General Certificate of Education
Advanced Subsidiary Examination
June 2012

Chemistry CHM3X/TN

Unit 3X AS 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 the 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.

The investigation of a hand-warmer

Task 1 Determination of the concentration of hydrochloric acid

Materials

Each candidate should be provided with the following reagents in suitable closed containers.

Reagents	Concentration / mol dm^{-3}	Volume / cm^3	Note
Hydrochloric acid	between 0.095 and 0.105	200	Labelled '**Hydrochloric acid for Task 1**'
Sodium hydroxide solution	0.100	150	Labelled '**Sodium hydroxide solution for Task 1**'
Phenolphthalein	Standard indicator		Labelled '**Phenolphthalein**' Individual supply not required

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.

Apparatus

Each candidate will require the following:

Number	Apparatus
1	50 cm^3 burette and stand
1	funnel suitable for filling a burette
1	25 cm^3 pipette
1	pipette filler
1	250 cm^3 conical flask
1	dropping pipette
	a plentiful supply of distilled or deionised water
	eye protection

Checking the burette reading

In the Task, candidates are instructed to have one of their final burette readings checked by their teacher. If the candidate has not read the burette correctly, the teacher must tell the candidate the correct reading. This is to ensure that a candidate does not lose several accuracy marks because of an incorrect reading.

Task 2 Determination of the enthalpy change of neutralisation between hydrochloric acid and sodium hydroxide

Materials

Each candidate should be provided with the following reagents in suitable closed containers.

Reagents	Concentration / mol dm^{-3}	Volume / cm^3	Note
Hydrochloric acid	between 0.95 and 1.05	50	Labelled '**Hydrochloric acid for Task 2**'
Sodium hydroxide solution	1.00	50	Labelled '**Sodium hydroxide solution for Task 2**'

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. The temperature rise in this task should be in the range 5−10 °C.

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

Apparatus

Each candidate will require the following:

Number	Apparatus
1	50 cm^3 burette
1	funnel suitable for filling a burette
1	25 cm^3 pipette
1	pipette filler
2	polystyrene cup
1	beaker suitable for holding a polystyrene cup
1	thermometer (able to read to 0.1 °C - not a digital thermometer)
1	clamp and stand for burette then thermometer
1	stirrer
1	timer
	paper towels or tissues for drying thermometer
	a plentiful supply of distilled or deionised water
	eye protection

Checking the thermometer reading

In step 3 of Task 2, candidates are instructed to ask their teacher to check one of their temperature readings. If a candidate does not read the thermometer correctly the teacher must tell the candidate the correct reading. There is no penalty for an incorrect reading. The centre is not required to inform AQA of an incorrect reading.

Teacher Results

A teacher must carry out both 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. Centres should slightly vary the concentrations of the hydrochloric acid used between different teaching groups.

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 determine the concentration of hydrochloric acid by titration and to determine the enthalpy of neutralisation for the reaction between hydrochloric acid and sodium hydroxide.

The main areas of the specification in the Written Test include Section 3.1.2 (Amount of Substance), Section 3.2.1 (Energetics) and Section 3.2.10 (Alcohols).

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

Record your titration results in the table below.

Final burette reading / cm^3				
Initial burette reading / cm^3				
Titre / cm^3				
Tick the titres to be used for concordancy				

Average titre / cm^3	

This sheet may be photocopied

Teacher Results Sheet for Task 2

Centre Number | | | | | |

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

Results

Initial temperature of the hydrochloric acid / °C	

Time / min	0	1	2	3	4	5	6	7	8	9	10
Temperature / °C											

This sheet may be photocopied

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use
Total Task 1

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Chemistry CHM3X/PM1

Unit 3X AS 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.

The investigation of a hand-warmer

Hand-warmers are small packets containing chemicals that produce heat. The heat produced can be used to keep hands and feet warm. Some types of hand-warmer provide soothing heat for pain in muscles and joints. Depending on the type and the source of heat, hand-warmers can stay warm for between 30 minutes and 24 hours.

A student decided to investigate whether two common laboratory chemicals, hydrochloric acid and sodium hydroxide, would be suitable as components in a commercial hand-warmer. The first steps in the investigation were to determine a suitable concentration for hydrochloric acid and then determine the amount of heat released.

Task 1 Determination of the concentration of hydrochloric acid

The laboratory has a sample of approximately 1 mol dm^{-3} hydrochloric acid. This has been diluted to give a solution that is approximately 0.1 mol dm^{-3}. You are to titrate this diluted solution with 0.100 mol dm^{-3} sodium hydroxide solution.

