Determination catalytic activity

Introduction

Catalysts are substances that speed up the rate of chemical reactions. It is possible to divide catalysts into two groups – inorganic catalysts and organic (biological) catalysts. Biological catalysts are called enzymes. Most enzymes are protein molecules, and they specifically catalyze only one reaction

Inorganic catalysts take a wide variety of forms. Metallic surfaces often serve as catalysts for gas phase reactions, such as the conversion of nitrogen oxides back to atmospheric oxygen and nitrogen gas, as occurs in catalytic converters in car engines.

In this task you will investigate the ability of one organic catalyst and two inorganic catalysts to catalyze the decomposition of hydrogen peroxide.

At room temperature hydrogen peroxide spontaneously decomposes according to the equation

$$H_2O_{2(l)} \longrightarrow H_{2(g)} + 1/_2\, O_{2(g)}$$

Adding a catalyst increases the rate of this reaction. To investigate the action of different types of catalysts, you will measure the length of time that a fixed volume of H_2O_2 reacts in the presence of a fixed mass of catalyst.

You have been provided with:

1X 24 well-plate

3 Beral pipets, graduated

1 scoop

25 mL 3% hydrogen peroxide (H_2O_2) solution

1g Potassium iodide KI $_{(s)}$

1 g Yeast $_{(s)}$

1 g Iron (III) chloride, $FeCl_3$ $_{(s)}$

Stopwatch

Procedure:

Add one level scoop of $FeCl_{3(s)}$ to each of the wells A1, A2, and A3

Add one level scoop of $KI_{(s)}$ to each of the wells B1, B2, and B3

Add one level scoop of yeast to each of the wells C1, C2, and C3

Add $2cm^3$ $H_2O_{2(l)}$ to well plate A1. Record the time taken for the reaction to complete.

Repeat for each sample in A2 and A3.

Record your data in the table below.

Catalyst		**Time (sec)**			
		1	2	3	Average
Iron (III) chloride $FeCl_{3(s)}$	A				
Potassium iodide $KI_{(s)}$	B				
Yeast	C				

1. How did you judge the reaction to be complete?

   _____

2. What is the independent variable in your investigation? What type of variable (e.g. continuous) is this? _____

3. What is the dependent variable in your investigation? What type of variable is this?

   _____

4. What other variables have been controlled?

   _____

5. What variables should have been controlled but were not?

   _____

6. List the catalysts in order of decreasing effectiveness. Give your reasons for placing them in this order.

_____

7. State, with reasons whether you consider the results to be reliable.

_____

8. State, with reasons whether you consider your conclusion (i.e. answer to (6) to be valid.

_____

9. State two practical ways in which your investigation could be improved.

_____

10. Catalysts are often very expensive materials (e.g. platinum). Give two reasons why this does not necessarily make the product of the reaction very expensive too.

_____

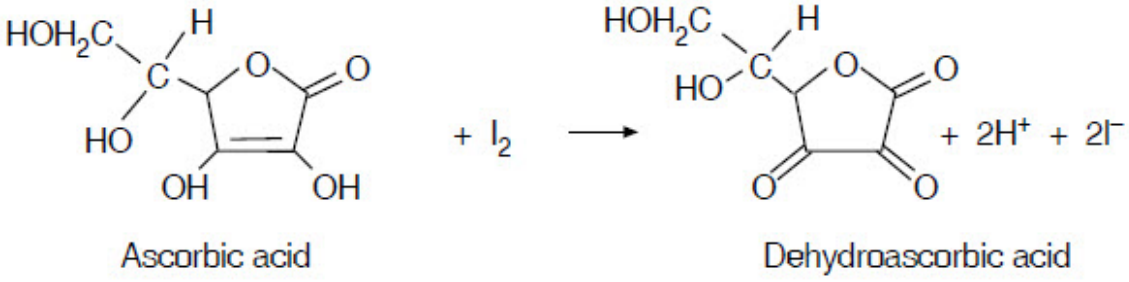
Measuring the amount of vitamin c in fruit drinks

In this task you will perform a titration to measure the amount of vitamin C (ascorbic acid) in fruit drinks. The basis of the measurement is as follows.

A known excess amount of iodine is generated by the reaction between iodate, iodide and sulphuric acid:

$IO_3^-(aq) + 5I^-(aq) + 6H^+(aq) \quad 3I_2(aq) + 3H_2O(aq)$

A measured amount of fruit drink is added. The ascorbic acid in the drink reacts quantitatively with some of the iodine as the iodine is in excess: The excess iodine is then titrated against standard thiosulphate solution:



Ascorbic acid Dehydroascorbic acid

The excess iodine is then titrated against standard thiosulphate solution. You carry out a titration to determine the volume of thiosulfate required to react with the excess iodine.

You have been provided with

Sodium thiosulphate 0.010 mol /L	Microburette
Potassium iodate 0.001 mol /L	One 1 cm^3 pipette (glass)
Potassium iodide 0.005 mol /L	One 2 cm^3 pipette (glass)
Starch solution (freshly made)	Pipette filler
Sulphuric acid 1 mol /L	One 25 cm3 beaker
Sample(s) of fruit juice.	One 5 cm3 measuring cylinder
	One 10 cm3 beaker (for filling burette).

Instructions

1. Fill the microscale titration apparatus with sodium thiosulphate solution. To do this, place the thiosulfate solution into one of the 10 cm^3 beakers. Place the tip of the

burette into the thiosulfate and slowly raise the plunger of the syringe. If air bubbles are drawn up, raise and lower the plunger slowly a few times to expel them. When the thiosulfate has reached the level you want, let go of the plunger.

