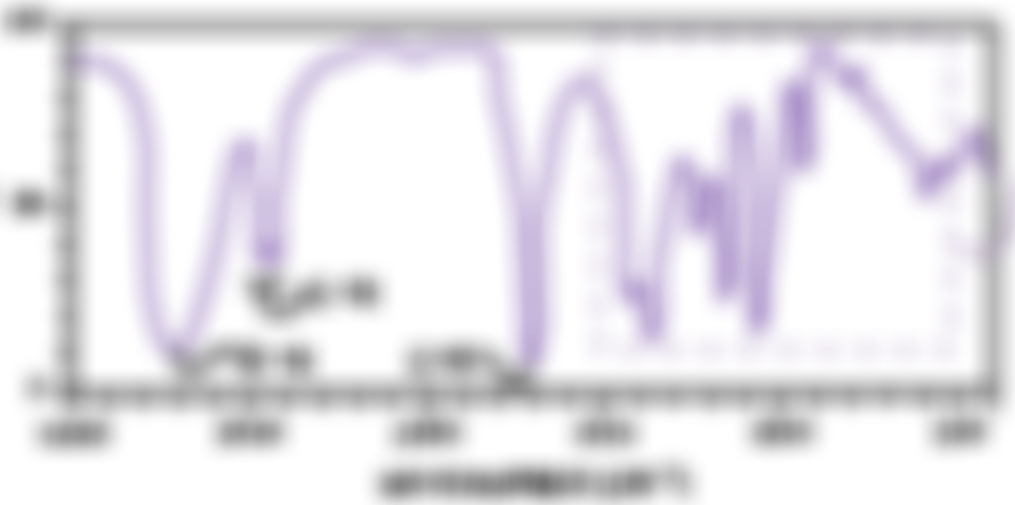


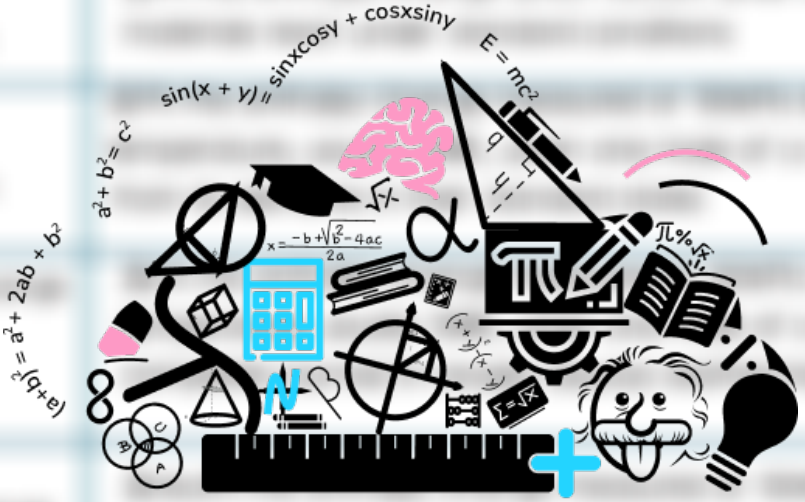
[redacted]





