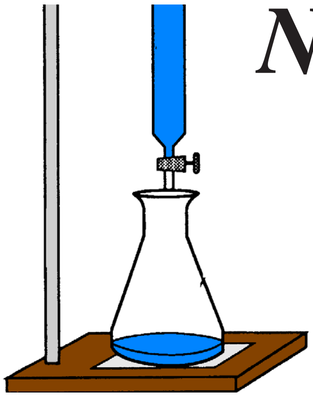
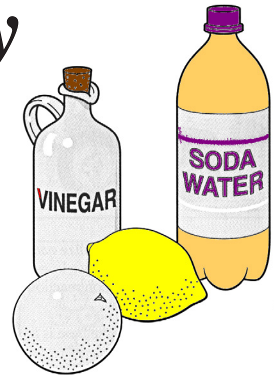


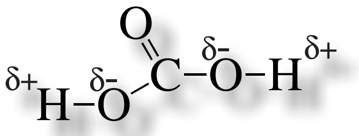
National 5 Chemistry



Unit 1:

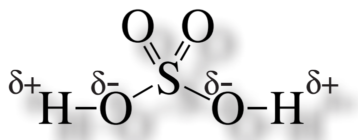
Chemical Changes & Structure

Student:



Topic 4

Chemistry of Acids & Bases

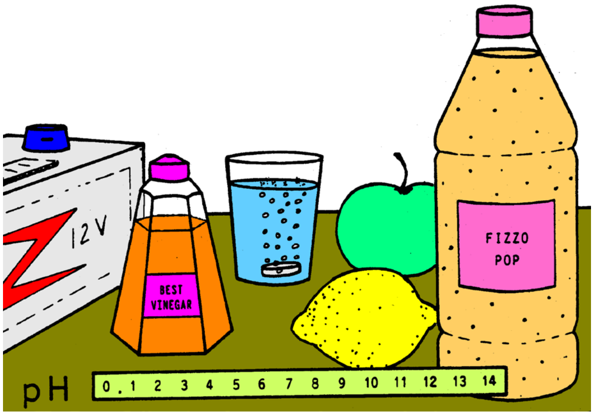


Topics		Sections	Score	Done	Checked
4.1 *Acids & Bases*	1.	Common Acids			
	2.	Common Bases			
	3.	Bases & Alkalis			
	4.	Making Acids			
		Self -Check Questions 1 - 8	Score: /		
4.2 *Acid & Base Structures*	1.	Acid Molecules			
	2.	Covalent to Ionic			
	3.	Ammonia			
	4.	Water Ions - Dissociation			
	5.	pH Numbers			
		Self -Check Questions 1 - 8	Score: /		
4.3 *Reactions of Acids*	1.	With Metals			
	2.	With Metal Oxides			
	3.	With Metal Carbonates			
	4.	With Alkalis			
	5.	Making Salts			
		Self -Check Questions 1 - 8	Score: /		
4.4 *Quantitative Analysis*	1.	Standard Solution			
	2.	Titrations			
	3.	Technique			
	4.	Results			
	5.	Evaluation			
		Self -Check Questions 1 - 8	Score: /		
Consolidation Work		Consolidation A	Score: /		
		Consolidation B	Score: /		
		Consolidation C	Score: /		
		Consolidation D	Score: /		

End-of-Topic Assessment	Score: %	Grade:

4.1 Acids & Bases

Common Acids

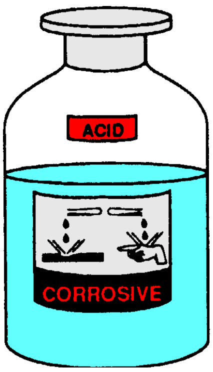


Ac are all around you. *Most* are ***sa*** to handle but some are definitely not.

Fiz drinks (CO_2,*carbonic* ***acid***) , some fruits like ***lem*** and ***ora*** (*citric* ***acid***), ***vin*** and ***ket*** (*ethanoic* ***acid***), and even many ***veg*** (*ascorbic* ***acid***, *vitamin C*) contain ***ac*** . These are examples of weak acids. A more unpleasant example is a ***bee*** sting, ***net*** sting or ***ant*** bite (*formic acid*).

Stronger acids are found in car ***bat*** (*sulfuric acid*) while our ***stom*** contain acid (*hydrochloric*) to break down our ***fo*** into ***sma*** molecules.

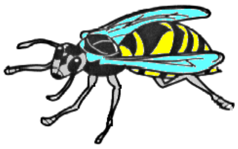
- ***Acids taste sour*** - the ***lat*** word for ***so*** was "*acidus*"
- ***Acids kill cells*** - the most vulnerable part of you is your ***ey*** ,because they have ***liv*** cells on the ***sur*** (Safety Glasses !)



Pickling food in ***vin*** (***eth*** *acid*) is an ancient way of killing ***bac*** and keeping food. It made food taste ***so*** , but many people like that, so we still ***pic*** food.

- ***Acids react with metals*** - ***ir*** objects, like the ***Fo*** *Rail Bridge*, ***ru*** much ***fas*** these days because of ***ac*** *rain*.
- ***Acids react with carbonates*** - ***ac*** *rain* is destroying many of the ***mar*** (*calcium carbonate*) ***stat*** in the world
- ***Acids react with alkalis*** - the ***lea*** of a *dock* (or *docken*) plant can ***neut*** the ***sti*** from a ***net***
- ***Acids change the colour of indicators*** - e.g. they turn ***univ*** *indicator* from ***gr*** to ***r***
- ***Acids have a pH less than 7*** - on a pH scale that goes from to .

Common Bases



Bases are also all around you. *Most* are ***sa*** to handle but some are definitely not.

To ***paste*** contains a ***base*** to help neutralise the ***ac*** on your ***tee*** , produced by ***bac*** . Most ***soa*** and ***dete*** contain bases to help cope with ***gre*** and ***oi*** stains. Our ***liv*** produces ***bile*** (a *base*) to help break down ***fat*** foods. ***Far*** and ***gar*** will spread ***li*** (*calcium hydroxide*) on the ***so*** if it is too ***aci*** .

Wa stings are basic, and just as painful as any acid. Other harmful ***bases*** are found in ***blea*** (*ammonia*)

- ***Bases feel slippy*** - most ***soa*** are basic
- ***Bases kill cells*** - the most vulnerable part of you is your ***ey*** , because they have ***liv*** cells on the ***sur*** (Safety Glasses !)
- ***Bases react with acids*** - ***wa*** stings (***alk***) should be treated with an acid like ***vin*** or ***lem*** juice, while ***bee*** stings need ***bak*** ***soda*** (a base).

Aci fumes (SO_2 and CO_2) from ***co*** burning ***pow*** stations are passed through ***li*** to be neutralised.

The ***hum*** stomach produces ***hy*** ***chl*** acid to help the ***enz*** (***cat***) *pepsin* to break down ***pro*** . Sometimes too much ***ac*** is made and it begins to attack the stomach ***wa*** causing ***pa*** . All stomach remedies contain ***bases*** to ***neut*** the stomach acid.

- ***Bases change the colour of indicators*** - e.g. they turn ***univ*** *indicator* from ***gr*** to ***pur***
- ***Bases have a pH greater than 7*** - on a pH scale that goes from to .

Bases & Alkalis

Our main source of *bases* are the ***Metal Oxide***s.

e,g,	*lime*	***calcium oxide***
	soda	***sodium oxide***
	magnesia	***magnesium oxide***
	pearl ash	***potassium oxide***

Though, we also use many ***Metal Carbonates***.

e,g,	*limestone*	***calcium carbonate***
	marble	***calcium carbonate***
	baking soda	***sodium carbonate***
	potash	***potassium carbonate***

Bases *are mainly* ***metal oxides*** *and* ***metal carbonates***

All of these *bases* are ***ionic compounds*** and, therefore, ***solids*** at *room temperature*. As ***solids***, they can be directly added to an acid and will ***neutralise*** the acid.

base **+** ***acid*** **→** ***salt*** **+** ***water***

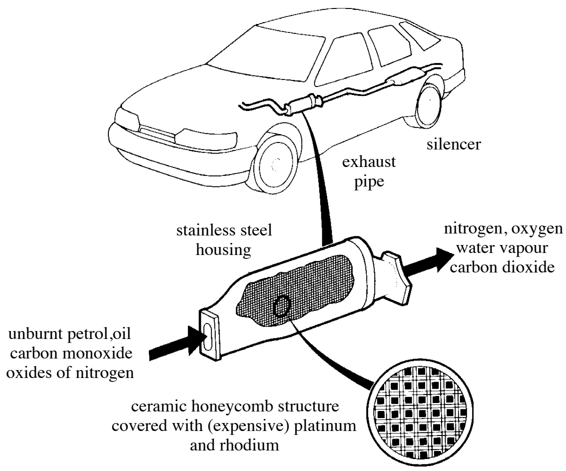
Sometimes, however we prefer to use ***sol*** of *soluble bases* which we then can call ***alk*** .

Most ***alk*** are made by ***dis*** a ***me*** ***oxide*** in ***wa*** - though only those in ***Group 1*** are very ***sol*** . (*Data Booklet*)

$_{(s)}$ soda	+	$H_2O_{(l)}$	→	$NaOH_{(aq)}$ sodium hydroxide
$K_2O_{(s)}$ pearl ash	+	$H_2O_{(l)}$	→	$_{(aq)}$ potassium hydroxide
$CaO_{(s)}$ lime	+	$H_2O_{(l)}$	→	$_{(aq)}$ calcium hydroxide
$_{(s)}$ magnesia	+	$H_2O_{(l)}$	→	$Mg(OH)_{2\,(aq)}$ magnesium hydroxide

The ***soluble metal oxides*** *can form* ***alkalis*** *with water*

Making Acids



Probably one of the first times the word ***ac*** was met was in the phrase "***ac*** ***ra*** ".

