CONVENT OF THE HOLY INFANT JESUS SECONDARY
Preliminary Examination in preparation for
the General Certificate of Education Ordinary Level 2024

CANDIDATE NAME	
CLASS	
REGISTER NUMBER	

CHEMISTRY

6092/03

Paper 3 Practical

15 August 2024

1 hour 50 minutes

Candidates answer on the question Paper.

Additional Materials: As listed in the confidential instructions

READ THESE INSTRUCTIONS FIRST

Write your class, register number and name in the spaces on top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided.

The use of an approved scientific calculator is expected, where appropriate.
You should show the essential steps in any calculations and record experimental results.
Qualitative analysis notes are printed on page 10.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	
2	
3	
Total	

This document consists of **10** printed pages and **2** blank pages.

1 Hydrated potassium carbonate forms crystals of formula $K_2CO_3•\mathbf{x}H_2O$.

You are going to determine the value of **x** in the formula $K_2CO_3•\mathbf{x}H_2O$ by titration with dilute hydrochloric acid.

$$K_2CO_3•\mathbf{x}H_2O + 2HCl \rightarrow 2KCl + (\mathbf{x}+1)H_2O + CO_2$$

Read all the instructions below carefully before starting the experiment in Question 1.

Instructions

P is a solution containing 8.00 g of $K_2CO_3•\mathbf{x}H_2O$ in 1.00 dm^3 of solution.
Q is 0.100 mol/dm^3 hydrochloric acid.

(a) (i) Put **Q** into the burette.

Pipette 25.0 cm^3 of **P** into a conical flask.

Add a few drops of methyl orange indicator to the solution in the conical flask.

Add **Q** from the burette, swirling the flask constantly, until the end-point is reached.

Record your titration results in the space provided. Repeat the titration as many times as you consider necessary to achieve consistent results.

Results

[5]

(ii) From your titration results, obtain an average volume of **Q** used.

Show clearly how you obtained this volume.

average volume of **Q** .... cm^3 [1]

[Turn over

(b) **Q** is 0.100 mol/dm^3 hydrochloric acid.

Using your results from **(a)**, calculate the amount, in mol, of potassium carbonate in 25.0 cm^3 of **P**.

amount of potassium carbonate in 25.0 cm^3 of **P** .... mol [2]

(c) Using your answer from **(b)**, calculate the amount, in mol, of potassium carbonate in 1.00 dm^3 of **P**.

amount of potassium carbonate in 1.00 dm^3 of **P** .... mol [1]

(d) **(i)** Using your answer from **(c)**, calculate the concentration, in g/dm^3, of potassium carbonate in **P**.
[M_r: K_2CO_3, 138]

concentration of potassium carbonate .... g/dm^3 [1]

(ii) Hence, calculate the mass of water in 8.00 g of hydrated potassium carbonate.

mass of water .... g [1]

(iii) Hence, calculate the amount, in mol, of water in 8.00 g of hydrated potassium carbonate.
[M_r: H_2O, 18]

amount of water = ... mol [1]

(iv) Calculate the value of **x** in the formula $K_2CO_3 \cdot xH_2O$.

x = ... [1]

(e) Describe another method by which the value of **x** in the formula $K_2CO_3 \cdot xH_2O$ can be determined.

Your method should include the apparatus you would use, and the measurements you would take in order to carry out the calculations required. You may use the space below to present your answers.

You can assume the apparatus and reagents normally found in a school laboratory are available.
[M_r: K_2CO_3, 138; M_r: H_2O, 18]

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.... [5]

[Total: 18]

[Turn over

CHIJ SECONDARY

Sec 4 Preliminary Examination 2024

Chemistry 6092 **Mark Scheme**

Updated on 05/09/2024

Paper 3 (40 marks)