My Maths Cloud





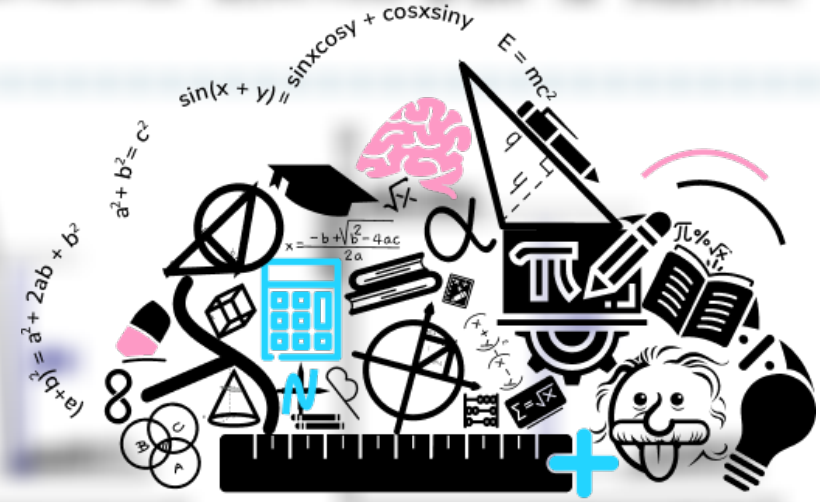
My Maths Cloud

energy level diagrams









My Maths Cloud

How it's Use

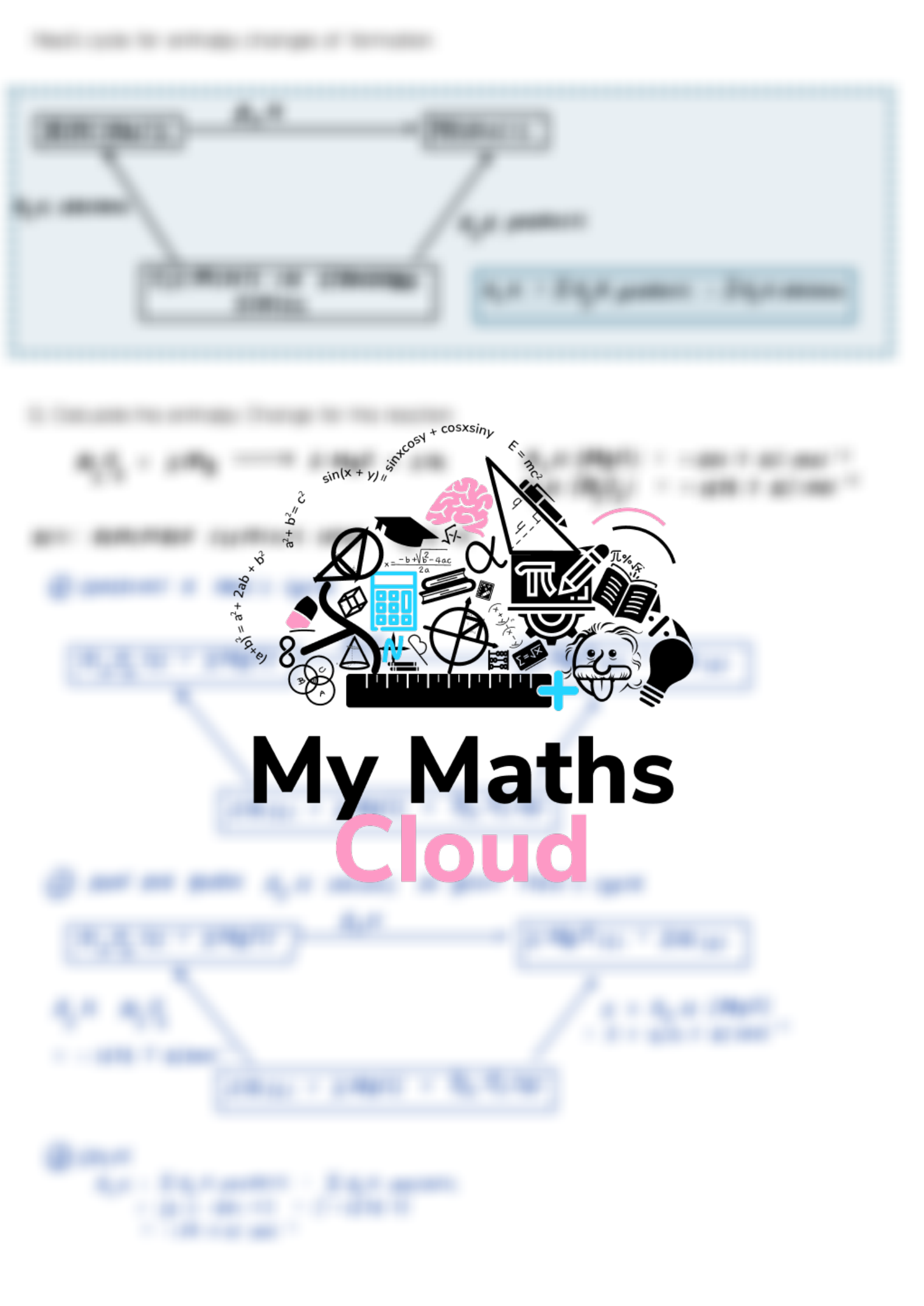
Hess's Law states that the total enthalpy change of a reaction is independent of the route taken between the initial and final states, provided that the initial and final conditions are the same for each route.

Hess's Law is often used to calculate enthalpy change for reactions that cannot be determined directly by experiments (hydro enthalpy change of formation). Instead, alternative reactions are carried out that can be measured experimentally.