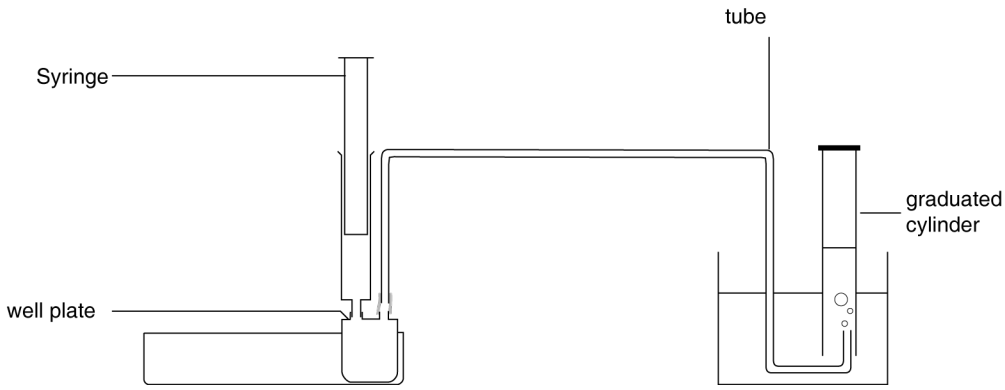
2. Using the glass pipette add 2 cm^3 of potassium iodate solution to the beaker.
3. Using the measuring cylinder, measure 3 cm^3 of potassium iodide solution and then add this to the beaker. (Note: the potassium iodide solution is added in slight excess.)
4. Add three drops of sulphuric acid. What do you observe?
5. Add a few drops of starch solution. What do you observe?
6. Using a glass pipette add 1 cm^3 of the fruit drink to the beaker and swirl gently.
7. Titrate the remaining iodine in the beaker against the sodium thiosulphate solution. (The beaker can be swirled very gently to mix the chemicals. Alternatively, the tip of a plastic pipette can be used as a mini stirring rod.) The disappearance of the colour marks the end-point.
8. Do a duplicate titration and check the agreement between the two titres. If it is acceptable take the mean value of the two titres.
9. Draw a suitable table, and record your results.
10. You will not be required to carry out a calculation to find the vitamin C content, however, if you were, what value would you use for the volume of thiosulfate in your calculation?
11. Before she carried out this titration, a student washed out all of the microscale apparatus (the beaker with the filling solution, the 2cm^3 pipette and the syringe) with deionised water. Comment on this action
12. Why is the potassium iodide solution added in slight excess?

Estimation of the concentration of household bleach

In this task you will measure the relative concentrations of three samples of household bleach. You will do this by adding excess **hydrogen peroxide** to measured samples of household **bleach** and collecting and measuring the volume of oxygen produced. In this way you will measure the **chlorine** content of the different bleaches.

You have been provided with three samples of bleach. Sample A costs 3.50 per L sample B costs 5.00 per L and sample C costs 4.00 per L

Apparatus



1. Use a plastic syringe to measure out 5 cm^3 of the first bleach into well A1 in the comboplate.
2. Set up the apparatus
3. Measure 10 cm^3 hydrogen peroxide solution into a clean plastic syringe, attach it to the bung and gently empty the contents into the flask. Leave the syringe in place.
4. Collect the gas liberated.
5. Continue until no further reaction is seen. Measure and record the final volume.
6. Carefully disconnect the delivery tube from the flask.

7. Repeat the procedure with the other samples of bleach.

Sample	Volume of gas Recorded (cm^3) trial 1
Bleach 1	
Bleach 2	
Bleach 3	

a) Rate the bleaches in order of value for money, with the best value first?
b) What was the independent variable in this investigation?
c) What was the dependent variable
d) Name another variable that you controlled
e) Give your reasons for placing the bleach samples in this order
f) What would you change in this procedure in order to make it a more reliable test?
g) Would you consider this to be a qualitative or quantitative investigation? Give your reasons

Extraction of bromine and testing for unsaturation

A solution of bromine in hexane is used to detect whether an organic compound is unsaturated.

In this task, you will extract elemental bromine into hexane in a plastic pipette. The pipette acts like a separating funnel. The resulting solution is decanted into a well plate and then used to test for unsaturation in a number of organic compounds.

You have been provided with

Potassium bromate 0.1mol/L

Potassium bromide 0.2 mol/L Hydrochloric acid 1 mol/L Hexane 6 Organic liquids labelled A-F	1 plastic well plate (24 well size) 1 Plastic dropping pipette

Procedure:

- Put 10 drops of potassium bromate(V) solution into a well plate
- Add 20 drops of potassium bromide solution
- Add 5 drops of hydrochloric acid
- Leave for 5 minutes for the bromine to form fully

1. Record your observations

_____

_____

- Add the hexane to the well until it is about half full
- Use your plastic pipette. Take up all the liquid into the pipette and invert the pipette. Leave to settle.

2. Record your observations

_____

_____

3. Record the shape of the meniscus at the interface of the two liquids

_____

_____

- Gently flick the bulb of the pipette. This will mix the liquids and allow the bromine to be extracted into the upper hexane layer.

4. Record your observations

_____

_____

- When the upper layer is coloured red-yellow and the lower layer is colourless, your extraction is complete.
- Very carefully invert the pipette again and decant the lower aqueous layer into a well on your well plate
- In another well, decant the upper layer of bromine dissolved in hexane.
- This is the solution you will use to carry out tests for unsaturation

5. Suggest a reason why the red/yellow colour moved from the lower (aqueous) layer to the upper layer.

_____

_____

_____

Testing for unsaturation

You have been supplied with a range of organic chemicals A-F.