			Answers	Marks	Total
1	**(a)**	**(i)**	Results • correct headings and units [1] • burette readings to 2 d.p. [1] • accuracy within ±0.2 cm^3 [2] or ±0.3 cm^3 [1] of actual titre values • concordance within ±0.1 cm^3 [1]	5	18
		(ii)	Calculation of average volume using best 2 values to 2 d.p.	1	
	(b)		Volume of Q = **X** cm^3 No. of moles of Q = **X**/1000 × 0.100 = 0.0001**X** mol [1] No. of moles of of K_2CO_3 in 25 cm^3 = 0.0001**X** ÷ 2 = 0.00005**X** mol [1]	2	
	(c)		No. of moles of K_2CO_3 in 1 dm^3 = 1000/25 × 0.00005**X** mol = 0.002**X** mol	1	
	(d)	**(i)**	Mass concentration of of K_2CO_3 = 0.002**X** mol × 138 = 0.276**X** g/dm^3	1	
		(ii)	Mass of H_2O in 1dm^3 = 8.00 – 0.276**X** g	1	
		(iii)	No. of moles of H_2O = (8.00 – 0.276**X**) g ÷ 18	1	
		(iv)	***x*** = 0.09178 ÷ 0.046 ≈ 2	1	
	(e)		Every 2 points is 1 mark: 1. Measure the mass *[reject weight, penalize once]* of an empty test-tube/ boiling tube/ evaporating dish/ crucible *[reject beaker/ conical flask etc.]* (***p***) using an electronic mass balance *[reject weighing scale]* 2. Add the solid sample to the test-tube, measure the initial mass of the test-tube and its contents (***q***) *[accept measure the mass of hydrated K_2CO_3, if no apparatus mentioned point 1 not awarded] [reject measuring mass of solution]* 3. Calculate the mass of hydrated K_2CO_3 used by taking ***q*** – ***p*** 4. Heat the sample (at regular / 1-minute intervals) *[point only awarded if appropriate apparatus for heating was mentioned earlier; accept evaporate (to dryness)]* 5. until the mass of the remaining solid / residue is constant / to dryness / all the water has evaporated *[reject to saturation]* 6. Measure the mass of the remaining residue and test-tube (***r***) *[reject measure the mass of the test-tube after heating] [accept*	5	

			Answers	Marks	Total
			measure the mass of anhydrous K_2CO_3 as ecf if point 1 not mentioned] 7. Calculate the mass of the residue ***r* – *p*** *[reject **p** – **r**]* 8. Calculate the number of moles of K_2CO_3 by taking (***r*** – ***p***)/138. 9. Calculate the number of moles of H_2O by taking (***q*** – ***r***)/18. 10. The value is x is the number of moles of H_2O ÷ number of moles of K_2CO_3. OR 1. Using a burette/measuring cylinder/pipette, measure out 25.0 cm^3 of solution P 2. into a conical flask. Set up using rubber stopper with delivery tube, connected to gas syringe *[award point if set-up is drawn and labelled]* 3. Add solution Q / HCl 4. in excess 5. Measure the volume of gas *[reject amount/mass]* 6. Calculate the number of moles of CO_2 by taking ***v***/24000 *[reject finding no. of moles by mass/M_r if never mention to measure the mass of gas collected using electronic mass balance]* 7. The number of moles of K_2CO_3 is also ***v***/24000 8. The value of x can be determined using steps **(c)** to **(d)(ii)** *(Max. 4 marks, because the method is not very different from the original question)*		
2	(a)		A lilac/purple/violet flame was observed.	1	9
	(b)		The white solid melted to form a colourless liquid / water droplets were observed on the sides of the test-tube / a white residue remains [1] A gas was evolved that relights a glowing splint. [1]	2	
	(c)		**Test 1** • Upon adding potassium iodide, the yellow solution turns yellow/brown/reddish-brown/dark orange. [1] • Upon adding starch, a blue-black solution forms. [1] **Test 2** • A white precipitate forms. [1] **Test 3** • No visible change observed. [1]	4	
	(d)		Nature: Oxidising agent (no mark) Reasoning: In Test 1, when potassium iodide is added, the solution changes to brown, [1] indicating that Y oxidised potassium iodide to form iodine. [1]	2	
3	(a)		Table • temperatures recorded to 1 d.p. [1] • correct trend: temperature decrease from t=2 to t=5.5 [1] *(accept if first 2 temperatures are the same)* • accuracy: temperature within 1°C difference at t=0, t=0.5 and t=1, and 66.0±3.0°C for highest temperature reading [1]	3	13
	(b)		Graph • correct axes labels and units, including scale [1] • temperature to 1 d.p., time to 1 d.p. or nearest whole number [1] • correctly plotted values [1] • best-fit lines [1]	4	

3 (a) All chemical reactions would involve the absorption of energy to break bonds and the release of energy when new bonds are formed. In a chemical reaction, a difference between the amounts of energy absorbed and released would result in an energy change. This usually takes the form of heat energy, which could register as a temperature rise or temperature drop of the reacting solution.