Hess's cycle for enthalpy change of formation

Q. Calculate the enthalpy change for this reaction.





My Maths Cloud

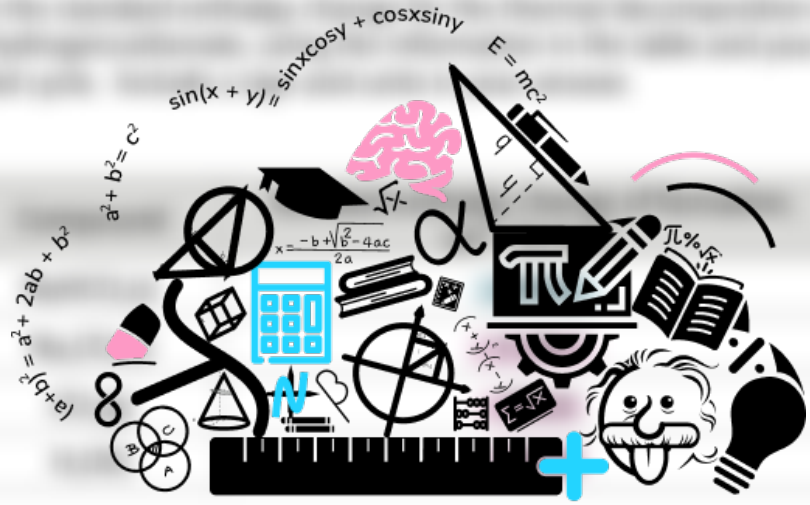
My Maths Cloud



My Maths Cloud



My Maths Cloud

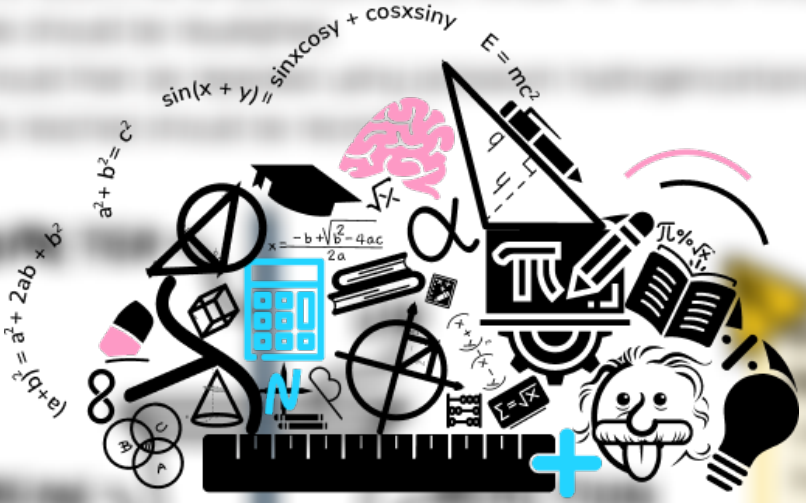


My Maths Cloud

CCEE PRACTICAL 02: Determining Enthalpy change of a reaction

Procedure

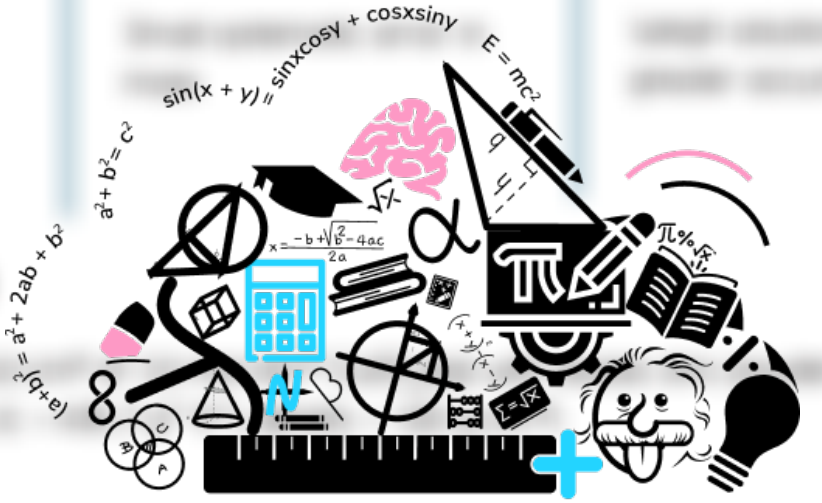
- Place a polystyrene cup in a beaker for both insulation and support.
- Using a pipette, transfer desired volume of hydrochloric acid or other solution to the cup.
- Place a thermometer in the cup and measure the initial temperature of the solution.
- Potassium carbonate or other solid reagent should be added to the cup after the last scale with the solid is
- weighed using a balance.
- Stir the mixture and record the temperature every minute for several minutes.
- The empty test tube should be rinsed
- The experiment should then be repeated using a hydrogencarbonate and the lowest temperature reached should be recorded.



