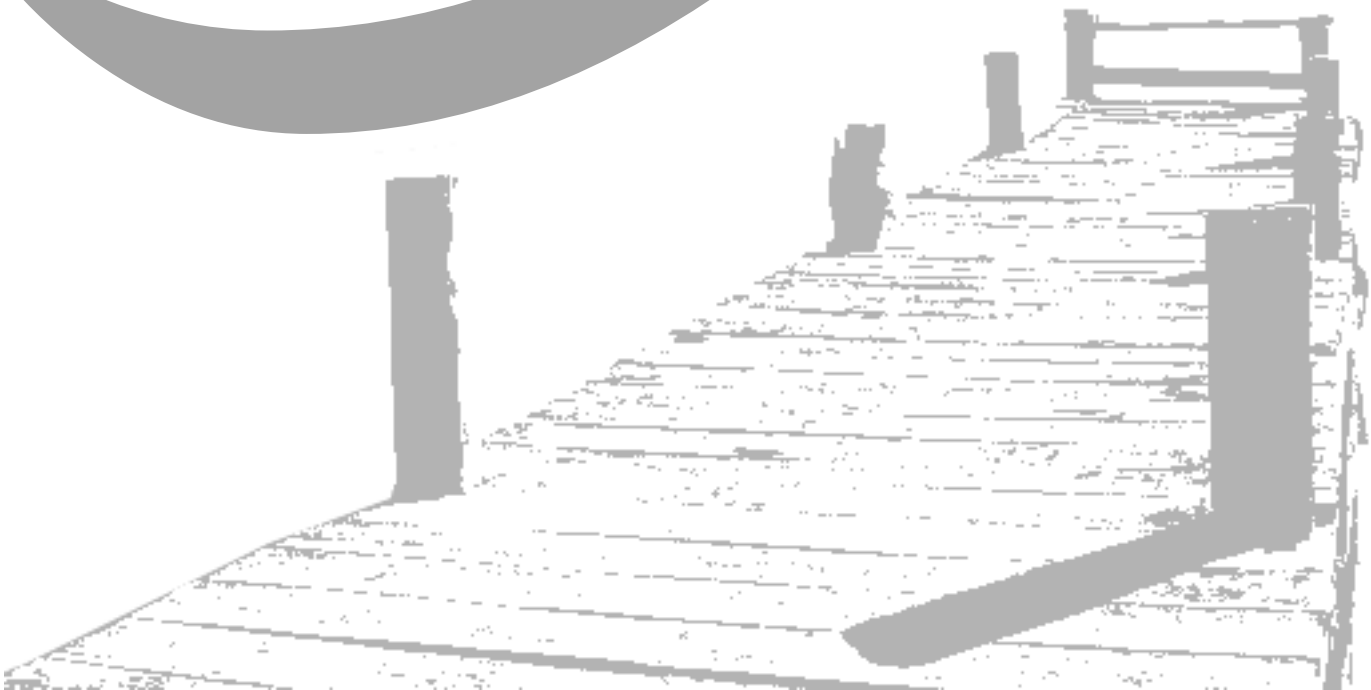
GCE
AS and A Level

Chemistry

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 3X: EMPA
Specimen question paper

Version 1.0



Surname					Other Names					
Centre Number						Candidate Number				
Candidate Signature										

General Certificate of Education
Advanced Subsidiary Examination

AQA
ASSESSMENT and QUALIFICATIONS ALLIANCE

CHEMISTRY 1421/1421 CHM3X
Externally Marked Practical Assignment (EMPA)
Board Assessed Unit

Specimen Paper

In addition to this paper you will require
- task sheets and your Candidate Results Sheets

You may use a calculator.

Time allowed: 1 hour 20 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 40.
- The marks for questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.
- Use accurate scientific terminology in all answers.

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1.0 **H** hydrogen 1										(18) 4.0 **He** helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 **Li** lithium 3	9.0 **Be** beryllium 4		relative atomic mass **atomic symbol** name atomic (proton) number									10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	95.9 **Mo** molybdenum 42	[98] **Tc** technetium 43	101.1 **Ru** ruthenium 44	102.9 **Rh** rhodium 45	106.4 **Pd** palladium 46	107.9 **Ag** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La*** lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