When zinc powder is added to aqueous copper(II) sulfate, an exothermic reaction occurs.

$$CuSO_4(aq) + Zn(s) \rightarrow ZnSO_4(aq) + Cu(s) \quad \Delta H < 0$$

The maximum temperature change, ΔT_{max}, occurring during this reaction may be determined experimentally.

In this question, you are to plan a procedure that would provide sufficient data to allow you to determine a value for ΔT_{max}. You may assume that you are provided with:

- aqueous copper(II) sulfate
- powdered zinc solid
- the equipment normally found in a school laboratory.

In your plan you should include brief details of:

- the apparatus you would use
- the procedure you would follow
- the measurements you would make to allow you to determine a value for ΔT_{max}.
- how you would use your measurements to calculate a value for ΔT_{max}.

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.... [4]

(b) Describe and explain the expected observations during the reaction between zinc powder and aqueous copper(II) sulfate.

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.... [2]

(c) Jane carried out an experiment by adding 0.5 g of zinc to 100 cm^3 of 0.1 mol/dm^3 aqueous copper(II) sulfate. Show, by calculations, that zinc is the limiting reagent.
[A_r of Zn = 65]

[2]

(d) Jane found that the ΔT_{max} for her experiment was +6.5 °C.
Calculate the enthalpy change, ΔH, of the reaction using the equation given below:

$$\Delta H = -\frac{V \times 4.2 \times \Delta T_{max}}{no.\ of\ moles\ of\ limiting\ reagent}\ \text{J/mol}$$

where V is the volume of copper(II) sulfate in cm^3

ΔH = ... J/mol [1]

[Total: 9]

3 (a) All chemical reactions would involve the absorption of energy to break bonds and the release of energy when new bonds are formed. In a chemical reaction, a difference between the amounts of energy absorbed and released would result in an energy change. This usually takes the form of heat energy, which could register as a temperature rise or temperature drop of the reacting solution.

When zinc powder is added to aqueous copper(II) sulfate, an exothermic reaction occurs.

$$CuSO_4(aq) + Zn(s) \rightarrow ZnSO_4(aq) + Cu(s) \qquad \Delta H < 0$$

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In this question, you are to plan a procedure that would provide sufficient data to allow you to determine a value for ΔT_{max}. You may assume that you are provided with:

- aqueous copper(II) sulfate
- powdered zinc solid
- the equipment normally found in a school laboratory.

In your plan you should include brief details of:

- the apparatus you would use
- the procedure you would follow
- the measurements you would make to allow you to determine a value for ΔT_{max}.
- how you would use your measurements to calculate a value for ΔT_{max}.

1. Using an electronic balance, measure out 0.5 g of powdered Zn solid into a weighing boat.

2. Using a measuring cylinder, measure 50.0 cm^3 of $CuSO_4(aq)$ into a clean and dry styrofoam cup nested in a 250 cm^3 beaker.

3. Using a thermometer, measure and record the initial temperature of the $CuSO_4(aq)$ as T_1.

4. Quantitatively transfer the powdered Zn solid into the Styrofoam cup.

5. Stir gently with a thermometer, and record the highest temperature reached as T_2.

6. ΔT_{max} can be calculated by $T_2 - T_1$.

Quantities of chemicals used are stated – 1m

Use of Styrofoam cup and thermometer and measuring cylinder/electronic balance – 1m

Measurement and recording of initial and highest temperatures – 1m

Calculation of ΔT_{max} – 1m

[4]

(b) Describe and explain the expected observations during the reaction between zinc powder and aqueous copper(II) sulfate.