Procedure

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

1 Rinse a burette with the hydrochloric acid provided. Set up the burette and use a funnel to fill it with this hydrochloric acid. Record your initial burette reading in a table of your own design on the Candidate Results Sheet for Task 1.

2 Use a pipette filler to rinse a pipette with the sodium hydroxide solution. Use this pipette to transfer 25.0 cm^3 of the sodium hydroxide solution to a 250 cm^3 conical flask.

3 Add 2 or 3 drops of the phenolphthalein indicator to the conical flask. The solution should be pink.

4 Add hydrochloric acid from the burette until the mixture in the conical flask just becomes colourless. Record your final burette reading in your table.

5 Rinse the conical flask with distilled or deionised water. Repeat the titration until you obtain **two** titres that are within 0.10 cm^3 of each other.
You should do no more than five titrations.

Have one of your final burette readings checked by your teacher.

6 Calculate and record the average titre on the Candidate Results Sheet for Task 1.
Show clearly the titres that you used in calculating the average titre.

You are not required to carry out any further calculations.
You will use your results to determine the concentration of the hydrochloric acid in **Section A** of the Written Test.

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use
Total Task 2

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Chemistry CHM3X/PM2

Unit 3X AS 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 Determination of the enthalpy change of neutralisation for the reaction between hydrochloric acid and sodium hydroxide

After the titration of hydrochloric acid in Task 1, the student then determined a value for the enthalpy change of neutralisation for the reaction between hydrochloric acid and sodium hydroxide solution. These results allowed the student to make predictions about the suitability of using this reaction in a commercial hand-warmer.

To check the student's results, you will use 1.00 mol dm^{-3} hydrochloric acid together with 1.00 mol dm^{-3} sodium hydroxide solution.

Procedure

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

Read all the instructions below carefully so that you can design your results table before starting the Task.

1 Rinse a burette with the 1.00 mol dm^{-3} hydrochloric acid. Set up the burette and use a funnel to fill it with this hydrochloric acid.

2 Use this burette to transfer 25.0 cm^3 of the hydrochloric acid into a clean, dry, plastic cup.

3 Measure the initial temperature of the hydrochloric acid in the cup to one decimal place. Record your result in the box on the Candidate Results Sheet for Task 2.

Have one of your temperature readings checked by your teacher at some stage in the Task.

4 Wash the thermometer with distilled or deionised water and dry it.

5 Use a pipette filler to rinse a pipette with the 1.00 mol dm^{-3} sodium hydroxide solution provided. Use this pipette to transfer 25.0 cm^3 of the sodium hydroxide solution into a second clean, dry, plastic cup.

6 Place this second plastic cup containing the sodium hydroxide solution in a beaker to provide support and additional insulation. Mount the thermometer in the cup using a clamp and stand. Make sure that the bulb of the thermometer is completely immersed in the solution. Place a stirrer in the cup.

7 Stir the sodium hydroxide solution in the cup and measure the temperature to one decimal place. Start the timer. Record this temperature in a table you have designed on the Candidate Results Sheet for Task 2. This will be the temperature at zero minutes.

8 Take further temperature readings at one, two and three minutes. Make sure that the mixture is well stirred before taking a reading. Record these temperatures in your table.

9 At the fourth minute, add all the hydrochloric acid from the first plastic cup. Stir the mixture well but do not record the temperature at the fourth minute.

10 Continue to stir the mixture and measure the temperature at the fifth minute. Continue to stir the mixture and measure the temperature each minute up to and including the tenth minute. Record the temperatures in your table.

You are not required to complete any calculations in this Task. You will use the results from Tasks 1 and 2 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 CHM3X

Unit 3X AS Externally Marked Practical Assignment

Written Test

For submission by 15 May 2012

For this paper you must have:	**Time allowed**
• 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.	• 1 hour 20 minutes
Instructions	**Information**
• 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.	• 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 .....

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Section A

These questions are about the tasks, the investigation of a hand-warmer.

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

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

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1 Record the average titre from your Candidate Results Sheet for **Task 1**. Give your answer to the appropriate precision.

