Surname		Other Names	
Centre Number			Candidate Number								
Candidate Signature											

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General Certificate of Education
June 2003
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

CHEMISTRY CHM3/P
Unit 3(b) Practical Examination

Wednesday 14 May 2003 9.00 am to 11.00 am

In addition to this paper you will require:
a calculator.

Time allowed: 2 hours

The Instructions to Supervisors are attached

Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Carry out **all three** exercises.
- Answer **all** 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.
- Take careful note of all the instructions given in each exercise.
- The Periodic Table/Data Sheet is provided on pages 3 and 4. Detach this perforated sheet at the start of the examination.

Information

- The use of note books and laboratory books is **not** permitted.
- The maximum mark for this paper is 30.
- The skills which are being assessed are
  Skill 1 Planning (8 marks)
  Skill 2 Implementing (8 marks)
  Skill 3 Analysing (8 marks)
  Skill 4 Evaluating (6 marks)
- This paper carries 15 per cent of the total marks for AS. For Advanced Level this paper carries $7\frac{1}{2}$ per cent of the total marks.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.

Advice

- You are advised to spend approximately 40 minutes on each of the three exercises.
- You are advised to carry out Exercise 1 first.

For Examiner's Use			
Number	Mark	Number	Mark
Skill 1			
Skill 2			
Skill 3			
Skill 4			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

This paper consists of the following.

Exercise 1	**Implementing and Analysing**	Determination of the temperature rise during a neutralisation reaction.
Exercise 2	**Analysing and Evaluating**	Determination of the molar enthalpy change for the reaction between zinc and copper(II) sulphate.
Exercise 3	**Planning**	Determination of the concentration of a solution of lactic acid.

An essential part of any practical work is to plan for the most efficient use of the time available. There is enough time to complete the exercises set provided that a sensible approach is used.

You are advised to spend approximately

40 minutes on Exercise 1
40 minutes on Exercise 2
40 minutes on Exercise 3.

The Periodic Table of the Elements

■ The atomic numbers and approximate relative atomic masses shown in the table are for use in the examination unless stated otherwise in an individual question.

I	II										III	IV	V	VI	VII	0
1.0 **H** Hydrogen 1																4.0 **He** Helium 2
6.9 **Li** Lithium 3	9.0 **Be** Beryllium 4										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										27.0 **Al** Aluminium 13	28.1 **Si** Silicon 14	31.0 **P** Phosphorus 15	32.1 **S** Sulphur 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	98.9 **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	183.9 **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	210.0 **Po** Polonium 84	210.0 **At** Astatine 85	222.0 **Rn** Radon 86
223.0 **Fr** Francium 87	226.0 **Ra** Radius 88	227 **Ac** Actinium 89 †															

Key

relative atomic mass — 6.9 **Li** Lithium

atomic number — 3

140.1 **Ce** Cerium 58	140.9 **Pr** Praseodymium 59	144.2 **Nd** Neodymium 60	144.9 **Pm** Promethium 61	150.4 **Sm** Samarium 62	152.0 **Eu** Europium 63	157.3 **Gd** Gadolinium 64	158.9 **Tb** Terbium 65	162.5 **Dy** Dysprosium 66	164.9 **Ho** Holmium 67	167.3 **Er** Erbium 68	168.9 **Tm** Thulium 69	173.0 **Yb** Ytterbium 70	175.0 **Lu** Lutetium 71
232.0 **Th** Thorium 90	231.0 **Pa** Protactinium 91	238.0 **U** Uranium 92	237.0 **Np** Neptunium 93	239.1 **Pu** Plutonium 94	243.1 **Am** Americium 95	247.1 **Cm** Curium 96	247.1 **Bk** Berkelium 97	252.1 **Cf** Californium 98	(252) **Es** Einsteinium 99	(257) **Fm** Fermium 100	(258) **Md** Mendelevium 101	(259) **No** Nobelium 102	(260) **Lr** Lawrencium 103

*** 58 – 71** Lanthanides

† 90 – 103 Actinides

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

Exercise 1 Determination of the temperature rise during a neutralisation reaction.

Skills assessed: **Implementing** (8 marks) **and Analysing** (2 marks)

Introduction

You are provided with aqueous solutions of hydrochloric acid and sodium hydroxide. The concentration of both solutions is 1.00 mol dm^{-3}. You are required to determine the temperature rise as described below.

Wear safety glasses at all times.
Assume that all solutions are toxic and corrosive.

Procedure

1. Rinse a burette with the hydrochloric acid solution provided. Set up the burette and, using a funnel, fill it with the hydrochloric acid solution provided.

2. Using the burette, transfer 25.00 cm^3 of the hydrochloric acid solution to a clean, dry plastic cup.

3. Measure the temperature of the hydrochloric acid solution in the cup to one decimal place. Record your result in the space provided below. Wash the thermometer with distilled or de-ionised water and dry the thermometer.

4. Rinse a pipette with the sodium hydroxide solution provided. Using this pipette and a filler, transfer 25.0 cm^3 of the sodium hydroxide solution to a second clean, dry plastic cup.

5. Place the plastic cup containing the sodium hydroxide solution in a beaker to provide additional insulation, and 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.