If you have no bromine solution from stage 1, ask the invigilator.

Using a plastic pipette, add three drops of the bromine solution you prepared in part 1 to each of the six wells in the well plate.

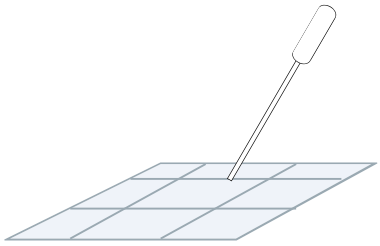
Put three drops of each of the organic liquids under test in the wells and observe any changes. Use your observations to decide if the organic chemical is saturated or unsaturated.

	Observation	**Conclusion**
Chemical A		
Chemical B		
Chemical C		
Chemical D		
Chemical E		

Periodic table- properties of group 2 elements

In this experiment you will be observing and interpreting the changes when drops of solutions of various anions are added to drops of solutions of Group 2 element cations.

Instructions



You have been provided with:

A reaction sheet

A piece of plastic sheet

11 droppers

The following solutions

Group2 cations	**Anions**
Magnesium solution Calcium solution Strontium solution Barium solution	hydroxide solution fluoride solution chloride solution bromide solution iodide solution carbonate solution sulphate solution

1. Put one drop of magnesium solution into each box in the magnesium ions row.
2. Repeat using calcium solution in the next row, then strontium solution in the next row and barium solution in the last row.
3. Add one drop of fluoride solution to each drop in the fluoride ions column.
4. Observe what happens, record your observations.
5. Repeat step 3 using each of the other solutions of anions in the subsequent columns.
6. Observe each reaction carefully and record your observations.

What explanations can you give for your observations? Comment on the trends in the group 2 elements.

Reaction worksheet

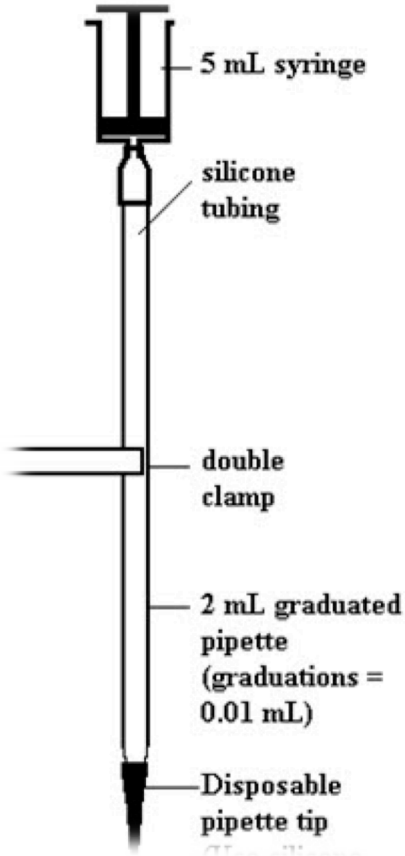
	Fluoride ions	Chloride ions	Bromide ions	Iodide ions	Hydroxide ions	Sulfate ions	Carbonate ions
Magnesium ions							
Calcium ions							
Strontium ions							
Barium ions							

Record your observations on this sheet

	Fluoride ions	Chloride ions	Bromide ions	Iodide ions	Hydroxide ions	Sulfate ions	Carbonate ions
Magnesium ions							
Calcium ions							
Strontium ions							
Barium							

Neutralisation reaction of an acid and a base

In this task you will determine the molarity of a solution of sodium hydroxide by titration with a 1.0 m dm^3 solution of HCl.



Microscale titration apparatus

Hydrochloric acid 0.10 mol dm–3

Sodium hydroxide solution

Phenolphthalein indicator solution.

2 10 cm^3 beakers

To fill the apparatus with dilute hydrochloric acid, place the acid into one of the 10 cm^3 beakers. Place the tip of the burette into the acid and slowly raise the plunger of the syringe. If air bubbles are drawn up, raise and lower the plunger slowly a few times to expel them. When the acid has reached the level you want, let go of the plunger.

Using a 1 cm^3 pipette, add 1 cm^3 of sodium hydroxide solution to a 10 cm^3 beaker.
Add 1 drop of phenolphthalein indicator solution.

Carry out the titration by very gently pressing down the plunger on the syringe at the top of the apparatus.

Continue until the solution in the beaker is just permanently light pink.

Record the volume of hydrochloric acid used in the titration.

Repeat the titration until you get reproducible answers.

Draw a suitable table in the space below and record your data.

Questions

The equation for the neutralisation reaction is:

$$HCl_{(aq)} + NaOH_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$$

From this equation you will see that one mole of hydrochloric acid reacts with one mole of sodium hydroxide

1. Determine the average value of the volume of hydrochloric acid used in your titrations (let this value be v cm^3).

2. Calculate the number of moles of hydrochloric acid used using the formula:

   $\left(\frac{v}{1000}\right) x\ C$ where C is the concentration of the hydrochloric acid (mol/L)

   Moles of HCl used

3. What volume of sodium hydroxide did you use?
4. Concentration of the sodium hydroxide in mol/L
5. Why was it particularly important that you used as little indicator as possible?

21. Identifying alcohols

Illicit Vodka 70cl has been discovered on sale in the UK.

There is a food safety concern in that products sampled by local authorities have identified the presence of Propan-2-ol and other substances that can be potentially damaging to health. Your task is to correctly identify which of the suspect alcohols contains propan-2-ol.