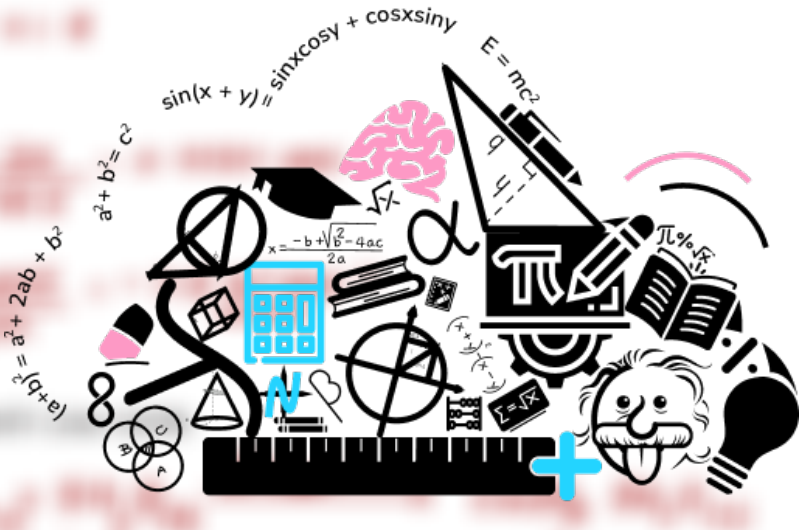
My Maths Cloud

Q and A

1. Why use a polystyrene cup?
   It acts as an insulator and reduces heat transfer to the surroundings.
2. Why stir continuously?
   To distribute heat evenly and obtain a uniform temperature.
3. Why use excess hydrochloric acid?
   To ensure the carbonate is the limiting reagent and reacts completely.
4. Why is ΔH negative for H_2CO_3 + HCl?
   The temperature increases, meaning heat is released to the surroundings.
5. Why is ΔH positive for NH_4Cl + HCl?
   The temperature decreases, meaning heat is absorbed from the surroundings.



My Maths Cloud



My Maths Cloud

Measuring enthalpy change experimentally

1. Experiment Neutralisation



- Using a pipette, filled with a suitable, fairly dilute acid of known concentration, add a measured volume of the acid to a polystyrene cup.
- Measure the temperature of the acid.
- Using a pipette, filled with a suitable, fairly dilute alkali of known concentration, add a measured volume of the alkali to the acid in the polystyrene cup. The alkali should be in excess to ensure that all the acid reacts.
- Measure the temperature of the alkali. Ensure it is the same as the acid.
- Stir the alkali into the acid, and measure the maximum temperature reached.

Polystyrene cups are used as the calorimeter, as it is a calorimeter material of good insulator, because polystyrene is a better insulator than metal, is cheap, and has a low specific heat capacity. These properties reduce the heat loss to the surroundings and minimise the amount of heat absorbed by the calorimeter itself.

2. Experiment Combustion

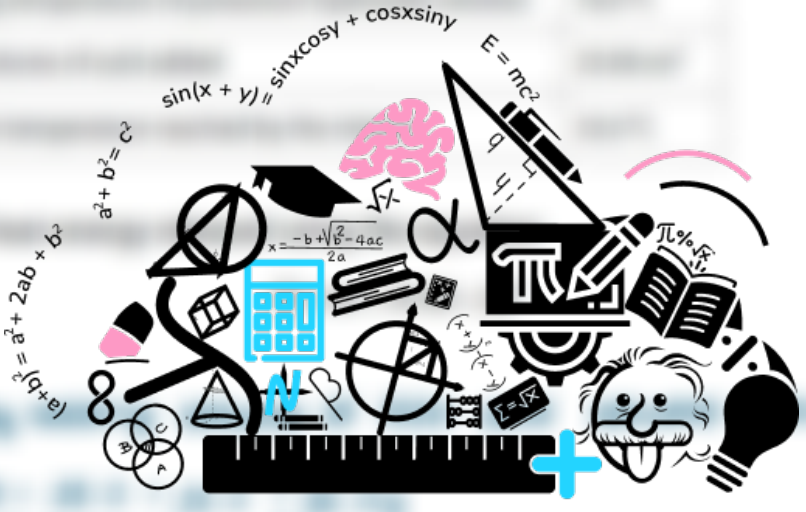


- Using a pipette, filled with a suitable, fairly dilute acid of known concentration, add a measured volume of the acid to a copper can. Avoid spilling any acid on the outside of the can.
- Measure the temperature of the acid.
- Stir the alkali into the acid, and measure the maximum temperature reached.