**** The Lanthanides (atomic numbers 58-71) and the Actinides(atomic numbers 90-103) have been omitted.***

Gas constant R = 8.31 J K–1 mol–1

Table 1
Proton n.m.r chemical shift data

Type of proton	**δ/ppm**
RCH_3	0.7–1.2
R_2CH_2	1.2–1.4
R_3CH	1.4–1.6
$RCOCH_3$	2.1–2.6
$ROCH_3$	3.1–3.9
$RCOOCH_3$	3.7–4.1
ROH	0.5–5.0

Table 2
Infra-red absorption data

Bond	**Wavenumber/cm^{-1}**
C—H	2850–3300
C—C	750–1100
C═C	1620–1680
C═O	1680–1750
C—O	1000–1300
O—H (alcohols)	3230–3550
O—H (acids)	2500–3000

SECTION A

These questions are about the task, an investigation of a varnish remover
You should use your task sheet, your own results and the data given to answer them.
Full marks can only be scored in calculations if you show all of your working.

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

ANALYSING

1 The aqueous solutions used in Stage 1 of the Task Sheet were as follows.

Solution A was magnesium chloride
Solution B was calcium chloride
Solution C was barium chloride
Solution D was aluminium chloride

State which metal ion is most likely to be present in the varnish remover. State **two** observations to support your answer.

Metal ion .....

Observation 1.....

.....

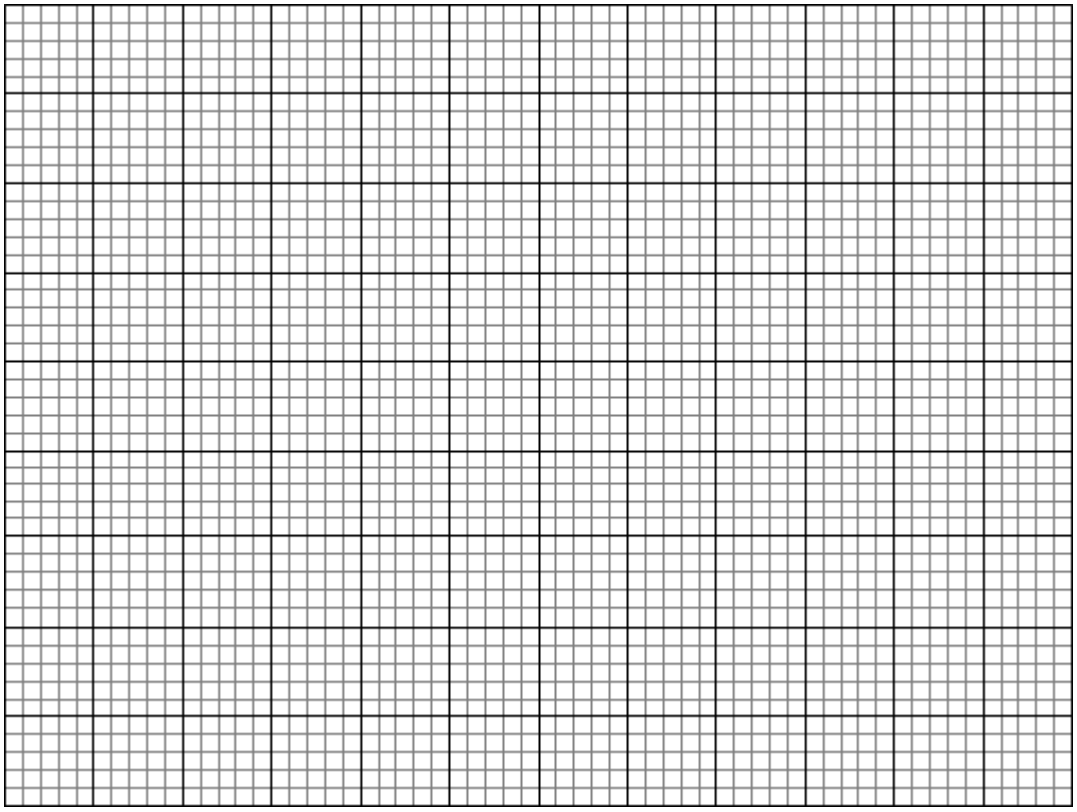
Observation 2.....

.....

(3 marks)

2 Using your results from Step 2 plot a graph of **temperature** (y axis) against **time** on the graph paper provided. Draw a line of best fit for the points before the fourth minute. Draw a second line of best fit for the points after the fourth minute. Extrapolate both lines to the fourth minute. Hence determine an accurate value for the temperature rise at the fourth minute.