Important functional groups can be distinguished by a reaction called the iodoform reaction. Secondary alcohols give a positive result with this test; this can be used to distinguish secondary alcohols from primary alcohols

Iodoform is a pale yellow, crystalline, volatile substance; it has a penetrating odor (the smell is sometimes referred to as the smell of hospitals). It is occasionally used as a disinfectant.

In the iodoform test, the substance to be tested is mixed with an iodine solution followed by a sodium hydroxide solution. A positive result is the appearance of the distinctively smelling yellow precipitate, iodoform.

Procedure

1. Label a row of wells A, B, C and D
2. Add 25 drops of liquid A into well A
3. Add 25 drops of Iodine solution to well A
4. Add 25 drops of sodium hydroxide solution to well A.
5. Gently swirl the well plate a few times.
6. After 2 minutes, carefully observe the well. Record your observations in Table 2.
7. Repeat this procedure for each of the liquids B, C, and D.
8. Use the information above to record your conclusions in table 2.

Liquid	**Observation**	**Conclusion**
A		
B		
C		
D		

Preparation and testing of ethyne

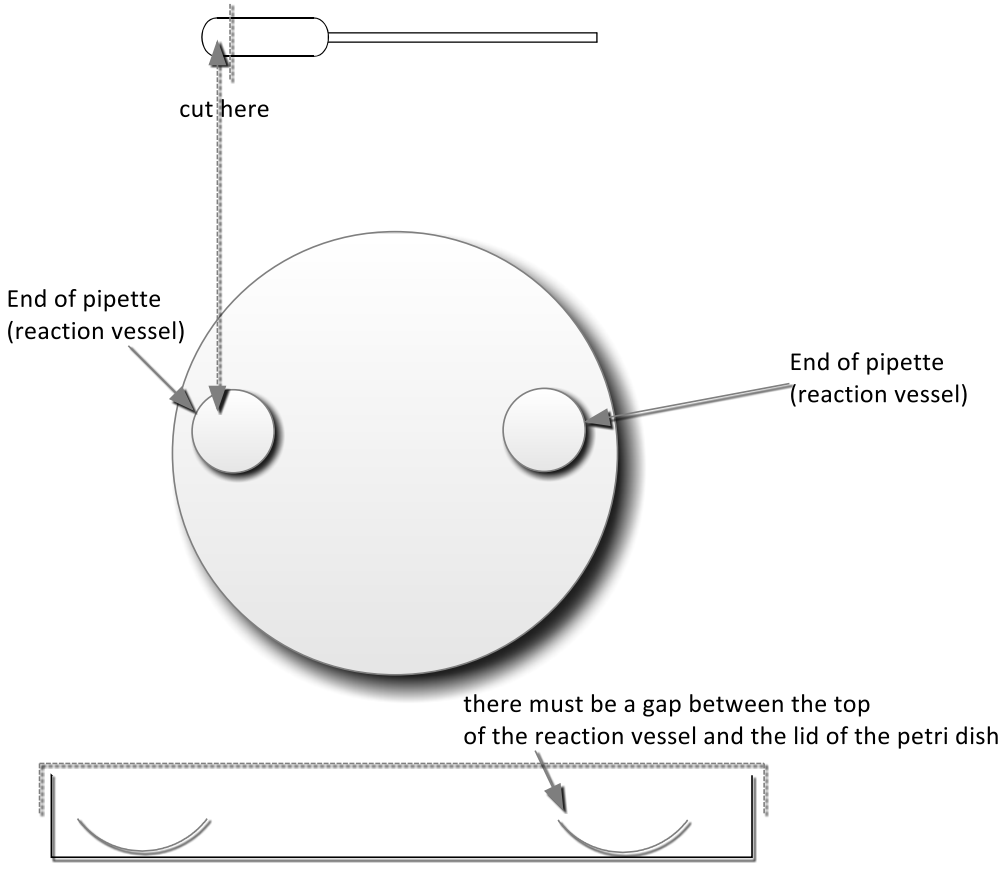
In this task, you will be generating ethyne gas inside a plastic petri dish and testing its properties using a solution of potassium manganate in propanone.

Apparatus

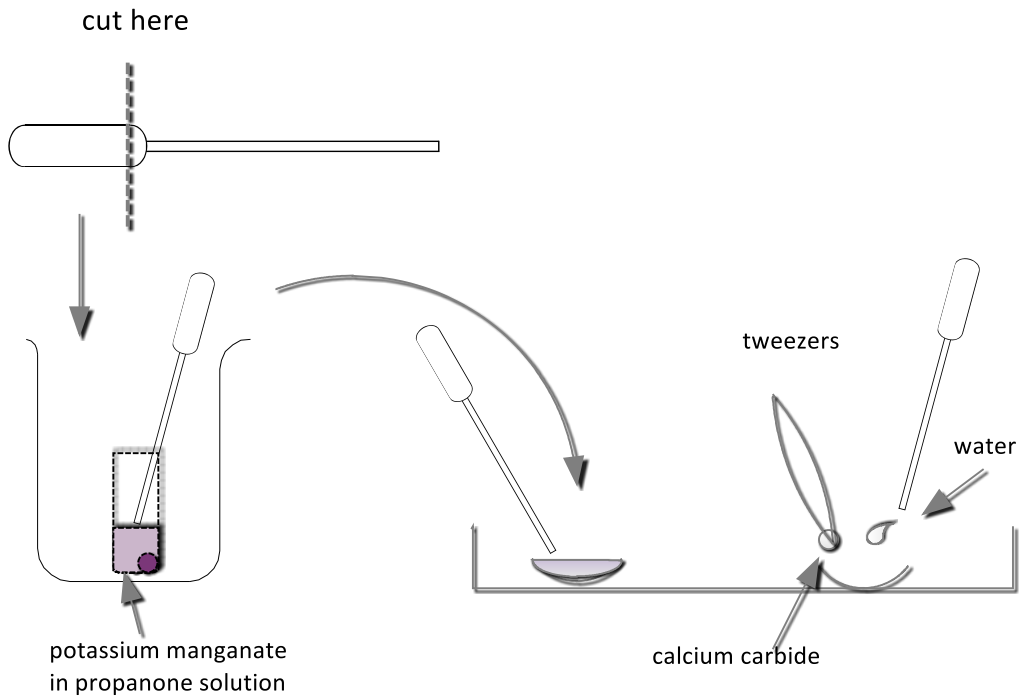
- One clear plastic sheet
- Plastic pipettes
- One plastic petri dish
- One 10 cm^3 beaker
- Scissors
- Tweezers