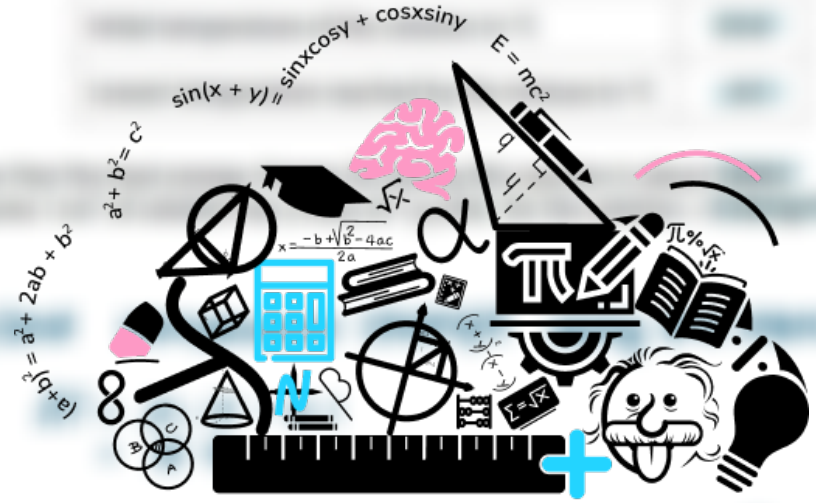
Some possible sources of error

- Some of the heat energy produced in burning is transferred to the air and not the water.
- Some of the ethanol may not burn completely to form carbon dioxide and water. Incomplete combustion would produce less heat energy and also could lead to soot on the bottom of the copper can.
- Some of the heat energy produced in burning is transferred to the copper can and not to the water.
- The conditions are not standard. For example, water vapour, not liquid water, is produced.
- The experiment takes a long time. This means that not all the heat energy transferred from the water to the surroundings is compensated for.