Ga like ***nitr*** ***dioxide***, NO_2 , (produced in ***pet*** engines) and ***sul*** ***dioxide***, SO_2, (***co*** burning ***pow*** stations) both dissolve to produce ***ac*** ***solu*** .

$$SO_{2\,(g)} + H_2O_{(l)} \rightarrow H_2SO_{3\,(aq)}$$

covalent gas — ionic solution

Fiz drinks are ***ac*** because ***car*** ***dioxide***, CO_2, dissolves to form ***carb*** acid, H_2CO_3.

Other ***n*** ***-met*** ***oxi*** like SO_3 (***sulf*** ***acid***, H_2SO_4) and P_2O_5 (***phosph acid***) behave this way, though ***insol*** ***oxi*** like ***carbon mo*** ***ide***, CO, cannot form ***ac*** solutions.

> *The **soluble non-metal oxides** can form **acids** with water*

$SO_{2\,(g)}$ sulfur dioxide	+	$H_2O_{(l)}$	→	$_{(aq)}$ hydrogen sulfite	»	***sulfurous acid***
$_{(g)}$ sulfur trioxide	+	$H_2O_{(l)}$	→	$H_2SO_{4\,(aq)}$ hydrogen sulfate	»	***sulfuric acid***
$CO_{2\,(g)}$ carbon dioxide	+	$H_2O_{(l)}$	→	$_{(aq)}$ hydrogen carbonate	»	***carbonic acid***
$_{(g)}$ nitrogen dioxide	+	$H_2O_{(l)}$ + $O_{2\,(g)}$	→	$HNO_{3\,(aq)}$ hydrogen nitrate	»	***nitric acid***
$_{(s)}$ diphosphorus pentoxide	+	$H_2O_{(l)}$	→	$_{(aq)}$ hydrogen phosphate	»	***phosphoric acid***

Not all of our acids are made from oxides, however.

$_{(g)}$ hydrogen	+	$_{(g)}$ chlorine	→	$HCl_{(g)}$ hydrogen chloride	»	***hydrochloric acid***
$_{(g)}$ hydrogen	+	$_{(s)}$ sulfur	→	$H_2S_{(aq)}$ hydrogen sulfide	»	***hydrosulfuric acid***

Q1. Int2

Acids and Bases are found everywhere around us. For each of the substances listed below, decide whether they are acids *(A)* or bases *(B)*.

lemon juice	*toothpaste*	*lime*
wasp stings	*vitamin C*	*Coca Cola*
tomato ketchup	*nettle sting*	*bleaches*
baking soda	*stomach juices*	*detergents*

Q2. S

The grid shows pH numbers and test colours of some solutions.

A Purple	B pH 5	C pH 7
D pH 1	E Orange	F pH 14
G pH 8	H Red	I pH 4

a) Which box or boxes show acid pH colours ________

b) Give the ***two*** boxes with alkali pH numbers. ________

c) Hydrochloric acid was tested with indicator solution. Which box gives the colour produced? ________

d) The pH number of water is on the grid. Which box is it in? ________

Q3. Int2

The grid shows the names of some compounds.

A lead sulphate	B sodium chloride
C calcium hydroxide	D potassium phosphate

a) Identify the compound which contains only two elements. ________

b) Identify the compound which will neutralise an acid. ________

Q4. SC

The grid shows the formulae of some oxides.

A ZnO	B NO_2	C K_2O
D CuO	E Fe_2O_3	F CO

a) Identify the two oxides which are covalent.

____

b) Identify the oxide which dissolves in water to give an alkaline solution.
You may wish to use the data booklet to help you.

____

Q5. Int2

The grid shows the names of some oxides.

A Magnesium oxide	B Sulphur dioxide	C Copper(II) oxide
D Sodium oxide	E Silicon dioxide	F Calcium oxide
G Iron(III) oxide	H Potassium oxide	I Carbon dioxide

a) Give the ***four*** boxes in the grid containing chemicals that would make an alkaline solution

____

b) Give the ***two*** boxes in the grid containing chemicals that would make an acidic solution.

____

c) Give the ***three*** boxes in the grid containing chemicals that would make ***neither*** an acidic ***nor*** an alkaline solution.

____

d) Write a balanced equation for the reaction of one of the chemicals you chose in ***a)***, showing the formation of the *alkali*.

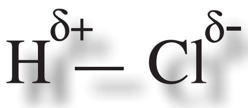
e) Write a balanced equation for the reaction of one of the chemicals you chose in ***b)***, showing the formation of the *acid*.

4.2 Acid & Base Structures

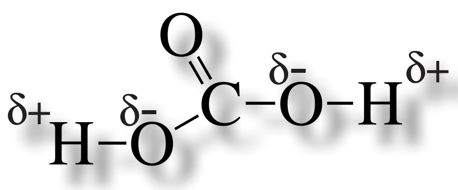
Acid Molecules

If we look carefully at the *structures* of the substances that ***diss*** ***in water*** to produce ***ac*** ***solutions*** we can see a *pattern* emerge.

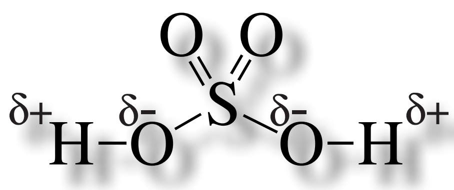
hydrogen chloride



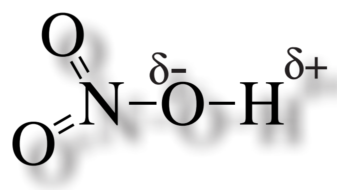
Firstly, they are all ***cov*** ***mol*** but all have a ***very pol*** ***bond*** involving a ***hy*** atom.



hydrogen carbonate

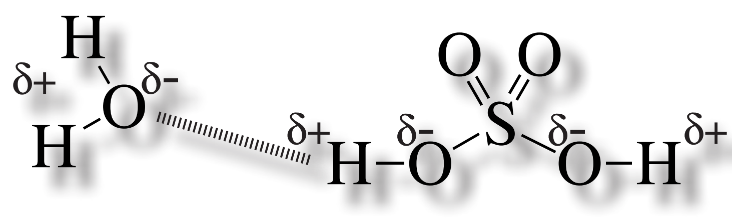


hydrogen sulfate



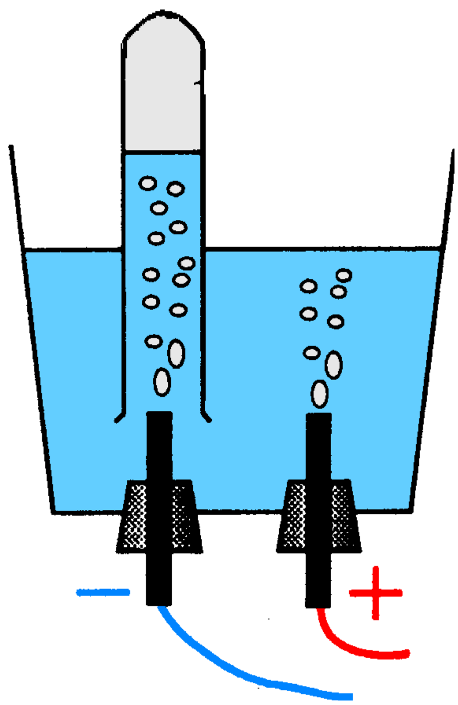
hydrogen nitrate

Secondly, most of these molecules have a ***do*** ***cov*** ***bond*** from the central atom to an ***ox*** atom next to the ***pol*** O — H bond.



Since ***water mol*** are also ***pol*** , there will be ***strong att*** set up between the ***water mol*** and the ***acid mol***

As a result, the ***acid mol*** will be *very soluble in water*.



However, whilst water *cannot* be ***elec*** at *low* ***vol*** , *solutions* of these ***acid mol*** *can* be ***elec*** and *always produce hydrogen gas at the negative electrode* (***cath***).

$$2H^+_{(aq)} \quad + \quad 2e \quad \rightarrow \quad H_{2(g)}$$

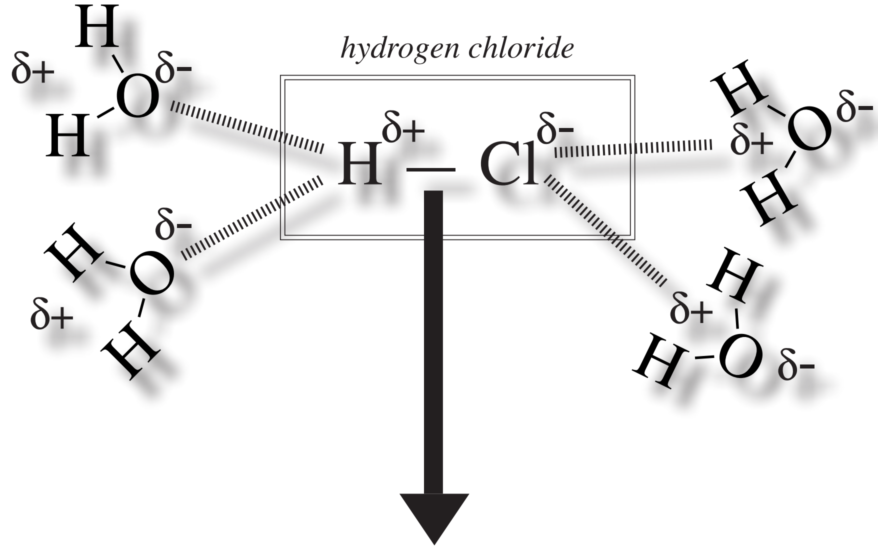
This suggests that the following *change* has taken place:

covalent molecule ➡ ***ionic solution***

> *acids are substances which dissolve in water to produce* ***hydrogen ions, $H^+_{(aq)}$.***

Covalent to Ionic

The ***str*** ***att*** between ***wa*** ***mol*** and the ***acid mol*** do much more than simply make them ***sol*** in water.