- Blue $CuSO_4$ solution decolourises as the concentration of Cu^{2+} decreases. [1]
- Reddish brown Cu solid is produced as the more reactive Zn displaces copper from copper(II) sulfate. [1]

[2]

(c) Jane carried out an experiment by adding 0.5 g of zinc to 100 cm^3 of 0.1 mol/dm^3 aqueous copper(II) sulfate. Show, by calculations, that zinc is the limiting reagent.
[A_r of Zn = 65]

No. of moles of Zn = 0.5 ÷ 65 = 0.007693 mol
No. of moles of $CuSO_4$ = $\frac{100}{1000}$ x 0.1 = 0.01 mol [1m for both no. of moles]

Since the 0.01 mol of $CuSO_4$ requires 0.01 mol of Zn for complete reaction, while only 0.007693 mol of Zn is available, Zn is the limiting reagent. [1]

[2]

(d) Jane found that the ΔT_{max} for her experiment was +6.5 °C.
Calculate the enthalpy change, ΔH, of the reaction using the equation given below:

$$\Delta H = -\frac{V \times c \times \Delta T_{max}}{no.\ of\ moles\ of\ limiting\ reagent}\ J/mol$$

where V is the volume of copper(II) sulfate in cm^3
c has a value of 4.2

$$\Delta H = -\frac{(100)(4.2)(+6.5)}{0.007693}$$
= –354 868 J/mol
≈ –355 000 J/mol (3 s.f.)

ΔH = –355 000 J/mol [1]

[Total: 9]

4 The label on a bottle of orange drink states 'this drink contains no artificial colours'.

However, a chemist thinks that the orange colour in the drink is a mixture of two artificial colours:
- Sunset Yellow E110
- Allura Red E129.

Plan an experiment to show that the orange colour in the drink does **not** contain these two artificial colours.

Your plan should describe the use of common laboratory apparatus and samples of E110, E129 and the orange colouring from the drink.

You can assume that all apparatus normally found in a school laboratory is available.

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.... [4]

[Total: 4]

4 key marking points: max 4

- method stated or implied clearly: chromatography / paper chromatography
- draw a pencil baseline / pencil start line (reject: pencil solvent front)
- use the pointed end of a toothpick to apply a small spot of orange colouring from drink onto the pencil start line of the paper/ chromatogram / paper chromatogram
- as well as samples of both E110 and E129
- depth of solvent (state water or ethanol) in beaker is below base line/ start line / spots on chromatogram
- allow the solvent to travel up the paper for about 10 minutes (suitable time period) so as to separate the components of the samples
- use a ruler to measure the distance / heights of spots from pencil start line of E-colours against orange drink
- **conclusion** based on height of spots from start line / comparison to known R_f values [orange drink will **not** have spots on the same horizontal height as E110 and E129 / different R_f values] [OWTTE]

descriptors	marks awarded
o all 8 points mentioned in proper sequence	4
o 6 points mentioned in proper sequence	3
o 4 points mentioned in proper sequence	2
o 2 points mentioned	1

Note: if clearly-labelled diagram is drawn instead, relevant marks that correspond to the descriptors above can also be awarded

(d) Gymnasts and rock climbers use chalk to absorb sweat and to improve their grip. The chalk used for this purpose contains a naturally occurring white mineral called magnesium carbonate.

Given 0.100 g of chalk sample from an unidentified brand, outline a method to determine the percentage by mass of magnesium carbonate in the solid sample.

You can assume all the apparatus and reagents normally found in school laboratory are available.

In your method, include the measurements you would take, and explain how you would use your result to determine the percentage by mass of magnesium carbonate in the 0.100 g sample.

You may wish to use a labelled diagram to illustrate your answer.

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....[4]

[Total: 15]

3 Crystals of ethanedioic acid have the formula $H_2C_2O_4.xH_2O$.
A student attempts to determine the value of x by titration.

(a) The student weighs a sample of the ethanedioic acid crystals in a beaker.

Mass of beaker + crystals = 39.526 g
Mass of beaker = 38.664 g

Calculate the mass of the crystals used in the experiment.

