# PLANNING

**AIM:** To determine the concentration of a limewater solution.

You have been provided with $250cm^3$ of limewater, which contains approximately 1g $dm^{-3}$ of calcium hydroxide. Hydrochloric acid is also available, which has a concentration of exactly 2.00 mol $dm^{-3.}$

In order to determine the concentration of the limewater solution I will have to carry out a titration experiment between the acid being hydrochloric acid, HCl and the base being the limewater, $Ca(OH)_{2.}$

However before continuing on with the titration you need to dilute the HCl acid since it is too concentrated to use. In order for you to do this you will need to work out the concentration of $Ca(OH)_{2.}$

Balanced Equation of the titration:

| | | | | | | |
|---|---|---|---|---|---|---|
| **2HCl** | **+** | **$Ca(OH)_2$** | | **$CaCl_2$** | **+** | **$2H_2O$** |
| *2 moles* | | *1 mole* | | | | |
| *2 mol dm-3* | | *?* | | | | |

$Ca(OH)_2$ is 1g $dm^{-3}$= 1 gram per $1dm^3$

No. of moles in $Ca(OH)_2$ = Mass / Relative formula mass (RFM)
= 1 / 74
= 0.0135 moles

Concentration of $Ca(OH)_2$ = No. of moles / Volume
= 0.0135 / 1
= $Ca(OH)_2$ mol $dm^{-3}$

Now that you have worked out the concentration of the lime water solution you can continue with the dilution process of HCl acid. In order to do this you will need to select a suitable concentration for the HCl acid to be diluted to.

As we already know according to the balanced equation 1 mole of $Ca(OH)_2$ reacts with exactly 2 moles of HCl, so you should try and make HCl two times concentrated as the $Ca(OH)_{2.}$

So in order to make HCl twice as concentrated as $Ca(OH)_2$ you will do the following calculation: 0.0135 x 2 = 0.027 mol $dm^{-3}$ . This means the 2 mol $dm^{-3}$ will need to be diluted to 0.027 mol $dm^{-3}$ however this is to difficult to measure so a better concentration to dilute HCl to would be 0.02 mol $dm^{-3}$.

The dilution factor of HCl will be 100 times as: 2 / 0.02 = 100.

I have decided to dilute the 2.00 mol $dm^{-3}$ HCl acid to 0.02 mol $dm^{-3}$. So I will carry out cross multiplication to work out the amount of acid I will need.

Volume of HCl provided ($cm^3$)

Volume of HCl required ($cm^3$) for 0.02 mol $dm^{-3}$

$$\frac{250}{2} = \frac{?}{0.02}$$

Concentration of HCl provided (mol $dm^{-3}$)

Concentration of diluted HCl (mol $dm^{-3}$)

? = (250/2) x 0.02
  = 2.5$cm^3$ of HCl needed for 0.02 mol $dm^{-3}$.

Amount of water needed for dilution = Total Volume – Volume of HCl acid
= 250 – 2.5
= 247.5$cm^3$ of water needed.

In order to complete the titration experiment you will need a suitable indicator.

*[1] $\mathbf{2HCl \quad + \quad Ca(OH)_2 \qquad CaCl_2 \quad + \quad 2H_2O}$
*Strong acid* *Weak base*

$CaCl_2$ is the salt of a strong acid and weak base so the solution of $CaCl_2$ will have a pH of <7. Therefore a suitable indicator would be methyl orange because it has a pH between 3.1 and 4.4.

Now that you know the quantities and concentrations of the reagents, $Ca(OH)_2$ and HCl you will now carry out the dilution process.

**DILUTION:**

APPARATUS:

- Burette and burette stand.
- 250$cm^3$ of HCl, 2.00 mol $dm^{-3}$.
- Distilled water.
- 250$cm^3$ volumetric flask and stopper.
- Funnel.
- Eye protection.