Wa ***mol*** are able to *pull* the ***acid mol*** apart.

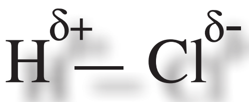
In the process, the ***sha*** ***ele*** are *completely transferred* to the atom with the ***str*** ***pull*** - in this case the ***chl*** atom.

hydrochloric acid

$H^+_{(aq)}\ Cl^-_{(aq)}$

The ***acid mol*** is ***ionised*** - turned into *ions dissolved in water*.

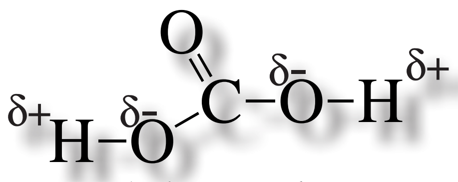
acids are substances which dissolve in water to produce ***hydrogen ions, $H^+_{(aq)}$***.



hydrogen chloride

$H^+\ Cl^-{}_{(aq)}$

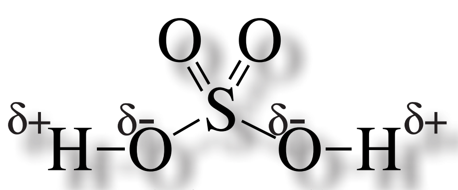
hydrochloric acid



hydrogen carbonate

$(H^+)_2\ CO_3^{2-}{}_{(aq)}$

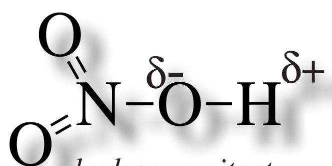
carbonic acid



hydrogen sulfate

$(H^+)_2\ SO_4^{2-}{}_{(aq)}$

sulfuric acid



hydrogen nitrate

$H^+\ NO_3^-{}_{(aq)}$

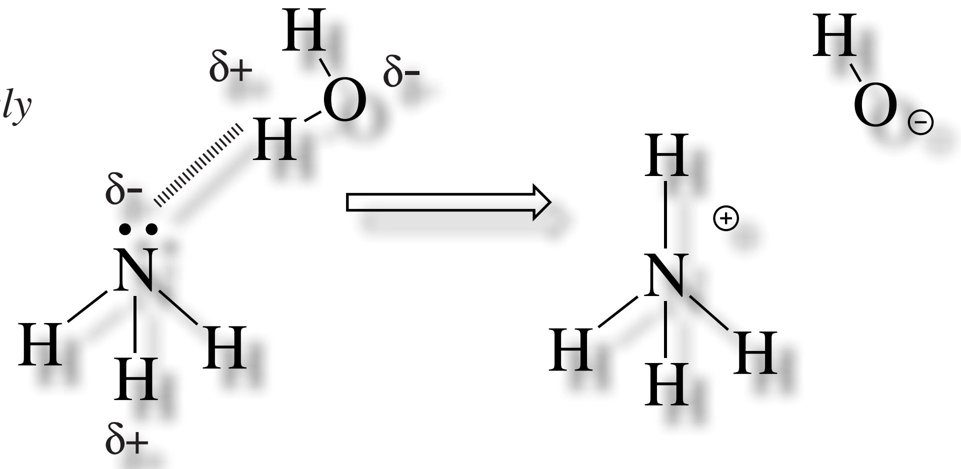
nitric acid

Ammonia

Amm, is the '*only*' base that starts off as a ***cov*** ***mol*** but when it ***dis*** in ***wa*** the ***solu*** ***con*** showing that ***io*** are formed. The pH of the ***solu*** is > showing that it has formed an ***alk*** solution.

The two ***pol*** ***mol*** ***att*** each other *strongly* enough to pull a ***hydr*** ***ion*** (H^+) off the ***wa*** molecule.

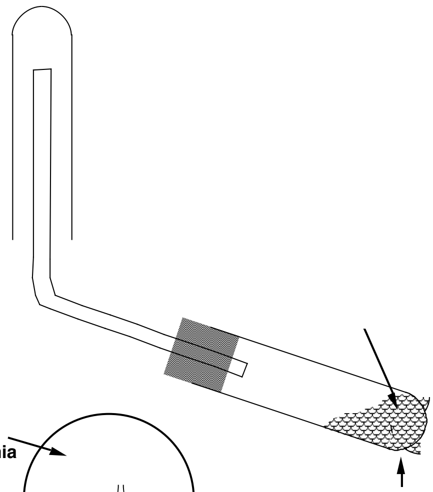
The resulting **OH^-** ***ion*** makes the solution ***alk*** .

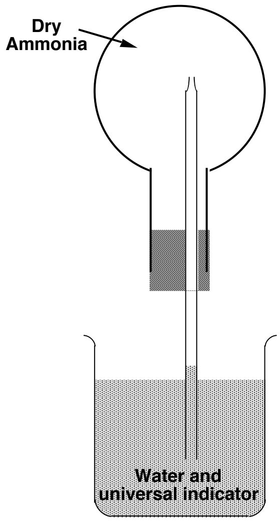


ammonia + water *ammonium hydroxide*

$_{(g)}$` + $H_2O_{(l)} \rightarrow$ $^{+}$ $^{-}_{(aq)}$ (***amm*** ***hyd***)

A convenient way to make ***amm*** in the ***lab*** is to heat an ammonium ***comp*** with a ***strong ba*** or ***alk*** . (*The reverse of the reaction above)*





Properties of Ammonia

Ammonia is a ***co*** ***less ga*** at 20 °C

Ammonia is the *only* ***alk*** *gas*

Ammonia has a strong ***pun*** smell

Ammonia is ***le*** dense than air

Ammonia ***dis*** in ***wa*** to form an ***alk*** solution which will ***con*** electricity

As the ammonia gas cools and contracts, the water is slowly sucked up the tube. As the first drop appears at the end of the tube ALL the ammonia gas dissolves in this single drop of water.

As a result, a partial vacuum exists in the flask resulting in more water being sucked in very quickly to replace the ammonia gas molecules.

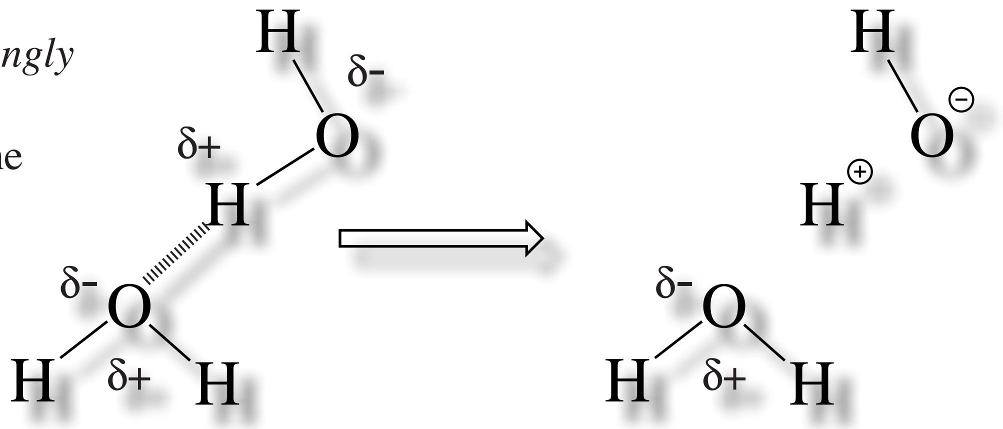
A 'fountain' is the result, showing that ammonia is extremely soluble in water. This is known as the ***Fountain Experiment***.

Water Ions

More surprisingly, perhaps, is the fact that ***att*** between ***wa*** ***mol*** can also result in this ***cov*** ***mol*** being pulled apart to form ***ions***.

The two ***pol*** ***mol*** ***att*** each other *strongly* enough to pull a ***hydr*** ***ion*** (H^+) off one of the ***wa*** molecules.

However an **OH^-** ***ion*** is also formed so water remains overall ***neutral***, pH = 7.



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

Almost immediately, the ***ions*** will ***att*** each other and the ***mol*** will reform.

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

Water is a *mixture* of ***mol*** and ***io*** , constantly ***bre*** ***up*** and ***ref*** .

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

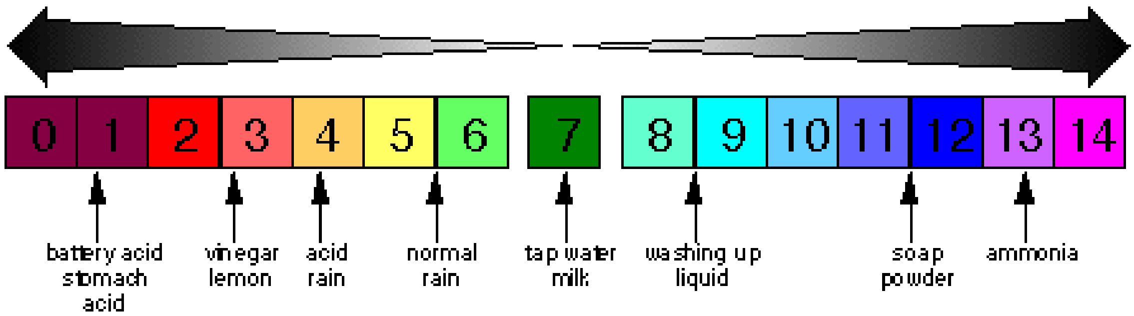
$H_2O_{(l)}$	$H^+_{(aq)}$	$OH^-_{(aq)}$
~50 *moles per litre*	10^{-7} *moles per litre*	10^{-7} *moles per litre*
99.99999999 %	0.000000005 %	0.000000005 %

The *vast majority* of water is ***mol*** but there are always enough ***ions*** to make ***wa*** a ***poor con***

acids are substances which dissolve in water to ***increase*** *the concentration of* ***hydrogen ions, $H^+_{(aq)}$ - H^+ concentration > 10^{-7}***

bases are substances which dissolve in water to ***increase*** *the concentration of* ***hydroxide ions, $OH^-_{(aq)}$ - OH^- concentration > 10^{-7}***

pH Numbers



H^+								***10^{-7}***							***mol l^{-1}***
mol l^{-1}								***10^{-7}***							***OH^-***

Neu ***solu*** have a which ***equ*** *7*, pH = .
Neu solutions have ***equ*** amounts of ***H^+*** ions and ***OH^-*** ions

Ac ***solu*** have a which is ***le*** ***than*** *7*, pH < .
Ac ***solu*** have ***mo*** ions than ions, >

Alk ***solu*** have a which is ***mo*** ***than*** *7*, pH > .
Alk ***solu*** have ***more*** ions than ions, >

If you ***dil*** an ***ac*** by adding more ***wa*** , the pH will ***inc*** towards pH = *7*.