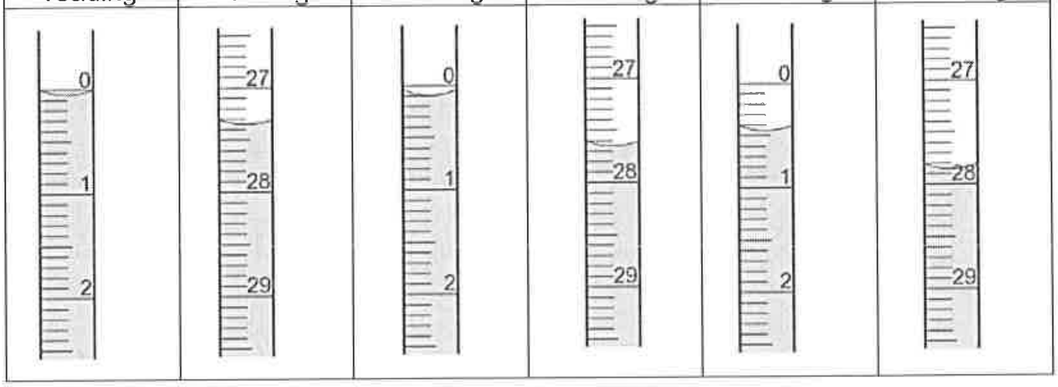
mass:..g [1]

(b) The crystals in the beaker are dissolved in water to form a colourless solution.
The solution is then transferred to a volumetric flask and made up to 250 cm^3 with water.
This is solution **Z**.

25.0 cm^3 of **Z** is transferred into a conical flask using a pipette. The student titrates the sample of **Z** in the conical flask with 0.0100 mol/dm^3 aqueous potassium manganate(VII) from a burette, until the end-point is reached.

(i) The results of the titration are shown.

Titration 1		Titration 2		Titration 3	
Initial reading	Final reading	Initial reading	Final reading	Initial reading	Final reading



Fill in the titration table below.

titration number	1	2	3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of aqueous potassium manganate(VII) used / cm^3			
best titration results (✓)			

[2]

[Turn over

(ii) Calculate the average volume of aqueous potassium manganate(VII) used.

average volume :.. cm^3 [1]

(c) Calculate the number of moles of potassium manganate(VII) in the average volume calculated.

number of moles: ....mol [1]

(d) Two moles of potassium manganate(VII) react with five moles of ethanedioic acid, $H_2C_2O_4.xH_2O$.

Calculate the number of moles of $H_2C_2O_4.xH_2O$ in 25.0 cm^3 of **Z**.

number of moles: ....mol [1]

(e) Calculate the number of moles of $H_2C_2O_4.xH_2O$ in 250 cm^3 of **Z**.

number of moles: ....mol [1]

(f) Use your answers in **(a)** and **(e)** to calculate the relative molecular mass of $H_2C_2O_4.xH_2O$.

[A_r: H, 1; C, 12; O, 16]

relative molecular mass: ....[1]

(g) Hence, calculate the value of x in $H_2C_2O_4.xH_2O$.

x: ....[1]

(h) Another student repeated the experiment and accidentally washed the conical flask with solution **Z**.

Describe and explain the effect that this would have on the calculated value of x in part **(g)**.

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....[2]

[Total: 11]

Question		Indicative material	Mark	Total
3	**P**	**Approach 1** To measure the volume of carbon dioxide produced by reacting the chalk with hydrochloric acid (or any other named acid). *Procedure* 1. Place the 0.100 g chalk sample into a conical flask 2. Add an excess of 1.0 mol/dm^3 hydrochloric acid 3. Record the volume of the gas collected in the gas syringe when effervescence has stopped. (Rej: displacement of water / all the chalk has dissolved) *Calculation* number of moles of CO_2 = volume of gas / 24 dm^3 number of moles of $MgCO_3$ = number of moles of CO_2 mass of $MgCO_3$ = number of moles of $MgCO_3$ x (24 + 12 + 16 x 3) % mass of $MgCO_3$ in sample = (mass of $MgCO_3$ / 0.100 g) x 100% OR **Approach 2** To measure the mass loss of the chalk by reacting the chalk with hydrochloric acid (or any other named acid). *Procedure* 1. Place the 0.100 g chalk sample into a conical flask 2. Add excess of 1.0 mol/dm^3 HC*l* into the flask. Measure the initial mass of the reactants and flask. 3. After effervescence has stopped, measure the final mass of the flask and its contents. *Calculations* number of moles of CO_2 = mass loss / (12 + 16 x 2) number of moles of $MgCO_3$ = number of moles of CO_2 mass of $MgCO_3$ = number of moles of $MgCO_3$ x (24 + 12 + 16 x 3) % mass of $MgCO_3$ in sample = (mass of $MgCO_3$ / 0.100 g) x 100%	1m - use correct reactant 1m - measure correct quantity 1m - describe correct apparatus or draw correct apparatus 1m - correct description of calculation methods	**[4]**

