General Certificate of Education
Advanced Level Examination
June 2012

Chemistry CHM6X/TN

Unit 6X A2 Externally Marked Practical Assignment

Teachers' Notes Confidential

A copy should be given immediately to the teacher responsible for GCE Chemistry

Open on receipt

Estimated entries must be submitted to AQA in order for centres to receive hard copies of the materials to be used by candidates.

Teachers' Notes

Confidential

These notes must be read in conjunction with the *Instructions for the Administration of the Externally Marked Practical Assignment: GCE Chemistry* published on the AQA Website.

An investigation of rates of reaction

Task 1 The effect of a change in concentration of iodide ions on the reaction between hydrogen peroxide and iodide ions

Materials

Each candidate should have access to the following solutions in burettes for communal use (approximately one set for every five candidates).

Reagents	Concentration / mol dm^{-3}	Volume / cm^3 per candidate	Note
Hydrogen peroxide	0.10	100	Labelled **'Hydrogen peroxide solution'**. A recently purchased solution is recommended.
Sodium thiosulfate	0.05	50	Labelled **'Sodium thiosulfate solution'**.

Each candidate should also be provided with the following solutions in suitable containers for individual use.

Reagents	Concentration / mol dm^{-3}	Volume / cm^3	Note
Potassium iodide	0.10	100	Labelled **'Potassium iodide solution'**.
Starch	Standard indicator	10	Labelled **'Starch solution'**.
Sulfuric acid	0.25	150	Labelled **'Sulfuric acid'**.

General

It is the responsibility of the centre to ensure that the investigation works with the materials provided to the candidates **before** candidates carry out the task.

Spare supplies of all solutions specified in these notes must be available.

Teachers are advised that frequent refilling of the burettes containing hydrogen peroxide and sodium thiosulfate solutions will be required.

Apparatus

Each candidate will also require the following:

Number	Apparatus
1	25 cm^3 pipette
1	50 cm^3 burette
1	burette stand and clamp
1	pipette filler
1	100 cm^3 beaker
1	250 cm^3 beaker
1	plastic dropping pipette with volume graduations
1	25 cm^3 or 50 cm^3 measuring cylinder
1	stirring rod
1	timer
	distilled or deionised water
	paper towels or tissues for drying beaker
	eye protection

Task 2 A study of some catalysts

Materials

Each candidate should have available the following reagents. Individual supplies of all reagents are not essential.

Reagents	Concentration	Quantity per candidate	Note
Hydrogen peroxide	'20 volume'	10 cm^3	Labelled **'Solution A'**.
Manganese(IV) oxide	solid	approx. 0.5 g	Labelled **'Solid B'**.
Potassium iodide	1.0 mol dm^{-3}	10 cm^3	Labelled **'Solution C'**.
Sodium peroxodisulfate(VI)	0.04 mol dm^{-3}	10 cm^3	Labelled **'Solution D'**.
Iron(III) nitrate	0.1 mol dm^{-3}	10 cm^3	Labelled **'Solution E'**.
Sodium thiosulfate	0.1 mol dm^{-3}	10 cm^3	Labelled **'Solution F'**.
Hydrochloric acid	0.1 mol dm^{-3}	10 cm^3	Labelled **'Solution G'**.
Potassium sodium tartrate	solid	approx. 0.6 g	Labelled **'Solid H'**.
Cobalt(II) chloride	0.5 mol dm^{-3}	10 cm^3	Labelled **'Solution J'**.

General

It is the responsibility of the centre to ensure that the investigation works with the materials provided to the candidates **before** candidates carry out the task.

Spare supplies of all solutions specified in these notes must be available.

Turn over ▶

Apparatus

Each candidate will require the following:

Number	Apparatus
4	test tube
1	test tube rack
1	boiling tube
1	small spatula
7	plastic dropping pipette with volume graduations
	distilled or deionised water
1	250 cm^3 beaker
1	holder suitable for a boiling tube
	access to suitable supply of boiling water (eg kettle)
	access to suitable balance (one decimal place is sufficient)
1	weighing boat or similar
	eye protection

Teacher Results

A teacher must carry out the tasks, using similar apparatus and samples of the same stock solutions/chemicals as the candidates, in order to obtain Teacher Results. This must **not** be done in the presence of candidates.