METHOD:

1. Set up the burette stand and place the burette inside it.
2. Fill the burette with HCl acid, 2.00 mol $dm^{-3}$ using a funnel to avoid spillage making sure the bottom of the meniscus touches the line.
3. Make sure the volumetric flask is clean and dry.
4. Place the volumetric flask underneath the tap of the burette.
5. Gently open the tap of the burette to allow the HCl acid to flow into the volumetric flask and close the tap when 2.5$cm^3$ of HCl have been added.
6. Add distilled water to the volumetric flask containing the acid. *[2] However you should not add water to HCl acid as the first drops of water will react completely, exothermically with the acid, boiling it and causing spillage. Nevertheless in this case you will add water but a little bit at a time and

then put the stopper onto the volumetric flask and shake it to dilute the acid each time. Continue doing this gradually each time adding water until the bottom of the meniscus touches the line measuring $250cm^3$. At the end thoroughly shake the volumetric flask and the acid is diluted.

## **TITRATION:**

APPARATUS:

- Diluted HCl acid, 0.02 mol $dm^{-3}$ produced in dilution process.
- $250cm^3$ limewater- $Ca(OH)_2$.
- Methyl orange indicator.
- Burette.
- Burette stand.
- Funnel.
- Conical flask.
- White tile
- $25cm^3$ pipette and filler.
- Eye protection.

METHOD:

1. Set up the burette stand and place the burette inside it.
2. Fill the burette using a funnel to avoid spillage with the diluted HCl acid so that the bottom of the meniscus touches the line at $0cm^3$. Record the initial titre of the volume.
3. *3 Gently insert the pipette into the filler.
4. You will now need to create a vacuum in the filler so with your thumb and index finger squeeze the valve, 'A' which means 'aspirate' or 'air'. Whilst doing this use the other hand to squeeze the bulb.
5. Place the pipette into the $Ca(OH)_2$. In order for the $Ca(OH)_2$ to enter you must squeeze on the 'S' valve which represents 'suction' until the bottom of the meniscus touches the reference line on the pipette measuring $25cm^3$.
6. Then remove the pipette from the flask containing $Ca(OH)_2$ and place in the conical flask.
7. In order to remove the $Ca(OH)_2$ squeeze the 'E' valve this stands for 'expel'. The $Ca(OH)_2$ will flow out of the pipette into the conical flask.
8. If there are any more drops still remaining, then squeeze the 'E' valve with your thumb and forefinger and squeeze the bulb.
9. Place a white tile at the base of the burette stand below the tap and put the conical flask containing $25cm^3$ of $Ca(OH)_2$ on top of the white tile.
10. Add three drops of methyl orange indicator to the $Ca(OH)_2$ turning the solution pale orange.
11. The acid is then added to the $Ca(OH)_2$ from the burette by opening the tap. A right handed person should use his left hand to open to open the burette tap and the right hand to hold the flask at the neck.
12. Release the solution of the HCl into the limewater solution slowly, observing the volumetric flask. When the solution changes from a light orange to a very light pink colour, this is an indication to stop and record

the result. The white tile underneath the volumetric flask helps you with this because it gives you a better view of the colour change.

13. If the solution has turned pink then this is an indication that you have stepped over the end point and the titration is not valid.
14. Read off the side of the burette accurately how much volume is left and take this away from the initial volume to give you the volume of acid required to neutralise the base and record the titre.
15. Repeat the experiment 3 more times to give you more accurate results as anomalies do occur in this experiment.
16. Note all readings and work out the average of the volumes and work out the concentration of the limewater solution using the formula: *concentration = no of moles / volume.*

**<u>BIBLIOGRAPHY:</u>**


*1 http://www.ausetute.com.au/indicata.html

*2 http://antoine.frostburg.edu/chem/senese/101/safety/faq/always-add-acid.shtml

*3 http://www.umd.umich.edu/casl/natsci/slc/slconline/PIPET/sld031.htm