If you ***dil*** an ***alk*** by adding more ***wa*** , the pH will ***dec*** towards pH = *7*.

It would be tempting to assume that an ***ac*** of pH = 1, eg ***stom*** acid, was ***thr*** *times* as ***conc*** as an acid of pH = 3, e.g. ***lem*** juice.

In fact, it is 10 x 10 i.e. *times* as ***conc*** .

For each change in pH, a solution will become ***ten times*** *more concentrated or* ***ten times*** *less concentrated*

pH ***pap*** , ***univ*** ***ind*** and other ***col*** substances, such as ***re*** and ***bl*** ***lit*** paper and even the juice from ***red cab*** , can be used to measure the pH of solutions

Cond devices, (H^+ ions are good conductors), such as pH ***met*** and pH ***pro*** can also be used.

Q1.

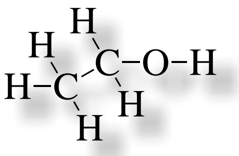
a) What two features are found in most acid molecules?

____

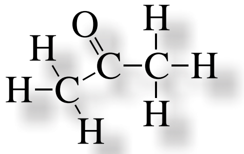
____

b) Which of the following is an acid molecule?

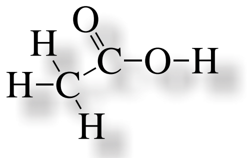
A



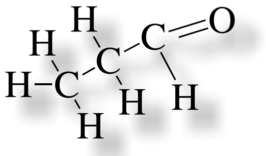
B



C



D



Q2. SC

The grid shows some statements which can be applied to different solutions.

A	It has a pH less than 7.
B	It conducts electricity.
C	It contains less OH^-(aq) ions than pure water.
D	It does not neutralise dilute hydrochloric acid.
E	When diluted the concentration of OH^-(aq) ions decreases.

Identify the two statements which are correct for an alkaline solution.

____

Q3. Int2

What is the most likely pH value that would be obtained when zinc oxide is added to water?

(You may wish to use page 5 of the data booklet to help you.)

A 5

B 7

C 9

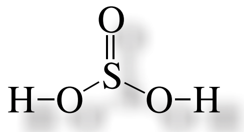
D 11

Q4.

For each of the acids below

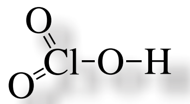
a) Write the formula for the molecule

b) Write the formulae for the two ions formed when it dissolves (*dissociates*) in water?



sulphurous acid *molecular formula* *ions*

nitrous acid *molecular formula* *ions*



chloric acid *molecular formula* *ions*

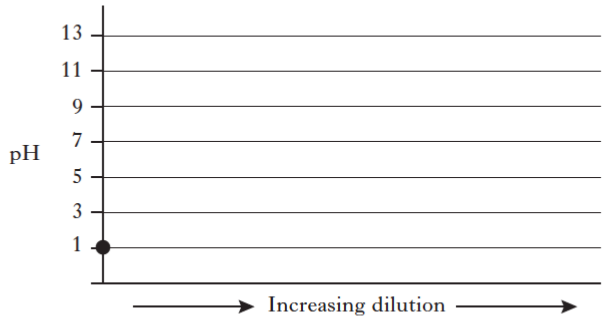
Q5. SC

A solution of 0·1 mol/l hydrochloric acid has a pH of 1.

a) What colour would universal indicator turn when added to a solution of hydrochloric acid?

____

b) Starting at pH 1, draw a line to show how the pH of this acid changes when diluted with water.



c) Calculate the number of moles of hydrochloric acid in 50 cm^3 of 0·1 mol/l hydrochloric acid solution.

d) Magnesium carbonate can be used to neutralise acid:

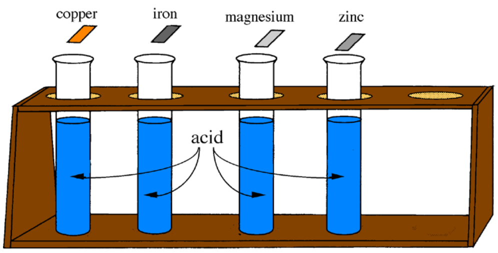
$$MgCO_{3(s)} + 2\,HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$$

i) Calculate the ***number of moles*** of $MgCO_3$ needed to neutralise 50 cm^3 of 0·1 mol/l $HCl_{(aq)}$.

i) Calculate the ***mass*** of $MgCO_3$ needed to neutralise 50 cm^3 of 0·1 mol/l $HCl_{(aq)}$.

4.3 Reactions of Acids

With Metals

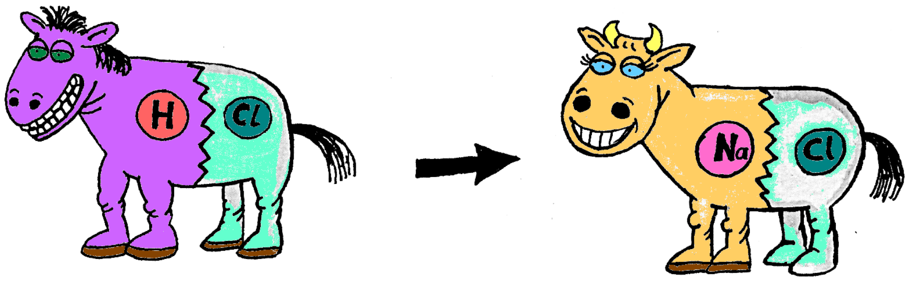


As you have probably learnt in earlier courses, ***rea*** ***met*** that are above ***hydr*** in the ***Reac*** ***Series*** are able to ***rea*** with ***ac*** .

The gas produced ***b*** with a ***sq*** ***-p*** . This shows that the gas is again ***h*** .

Reac ***met*** are able to force ***hydr*** ***ions*** to change back to ***hydr*** ***ato*** . This allows the ***met*** to take the place of the ***hydr*** and form a new ***subst*** called a ***Salt***.

The ***sodi*** ***ion*** takes the place of the ***hydr*** ***ion*** to form the salt called ***sod*** ***chlo*** .



Each acid has its own salts:-

hydro***chloric*** acid, HCl	$\rightarrow$ ***chlor***	e.g. ***sod*** ***chl*** , NaCl
sulfuric acid, H_2SO_4	$\rightarrow$ ***sulf***	e.g. ***cop*** ***sul*** , $CuSO_4$
nitric acid, HNO_3	$\rightarrow$ ***nitr***	e.g. ***pot*** ***nitr*** , KNO_3

Acid	+	***metal***	$\rightarrow$	***salt***	+	***hydrogen***

e.g *magnesium* + *sulfuric acid* $\rightarrow$ + *hydrogen*

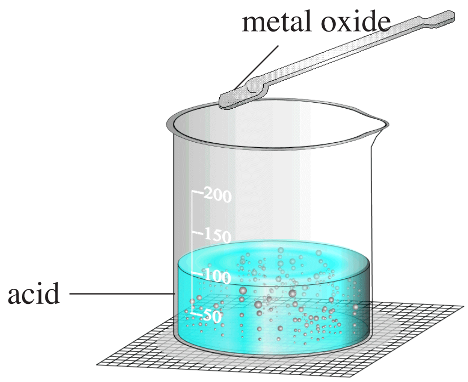
$_{(s)}$ + $H_2SO_{4(aq)}$ $\rightarrow$ $_{(aq)}$ + $_{(g)}$

We will learn more about this reaction if we firstly write an *ionic equation* and then *remove spectator ions*.

e.g $_{(s)}$ + $(H^+)_2SO_4^{2-}{}_{(aq)}$ $\rightarrow$ $_{(aq)}$ + $_{(g)}$

$_{(s)}$ + $2\,H^+_{(aq)}$ $\rightarrow$ $_{(aq)}$ + $_{(g)}$

With Metal Oxides



In ***me*** ***oxi*** the ***me*** has already formed an ***io*** and will not ***re*** any more.

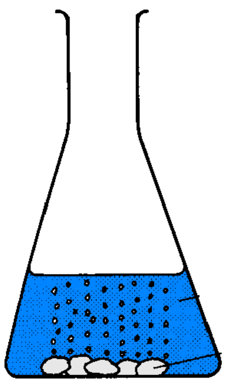
The ***oxi*** ***ion***, O^{2-}, reacts with the ***hydr*** ***ions*** in the ***ac*** to form ***wa*** , H_2O.

This leaves the ***me*** ***ion*** to take the ***hydr*** ***ions*** place, so again a ***sa*** will be produced.

Acid	**+**	***metal oxide***	→	***salt***	**+**	***water***

e.g	*iron (III) oxide*	+	*nitric acid*	→		+	*water*	
balanced	$Fe_2O_{3\,(s)}$	+	$_{(aq)}$	→	$_{(aq)}$	+	$H_2O_{(l)}$	
ionic	$_{(s)}$	+	$_{(aq)}$	→	$_{(aq)}$	+	$H_2O_{(l)}$	
without spectator ions	$3\ O^{2-}{}_{(s)}$	+	$H^+{}_{(aq)}$	→	$H_2O_{(l)}$			

With Metal Carbonates



In ***me*** ***carb*** the ***me*** has already formed an ***io*** and will not ***re*** any more.