Accurate value for the temperature rise ..... °C



(7 marks)

10

SECTION B

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

ANALYSING

INTRODUCTION

A solution containing sodium hydroxide, with a small amount of barium hydroxide, can be used as a varnish remover. Safe disposal of the varnish remover after use involves neutralising the excess alkali and removal of paint and varnish residues.

Neutralisation with hydrochloric acid forms a solution containing sodium chloride and barium chloride. Barium chloride can be obtained as a hydrated salt by crystallisation.

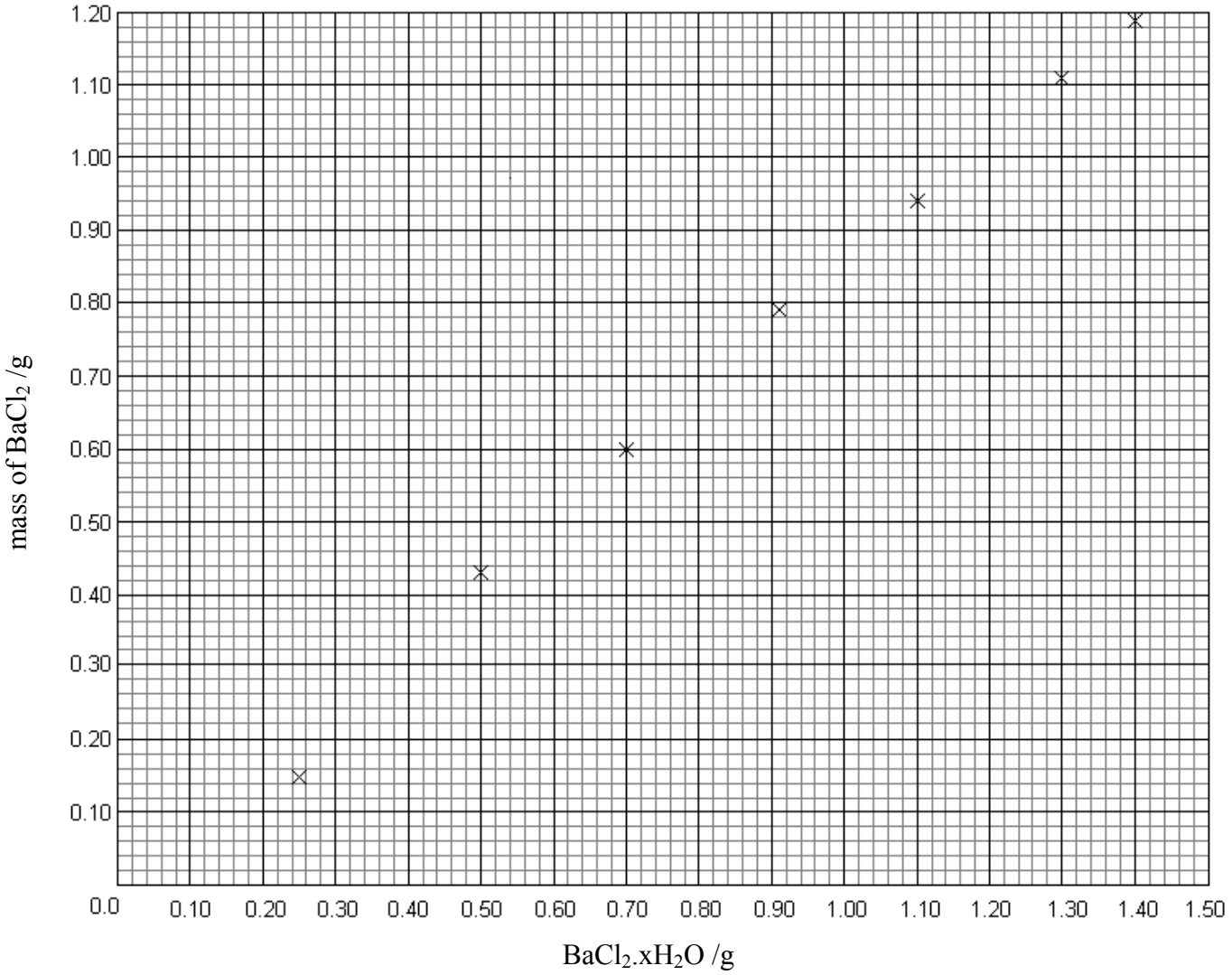
The water of crystallisation in barium chloride crystals can be removed as water vapour by heating as shown in the following equation:

$BaCl_2.xH_2O(s)$	$\rightarrow$	$BaCl_2$ (s)	+	$xH_2O(g)$
hydrated barium chloride		anhydrous barium chloride		

A student weighed a clean dry crucible. The student transferred 0.25 g of hydrated barium chloride to the crucible. The crucible was then heated. When the crucible and its contents had reached constant mass the mass was recorded.