Instructions

1. Cover the worksheet with a clear plastic sheet.
2. Place the base of the petri dish over the circle below
3. Cut off the ends of two plastic pipettes (as shown below) and place them inside the petri dish as shown.



4. Cut off the bulb of another pipette as shown below, and place in a beaker.



5. Carefully add a few crystals of potassium manganate (VII) to the pipette.
6. Add propanone to the pipette until it is about half-full
7. Using a pipette, add four drops of the potassium manganate (VII) in propanone solution to one of the pipette ends in the petri dish
8. Using tweezers carefully place one small lump of calcium carbide into the other pipette end.
9. Carefully add four drops of deionised water to the calcium carbide, and quickly place the lid on the petri dish.
10. Observe any changes over the next few minutes.
11. When no more gas is formed, add one drop of full range indicator solution to the residue of the calcium carbide and observe

Investigating the effect of concentration on the rate of a chemical reaction

In this task you will investigate the reaction between sodium thiosulphate solution and hydrochloric acid solution which react to produce a fine precipitate of sulphur according to the following equation

$$S_2O_3^{2-}(aq) + 2H^+(aq) \longrightarrow H_2O(l) + SO_2(g) + S(s)$$

You will be varying the concentration of thiosulfate ions and hydrochloric acid to see what effect these have on the rate at which the precipitate of sulphur is formed.

Apparatus

You have been provided with

Sodium thiosulfate 0.1 mol dm^{-3}

Hydrochloric acid 1 mol dm^{-3}

Deionised water

Graph paper

Stopclock

Well-plate

Plastic pipettes

Instructions

Place the well plate onto the grid of crosses that you have been given (see page 4). Ensure that the array of crosses is under wells A1 – A6.

Add drops of the solutions to each of the wells A1 – A6 as follows:

Well no	A1	A2	A3	A4	A5	A6
Drops of hydrochloric acid	20	20	20	20	20	20
Drops of water	25	20	15	10	5	0

Start the stop-clock and add 30 drops of thiosulfate to well A6 and measure the time until you can no longer see the cross under well A6. Record the time taken to obscure the cross in the table below.

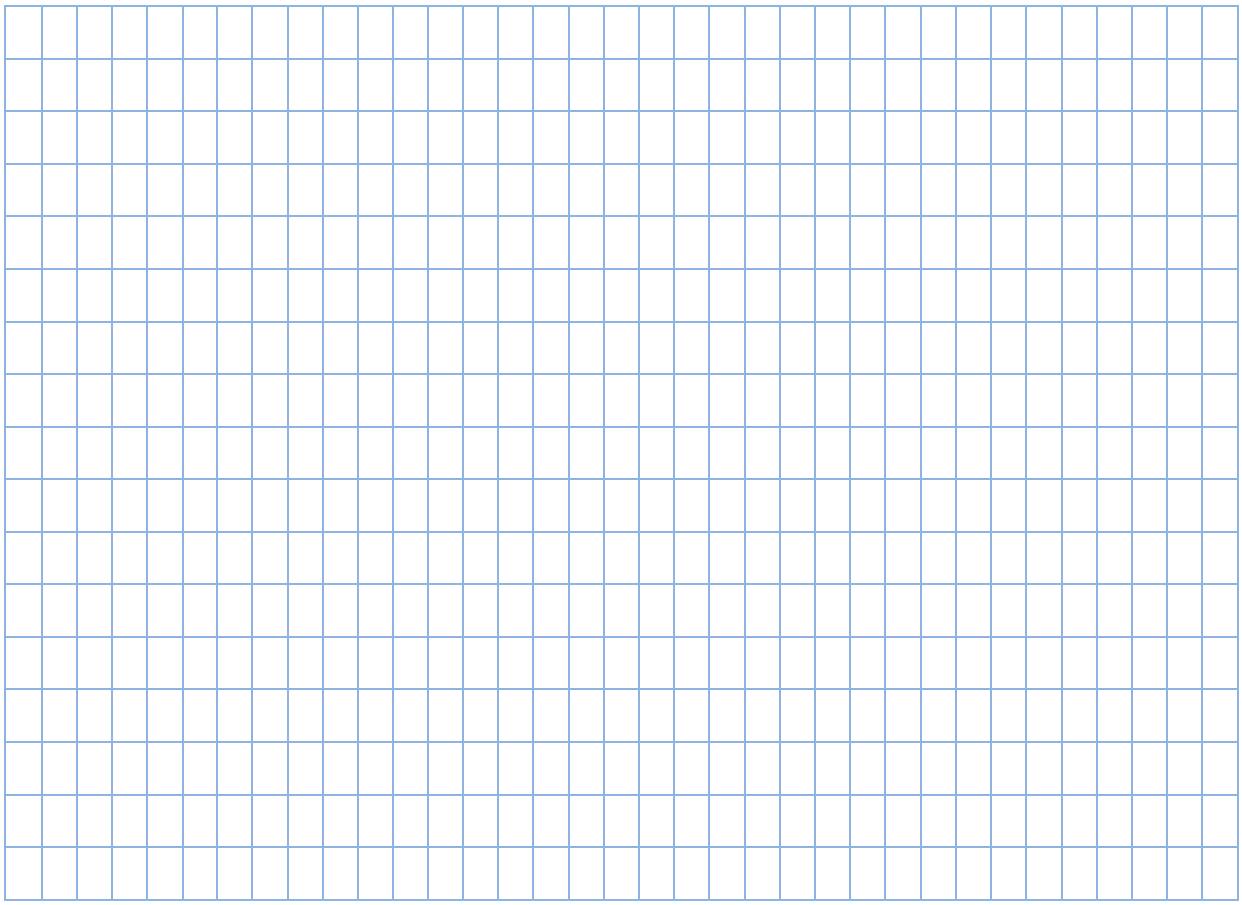
Repeat the procedure with the other wells adding drops of thiosulfate according to the following table:

Well no	A1	A2	A3	A4	A5	A6
Drops of thiosulfate solution	5	10	15	20	25	30

Well no	A1	A2	A3	A4	A5	A6
Concentration (Moles/L) HCl	0.44	0.5	0.57	0.66	0.8	1
Time taken (t)						
Rate $\frac{1}{t}$						

Questions

1. From your results, plot a graph of the concentration of thiosulfate ions in each well against the rate of reaction.



2. What does the shape of the graph tell you about the relationship between the rate of reaction and concentration?

3. What is the independent variable in your investigation?

4. What is the dependent variable in your investigation?

5. What other variables have been controlled?

6. What variables should have been controlled but were not?

7. State, with reasons whether you consider the results to be reliable.

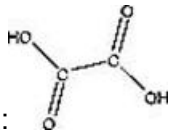
8. State, with reasons whether you consider your conclusion to be valid.

9. State two practical ways in which your investigation could be improved.

Place your-well plate onto the grid below.

X	X	X	X	X	X

Rates of reaction

Ethanedioic acid has the formula $C_2H_2O_4$:  it reacts with potassium permanganate in acidic solutions and is oxidised to carbon dioxide and water:

$$2MnO_4^- + 5C_2H_2O_4 + 6H_3O^+ \rightarrow 2Mn^{2+} + 10CO_2 + 14H_2O$$

Initially the reaction mixture is purple in colour due to the presence of the permanganate ions but it will turn colourless as soon as they are used up. This colour change allows you to follow the course of the reaction.

If t is the time it takes for the colour change to occur then we can take 1/t as a measure of the reaction rate.

You are going to investigate how the rate of this reaction changes when temperature is changed.

You have been provided with

100 cm3 glass beakers (4) selection of syringes - 1 cm^3 (1), 2 cm^3 (1), 5 cm^3 (1), 20 cm^3 (1) white tile (1) timer (1) tripod (1) Bunsen burner (1) heating mat (1) 0 - 100 °C thermometer (1)	0.20 mol/L oxalic acid (4 cm^3) 1.0 mol/L sulphuric acid (20 cm^3) 0.020 mol/L potassium permanganate (8 cm^3) deionised water (160cm^3)

Procedure

1. Using syringes add 5 cm^3 of sulphuric acid, 2 cm^3 of potassium permanganate solution and 40 cm^3 of water to a 100 cm^3 dry glass beaker.
2. Heat the mixture to about 40 °C.
3. Place the beaker on a white tile and measure 1 $cm^3$of oxalic acid solution into a syringe.

4. Add the oxalic acid to the mixture in the beaker as quickly as possible and at the same time start the timer.
5. Gently stir the reaction mixture with the thermometer.
6. When the reaction mixture just turns colourless stop the timer and record the time (in seconds). Measure and record the temperature of the reaction mixture.
7. Repeat the experiment another three times but heat the initial sulphuric acid/potassium permanganate/water mixtures first to 50 °C, then to 60°C and finally to 70 °C
8. In each experiment, measure and record the time it takes for the reaction mixture to just turn colourless and measure and record its temperature when this happens
9. Plot a graph of your results.

Questions

1. Explain why the point at which the colour disappears always represents the same extent of reaction.
2. What variables are kept constant in this reaction?
3. The reaction is autocatalysed by the Mn^{2+} ions. How might this affect the results of the investigations?
4. Complete the following table use correct units

Temperature	Time	Rate

5. Plot a graph of reaction rate ($s^{-}1$) against temperature (^{0}C)
6. Use your graph to predict the rate of reaction at $45^{o}C$
7. Identify two sources of error in this experiment?
8. If you were repeating this experiment, what would you do to minimise these errors?

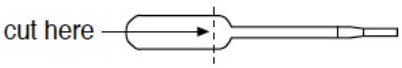
Test for unsaturation

In this task, a solution of potassium permanganate in propanone is used to detect whether an organic compound is unsaturated. The solution mixes easily with non-polar organic compounds such as cyclohexane, cyclohexene and limonene. Unsaturated compounds turn the solution a brownish colour as the manganese(VII) is reduced to manganese(IV) – ie MnO_2.