Teacher Results
- are required for both tasks
- are required for each group of candidates
- must be recorded on the Teacher Results Sheets
- are used to assess the accuracy of candidates' results
- must be included with the scripts sent to the examiner.

In order to ensure that each candidate can be matched to the appropriate Teacher Results, teachers must
- complete all details on each Teacher Results Sheet
- ensure that all candidates complete all details on the Candidate Results Sheets, clearly identifying their teaching group and/or teacher.

Centres with more than one teaching set

Centres may wish to divide their candidates into manageable groups and to conduct the tasks at different times.

Assessment Advisers

If you have any queries about the practical work for the EMPA, please contact your Assessment Adviser. Contact details for your Assessment Adviser can be obtained by e-mailing your centre name and number to chemistry-gce@aqa.org.uk

Information to be given to candidates

Candidates **must not** be given information about an EMPA assessment until one week before they attempt Task 1. One week before **Task 1**, candidates should be given the following information.

The aims of these tasks are to investigate rates of reaction and to study some catalysts.

The main areas of the specification in the Written Test include Section 3.4.1 (Kinetics), Section 3.4.5 (Compounds Containing the Carbonyl Group) and Section 3.5.4 (Transition Metals).

There **must** be no further discussion and candidates **must not** be given any further resources to prepare for the assessment.

Teacher Results Sheet for Task 1

Centre Number | | | | | |

Teacher Name ..... Teacher Group .....

Results

Experiment	Volume, V, of potassium iodide solution / cm^3	$\log_{10} V$	Time, t / s	$\log_{10}\left(\frac{1}{t}\right)$
1	5	0.70		
2	10	1.00		
3	15	1.18		
4	20	1.30		
5	25	1.40		

This sheet may be photocopied

Teacher Results Sheet for Task 2

Centre Number | | | | | |

Teacher Name ..... Teacher Group .....

Results

Test 1 (MnO_2 + H_2O_2)	
Test 2 (I^- + $S_2O_8^{2-}$ then Fe^{3+})	
Test 3 ($S_2O_3^{2-}$ + H^+)	
Test 4 ($S_2O_3^{2-}$ + H^+ then Fe^{3+})	
Test 5 (Tartrate + H_2O_2 then Co^{2+})	

This sheet may be photocopied

Turn over ▶

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use
Total Task 1

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Chemistry CHM6X/PM1

Unit 6X A2 Externally Marked Practical Assignment

Task Sheet 1

To be completed before Task Sheet 2

For submission by 15 May 2012

For this paper you must have:
- a ruler
- a calculator.

An investigation of rates of reaction

The study of rates of reaction is an important area of Chemistry. It allows chemists to suggest better ways of performing everyday jobs, particularly in reducing the time taken. We may, for example, be able to speed up the cooking process, produce better cleaning materials and shorten setting times for glues and building materials.

Sometimes, we wish to slow reactions down. This is particularly important in the problem of food spoilage.

Important factors for the study of rates of reaction are temperature, concentration of reagents and catalysts.

Task 1 The effect of a change in concentration of iodide ions on the reaction between hydrogen peroxide and iodide ions

Hydrogen peroxide reacts with iodide ions in the presence of acid to form iodine.

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \longrightarrow I_2(aq) + 2H_2O(l)$$

The initial rate of this reaction is found by measuring the time taken to form sufficient iodine that will react with a fixed amount of thiosulfate ions added to the reaction mixture. The thiosulfate ions react rapidly with the iodine formed and turn them back to iodide ions.

$$2S_2O_3^{2-}(aq) + I_2(aq) \longrightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

When the fixed amount of thiosulfate ions has reacted completely, the iodine is not removed. In the presence of starch, this iodine produces a blue-black complex. The time taken for the blue-black colour to appear can be measured.

By varying the iodide ion concentration, and keeping all other concentrations constant, the order of reaction with respect to iodide ions can be found.

Wear eye protection at all times.

Assume that all solutions are toxic and corrosive.

Procedure

Read all of the following steps.
Design an appropriate results table on your Candidate Results Sheet for Task 1 to record **only** the volume of potassium iodide solution used and the time taken in each experiment.
When carrying out each experiment, it is essential that you complete the steps in the order shown.