The ***carb*** ***ion***, $CO_3{}^{2-}$, reacts with the ***hydr*** ***ions*** in the ***ac*** to form ***wa*** , H_2O and ***car*** ***di*** gas, CO_2.

This leaves the ***me*** ***ion*** to take the hydrogens place, so again a ***sa*** will be produced.

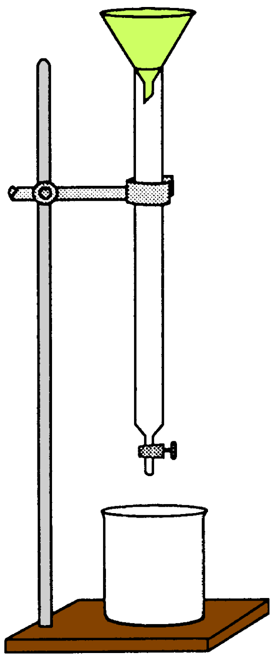
Acid	**+**	***metal carbonate***	→	***salt***	**+**	***water***	**+**	***carbon dioxide***

e.g	calcium carbonate	+	hydrochloric acid	→	calcium chloride	+	water	+	carbon dioxide
bal	$CaCO_{3\,(s)}$	+	$2\ HCl_{(aq)}$	→	$CaCl_{2\,(aq)}$	+	$H_2O_{(l)}$	+	$CO_{2\,(g)}$

ionic $_{(s)}$ + $_{(aq)}$ → $_{(aq)}$ + $H_2O_{(l)}$ + $CO_{2(g)}$

without spectator ions $CO_3^{2-}{}_{(s)}$ + $H^+_{(aq)}$ → $H_2O_{(l)}$ + $CO_{2(g)}$

With Alkalis



Alk are <u>*solutions*</u> which contain ***hydrox*** ***ions***.

Most ***alk*** are made by ***dis*** a ***me*** ***oxide*** in ***wa*** - though only those in ***Group 1*** are very ***sol*** .

$Na_2O_{(s)}$ soda	+	$H_2O_{(l)}$	→	$NaOH_{(aq)}$ sodium hydroxide
$K_2O_{(s)}$ pearl ash	+	$H_2O_{(l)}$	→	$_{(aq)}$ potassium hydroxide
$CaO_{(s)}$ lime	+	$H_2O_{(l)}$	→	$_{(aq)}$ calcium hydroxide
$_{(s)}$ magnesia	+	$H_2O_{(l)}$	→	$Mg(OH)_{2(aq)}$ magnesium hydroxide

It is the ***hydrox*** ***ion*** which will react with the ***hydr*** ***ion*** in the ***ac*** , and ***wa*** is the product

Acid	**+**	***alkali***	→	***salt***	**+**	***water***

e.g sodium hydroxide + sulfuric acid → + water

$2\ NaOH_{(aq)}$ + $H_2SO_{4(aq)}$ → $Na_2SO_{4(aq)}$ + $2\ H_2O_{(l)}$

ionic $2\ Na^+OH^-{}_{(aq)}$ + $(H^+)_2SO_4^{2-}{}_{(aq)}$ → $(Na^+)_2SO_4^{2-}{}_{(aq)}$ + $2\ H_2O_{(l)}$

Once again, the ***me*** ***ion*** to take the hydrogens place, so again a ***sa*** will be produced. The ***me*** ***ions*** are ***spec*** ***ions*** as are the ***sul*** ***ions*** in the example above.

without spectator ions $2\ OH^-{}_{(aq)}$ + $2\ H^+_{(aq)}$ → $2\ H_2O_{(l)}$

Making Salts

Salt Preparation

Because of the large number of, in particular, metal oxides and carbonates that it is possible to react easily with a number of acids, a whole range of 'new substances' can be made using acid reactions. If we include, ***precipitation*** reactions (met earlier in the course) there are very few compounds that cannot be made quickly and easily.

This is basically a ***Problem Solving*** activity that will test your knowledge of ***acid reactions***, your use of ***solubility tables***, your appreciation of ***practical considerations*** (such as ensuring complete reaction) and your knowledge of ***separation techniques***.

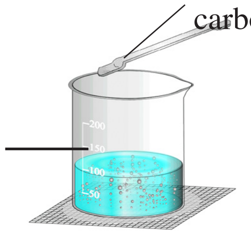
There are 3 parts to salt preparation
1) ***Choice of Reaction***
2) ***Reaction Method***
and 3) ***Separation of Salt produced***

1) ***Possible Reactions***

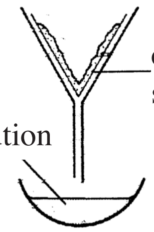
a) ***Acid*** + (solid) ***Metal***
b) ***Acid*** + (solid) ***Oxide, Hydroxide or Carbonate***
c) ***Acid*** + ***Alkali*** (solution)
d) ***Precipitation*** (solutions, one of which **may** be acid)

2) ***Reaction Methods*** & 3) ***Separation of Salt***

Solid *Metals, Oxides, Hydroxides & Carbonates*



The solid is added spatula by spatula, stirring all the time, until there is an obvious layer of unreacted (***excess)*** solid lying at the bottom. The acid may need to be heated to speed up the reaction.



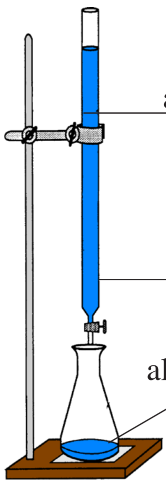
The ***excess*** solid must now be separated from the ***salt*** solution by filtering. The solid trapped in the filter paper can be discarded.

The ***salt*** solution can now be heated until all the water has evaporated away leaving solid ***salt*** powder. If preferred, the solution can be left to evaporate **slowly** in which case ***salt crystals*** will form.

Alkali solutions

The acid will need to be added **slowly** and carefully (eventually drop by drop) until the indicator **just** changes colour.

Then, to another flask, the **exact** same volumes will be reacted but **without** the indicator present.



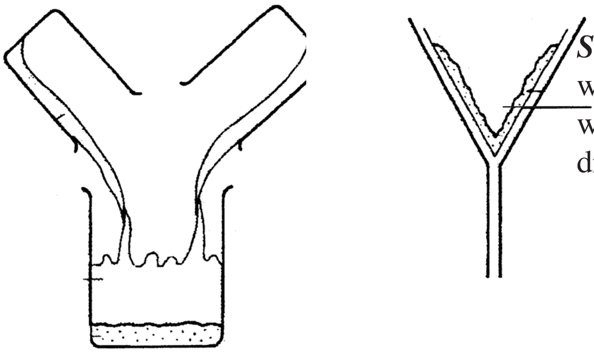
As above.

Precipitation reactions

Using the Data Book, two suitable solutions will need to be made up.

Each solution will provide one half of the ***salt*** to be made.

Once made, the two solutions are simply mixed together.



Sometimes a choice of methods is available. To help choose the 'best' method the following summary may be useful.

Reaction	***'Advantages'***	***'Disadvantages'***	***'Suitability'***
solid ***metals***	Easy to ensure 'complete' reaction - excess metal left over at end.	Must filter excess metal. Not all metals reactive enough to react with acid.	Not suitable if salt is insoluble - too difficult to separate from excess solid metal.
solid ***oxides***, ***hydroxides***, ***carbonates***	Easy to ensure 'complete' reaction - excess solid left over at end.	Must filter excess solids. Often need to heat oxides and hydroxides.	Not suitable if salt is insoluble - too difficult to separate from excess solid.
alkali *solutions*	Reaction immediate. No need to filter excess solids.	Difficult to ensure 'exact' neutralisation. Technique may take a very long time.	Very limited choice of alkalis - so limited number of salts can be prepared by this method.
precipitation from *solutions*	Reaction extremely quick.	None really.	Limited to insoluble salts only.

Examples

To prepare ***copper sulfate***

1. The Data Book will tell you that copper sulfate is ***soluble***, so precipitation is out.
2. Acid to use:- ***sulfuric acid***
3. Copper ***metal - no*** reaction with acid.
4. Copper oxide/hydroxide is ***insoluble*** so there is no alkali solution, so titration is out.
5. Best method would be to add solid copper oxide/hydroxide/carbonate to sulfuric acid.

To prepare ***zinc chloride***

1. The Data Book will tell you that zinc chloride is ***soluble***, so precipitation is out.
2. Acid to use:- ***hydrochloric acid***
3. Zinc reacts slowly with acid.
4. Zinc oxide/hydroxide is ***insoluble*** so there is no alkali solution, so titration is out.
5. Best method would be to add solid zinc or zinc oxide/hydroxide/carbon ate to hydrochloric acid.

To prepare ***silver chloride***

1. The Data Book will tell you that silver chloride is ***insoluble***, so precipitation is the best method.
2. Use the Data Book to find a soluble silver compound eg *silver nitrate*.

Use the Data Book to find a soluble chloride compound eg *sodium chloride*.

Q1. SC

The grid shows the names of some metals.

A silver	B sodium	C magnesium
D nickel	E lead	F iron

Identify the metal that does not react with dilute acid.

You may wish to use page 7 of the data booklet to help you.

Q2. SC

Copy and ***complete*** the following equations

lithium hydroxide + *hydrochloric acid* → + *water*

aluminium oxide + *nitric acid* → + *water*

strontium carbonate + *nitric acid* → + *water* +

zinc + *sulphuric acid* → +

Q3. SC

Copy, ***complete*** and ***balance*** the following equations

$Ca(OH)_2$ + HCl → + H_2O

CuO + → $Cu(NO_3)_2$ +

+ H_2SO_4 → K_2SO_4 + + CO_2

Li + → $LiCl$ +

Q4. SC

Lead(II) nitrate solution reacts with potassium iodide solution to give a yellow solid.

$$Pb^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} + 2K^+_{(aq)} + 2I^-_{(aq)} \rightarrow Pb^{2+}(I^-)_{2(s)} + 2K^+_{(aq)} + 2NO_3^-{}_{(aq)}$$

Identify the ***two*** spectator ions in the reaction.