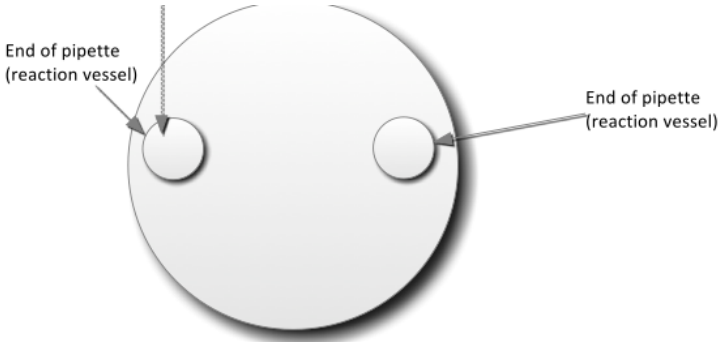
Apparatus	**Chemicals**
Plastic pipettes	Propanone
One plastic petri dish	Potassium permanganate(VII) crystals
One 10 cm^3 beaker	Cyclohexane
Scissors.	Cyclohexene
	Limonene.

Instructions

- Cut the end off a plastic pipette as shown below and place the cup in a beaker



- Carefully add a few crystals of potassium permanganate (VII) to the cup.
- Add propanone to the cup until it is about half-full. You will notice that the potassium permanganate (VII) dissolves to give a purple solution.
- Cut the ends off three pipettes to make small reaction vessels as shown below and place them in the lid of a plastic petri dish.



- Using a plastic pipette, add four drops of the potassium permanganate (VII) in propanone solution to each of the reaction vessels.
- Put three drops of each of the organic liquids under test in the reaction vessel and observe any changes over the next few minutes.

Solution	**Result**
Cyclohexane	
Cyclohexene	
Limonene	

Thermometric titration

Hydrochloric acid is neutralised by sodium hydroxide according to the equation:

$$HCl_{(aq)} + NaOH_{(aq)} \longrightarrow NaCl_{(s)} + H_2O$$

Ethanoic acid is neutralised by sodium hydroxide according to the equation

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

Neutralisation is an exothermic reaction and the maximum temperature is reached at the end-point. In this task, you will titrate hydrochloric acid and ethanoic acid against a standard sodium hydroxide solution.

Apparatus and chemicals

1 x polystyrene cup	200cm^3 1.0M sodium hydroxide solution:
1 x microburette burette and stand	150cm^3 2M approx hydrochloric acid
1 x 25cm^3 pipette	150cm^3 2M approx. ethanoic acid
1 x pipette filler	Universal indicator
1 x plastic filter funnel	
1 x digital thermometer	

Procedure

Part 1 Titration of hydrochloric acid with standard sodium hydroxide solution

Due to time constraints, you will not have time to repeat this titration to average your results.

1. Transfer 50 cm^3 sodium hydroxide solution to a polystyrene cup. Place the polystyrene cup inside a beaker.
2. Allow it to stand for a few minutes, and then record the temperature of the sodium hydroxide solution.
3. Fill the burette to 50cm^3
4. Add 5.00 cm^3 of hydrochloric acid from a burette to the cup
5. Immediately stir the mixture with the thermometer and record the temperature
6. Repeat adding 5cm^3 hydrochloric acid each time, until you have added a total of 50.0cm^3 of acid.
7. Add two drops of universal indicator

8. Record your data in the table below

Results

Data table 1

Volume HCL (cm^3)	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0
Temperature ^0C											
PH of final solution											

Part 2 Titration of ethanoic acid with standard sodium hydroxide solution

Follow the same procedure as above, except use ethanoic acid in the burette. When filling the burette, remember to use correct rinsing procedures.

Record your results in data table 2.

Data table 2

Volume ethanoic acid (cm^3)	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0
Temperature ^0C											
PH of final solution											

On the graph paper provided, plot temperature (y-axis) against volume of acid added (x-axis). Plot both sets of data on the same graph.

1. From the information on the graph, what as the total volume of acid at the end point for
   i. hydrochloric acid ?

   ii. ethanoic acid?

2. At what temperature was the end point reached for
   i. hydrochloric acid ?

   ii. ethanoic acid?

3. Explain any similarities or differences that exist for each acid with reference to both the volume of acid required to reach the end point and the increase in temperature.
4. Comment on your results, their accuracy, and the likely sources of error in the experiment. Outline the limitations of the experiment, and possible improvements to it.

Displacement reactions

In this task you will react some metals with a variety of solutions of metal salts. A more reactive metal will displace a less reactive metal from its salt solution (irrespective of which salt)

You will use your observations to place the metals in order of their reactivity

You have been provided with:

A reaction sheet A clear plastic sheet A magnifying glass	copper sulfate 0.2 mol/L Iron (III) nitrate 0.2 mol/L Magnesium nitrate 0.2 mol/L Zinc chloride 1 mol/L Magnesium ribbon Zinc metal- small granules Iron filings Copper turnings

Procedure

Cover **reaction sheet 1** with the plastic sheet. You will carry out the procedures on the acetate sheet

1. Place a copper turning on each box in the copper row
2. Place a small piece of magnesium in each box in the magnesium row
3. Place a few zinc granules in each box in the zinc row
4. Place some iron filings in each box in the iron row.

When all the pieces of metal are in place:

5. Add two drops of Copper (II) sulfate solution to each metal in the first column. Observe and record your observations
6. Add two drops of magnesium nitrate solution to each metal in the second column. Observe and record your observations
7. Add two drops of zinc chloride to each metal in the third column. Observe and record your observations
8. Add two drops of iron (III) nitrate solution to each metal in the fourth column. Observe and record your observations.

