PHYSICAL SCIENCES

Practical Booklet A

GRADE 12 TERM 2

TECHNICAL INSTRUCTIONS

Grade 12 Chemistry Practical:
Acid-base titration

Acid-base titration

TECHNICAL INSTRUCTIONS

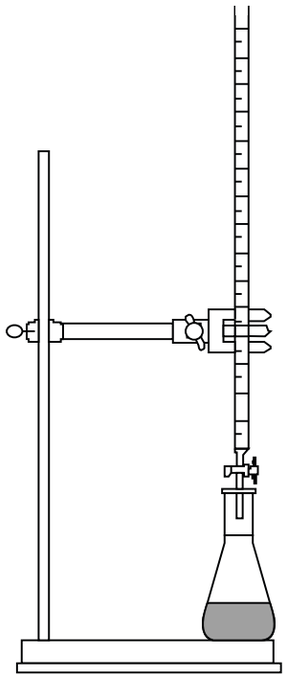
Aim: To determine the concentration of a given sodium hydroxide solution of unknown concentration by titration against a standard solution of oxalic acid.

SAFETY: Label the substances with these facts, and provide safety goggles and gloves at each workstation.

1. Oxalic acid is corrosive. It can be fatal if swallowed.
2. Sodium hydroxide is poisonous, harmful if inhaled, burns the skin and it may be fatal if swallowed.
3. Wear safety goggles and gloves when handling these substances.

Apparatus

- 0,1 mol.dm^{-3} oxalic acid (standard solution)
- NaOH solution (unknown concentration)
- Phenolphthalein indicator
- Distilled water
- Pipette of volume 25 ml with pipette filler
- Erlenmeyer flask, volume 250 ml
- Piece of paper towel
- Piece of white paper
- Retort stand with base, retort clamp
- Burette, volume 50 ml
- Wash bottle filled with distilled water
- Dropper



Making the standard solution of oxalic acid.

To prepare a litre of 0,1 mol.dm^{-3} oxalic acid, use 9 g of anhydrous oxalic acid per litre of solution.

Method

1. Pipette 25 ml of oxalic acid into the Erlenmeyer flask.
2. Add 3 drops of phenolphthalein indicator to the flask.
3. Rinse the burette once with distilled water, and then with small (5-10 ml) portions of the NaOH solution draining off the solution through the burette tip.
4. Check that the burette drains properly, and that there are no air bubbles are trapped in the tip and no leaks are apparent.
5. Fill the burette to the zero mark with the NaOH solution, and make sure that the burette tip is full of solution. With a piece of paper towel, remove any drop of NaOH hanging from the tip.
6. Make a preliminary titration to learn approximately how the titration proceeds. Place a piece of white paper under the flask so that it is easy to see the colour of the solution. Swirl the flask and add the NaOH solution. Occasionally rinse down the walls of the flask with distilled water from the wash bottle. Titrate until the last drop of NaOH solution leaves a permanent pink colour in the solution. Read and record the position on the burette of the lowest point of the meniscus of the NaOH solution.

7. Now titrate at least ***three*** more samples of oxalic acid, being certain that the burette is refilled to the zero mark with NaOH solution and that you use a clean flask.
8. In this and subsequent runs you may add NaOH solution from the burette very rapidly up to about 2 ml of the volume you estimate on the basis of your first titration. Then carefully add the rest of the base drop by drop so that you can determine the endpoint accurately.
9. Record the results in a table. Decide which values are accurate and calculate the average volume of NaOH used. Use the mole ratio in the balanced equation to calculate the concentration of the unknown sodium hydroxide solution.

PRACTICAL INVESTIGATION

Grade 12 Chemistry Practical:
Acid-base titration

Acid-base titration

PRACTICAL INVESTIGATION 30 MARKS

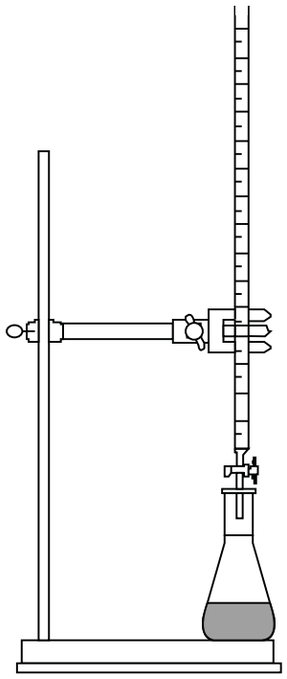
Aim: To determine the concentration of a given sodium hydroxide solution of unknown concentration by titration against a standard solution of oxalic acid.

SAFETY: Label the substances with these facts, and provide safety goggles and gloves at each workstation.

1. Oxalic acid is corrosive. It can be fatal if swallowed.
2. Sodium hydroxide is poisonous, harmful if inhaled, burns the skin and it may be fatal if swallowed.
3. Wear safety goggles and gloves when handling these substances.

Apparatus

- 0,1 mol.dm^{-3} oxalic acid (standard solution)
- NaOH solution (unknown concentration)
- Phenolphthalein indicator
- Distilled water
- Pipette of volume 25 ml with pipette filler
- Erlenmeyer flask, volume 250 ml
- Piece of paper towel
- Piece of white paper
- Retort stand with base, retort clamp
- Burette, volume 50 ml
- Wash bottle filled with distilled water
- Dropper



Making the standard solution of oxalic acid.

To prepare a litre of 0,1 mol.dm^{-3} oxalic acid, use 9 g of anhydrous oxalic acid per litre of solution.