<table>
<tr><th>Question</th><th></th><th>Indicative material</th><th>Mark</th><th>Total</th></tr>
<tr><td>4a</td><td>MMO</td><td>0.862g</td><td>1</td><td>1</td></tr>
<tr><td>4bi</td><td>PDO</td><td>
<table>
<tr><td>titration number</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>final burette reading / cm^3</td><td>27.35</td><td>27.65</td><td>27.85</td></tr>
<tr><td>initial burette reading / cm^3</td><td>0.05</td><td>0.10</td><td>0.45</td></tr>
<tr><td>volume of aqueous potassium manganate(VII) used / cm^3</td><td>27.30</td><td>27.55</td><td>27.40</td></tr>
<tr><td>best titration results (✓)</td><td>✓</td><td></td><td>✓</td></tr>
</table>
</td><td>1m for 2dp
1m for correct calculation</td><td>2</td></tr>
<tr><td>4bii</td><td>MMO</td><td>Average volume: (27.30+27.40)/2 = 27.35cm^3</td><td>1</td><td></td></tr>
<tr><td>4c</td><td>MMO</td><td>No. of mols: 0.0100 x(27.35/1000)= 0.000274mol</td><td>1</td><td>1</td></tr>
<tr><td>4d</td><td>MMO</td><td>Mole ratio
$KMnO_4$: $H_2C_2O_4.xH_2O$
2: 5
0.000274: 0.000684mol</td><td>1</td><td>1</td></tr>
<tr><td>4e</td><td>MMO</td><td>No. of moles = 0.000684 x 10 = 0.00684mol</td><td>1</td><td>1</td></tr>
<tr><td>4f</td><td>MMO</td><td>Mass / mol = 0.862 / 0.00684 = 126</td><td>1</td><td>1</td></tr>
<tr><td>4g</td><td>MMO</td><td>X = (126-2-24-64)/18 = 2</td><td>1</td><td>1</td></tr>
<tr><td>4h</td><td>ACE</td><td>X would be smaller.
It would result in a larger volume of $KMnO_4$ used and number of moles calculated for $H_2C_2O_4.xH_2O$ would be bigger, resulting in a smaller Mr calculated.</td><td>1

1</td><td>2</td></tr>
</table>

3 (a) Vinegar contains dilute ethanoic acid. Different brands of vinegar contains different concentrations of ethanoic acid.

You are provided with two different brands of vinegar; brands **A** and **B**, as well as the apparatus and chemicals normally found in the laboratory.

With the help of a well-labelled diagram, describe how you would carry out an experiment to determine which of the two brands of vinegar contains a higher concentration of ethanoic acid.

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[5]

(b) Ethanoic acid can be produced by reacting ethanol with oxygen in the air.

State a suitable chemical reagent that can be used to test for ethanol. Describe what is observed if ethanol is present.

reagent: ....

observation: ....

[2]

[Total: 7]

3 (a) Vinegar contains dilute ethanoic acid. Different brands of vinegar contains different concentrations of ethanoic acid.

You are provided with two different brands of vinegar; brands **A** and **B**, as well as the apparatus and chemicals normally found in the laboratory.

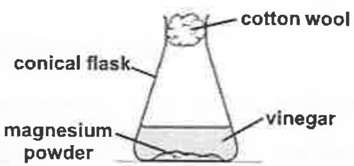
With the help of a well-labelled diagram, describe how you would carry out an experiment to determine which of the two brands of vinegar contains a higher concentration of ethanoic acid.

Method 1:

Approach:

Vinegar containing different concentrations of ethanoic acid will react with magnesium metal (or calcium carbonate) at different rates.

The time taken for all the magnesium metal (or calcium carbonate) to completely react with the acid can be recorded.