Q5. SC

The grid shows the names of some soluble compounds..

A sodium iodide	B potassium chloride	C lithium chloride
D barium bromide	E sodium hydroxide	F potassium sulphate

a) Identify the base. ________

b) Identify the two compounds whose solutions would form a precipitate when mixed.

You may wish to use the data booklet to help you.

________ and ________

Q6. Int2

Copy and ***complete*** the following equations, clearly showing which of the products is the ***precipitate***.

$BaCl_{2\,(aq)}$ + $K_2SO_{4\,(aq)}$ → +

$CuSO_{4\,(aq)}$ + $Na_2CO_{3\,(aq)}$ → +

$AgNO_{3\,(aq)}$ + $KCl_{(aq)}$ → +

Q7. Int2

Reactions can be represented using ionic equations. Which ionic equation shows a neutralisation reaction?

A $2H_2O_{(l)} + O_{2(g)} + 4e \rightarrow 4OH^-_{(aq)}$

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

C $SO_{2(g)} + H_2O_{(l)} \rightarrow 2H^+_{(aq)} + SO_3^{2-}{}_{(aq)}$

D $NH_4^+{}_{(s)} + OH^-_{(s)} \rightarrow NH_{3(g)} + NH_4^+{}_{(s)}$

Q8.

A solution of sulphuric acid can be used to neutralise a solution of sodium hydroxide.

a) What is the pH of the solution when it is exactly neutral. ________

b) What is the name of the salt formed in the neutralisation reaction? ________

c) Balance the following equation for the reaction.

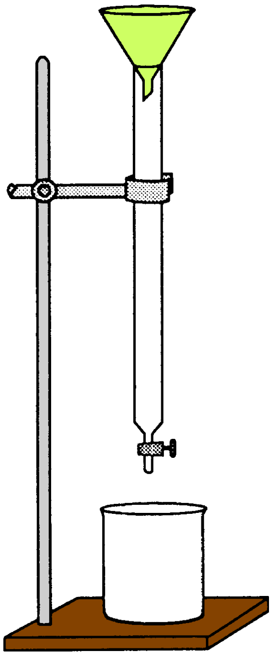
$$(H^+)_2SO_4^{2-} + Na^+OH^- \rightarrow (Na^+)_2SO_4^{2-} + H_2O$$

d) Rewrite the equation, omitting the spectator ions.

+ →

4.4 Quantitative Analysis

Titrations



It is quite common for a ***Che*** to be asked to measure *how much* ***ac*** or ***alk*** is present in a ***solu*** - for example, *how much* ***acid*** *is present in lemonade*.

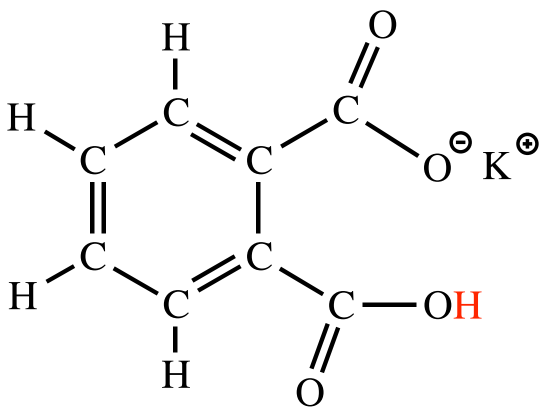
A technique call ***titr*** is used, and you may be expected to demonstrate your ability to carry out a ***titr*** .

A carefully measured ***vol*** of the ***lemonade*** would be placed in the ***fla*** . An ***indi*** that will change ***col*** is also added.

An ***alkali*** whose **conc** is *accurately* ***kno*** would be placed in a ***bur*** , and then added to the ***fla*** .

Eventually the ***alkali*** would be added ***dr*** by ***dr*** until the ***indi*** changes ***col*** to show that the ***acid in the lemonade*** has been ***neutr*** .

Before the ***al*** can be used to determine *how much* ***acid*** *is present in the lemonade*, it must be ***standardised*** - titrated against a ***Stan Sol*** of a suitable acid, such as *potassium hydrogen phthalate* (***KHP***).



potassium hydrogen phthalate

An unusual acid like this is chosen because it is ***extremely stable***, ***very soluble*** and can be made to a ***very high level of purity***.

An ***ana*** ***balance*** is used to ***very accurately*** weigh out a *calculated* mass of the chemical.

From this ***mass***, the ***number of moles*** of chemical can be *calculated* and used to *calculate* the **conc** of the solution made.

Molecular Formula:

Formula Mass:

Mass of one mole:

mass of KHP = ***10.00 g***

g ⟶ ***1 mole***

10.00 g ⟶ ***1 x 10.00***

= ***moles***

vol of flask = 500 ml = ***0.5 l***

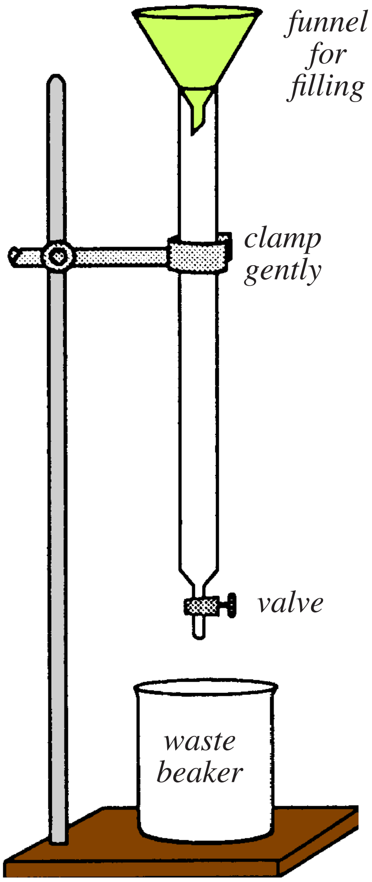
C = n / V

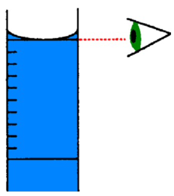
= ***/ 0.5***

= ***mol l^{-1}***

Technique - Standardisation of alkali (NaOH)

1. ***Filling the burette***





1. Set up the ***bur*** carefully in a stand. ***Cla*** ***gently*** !

2. Collect a ***bea*** ***ful*** of the ***alkali*** you are going to use and <u>*another*</u> empty ***was*** beaker.

3. Pour just a little of the ***alkali*** into the ***bur*** to rinse it. Pour it out into your ***was*** beaker.

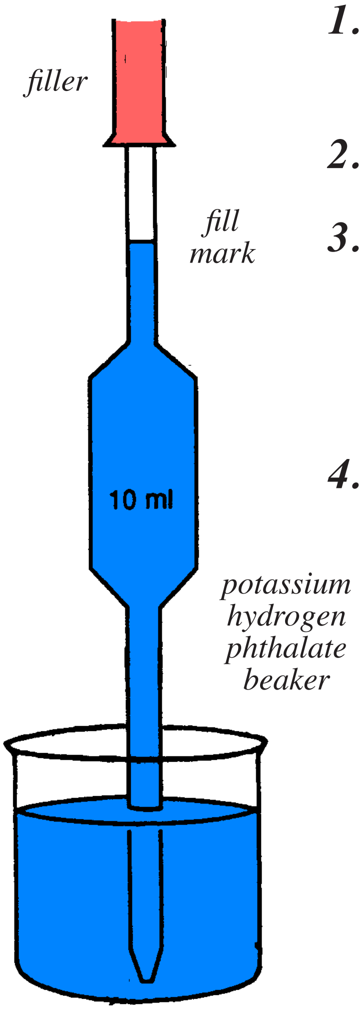
4. With the ***va*** closed, fill up the ***bur*** to just above the ***ze*** line. ***Then remove the funnel***.

5. Open the ***va*** slightly and let the ***alkali*** drip into your ***was*** beaker until the ***bot*** of the ***cur*** surface is on or below the ***ze*** line

6. Read your ***sta*** ***vol*** . Read with your eye level with the ***cur*** surface. Make a note of this reading.The ***bur*** is now ready for use.

2. *Using the pipette*

The ***pip*** is used to accurately measure out the same ***vol*** of ***KHP*** every time.



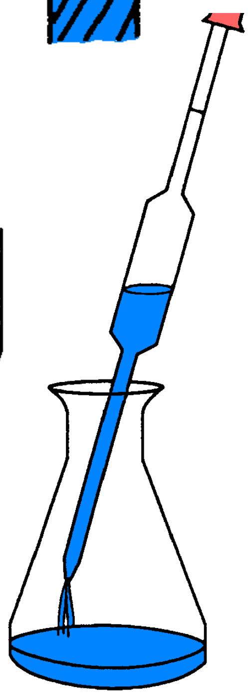
1. Collect a ***bea ful*** of the ***KHP*** you are going to use, and a conical ***fla*** .

2. Use the ***fil*** to suck the ***KHP*** above the fill mark.

3. Holding the ***pip*** above the beaker, slowly let the ***KHP*** drip out until the ***bot*** of the ***cur surface*** is on the fill mark.

4. Carefully transfer the ***KHP*** in the ***pip*** into your flask.

A tiny amount will remain inside the tip.This is supposed to happen.



Dip the tip of the ***pip*** into the ***KHP*** and some more will come out. Any still left in the pipette is allowed for.