1 Transfer 10.0 cm^3 of hydrogen peroxide solution from the burette provided to a clean, dry **100 cm^3** beaker. You will use this in step 6.

2 Using a pipette filler, rinse a 25.0 cm^3 pipette with sulfuric acid. Use this pipette and the pipette filler to transfer 25.0 cm^3 of sulfuric acid to a clean, dry **250 cm^3** beaker.

3 Use a measuring cylinder to place 20 cm^3 of distilled or deionised water into the 250 cm^3 beaker. Use a dropping pipette to add approximately 1 cm^3 of starch solution to this beaker.

4 Rinse a 50.0 cm^3 burette with potassium iodide solution. Fill the burette with potassium iodide solution. Use this burette to add 5.0 cm^3 of potassium iodide solution to the mixture in the 250 cm^3 beaker.

5 Finally, add 5.0 cm^3 of sodium thiosulfate solution from the burette provided to the mixture in the 250 cm^3 beaker. Make sure this sodium thiosulfate solution is added last.

6 Stir the mixture in the 250 cm^3 beaker. Pour the hydrogen peroxide solution from the 100 cm^3 beaker into the 250 cm^3 beaker and **immediately** start the timer.
Stir the mixture.

7 Stop timing when the mixture in the 250 cm^3 beaker turns blue-black. Record the time to an appropriate precision. This experiment could take several minutes.

8 Rinse the 250 cm^3 beaker with distilled or deionised water and dry it with a paper towel.

9 Repeat steps 1 to 8 in four further experiments but change the volumes of the water and the potassium iodide solution in the 250 cm^3 beaker as shown in the following table.
The volumes of the solutions of hydrogen peroxide, sulfuric acid, starch and sodium thiosulfate should be the same as in the first experiment.

Experiment	Water / cm^3	Potassium iodide solution / cm^3
2	15	10.0
3	10	15.0
4	5	20.0
5	0	25.0

You are not required to do any calculations in this Task. You will use your results in **Section A** of the Written Test.

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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Total Task 2

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Chemistry CHM6X/PM2

Unit 6X A2 Externally Marked Practical Assignment

Task Sheet 2

To be completed before the EMPA Written Test

For submission by 15 May 2012

For this paper you must have:
- a ruler
- a calculator.

Task 2 A study of some catalysts

Catalysts are used to speed up reactions. In this Task you will investigate a number of catalysed reactions.

Procedure

- **Wear eye protection at all times.**
- **Assume that all solutions are toxic and corrosive.**

Read all five tests detailed below. Design a table to record your observations on the Candidate Results Sheet for Task 2.

Carry out the following tests in separate, clean test tubes. Record **all** your observations.

Test 1

- Place a 2 cm depth of solution **A** in a test tube. Add one small spatula load of solid catalyst **B** to the test tube.
- Leave the mixture to stand for a few minutes.

Test 2

- Place a 2 cm depth of solution **C** and a 2 cm depth of solution **D** in a test tube.
- Add 3 drops of catalyst solution **E** to the test tube.

Test 3

- Place a 2 cm depth of solution **F** and a 2 cm depth of solution **G** in a test tube.
- Leave the mixture to stand for a few minutes.

Test 4

- Place a 2 cm depth of solution **F** and a 2 cm depth of solution **G** in a test tube. Add 3 drops of catalyst solution **E** to the test tube.
- Leave the mixture to stand for a few minutes.

Test 5

- Weigh out approximately 0.5 g of solid **H** and place this in a clean **boiling tube**. Add a 2 cm depth of distilled or deionised water to the boiling tube.
- Using a test tube holder, heat the mixture by placing the boiling tube in a 250 cm^3 beaker containing approximately 150 cm^3 of water that has just been boiled. Leave the boiling tube in the hot water for approximately one minute.
- Add a 2 cm depth of solution **A** to the boiling tube and warm again in the beaker of hot water for approximately one minute.
- Remove the boiling tube from the hot water.
- Use another dropping pipette to add 5 drops of catalyst solution **J** to the boiling tube. Shake the tube to mix the liquids.
- Replace the boiling tube in the beaker of hot water and leave the mixture to stand for approximately one minute.