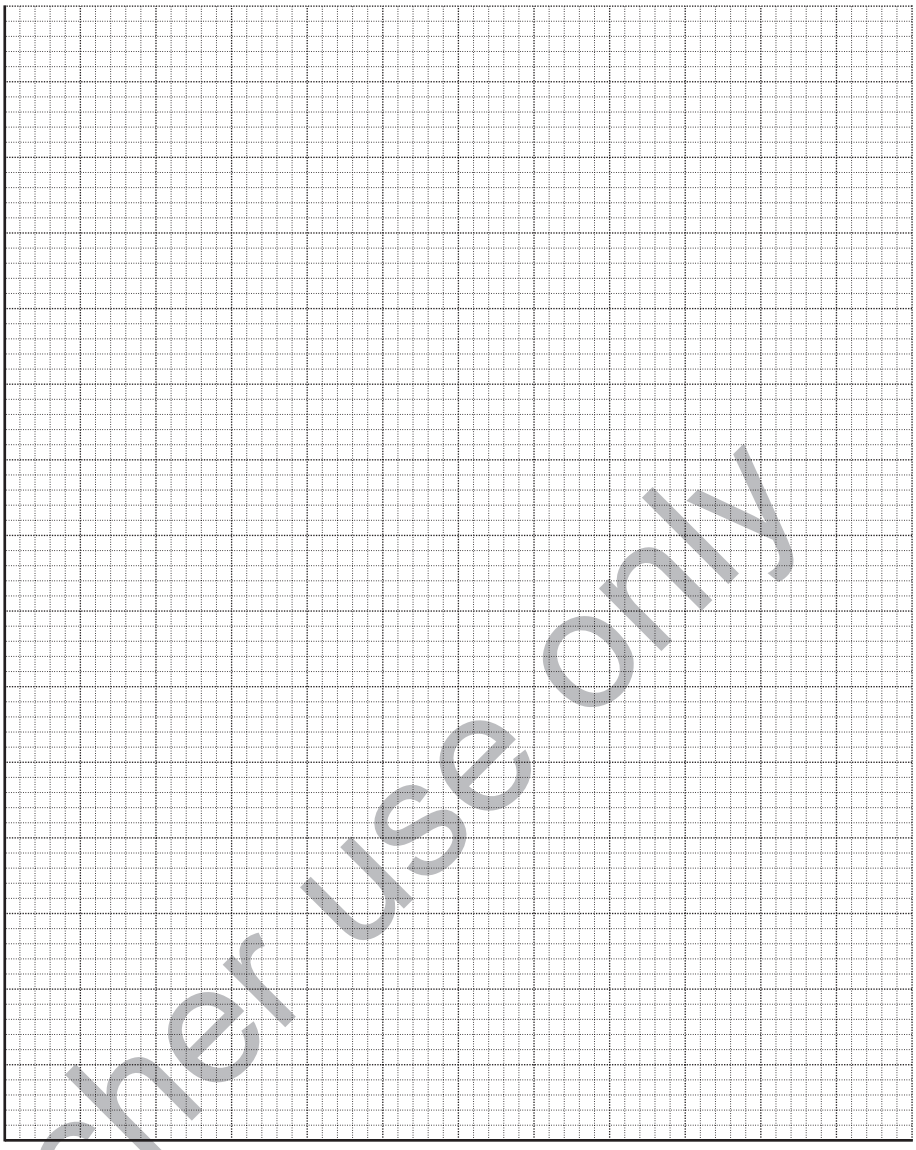
2 The concentration of the sodium hydroxide solution was 0.100 mol dm^{-3}.
Use your answer from Question **1** to calculate the concentration, in mol dm^{-3}, of the diluted hydrochloric acid used in **Task 1**.

3 Use your results from **Task 2** to plot a graph of temperature against time on the grid opposite. Draw a line of best fit for the points before the fourth minute.
Draw a line of best fit for the points after the fourth minute.
Extrapolate both lines to the fourth minute.

4 (a) Use your graph and the initial temperature of the hydrochloric acid that you have recorded on your Candidate Results Sheet for **Task 2** to determine an accurate value for the average temperature of the reagents at the fourth minute (**before** mixing).

4 (b) Use your graph to determine an accurate value for the temperature of the reaction mixture at the fourth minute (**after** mixing).

4 (c) Use your answers to parts **(a)** and **(b)** to determine an accurate value for the temperature rise at the fourth minute. Give your answer to the appropriate precision.



5 Use your answer from Question **4 (c)** to calculate the heat energy given out during your experiment. Assume that the reaction mixture has a density of 1.00 g cm^{-3} and a specific heat capacity of 4.18 J K^{-1} g^{-1}.
Assume that all of the heat energy given out is used to heat the reaction mixture.
Show your working.