Procedure:

1. **Prepare the set-up shown above.**
2. **Measure 50 cm^3 of Brand A vinegar into a conical flask *using* a measuring cylinder.**
3. **Weigh 1.0 g of magnesium powder *using* an electronic balance. Transfer the magnesium powder into the conical flask. Stopper the flask immediately.**
4. ***Using* a stopwatch, record the time taken for all the magnesium powder to completely react with the ethanoic acid in the flask. When effervescence is no longer produced, stop the stopwatch.**
5. **Repeat steps 1 to 4 using Brand B vinegar.**

Conclusion:

The higher the concentration of ethanoic acid present in the vinegar sample, the shorter the time taken for the reaction to be completed, the faster the rate of reaction.

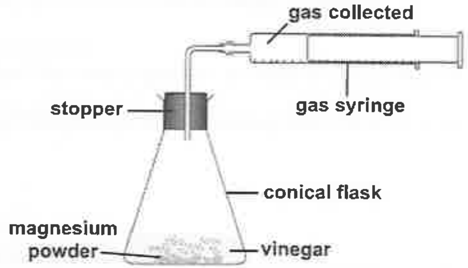
1 mark for an appropriate scientific approach to experiment
1 mark for a well-labelled diagram
1 mark for a logical and clear experimental procedure
1 mark for appropriate use of apparatus and specified quantities
1 mark for suitable conclusion

Method 2:

Approach:

Vinegar containing different concentrations of ethanoic acid will react with magnesium metal (or calcium carbonate) at different rates.

The time taken to collect a fixed volume of hydrogen gas (or carbon dioxide gas) can be recorded.



Procedure:

1. **Prepare the set-up shown above.**
2. **Measure 50 cm^3 of Brand A vinegar into a conical flask *using* a measuring cylinder.**
3. **Weigh 1.0 g of magnesium powder *using* an electronic balance. Transfer the magnesium powder into the conical flask. Stopper the flask immediately with a delivery tube connected to a gas syringe.**
4. ***Using* a stopwatch, record the time taken to collect 10 cm^3 of hydrogen gas.**
5. **Repeat steps 1 to 4 using Brand B vinegar.**

Conclusion:

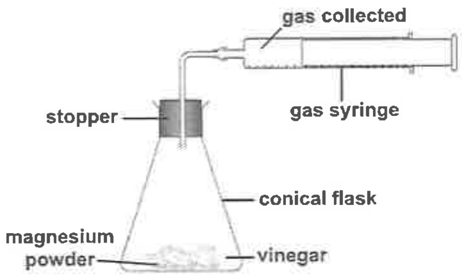
The higher the concentration of ethanoic acid present in the vinegar sample, the shorter the time taken to collect the 10 cm^3 of gas.

Method 3:

Approach:

Vinegar containing different concentrations of ethanoic acid will react with magnesium metal (or calcium carbonate) at different rates.

Measure the volume of hydrogen gas (or carbon dioxide gas) collected over a fixed duration.



Procedure:
1. **Prepare the set-up shown above.**
2. **Measure 50 cm^3 of Brand A vinegar into a conical flask *using* a measuring cylinder.**
3. **Weigh 1.0 g of magnesium powder *using* an electronic balance. Transfer the magnesium powder into the conical flask. Stopper the flask immediately with a delivery tube connected to a gas syringe.**
4. **Record the volume of hydrogen gas collected over 5 minutes, measured *using* a stopwatch.**
5. **Repeat steps 1 to 4 using Brand B vinegar.**

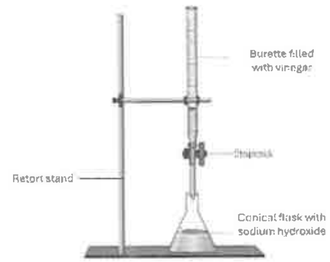
Conclusion:

The higher the concentration of ethanoic acid present in the vinegar sample, the greater the volume of hydrogen gas collected over 5 minutes.

Method 4:

Approach: Perform titration on a fixed volume and known concentration of sodium hydroxide, NaOH, against the vinegar solutions. Ethanoic acid reacts with sodium hydroxide to form sodium ethanoate and water only.

By comparing the volume of sodium hydroxide required to for complete neutralisation of ethanoic acid, the vinegar with a higher concentration of ethanoic acid can be determined.