You are not required to do any further work in this Task.

You will use your observations to answer the questions in **Section A** of the Written Test.

Centre Number						Candidate Number				
Surname						Other Names				

Notice to Candidate. The work you submit for assessment must be your own. If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified.

Candidate Declaration. I have read and understood the Notice to Candidate and can confirm that I have produced the attached work without assistance other than that which is acceptable under the scheme of assessment.

Candidate Signature		Date	

For Examiner's Use Total EMPA mark	
Examiner's Initials	
Section	Mark
Task 1	
Task 2	
Section A	
Section B	
Section C	
TOTAL EMPA MARK	

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Chemistry CHM6X

Unit 6X A2 Externally Marked Practical Assignment

Written Test

For submission by 15 May 2012

For this paper you must have:
- the Periodic Table/Data Sheet provided as an insert (enclosed)
- your Task Sheets 1 and 2, including your own Candidate Results Sheets
- a ruler with millimetre measurements
- a calculator

Time allowed
- 1 hour 20 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 36.
- You will be marked on your ability to:
  – organise information clearly
  – use scientific terminology accurately.

Details of additional assistance (if any). Did the candidate receive any help or information in the production of this work? If you answer yes give the details below or on a separate page.

Yes ☐ No ☐

Teacher Declaration:
I confirm that the candidate has met the requirements of the practical skills verification (PSV) in accordance with the instructions and criteria in section 3.8 of the specification.

Practical Skills Verification	**Yes** ☐

Signature of teacher ..... Date .....

Section A

These questions are about the tasks, an investigation of rates of reaction and a study of some catalysts.

Use your Task Sheets 1 and 2, including your own Candidate Results Sheets, to answer them.

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

1 Use your results from Task 1 on your Candidate Results Sheet to complete the **Time** column in the following table.

Calculate values for the columns headed $\log_{10} V$ and $\log_{10}\left(\frac{1}{t}\right)$.

Give your values to 3 significant figures.

Experiment	Volume, V, of potassium iodide solution / cm^3	$\log_{10} V$	Time, t / s	$\log_{10}\left(\frac{1}{t}\right)$
1	5			
2	10			
3	15			
4	20			
5	25			

2 A graph of $\log_{10}\left(\frac{1}{t}\right)$ against $\log_{10} V$ should give a straight line. The order of the reaction with respect to iodide ions is equal to the gradient of this line.

2 (a) Plot a graph of $\log_{10}\left(\frac{1}{t}\right)$ on the *y*-axis against $\log_{10} V$ on the grid opposite.

Label the axes. Draw a best-fit straight line through the points.

2 (b) Use your graph to determine the gradient of the straight line that you have drawn.
Give your answer to two decimal places.
Show your working.

2 (c) Use your graph to deduce the time, t, value that would be expected for a similar experiment in which the volume of potassium iodide solution was 17 cm^3 and the volume of water was 8 cm^3.

3 In **Test 1** of **Task 2**, the black insoluble solid is a catalyst in the reaction. Other than by investigating the rate of reaction, suggest what practical steps you could take in the test to show that this solid is a catalyst.

4 In **Test 2** of **Task 2**, iodide ions and peroxodisulfate(VI) ions ($S_2O_8^{2-}$) are helped to react by the addition of solution **E** containing iron(III) nitrate.
Suggest **one** other reagent, not containing iron(III) ions, that could have been used in solution **E**.

5 Thiosulfate ions ($S_2O_3^{2-}$) react slowly with H^+ ions in **Test 3** of **Task 2**.
The products of the reaction include the gas SO_2 and a solid.
By balancing the equation for the reaction, or otherwise, identify the solid produced by the reaction.

6 The catalyst used in **Test 5** of **Task 2** is a solution of cobalt(II) chloride. Catalytic activity due to variable oxidation states is one of the typical properties of transition metals. Give **one** observation that suggests that the oxidation state of cobalt has changed during this reaction.

Section B

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

7 The experiment in **Task 1** was designed to allow you to determine the order of reaction with respect to iodide ions in the reaction below.