My Maths Cloud



My Maths Cloud



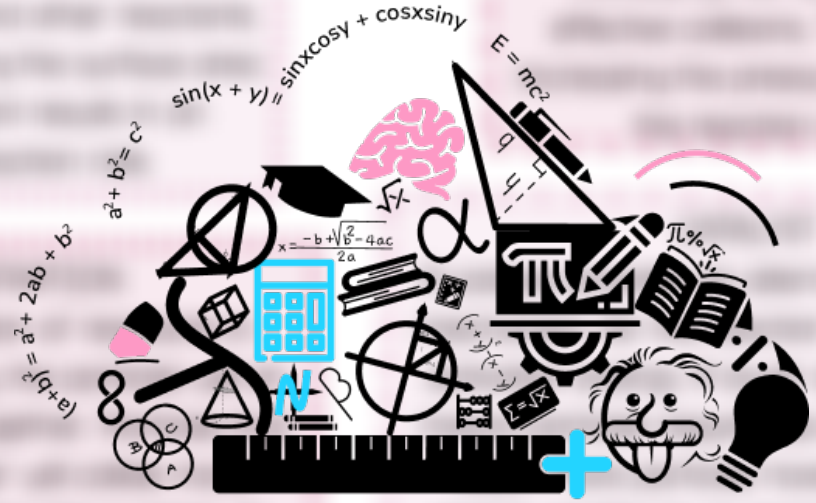
My Maths Cloud



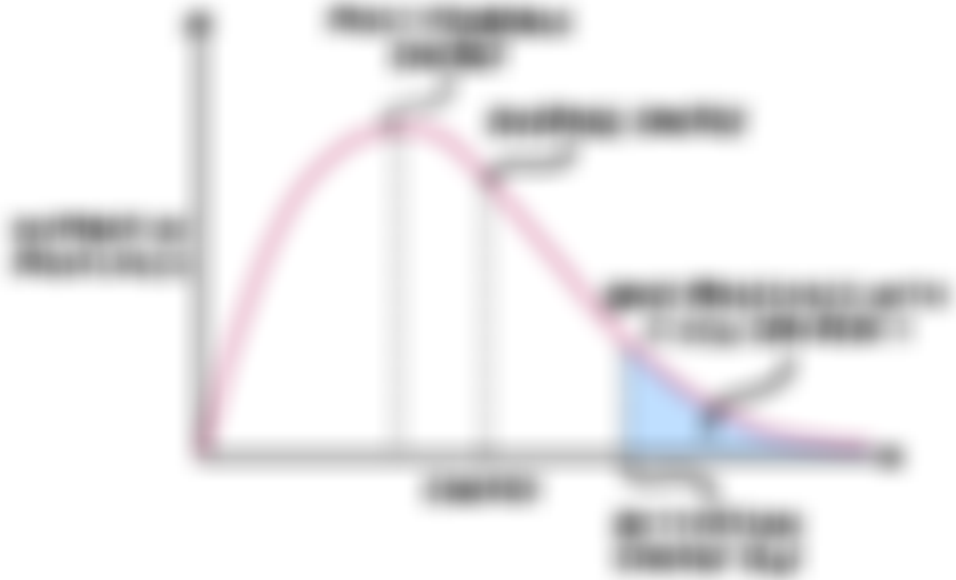
My Maths Cloud

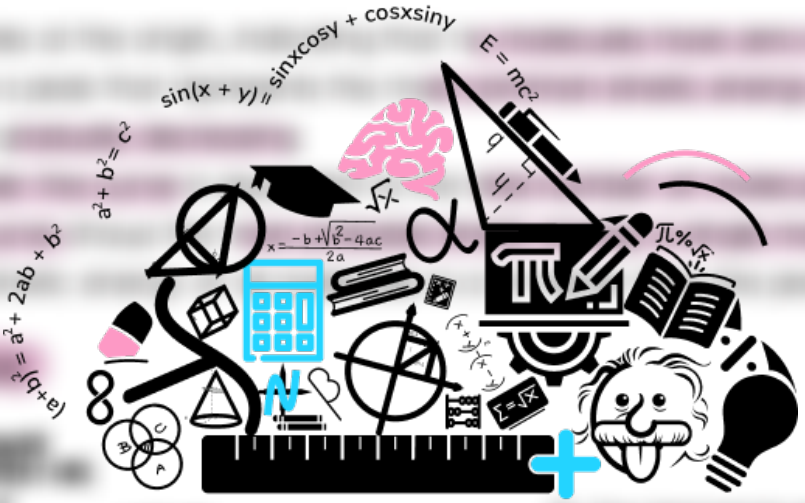


My Maths Cloud

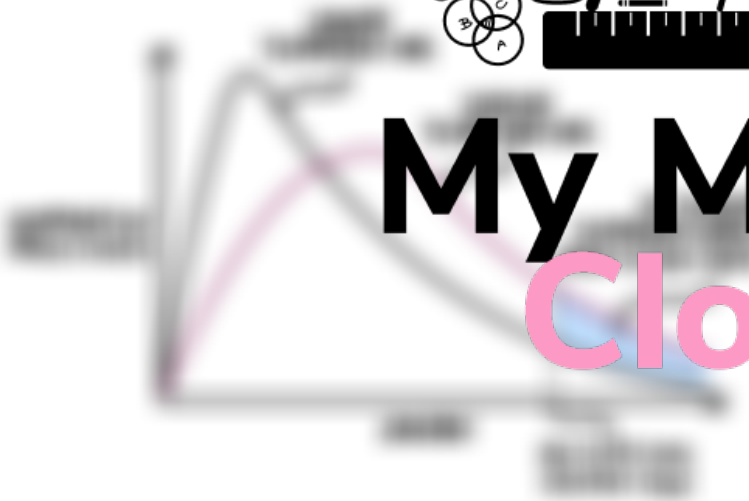


My Maths Cloud



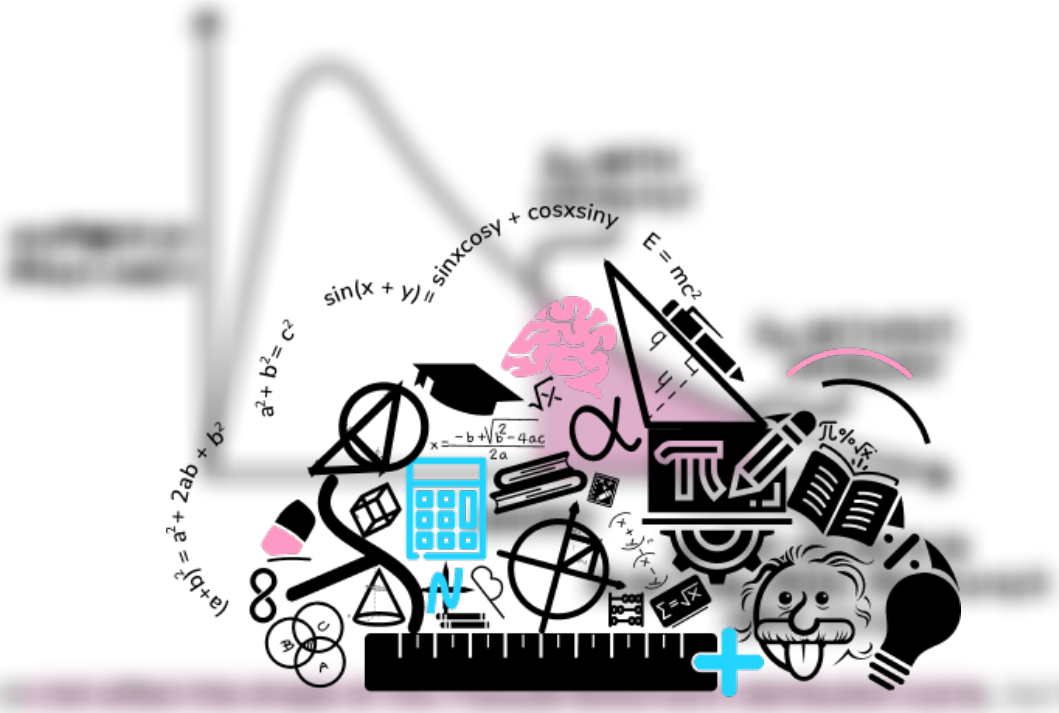


My Maths
Cloud





In many cases, reactants combine with the catalyst to form an intermediate species. This intermediate then reacts to form the products and regenerate the catalyst.



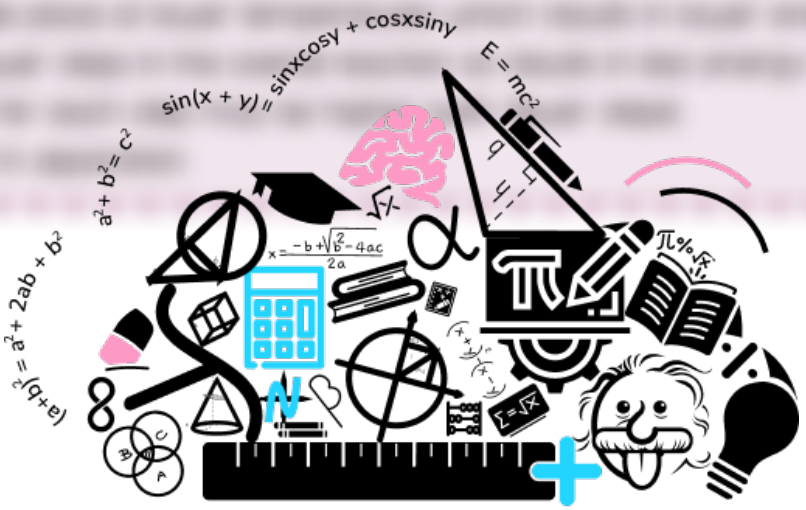
My Maths Cloud



1. **Homogeneous catalysts** are in the same physical state as the reactants.
2. These catalysts are **usually equations equations**, used to calculate reactions between equations reactants.
3. The reactants combine with the homogeneous catalyst to form an intermediate.

Examples: Reactivities of alkyl halides

1. These desired product can be obtained per unit time as catalysts increase the rate of reaction with little or no by-products.
2. Reactions can take place at lower temperatures which results in lower energy costs.