5. Add a few drops of ***indi*** .

3. *Doing the Titration*

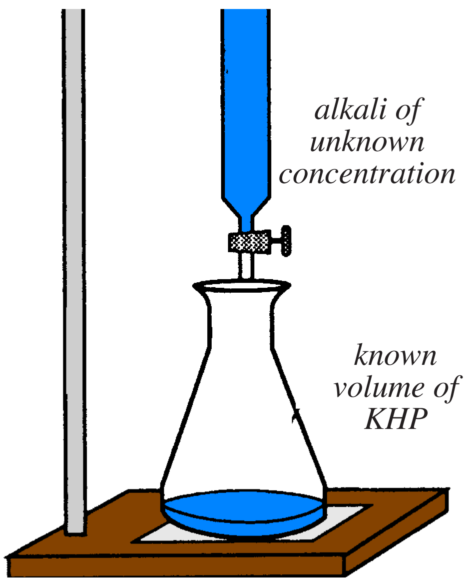
The aim is to find out exactly what ***vol*** of ***alkali*** is needed to ***neut*** the *known* ***vol*** of ***KHP***

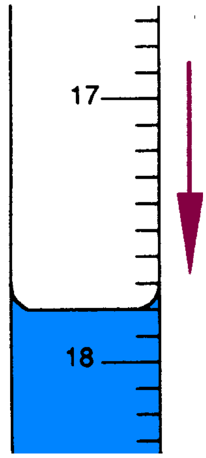
1. Put a piece of ***wh paper*** under the ***fla*** . It will help you to see the ***col*** of ***indi***

.

2. Start by adding the ***alkali*** 5 ml at a time. You should see the ***indi col*** change but then return quickly.

3. If the ***col*** takes longer to return, add less ***alkali*** next time.Ideally you should add ***one drop*** of ***alkali*** and see the ***indi*** change permanently.





4. Write down the ***fin*** ***bur*** reading to at least the nearest 0.1 ml.

Remember that a ***bur*** reads ***d*** ***wards***.

The ***bur*** opposite is reading ml (and not ml).

5. You will now need to ***rep*** your ***titr*** with a freshly ***pip*** sample of ***KHP***.

Knowing the ***ans*** from the first ***atte*** should allow you to ***qui*** add enough ***alkali*** to nearly ***neutr*** the ***potassium hydrogen phthalate***. Then you can add more alkali ***dr*** by ***dr*** to get an ***acc*** result.

Results

6. You should record your results in a table similar to the one on the right.

Attempt number	*Starting volume (ml)*	*Final volume (ml)*	*Volume added(ml)*
1	0.1	22.0	21.9
2	22.0	43.5	21.5
3	0.2	21.9	21.7
4	21.9	42.6	21.7

Your first ***atte*** is often a *'rough'* ***titr*** as you will often add too much ***alkali*** at a time.

Later attempts should produce results to the nearest ***dr*** .

You have to continue repeating the ***titr*** until you get two results at least within 0.1 ml of each other.

7. You should finish off by quoting your conclusion in terms of:-

"It takes 21.7 ml of NaOH to neutralise 20 ml of KHP".

If you have two, or more, answers close to each other then it may be better to use their ***average*** as your final answer.

To get similar results each time, (the aim of this technique), you will need to work hard to ensure that you pipette ***exactly*** the same volume of *potassium hydrogen phthalate* each time.

Evaluation *As part of the Assessment Task 1, you will be asked to evaluate experimental procedures, mentioning **at least one** of the below.*

- effectiveness of procedure

the effectiveness of a titration, for example, can often be determined by:
how often you had to repeat the titration? how was the colour change (1 drop)? how close to each other were your volumes?

- control of variables

how well did you control variables such as:
concentration of NaOH, volume of KHP, amount of indicator added etc?

- limitations of equipment

any issues with eqipment such as:
electronic balance (2 or 3 decimal place?), volumetric flasks (A or B grade?),

- sources of uncertainty

these are often 'built-in errors' such as:
weighings (± ? g), volumetric flasks (± ? cm^3), pipettes (± ? cm^3), burettes (± ? cm^3), burette readings (± ? cm^3) etc - we often express these as % errors.

- possible improvements

these will often emerge from the previous categories:

Q1.

The table below shows the colours of various indicators at different pH values.

indicator	*pH 1*	*colour 1*	*pH 2*	*colour 2*
bromophenol blue	3	yellow	4.5	blue
phenolphthalein	8	colourless	10	pink
methyl orange	3	red	4.5	yellow
thymol blue	6	yellow	7.5	blue

The table below shows the pH of some solutions.

solution	*pH*
0.1 M hydrochloric acid	1.0
0.1 M ethanoic acid	5.0
0.1 M ammonia	10.0
0.1 M sodium hydroxide	12.5

a) Complete the table below to show the colours of the indicators in the solutions.

indicator	*solution*	*colour*
bromophenol blue	0.1 M hydrochloric acid	
phenolphthalein	0.1 M ethanoic acid	
methyl orange	0.1 M ammonia	
thymol blue	0.1 M sodium hydroxide	

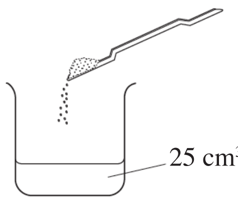
b) Name one indicator which turns the same colour in both ethanoic acid and sodium hydroxide. ______________________

c) Which two indicators turn the same colour in hydrochloric acid ______________________

Q2.

One of the solids often used in Antacid Tablets to treat indigestion is magnesium hydroxide.

A pupil decided to find out how much of the solid would be needed to neutralise some acid.



a) Complete the equation for the reaction of magnesium hydroxide with hydrochloric acid

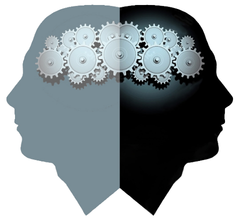
$Mg(OH)_{2\,(aq)} + 2HCl_{(aq)} \rightarrow \qquad + H_2O_{(l)}$

b) Calculate the ***number of moles*** of HCl present.

c) Calculate the ***number of moles*** of $Mg(OH)_2$ needed.

d) Calculate the ***mass*** of $Mg(OH)_2$ needed.

Knowledge Met in this Topic



Common household acids and alkalis

- ***Acids:*** vinegar, citrus fruits, cola drinks etc
- ***Alkalis:*** lime, oven cleaner, bleach, bicarbonate of soda, soap, ammonia

Oxides and hydroxides

- Oxides of ***non-metals*** which dissolve produce ***acidic*** solutions
  e.g. CO_2, SO_2 and NO_2.
- Non-metal oxides are the main cause of ***acid rain***.
- Oxides and hydroxides of ***metals*** which dissolve produce ***alkaline*** solutions.
- All the oxides of Group 1 metals are very soluble, only some from Group 2 are soluble.

Important acids

- Most acids start off as ***covalent molecules*** which break apart (***dissociate***) in water to produce ***hydrogen ions***, $H^+_{(aq)}$.
- ***hydrochloric*** acid — HCl — $H^+_{(aq)} + Cl^-_{(aq)}$
- ***sulphuric*** acid — H_2SO_4 — $H^+_{(aq)} + SO_4^{2-}{}_{(aq)}$
- ***nitric*** acid — HNO_3 — $H^+_{(aq)} + NO_3^-{}_{(aq)}$

The pH scale

- pH is a number that shows how acidic or alkaline a solution is.
- Universal indicator, pH paper or a pH meter can show the pH of a solution.
- ***Acids*** pH less than 7, $pH < 7$
  Neutral pH equals 7, $pH = 7$
  Alkalis pH more than 7, $pH > 7$
- When acids dissolve in water they produce hydrogen ions, $H^+_{(aq)}$
- When alkalis dissolve in water they produce hydroxide ions, $OH^-_{(aq)}$
- Pure water and all neutral solutions contain a tiny but equal concentration of hydrogen and hydroxide ions, $H^+_{(aq)} = OH^-_{(aq)}$
- An acid solution contains more hydrogen ions than hydroxide, $H^+_{(aq)} > OH^-_{(aq)}$
- An alkali solution contains less hydrogen ions than hydroxide, $H^+_{(aq)} < OH^-_{(aq)}$
- Diluting acids or alkalis will reduce the concentration of $H^+_{(aq)}$ and $OH^-_{(aq)}$, and move the pH towards 7.

Neutralisation

- ***Neutralisation*** is a reaction in which the pH of a solution moves towards 7.

Everyday examples of neutralisation

- Lime (calcium oxide) is used to reduce acidity in soil and water.
- Cures for acid indigestion contain neutralisers such as calcium carbonate.

Bases and alkalis

- *A **base** is a substance that neutralises an acid.*
- *An **alkali** is a base that dissolves in water.*

Salts

- ***Salts*** are ionic compounds formed in reactions between acids and neutralisers.
- A metal ion or an ammonium ion will have replaced the hydrogen in an acid.
Hydrochloric acid	HCl	forms ***chlorides***	e,g.	$NaCl$
Sulphuric acid	H_2SO_4	forms ***sulphates***	e,g.	$CuSO_4$
Nitric acid	HNO_3	forms ***nitrates***	e,g.	NH_4NO_3
- All the oxides of Group 1 metals are very soluble, only some from Group 2 aresoluble.

Acid Reactions

- **Acid + Alkali → Water + 'salt'**

  eg $H^+ Cl^- + Na^+ OH^- \rightarrow H_2O + Na^+ Cl^-$

  *removing **spectator ions**:-* $H^+ + OH^- \rightarrow H_2O$

- **Acid + Metal → Hydrogen + 'salt'**

  eg $(H^+)_2SO_4^{2-} + Mg \rightarrow H_2 + Mg^{2+} SO_4^{2-}$

  *removing **spectator ions**:-* $2H^+ + Mg \rightarrow H_2 + Mg^{2+}$

- **Acid + Oxide/Hydroxide → Water + 'salt'**

  eg $2H^+ NO_3^- + Cu^{2+} O^{2-} \rightarrow H_2O + Cu^{2+} (NO_3^-)_2$

  *removing **spectator ions**:-* $2H^+ + O^{2-} \rightarrow H_2O$

- **Acid + Carbonate → Water + Carbon dioxide + 'salt'**

  eg $2H^+ Cl^- + Ca^{2+} CO_3^{2-} \rightarrow H_2O + CO_2 + Ca^{2+} (Cl^-)_2$

  *removing **spectator ions**:-* $2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$

- ***Acid rain*** reacts with carbonate rocks such as marble (statues) and limestone, and with metals such as iron.
- Reacting acids is a good way of making ***salts***.
- Salts can also be made by ***precipitation***.