The experiment was repeated using different masses of hydrated barium chloride.

For each experiment the student recorded the original mass of hydrated barium chloride and the mass of anhydrous barium chloride left after heating. The student's results are shown on the graph below.



3 Draw a straight line of best fit on your graph.

(2 marks)

4 Use the graph to determine the mass of hydrated barium chloride which would have formed 1.00 g of anhydrous barium chloride.

Mass of hydrated barium chloride .....

(1 mark)

5 Calculate the number of moles of $BaCl_2$ present in 1.00 g of anhydrous barium chloride.

.....

.....

(1 mark)

6 Use your answers to **Questions 4** and **5** to calculate the M_r of hydrated barium chloride. Give your answer to the appropriate precision.

.....

.....

.....

(2 marks)

7 Use your answer to question 6 to calculate the value of x in $BaCl_2.xH_2O$

.....

.....

.....

(1 mark)

8 The maximum total error in weighing 0.25 g on the balance was 0.01 g. This error takes into account multiple measurements. Estimate the maximum percentage error in using the balance.

.....

.....

(1 mark)

9 Explain why it was unnecessary to use a more precise balance.

.....

.....

(1 mark)

10 To remove old varnish a table-top is immersed in hot alkali solution for several hours. Apart from the use of eye protection, suggest **one** appropriate safety precaution.

.....

.....

(1 mark)

EVALUATION

11 Consider your graph on page 5 and comment on the results obtained by the student. Is your line of best fit good enough for you to use it with confidence? Identify any anomalous results.

.....

.....

.....

(2 marks)

12 Explain why it was necessary for the student to heat the crucible to constant mass.

.....

(1 mark)

13 Pure hydrated barium chloride has the formula $BaCl_2.2H_2O$

(a) Calculate the M_r of $BaCl_2.2H_2O$

.....

(b) Calculate the difference between the M_r of $BaCl_2.2H_2O$ and the M_r determined in question 6 of the Analysis. Express this as a percentage of the M_r of the literature value.

If you could not complete question 6 of the Analysis section, you should assume that the M_r determined from the graph is 253.2. This is not the correct value.

Difference .....

Percentage .....

(2 marks)

14 Suggest **one** reason in each case why

(a) small amounts of hydrated barium chloride, such as 0.100 g, should **not** be used in this experiment.

.....

.....

(b) large amounts of hydrated barium chloride, such as 50 g, should **not** be used in this experiment

.....

.....

(2 marks)

15 Barium chloride solution is used to detect the presence of the sulphate ion in a solution. Describe what you would see if the test was positive.

.....

(1 mark)

16 Barium compounds are toxic but barium sulphate is sometimes given to a patient before an x-ray is taken in hospital. Explain why the patient is not poisoned by the barium sulphate.

.....

(1 mark)

17 Anhydrous barium chloride can also be made by reaction of barium and chlorine. Calculate the atom economy of this reaction.

.....

.....

.....

(1 mark)

18 Use the results of **this** experiment, shown on the graph, to explain why the student was wise to repeat the experiment using different masses of hydrated barium chloride.

.....

.....

.....

(2 marks)

22

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

19 The first two steps in the preparation of a standard solution involve weighing the appropriate mass of solute and dissolving this mass of solute in a small volume of deionised water. Describe the remaining steps you would take to prepare 250 cm^3 of the standard solution.

.....

.....

.....

.....

.....

(4 marks)

20 In an experiment to measure an enthalpy change, two reagents in aqueous solution were mixed and the temperature rise was recorded.

(a) Other than temperature, state one other measurement that must be recorded.

.....

.....

(b) State **one** precaution which might be taken to minimise heat loss during the experiment.

.....

.....

(2 marks)

21 Identify a reagent you could use in a simple chemical test to confirm the presence of an alkene in a mixture of hydrocarbons. State what you would observe when this reagent is added to the alkene.

Reagent .....

Observation .....

.....