3. Catalysts allow faster steps in the overall reaction which results in less energy costs.
4. Percentage yield for each step in the reaction is high.
5. Less product has to separated from.



My Maths Cloud

Equilibrium

Two conditions for dynamic equilibrium to be established:

1. Reactions must be reversible
2. Reactions / products must be in a closed container

Three features that define a system that is in dynamic equilibrium:

1. The rate of forward reaction is equal to the rate of backward reaction
2. The concentrations of the reactants and products remain constant
3. Both forward and backward reactions are continuously occurring



My Maths Cloud

Le Chatelier's principle

Le Chatelier's principle: If a change is made to a system in equilibrium, the position of equilibrium will move to counteract the change.

The position of equilibrium moves to the left or right to restore a new equilibrium.

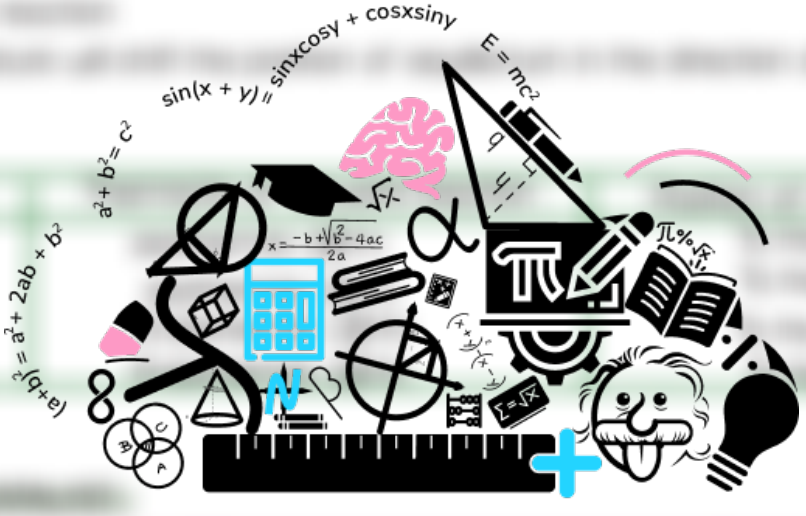
Shifting to the right means more products form.