Procedure:
1. **Prepare the set-up as shown above.**
2. **Using a pipette, pipette 25.0 cm^3 of 0.500 mol /dm^3 NaOH into a conical flask.**
3. **Fill the burette with Brand A vinegar solution. Add a few drops of methyl orange indicator into the conical flask.**
4. **Add NaOH solution into the conical flask, and record the volume of NaOH when one drop of NaOH turns methyl orange from yellow to orange. This is the end point of titration.**
5. **Repeat steps 1 – 4 for Brand B vinegar solution.**

Conclusion:

The vinegar brand that requires a greater volume of NaOH for complete neutralisation has a higher concentration of ethanoic acid.

[5]

(b) Ethanoic acid can be produced by reacting ethanol with oxygen in the air.

State a suitable chemical reagent that can be used to test for ethanol. Describe what is observed if ethanol is present.

reagent: **Acidified potassium manganate(VII) / $KMnO_4$**

observation: **Purple $KMnO_4$ solution will decolourise / turn colourless**

[2]

3 Metal **Y** is a Group 2 element.

The nitrate of **Y** is hygroscopic (absorbs moisture readily) and hence exists readily in a hexahydrate form (containing six water of crystallisation), **Y**$(NO_3)_2{\cdot}6H_2O$.

The hydrated nitrate of **Y** dissolves in water to give the following enthalpy change.

$$\mathbf{Y}(NO_3)_2{\cdot}6H_2O\ (s) \rightarrow \mathbf{Y}(NO_3)_2\ (aq) + 6H_2O\ (l) \qquad \Delta H = +26\ kJ/mol \qquad (3)$$

When strongly heated, hydrated nitrate of **Y** decomposes at 280 °C as shown.

$$2\mathbf{Y}(NO_3)_2{\cdot}6H_2O\ (s) \rightarrow 2\mathbf{Y}O\ (s) + 4NO_2\ (g) + O_2\ (g) + 12H_2O\ (g) \qquad (4)$$

Assume that you are given a sample of hydrated nitrate of Y in solid form to be used for part (a) and (b) below.

(a) Briefly describe how a simple experiment can be carried out to confirm the sign of the enthalpy change given in equation (3).

....

.... [1]

(b) Using equation (4), describe how an experiment can be carried out to identify metal **Y** using changes in mass. You can assume all the apparatus and reagents normally found in a school laboratory are available.

In your method you need to:
- include the measurements you would take.
- describe how you would know any reaction has been completed.
- show how you would use your results to identify **Y**.

[A_r: N, 14; O, 16; H, 1]

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.... [5]

[Total: 6]

3(a)	**Dissolves** some solid into **water** and measure a **decrease in temperature** to confirm a positive enthalpy change.	1
(b)	Measurements to collect Heat strongly **known mass** of hydrated nitrated of **Y**. Measure **mass of solid (YO) remaining when mass remains constant** (after mass loss due to NO_2 gas, O_2 gas and H_2O steam). Explain how to identify Y Calculate number of mole of **Y**$(NO_3)_2{\cdot}6H_2O$ and **YO**. No. of mole of **Y**$(NO_3)_2{\cdot}6H_2O$ = $\dfrac{\text{mass of } \mathbf{Y}(NO_3)_2{\cdot}6H_2O}{A_r \text{ of Y} + 2(14) + 6(16) + 6(18)}$ = $\dfrac{\text{mass of } \mathbf{Y}(NO_3)_2{\cdot}6H_2O}{A_r \text{ of Y} + 232}$ No. of mole of **YO** = $\dfrac{\text{mass of YO}}{A_r \text{ of Y} + 16}$ From equation (4), mole ratio of **Y**$(NO_3)_2{\cdot}6H_2O$: **YO** = 1:1. Hence, we can equate, number of mole of **Y**$(NO_3)_2{\cdot}6H_2O$ = number of mole of **YO**. Solve for **A_r of Y** to identify **Y**.	1 (or describe, e.g. measure 1.0 g of ...) 1 (mass constant is how we know reaction is completed) 1 (for both no. of moles) 1 (for 1:1 mole ratio) 1 (**reject "M_r of Y"**, accept "molar mass of Y")