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \longrightarrow I_2(aq) + 2H_2O(l)$$

Outline the changes that you would make to the task so that the order of reaction with respect to hydrogen peroxide could be determined.

8 (a) The reaction between hydrogen peroxide and iodide ions in acidic solution is first order with respect to hydrogen peroxide. In an experiment to determine the order of this reaction a value of 0.963 was obtained.
Calculate the percentage error in this result.

8 (b) The experimental error resulting from the use of the apparatus was determined to be 2.1%. Explain what this means in relation to the practical technique used.

9 A proposed mechanism for the reaction between iodide ions and acidified hydrogen peroxide is given below.

$$H_2O_2(aq) + I^-(aq) \longrightarrow IO^-(aq) + H_2O(l) \quad \text{slow}$$

$$IO^-(aq) + H^+(aq) \longrightarrow HOI(aq) \quad \text{fast}$$

$$HOI(aq) + I^-(aq) + H^+(aq) \longrightarrow I_2(aq) + H_2O(l) \quad \text{fast}$$

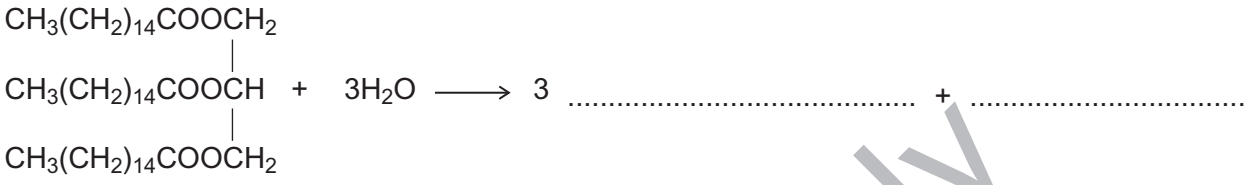
9 (a) Use this mechanism to deduce the order of the overall reaction with respect to hydrogen ions, $H^+(aq)$.

9 (b) **Task 1** was redesigned to determine the order of reaction with respect to hydrogen ions, $H^+(aq)$.

Sketch the graph of $\log_{10}\left(\frac{1}{t}\right)$ against $\log_{10}$(volume of acid) you would expect to be produced.

10 The slowing down of chemical processes is important in food storage. Over time, fats may become rancid. This involves the formation of compounds that have unpleasant odours and flavours within the food.
Hydrolysis of fats is one way in which rancid flavours are formed. Fats break down to long-chain carboxylic (fatty) acids and glycerol.

10 (a) Complete the right-hand side of the equation below to show how hydrolysis affects the molecule of fat shown.



10 (b) Other than by cooling, suggest **one** method that would decrease the rate of hydrolysis of fats.

10 (c) Food can also acquire unpleasant flavours when the fatty acids, produced by hydrolysis of fats, are oxidised by air. This oxidation occurs by a free-radical mechanism.
Chemicals called anti-oxidants can be added to food to slow down the oxidation.
Suggest why anti-oxidants are **not** regarded as catalysts.

10 (d) A student investigated the extent of hydrolysis in an old sample of the fat in part **10 (a)**.
The carboxylic acid extracted from a 2.78 g sample of this fat (M_r = 806.0) reacted with 24.5 cm^3 of a 0.150 mol dm^{-3} solution of NaOH.
Calculate the percentage of the fat that had hydrolysed.
Show your working.

Section C

These questions test your understanding of the skills and techniques you have acquired during your A-level course.

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

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11 When using potassium manganate(VII) in redox titrations with iron(II) ions it is essential that the reaction mixture is acidified. Normally, dilute sulfuric acid is used.

11 (a) State why an excess of hydrogen ions is added to the reaction mixture.

11 (b) State why the acid used must **not** be ethanoic acid.

11 (c) Explain why an indicator is **not** needed in this redox titration.

12 A student prepared a sample of aspirin (melting point 135 °C) in the laboratory and attempted to purify it by recrystallisation. To check the purity of the aspirin the student determined its melting point.

12 (a) State **two** observations, during this melting point determination, that would indicate that the sample is **not** pure.

12 (b) Suggest why a pure sample of aspirin may sometimes appear to melt at a temperature different from 135 °C.