Shifting to the left means more reactants form.

Effect on equilibrium concentrations:

- If you increase the concentration of a reactant in equilibrium, the rate of forward reaction will increase and more products will form. As the concentration of products increases, the rate of backward reaction will also increase until eventually a new equilibrium is established to the right hand side of the original.

Concentration change	Equilibrium moves to...	Position of equilibrium until...
Increased / Decreased		To the right / To the left
	Increased / Decreased	To the left / To the right



My Maths Cloud

The Caesars Projects

Image to Text | Image to Voice

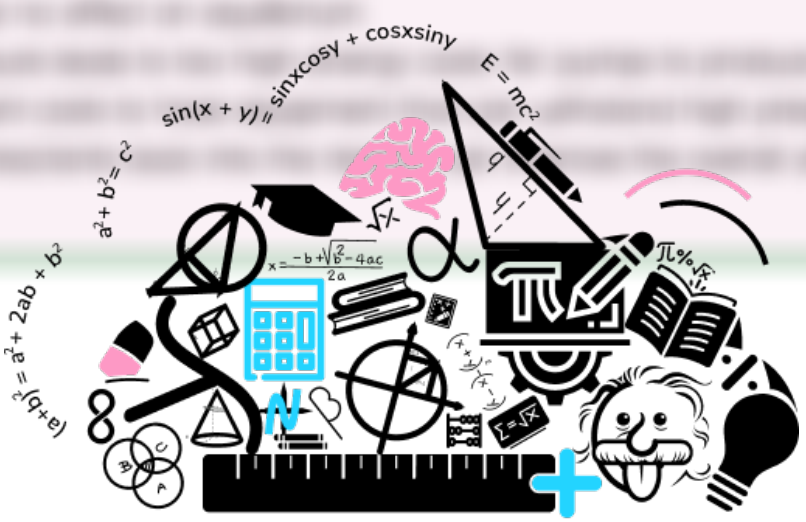
Image to Bitmap | Image to Bitmap to Vectorize

- As temperature becomes an important factor, many temperatures between high yields of 72°C but rate of reaction will be slow as compare with 87°C with effectively at low temperatures as a compromise temperatures of 80°C is used.
- High pressures would increase the yield as there are fewer moles of the reactant but high pressures will result in high energy costs as a compromise pressures of 50atm is used.
- To catalyst of vanadium(V) oxide is used.

In an exam, someone asked us the role diffusing could bring to the plant and how could energy costs be affect on equilibrium.

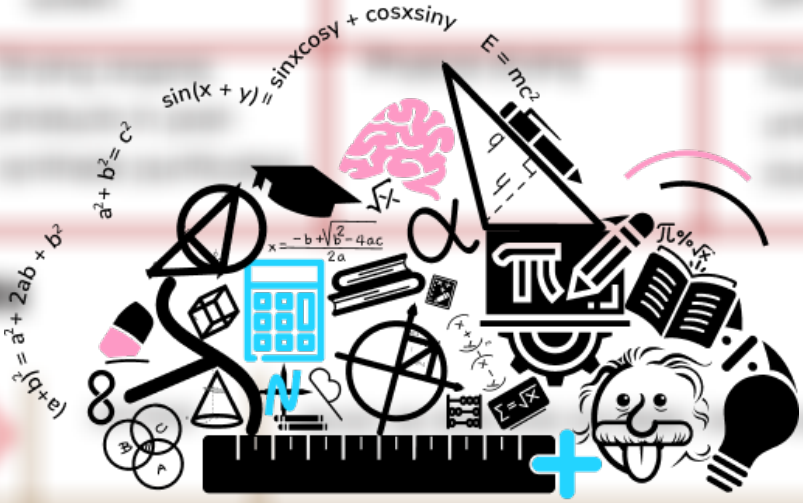
In an exam, high pressure leads to how high energy for pumps to produce the pressure and how high equipment costs to withstand high pressures.

Recycling unreacted reactants also has an impact on the overall yield of an industrial process.



My Maths Cloud

My Maths Cloud



My Maths Cloud