Observations

Record your observations on the following tables

A. Copper- reaction with:

copper (II) sulphate solution	
magnesium nitrate solution	
zinc chloride solution	
iron(III) nitrate solution	

B. Magnesium- reaction with:

copper (II) sulphate solution	
magnesium nitrate solution	
zinc chloride solution	
iron(III) nitrate solution	

C. Zinc- reaction with:

copper (II) sulphate solution	
magnesium nitrate solution	
zinc chloride solution	
iron(III) nitrate solution	

D. Iron - reaction with:

copper (II) sulphate solution	
magnesium nitrate solution	
zinc chloride solution	
iron(III) nitrate solution	

Questions

1. Based on your observations, what is the order of reactivity of the metals?

   _____

   _____

2. Explain your reasoning

   _____

   _____

   _____

Analysis of unknown salts

You will make and record your observations as you carry out anion tests on a number of salt solutions. You will use these observations, along with further tests for positive ions to identify 3 unknown salts.

You have been provided with a number of labelled solutions and some reagents. Follow the instructions on the table to carry out each of the tests and record your observations. You should carry out these tests in the small test tubes provided. Use a clean test-tube each time to avoid contamination. Use a small portion of the test solution each time (no more than 1 cm^3).

Repeat the tests on each of the unknown salts and deduce the anions in your unknown salts

Negative ion	Test	Observations
Cl^- Chloride	Add a few drops of dilute nitric acid, followed by a few drops of silver nitrate solution. Let the mixture stand for a few minutes then add some ammonia solution.	
Br^- Bromide	Add a few drops of dilute nitric acid, followed by a few drops of silver nitrate solution. Let the mixture stand for a few minutes then add some ammonia solution.	
I^- Iodide	Add a few drops of dilute nitric acid, followed by a few drops of silver nitrate solution. Let the mixture stand for a few minutes then add some ammonia solution.	
SO_4^{2-} Sulfate	Add a few drops of barium chloride solution and then a few drops of hydrochloric acid.	
CO_3^{2-} Carbonate	Add the sample to a separate test tube and add a few drops of hydrochloric acid. Bubble the gas given off through limewater (use microscale apparatus)	

Reaction sheet 1

Use this sheet for your reactions. Place the grid under the acetate sheet; the reactions can be carried out on the acetate sheet.

	copper (II) sulphate solution	**magnesium nitrate solution**	**zinc chloride solution**	**iron(III) nitrate solution**
Copper				
Magnesium				
Zinc				
iron				

Notes:

The zinc granules and magnesium ribbon rapidly darken in copper sulphate solution as they become covered with a layer of copper. Iron also reacts but the change is not so clear. Magnesium and zinc react with the iron (III) nitrate, the solution gradually darkens.

No reaction occurs between magnesium sulphate and any of the metals. Students should observe no change between any of the metals and a salt solution of the same metal.

Analysis of unknown salts

You will make and record your observations as you carry out anion tests on a number of salt solutions. You will use these observations, along with further tests for positive ions to identify 3 unknown salts.

You have been provided with a number of labelled solutions and some reagents. Follow the instructions on the table to carry out each of the tests and record your observations. You should carry out these tests in the small test tubes provided. Use a clean test-tube each time to avoid contamination. Use a small portion of the test solution each time (no more than 1 cm^3).

Repeat the tests on each of the unknown salts and deduce the anions in your unknown salts.

Iron by thiocyanate assay

Iron (III) ions in solution react with thiocyanate ions to form an intense red coloured complex ion:

$$Fe^{3+}_{(aq)} + SCN^{-}_{(aq)} \rightarrow [FeSCN]^{2+}_{(aq)}$$

You can use this reaction for the quantitative analysis of low concentrations of $Fe^{3+}_{(aq)}$ in solution.

You can find the concentration of the solution of Fe^{3+} using a colorimeter.

In this task you are going to prepare a calibration curve using solutions of known iron concentration using a colorimeter. You will use this calibration curve to determine the concentration of an unknown iron solution.

You have been provided with

- Graduated pipettes x 3
- 10 cm^3 pipette
- 100 cm^3 beaker x 7
- colorimeter and suitable filter (blue)
- iron(III) ammonium sulfate solution containing 0.050 g/L Fe^{3+} (50 ppm) (15 cm^3)
- ammonium thiocyanate solution, 1 M/L (70 cm^3)
- solution of unknown Fe^{3+} concentration (10 cm^3)

Procedure

1. Fill three burettes, one with the iron (III) solution (50 ppm Fe^{3+}), one with distilled or deionised water and one with 1 M ammonium thiocyanate solution.
2. Label six 50 or 100 cm^3 beakers A to F and use the burettes to add the volumes of solutions shown in the table:

Beaker	**A**	**B**	**C**	**D**	**E**	**F**
Volume of iron(III) solution (50 ppm Fe^{3+}) / cm^3	5.0	4.0	3.0	2.0	1.0	0.0
Volume of water/cm^3	5.0	6.0	7.0	8.0	9.0	10.0
Ppm iron	25	20	15	10	5	0
Absorbance						

3. Add 10.0 cm^3 of 1 M ammonium thiocyanate solution and 10 cm^3 of water to each beaker and stir
4. Using a pipette, add 10 cm^3 of the iron (III) solution of unknown Fe^{3+} concentration to a beaker labeled **X**.
5. Add 10.0 cm^3 of 1 M ammonium thiocyanate solution and 10 cm^3 of water to beaker X and stir

6. While you are waiting for the colour to develop in the beakers, draw a suitable graph to plot absorbance against $Fe^{3+}_{(aq)}$ concentration (in ppm iron) for beakers A-F and beaker X
7. Measure he absorbance of each of the solutions in the beakers A-F and beaker X
8. Plot a graph of absorbance against on your graph
9. Use the graph to find the concentration of $Fe^{3+}_{(aq)}$ as ppm iron in the unknown solution.