INTRODUCTION TO TITRATION TECHNIQUES

FA 1 is 0.100moldm^{-3} sodium hydroxide, NaOH(aq)
FA 2 is hydrochloric acid, HCl(aq)
methyl orange indicator

An acid neutralizes a bas to form a salt and water. Hydrochloric acid and sodium hydroxide are completely ionized in water. We say they are a strong acid or base because they are completely ionized in solution. The ions present in hydrochloric acid are H^+(aq)and Cl^-(aq) and in sodium hydroxide are Na^+(aq) and OH^-(aq).

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

You are going to use the technique of **titration** to produce a sodium chloride solution. Titration is a very accurate way of investigating the reaction of two solutions. It can be used to analyze the amount of a particular substance in a solution. This is known as **quantitative analysis**. In a titration, one solution is placed in a burette and the other is placed in a conical flask using a pipette. The solution in the burette is then run into the conical flask until there is a complete reaction. In this case you will completely neutralize a solution of sodium hydroxide with hydrochloric acid solution. You will use an indicator to tell you when there is complete neutralization. The indicator changes color at the exact point of neutralization. In this case you may use any acid-base indicator because you will titrate a strong acid with a strong base.

Method

1. Wash the burette with distilled water (aka deionised water) and then rinse with a little of the **FA 2**.
2. Once the burette has been washed and rinsed out with the acid solution, fill it nearly to the top. Clamp the burette carefully and run a little acid through into the beaker until the tip becomes full. (Fill the burette with **FA 2** solution and ensure the tip is full.)
3. The pipette can be cleaned in a similar way to the burette, remembering to finish by washing it out with a little of the alkali solution, **FA 1**. (A pipette safety filler is used to draw a measured volume of **FA 1** solution from the beaker into the pipette.
4. Rinse the conical flask with some deionised water. In this case it does not matter if there is some water left in the flask after rinsing it.
5. Pipette exactly 25.0 cm^3 of the 0.100mol dm^{-3} sodium hydroxide, **FA 1**, solution into a clean conical flask. Now add two or three drops of acid-base indicator, methyl orange.
6. Now read the burette and record the reading in the middle row of a table like the one below. Be careful that your eye is level with the bottom of the meniscus or your reading will not be accurate.
7. Place the conical flask below the burette on a white tile. Run **FA 2** into the flak fairly quickly, shaking it all the time. As soon as the color of the indicator changes, close the tap and note the final burette reading. Record this result in your table above your initial reading. Subtract the initial reading from the final reading to give you the volume of acid added.
8. The first titration is a rough titration to give you an idea of the volume you need to add to exactly neutrlise the acid. It is quite likely that you added a slight excess of acid as you were doing the titration quickly. Now repeat steps 2 to 7 but this time run in the acid quickly until you reach about 1cm^3 less than the volume you added in the rough titration. Swirl the contents of the flask and add one drop of acid, **FA 2**, at a time from the burette until the indicator just changes colour. Record this volume. This should represent the exact volume you need to add to neutralize 25.0cm^3 of 0.100mol dm^{-3} of sodium hydroxide, **FA 1**.
9. To ensure that you have a reliable volume of **FA 2**, you should repeat the whole titration again until you get two readings that agree within 0.10cm^3.

	Rough	1	2	3	4
Final burette reading / cm^3	26.30	38.40	28.90	41.50	
Initial burette reading / cm^3	0.20	12.90	3.60	16.30	
Volume of **FA 2** added / cm^3 **OR** Titre/cm^3	26.10	25.50	25.30 ✓	25.20 ✓	

From your accurate titration results, obtain a suitable value for the volume of **FA 2** to be used in your calculations. Show clearly how you obtained this value.

$\frac{25.30 + 25.20}{2} = 25.25 cm^3$

25.0cm^3 of **FA 1** required .....25.25..... cm^3 of **FA 2**.

Questions

(a) How many moles of NaOH, **FA 1**, were present in 25.0cm^3 solution?

$n = CV$
$= 0.100 \times \frac{25.0}{1000}$
2.50×10^{-3} mol

(b) How many moles of HCl, **FA 2**, were present in the volume of acid you used to neutralize the NaOH, **FA 1**, solution?

mole ratio
HCl : NaOH
1 : 1
2.50×10^{-3} : 2.50×10^{-3}
2.50×10^{-3} mol

(c) What was the exact concentration of hydrochloric acid, **FA 2**, in $moldm^{-3}$?

$C = \frac{n}{V} = \frac{2.50 \times 10^{-3}}{25.25/1000}$
$0.0990 mol dm^{-3}$

(d) Why was the conical flask placed on a piece of white tile?

To make the colour change visible during titration.

(e) Why were the pipette and burette washed with the solutions they were going to contain?

To prevent dilution of those solutions.

(f) Why was the conical flask not washed with the alkali solution it was going to contain?

To prevent adding extra un-calculated moles of alkali.

(g) Explain why it does not matter if there is water already in the flask.

Water will not change the number of moles present in the conical flask.
So the end point will remain same.

(h) Explain why a conical flask was used and not a beaker.

To prevent splashing of the solution.