Method

1. Pipette 25 ml of oxalic acid into the Erlenmeyer flask.
2. Add 3 drops of phenolphthalein indicator to the flask.
3. Rinse the burette once with distilled water, and then with small (5-10 ml) portions of the NaOH solution draining off the solution through the burette tip.
4. Check that the burette drains properly, and that there are no air bubbles are trapped in the tip and no leaks are apparent.
5. Fill the burette to the zero mark with the NaOH solution, and make sure that the burette tip is full of solution. With a piece of paper towel, remove any drop of NaOH hanging from the tip.
6. Make a preliminary titration to learn approximately how the titration proceeds. Place a piece of white paper under the flask so that it is easy to see the colour of the solution. Swirl the flask and add the NaOH solution. Occasionally rinse down the walls of the flask with distilled water from the wash bottle. Titrate until the last drop of NaOH solution leaves a permanent pink colour in the solution. Read and record the position on the burette of the lowest point of the meniscus of the NaOH solution.

7. Now titrate at least ***three*** more samples of oxalic acid, being certain that the burette is refilled to the zero mark with NaOH solution and that you use a clean flask.
8. In this and subsequent runs you may add NaOH solution from the burette very rapidly up to about 2 ml of the volume you estimate on the basis of your first titration. Then carefully add the rest of the base drop by drop so that you can determine the endpoint accurately.
9. Record the results in a table. Decide which values are accurate and calculate the average volume of NaOH used. Use the mole ratio in the balanced equation to calculate the concentration of the unknown sodium hydroxide solution.

QUESTIONS

1. Results: Titration of sodium hydroxide with standardised oxalic acid solution (6)

Expt. Number	Volume of oxalic acid (ml)	Volume of sodium hydroxide (ml)
Trial run		
1		
2		
3		
Average		

2. Balanced equation for the reaction. (3)

3. Calculation of concentration of sodium hydroxide solution. (5)

4. Explain the following procedures in this experiment:

4.1 Why is the burette washed in sodium hydroxide solution before starting the titration? (2)

4.2 There is an instruction to wash the drops of sodium hydroxide off the inside surfaces of the flask with distilled water.

a. Why is it critical that these drops are washed into the contents of the flask? (2)

b. Why does the addition of extra distilled water to the flask not affect the amount of sodium hydroxide that must be added to react with the oxalic acid? (3)

4.3 Give and briefly explain three safety precautions that were taken during this titration. (3)

5. Calculate the mass of oxalic acid which is required to make 250 ml of 0,1 mol.dm^{-3} oxalic acid solution.

PRACTICAL INVESTIGATION MEMORANDUM

Grade 12 Chemistry Practical:
Acid-base titration

30 Marks

Acid-base titration

PRACTICAL INVESTIGATION MEMORANDUM 30 MARKS

QUESTIONS

1. Results: Titration of sodium hydroxide with standardised oxalic acid solution (6)

Expt. Number	Volume of oxalic acid (ml)	Volume of sodium hydroxide (ml)
Trial run	25✓	36,6✓
1	25	37,6✓
2	25	37,4✓
3	25	37,6✓
Average	25	37,53✓

2. Balanced equation for the reaction. (3)

$(COOH)_2$ + 2 NaOH✓ → $(COONa)_2$ ✓ + 2 H_2O✓

3. Calculation of concentration of sodium hydroxide solution. (5)

1 mol of oxalic acid reacts with 2 mol of NaOH

$n_a : n_b = 1 : 2$✓ (Correct mol ratio)

$n_a = c_a V_a$
$= (0,1)(0,025)$
$= 0,0025$✓ mol (Correct no. of mol of acid)

$n_b = 2 \times n_a$
$= 2 \times 0,0025$
$= 0,0050$✓ mol (Correct no. of mol of base)

$n_b = c_b V_b$✓ (Method)

$0,0050 = c_b \times 0,03753$

$c_b = 0,13$ mol·dm^{-3} ✓ (Accuracy; SI units)

4. Explain the following procedures in this experiment:

4.1 Why is the burette washed in sodium hydroxide solution before starting the titration? (2)

We are finding the concentration of sodium hydroxide very accurately ✓ therefore there must not be any impurities (or distilled water) in the burette ✓to change (or affect) the results.

4.2 There is an instruction to wash the drops of sodium hydroxide off the inside surfaces of the flask with distilled water.

a. Why is it critical that these drops are washed into the contents of the flask? *(2)*

One drop of sodium hydroxide can change the colour of the indicator. ✓ If a drop is left on the side of the flask we could add too much sodium hydroxide, ✓ and get an inaccurate result.

b. Why does the addition of extra distilled water to the flask not affect the amount of sodium hydroxide that must be added to react with the oxalic acid? (3)

The flask contains a certain number of mols of acid which are neutralised by the base.✓ It makes no difference if extra distilled water is added to the flask because we <u>are not changing the number of mols</u>✓ of (either acid or) base✓ by doing so.

4.3 Give and briefly explain three safety precautions that were taken during this titration. (3)

- *Wear rubber gloves to protect your hands (from acid and base).*
- *Wear goggles to protect your eyes (from both substances).*
- *Use paper towel to wipe any excess NaOH from the tip of the burette – rather and knocking it away with your hand (or glove).*

  OR

- *Be careful not to damage the tip of the burette while cleaning it (don't let the tip of the burette bump against the basin). This prevents breakage of glass – which could cut the skin – and expose you to the acid and/or base.*

ANY THREE VALID precautions (One mark each)

5. Calculate the mass of oxalic acid which is required to make 250 ml of 0,1 mol.dm^{-3} oxalic acid solution. (6)

$c = \frac{n}{V}$ ✓	(method)
$n = cV = (0,1)(0,250)$✓ $= 0,025$✓ mol	(conversion to litres) (accuracy; ignore SI units)
$n = \frac{m}{M}$ ✓	(method)
$m = nM = 0,025 \times 2(12+16+16+1)$✓ $= 2,25$ g✓	(formula mass of oxalic acid) (accuracy; SI units)