6 In your experiment 25.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid were neutralised by 25.0 cm^3 of 1.00 mol dm^{-3} sodium hydroxide solution.
Use your answer to Question **5** to calculate a value, in kJ mol^{-1}, for the enthalpy change of neutralisation of hydrochloric acid by sodium hydroxide.
(If you could not complete the calculation in Question **5** assume that the heat energy given out was 1560 J. This is **not** the correct answer.)
Show your working.

Turn over ▶

Section B

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

Introduction

Another student carried out **Tasks 1** and **2** and calculated that the value for the enthalpy change of neutralisation was −51.2 kJ mol^{-1}.

The design of a possible hand-warmer using hydrochloric acid and sodium hydroxide was discussed. It was proposed that 500 cm^3 of hydrochloric acid should be used in a flexible, sealed plastic container with a breakable tube of solid sodium hydroxide also in the container. On breaking the tube, the sodium hydroxide would be released, react with the acid and produce heat. A 40 °C temperature rise was thought to be suitable.

7 Calculate the heat energy, in J, required to raise the temperature of the reaction mixture by 40 °C. Assume that the reaction mixture has a density of 1.00 g cm^{-3} and a specific heat capacity of 4.18 J K^{-1} g^{-1}.
Assume that all of the heat energy given out is used to heat the reaction mixture.

8 Use your answer from Question **7** and the value for the enthalpy change of neutralisation of −51.2 kJ mol^{-1} to calculate the minimum amount, in moles, and hence the minimum mass of sodium hydroxide required in the breakable tube.
(If you could not complete the calculation in Question **7** assume that the heat energy required was 77 400 J. This is **not** the correct answer).

Show your working.

9 Use the amount, in moles, of sodium hydroxide from Question **8** to calculate the minimum concentration, in mol dm^{-3}, of hydrochloric acid required in the 500 cm^3 of solution used in the sealed container.

10 Suggest **one** possible risk to a person who uses a hand-warmer containing sodium hydroxide and hydrochloric acid.

11 A commercial hand-warmer uses powdered iron sealed in a plastic container.
A valve allows air to enter the container, and oxygen in the air reacts slowly with the iron to form solid iron(III) oxide. The heat released warms the container.

11 (a) Write an equation for this reaction between iron and oxygen to form iron(III) oxide.

11 (b) One version of an iron-oxygen hand-warmer advertises that it is designed to stay warm for up to four hours.
Other than by increasing the amount of iron in the container, state **one** change to the iron in the hand-warmer that would increase this time.
Explain why this change to the iron might **not** be an advantage.

12 Another type of hand-warmer uses sodium thiosulfate. Sodium thiosulfate is very soluble in water at 80 °C but is much less soluble at room temperature.
When a hot, concentrated solution of sodium thiosulfate is cooled it does not immediately crystallise. The sodium thiosulfate stays dissolved as a stable 'super-saturated' solution until crystallisation is triggered.
Heat energy is then released when the sodium thiosulfate crystallises.

12 (a) This type of hand-warmer is re-usable.
Suggest **one** environmental advantage that a sodium thiosulfate hand-warmer has over the other two types.

12 (b) Describe the **two** steps that you would take to make the sodium thiosulfate hand-warmer ready for re-use.

Section C

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

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

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13 The following instructions are from an experimental procedure for the preparation of cyclohexene from cyclohexanol and concentrated phosphoric acid.
Read these instructions and answer the questions that follow.

1 Place 25 cm^3 of cyclohexanol into a round-bottomed flask with some porous pot to act as anti-bumping granules. Add 10 cm^3 of concentrated phosphoric acid carefully while shaking the flask. Cool the flask under the tap if it gets too hot. Make sure the reagents are thoroughly mixed.

2 Set up an apparatus for simple distillation using this flask.

3 Warm the flask, gently at first, for about 15 minutes. Then increase the heating so that cyclohexene begins to distil over. Collect the fraction that distils below 95 °C.

13 (a) State the purpose of the anti-bumping granules.

13 (b) Name the part of the distillation apparatus where cyclohexene vapour is changed back into a liquid.
Draw a simple diagram of this part of the apparatus.

14 Some alcohols can be oxidised by an acidified solution of potassium dichromate(VI). Aldehydes can be oxidised by Tollens' reagent or by Fehling's solution.

An unknown pure liquid **A** contains only a single alcohol.
Outline a simple procedure to allow you to determine whether **A** is a primary, a secondary or a tertiary alcohol.