Ammonia

- Ammonia is a colourless gas with a sharp, unpleasant (pungent) smell.
- Ammonia is a very soluble in water producing an ***alkaline*** solution.

  $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$
- Ammonia is the ***only*** common alkaline gas.
- Ammonia can neutralise an acid and form an ammonium salt.

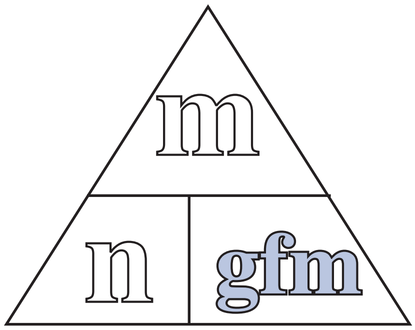
  $NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ *(ammonium sulphate)*
- Ammonia gas can be produced when an ammonium salt is heated with an alkali

  e.g. $NH_4Cl + NaOH \rightarrow NaCl + H_2O + NH_3$

Calculations (separate Calculations booklet)

- Knowing the formula for a substance, the ***Formula Mass*** can be calculated using *relative atomic masses* using values contained in the Data Booklet.
- The mass of ***1 mole*** of a substance is equal to the *Formula Mass* expressed in ***grammes*** - the *gramme formula mass* (***gfm***).
- The ***mass*** of any *number of moles* of a chemical can be calculated:

  mass = *no. of moles x gfm*



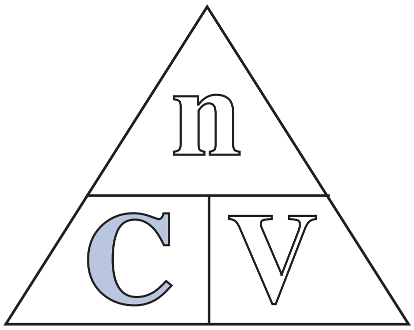
- The ***number of moles*** in any *mass* of a chemical can be calculated:

  no. of moles = *mass / gfm*

- Calculations involving ***solutions*** must have volumes expressed in ***litres***.

  concentration = *no. of moles / volume*

  no. of moles = *concentration x volume*



- ***Titration*** calculations can be done in steps or by using formulae such as:

$$C_{ACID} \times V_{ACID} \times p_{ACID} = C_{ALK} \times V_{ALK} \times p_{ALK}$$

*where **p** = 'power' of the acid (H^+) or alkali (OH^-)*

$$\frac{C_{ACID} \times V_{ACID}}{n_{ACID}} = \frac{C_{ALK} \times V_{ALK}}{n_{ALK}}$$

*where **n** = number of moles in the balanced equation*

CONSOLIDATION QUESTIONS A

Q1.

Below is information about six chemicals.

chemical	*state at 20 °C*	*pH in water*	*reaction with water*
A	gas	1	none
B	liquid	7	none
C	solid	4	none
D	solid	8	forms salt, carbon dioxide and water
E	solid	14	forms a salt and water
F	solid	no reaction	fizzes

Use the table to write the letter of the chemical substance which:

a) forms the most strongly acidic solution ________

b) forms a neutral solution ________

c) is a metal ________

d) forms a solution which turns ph paper orange ________

e) is a carbonate ________

f) is water ________

g) is sulphur dioxide ________

Q2. SC

Equations are used to represent chemical reactions.

A	$Zn(s) \longrightarrow Zn^{2+}(aq) + 2e^-$
B	$C_2H_5OH(\ell) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(\ell)$
C	$SO_2(g) + H_2O(\ell) \longrightarrow 2H^+(aq) + SO_3^{2-}(aq)$
D	$H^+(aq) + OH^-(aq) \longrightarrow H_2O(\ell)$
E	$SO_4^{2-}(aq) + 2H^+(aq) + 2e^- \longrightarrow SO_3^{2-}(aq) + H_2O(\ell)$

a) Identify the equation which represents the formation of acid rain.

____

b) Identify the equation which involves *sulphuric acid*.

____

Q3. Int2

Reactions can be represented using ionic equations. Which ionic equation shows a neutralisation reaction?

A $2H_2O_{(l)} + O_{2(g)} + 4e \rightarrow 4OH^-_{(aq)}$

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

C $SO_{2(g)} + H_2O_{(l)} \rightarrow 2H^+_{(aq)} + SO_3^{2-}{}_{(aq)}$

D $NH_4^+{}_{(s)} + OH^-_{(s)} \rightarrow NH_{3(g)} + NH_4^+{}_{(s)}$

Q4. SC

The grid shows some ions.

A Al^{3+}	B Cl^-	C Li^+
D H^+	E Br^-	F OH^-

a) Identify the two ions which combine to form an insoluble compound. ________________

You may wish to use the data booklet to help you.

b) Identify the ion present in all alkaline solutions. ________________

Q5. SC

Lead(II) nitrate solution reacts with potassium iodide solution to give a yellow solid.

$$Pb^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} + 2K^+_{(aq)} + 2I^-_{(aq)} \rightarrow Pb^{2+}(I^-)_{2(s)} + 2K^+_{(aq)} + 2NO_3^-{}_{(aq)}$$

Identify the ***two*** spectator ions in the reaction.

____

CONSOLIDATION QUESTIONS B

Q1 Both ammonia molecules and hydrogen chloride molecules are described as being polar.

a) What is meant by the word polar, as used in this context.

____

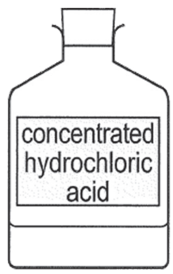
____

b) Complete the formula for hydrogen chloride to show its polar characteristics.

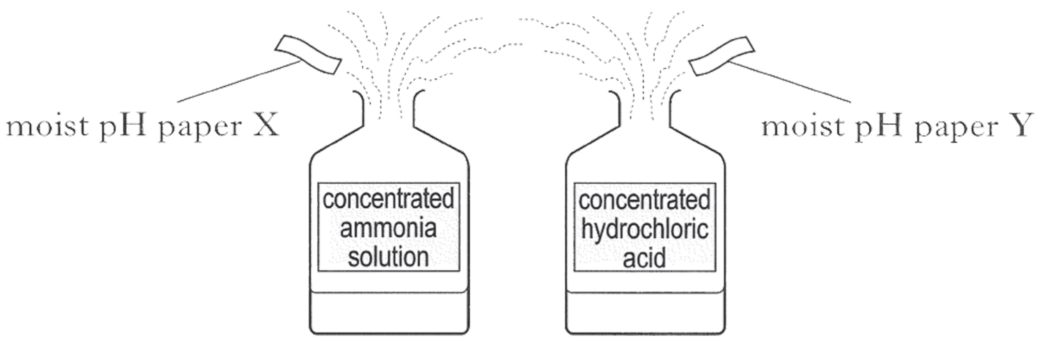
$$H — Cl$$

c) Ammonia gas $NH_{3\,(g)}$, can be dissolved in water to form concentrated ammonia solution.

Hydrogen chloride gas $HCl_{\,(g)}$, can be dissolved in water to form concentrated hydrochloric acid.



If both bottles are placed next to each other in a fume cupboard and the stoppers removed, both liquids evaporate and a white cloud is formed where the two gases meet.



i) State the colour of the pH paper at X and Y.

pH paper X ______________ pH paper Y ______________

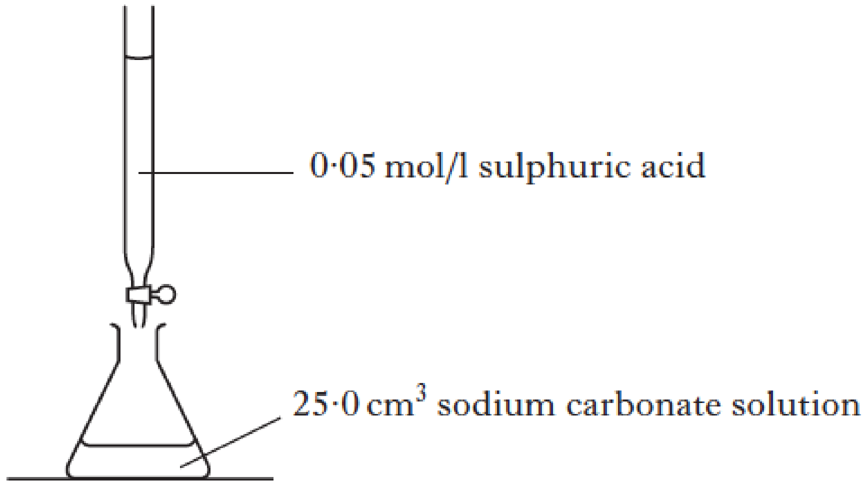
ii) The white cloud appears because the gases react to form a salt.
Name the salt formed.

____

CONSOLIDATION QUESTIONS C

Q1 A student investigated the reaction between dilute sulphuric acid and sodium carbonate.

His experiment involved determining the concentration of sodium carbonate solution by titration.



The results showed that 20 cm^3 of sulphuric acid was required to neutralise the sodium carbonate solution.

a) Calculate the number of moles of sulphuric acid in this volume.

________________ mol

b) One mole of sulphuric acid reacts with one mole of sodium carbonate.

Using your answer from part ***a)***,
calculate the concentration, in mol/l,
of the sodium carbonate solution.

________________ mol/l

c) Name the salt produced when dilute sulphuric acid reacts with sodium carbonate.

____