(2 marks)

END OF QUESTIONS

8

GCE CHEMISTRY 1421/2421

SPECIMEN PAPER EMPA: CHM3X

ASSESSMENT and QUALIFICATIONS ALLIANCE

TASK SHEET

An investigation of a varnish remover

Introduction

Varnish removers are used to remove paint and varnish from wooden objects such as tables and doors. A solution containing sodium hydroxide, with small amounts of another metal hydroxide, can be used as a varnish remover. Safe disposal of the varnish remover after use involves the identification of the unknown metal hydroxide, followed by the neutralisation of the excess alkali and the removal of paint and varnish residues. The neutralisation process is exothermic.

In this two-stage practical assessment you will identify a metal ion which is present in a varnish remover.

In Stage 1 you will complete a series of observational exercises. The results of these exercises will allow you to identify the metal ion which is present in the varnish remover.

In Stage 2 you will measure the enthalpy change of neutralisation of the main constituent of the varnish remover.

TASK 1 Observational Exercise (Implementing)

Identification of the unknown metal ion

You are provided with an aqueous solution of the varnish remover which has been neutralised with hydrochloric acid. You are also provided with aqueous solutions **A**, **B**, **C** and **D** of some metal salts.

Use a separate sample of each solution in each of the following tests.

Perform the tests described below on each solution in turn, recording what you **observe** in a table of your own design on the Candidate Results Sheet.

Where no visible change is observed, write "no visible change".

You are not required to identify the solutions or any of the reaction products in this part of the exercise.
Wear safety glasses at all times.
Assume that the varnish remover and all of the reagents and liquids are toxic, corrosive and flammable.

Test 1 Tests with dilute sulphuric acid

Place about 10 drops of **A** in a labelled test tube. Add 10 drops of dilute sulphuric acid and shake the mixture.
Allow the mixture to stand for ten minutes.
Repeat this test in separate clean test tubes with **B**, then **C,** then **D** and then with the solution of the varnish remover.

While you are waiting, begin the tests below.

Test 2 Tests with sodium hydroxide solution

Place about 10 drops of **A** in a labelled test tube. Add sodium hydroxide solution, dropwise with shaking, until in excess.
Repeat this test in separate clean test tubes with **B**, then **C,** then **D** and then with the solution of the varnish remover.

Test 3 Tests with ammonia solution

Place about 10 drops of **A** in a labelled test tube. Add 10 drops of ammonia solution and shake the mixture.
Repeat this test in separate clean test tubes with **B**, then **C,** then **D** and then with the solution of the varnish remover.

Test 4 Tests with sodium carbonate solution

Place about 10 drops of **A** in a labelled test tube. Add 10 drops of sodium carbonate solution and shake the mixture.
Repeat this test in separate clean test tubes with **B**, then **C,** then **D** and then with the solution of the varnish remover.

GCE CHEMISTRY 1421/2421

SPECIMEN EMPA: CHM3X

Candidate Results Sheet TASK 1

Centre Number | | | | | |

Candidate Name .....

Candidate number | | | | |

Results

Present your results in an appropriate form in the space below.

TASK 2 Determination of the enthalpy change of neutralisation of a varnish remover (Implementing)

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, using a funnel, fill it with the hydrochloric acid provided.

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

3 Measure the temperature of the hydrochloric acid in the cup to one decimal place. Record your result.

Temperature of the hydrochloric acid/ °C	

4 Wash the thermometer with distilled or de-ionised water and dry the thermometer.

5 Using a pipette filler, rinse a pipette with the varnish remover solution provided. Using this pipette and the filler, transfer 25.0 cm^3 of the varnish remover solution to a second clean, dry plastic cup.

6 Place the plastic cup containing the varnish remover solution in a beaker to provide support and additional insulation. Mount the thermometer in the cup using a clamp and stand. The bulb of the thermometer must be fully immersed in the solution. Place a stirrer in the cup.

7 Stir the varnish remover solution in the cup and measure the temperature to one decimal place. Record your result in table of your own design on the Candidate Results Sheet.

Every minute for a further three minutes stir the solution, measure the temperature and record each result in your table.

8 At the fourth minute add the 25.0 cm^3 of hydrochloric acid from the plastic cup. Stir the mixture but do not record the temperature.

9 Continue to stir the mixture, and measure the temperature at the fifth minute, and then every subsequent minute for a further five minutes. Record the results for each temperature in a table on Candidates Results Sheet **TASK 2**.

GCE CHEMISTRY 1421/2421

SPECIMEN EMPA: CHM3X

Candidate Results Sheet TASK 2

Centre Number | | | | | |

Candidate Name .....

Candidate number | | | | |

Results

Present your results in an appropriate form in the space below.