6. Measure the temperature of the sodium hydroxide solution in the cup, stirring the solution before recording the temperature. Record your result in **Table 1**. Measure the temperature of the solution in the cup every minute for a further three minutes. Each time, stir the solution before recording the temperature in **Table 1**.

7. At the fourth minute, add the 25.00 cm^3 of hydrochloric acid solution from the plastic cup, but do not record the temperature.

8. Stir the mixture, and measure the temperature at the fifth minute, and then every subsequent minute up to ten minutes. Record the temperature in **Table 1**.

Temperature of the hydrochloric acid solution in the plastic cup ..... °C

Table 1

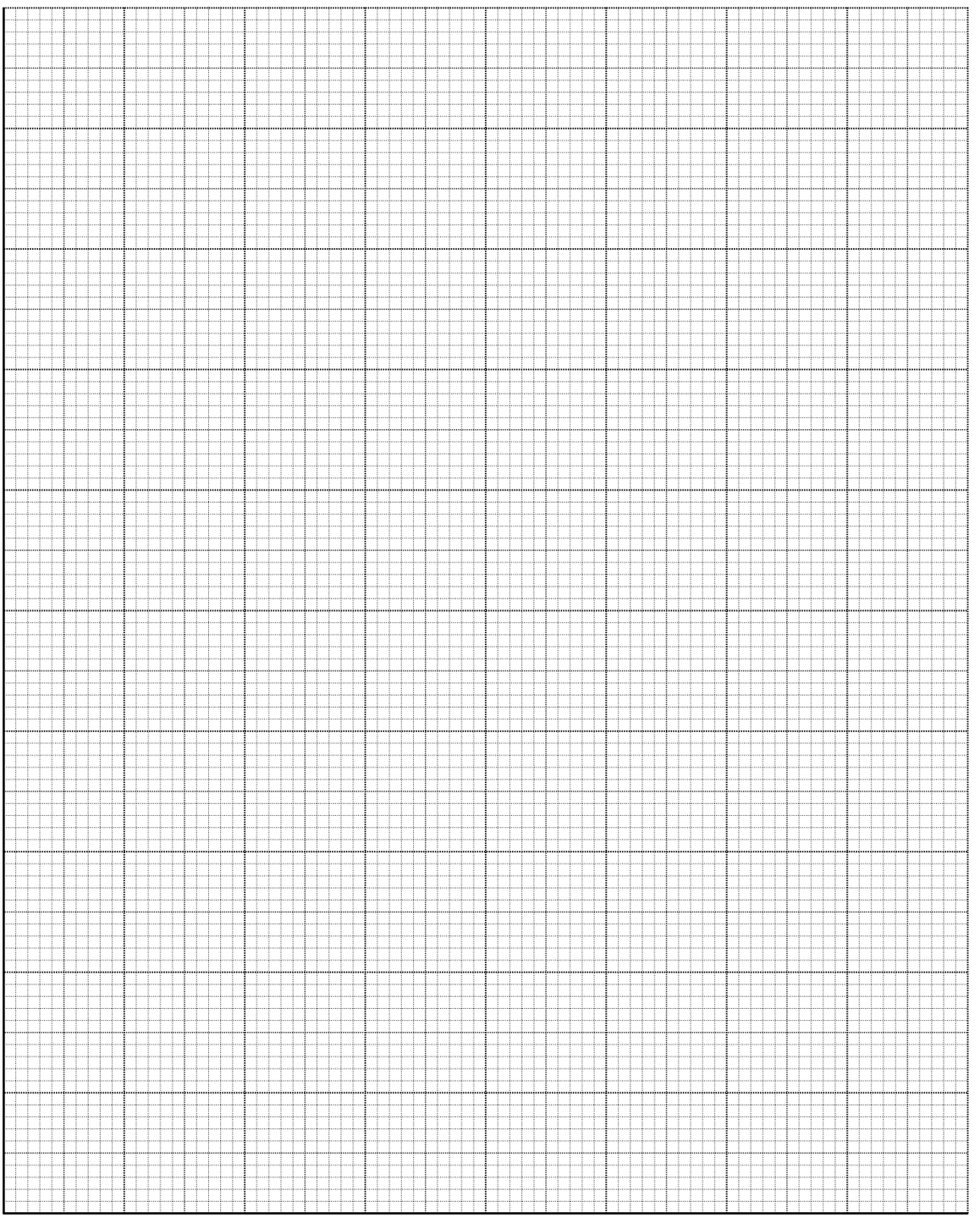
Time / minutes	0	1	2	3	4	5	6	7	8	9	10
Temperature / °C											

For Examiner's use only			
M		P	
R		A	

LEAVE MARGIN BLANK

9. 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 and a second line for the points after the fourth minute. Extrapolate both lines to the fourth minute, and hence determine the temperature rise which would have occurred at the fourth minute.

Temperature rise from the graph after extrapolation ..... °C



2

Turn over ▶

Exercise 2 Determination of the molar enthalpy change for the reaction between zinc and copper(II) sulphate.

Skills assessed: **Analysing** (6 marks) **and Evaluating** (6 marks)

Introduction

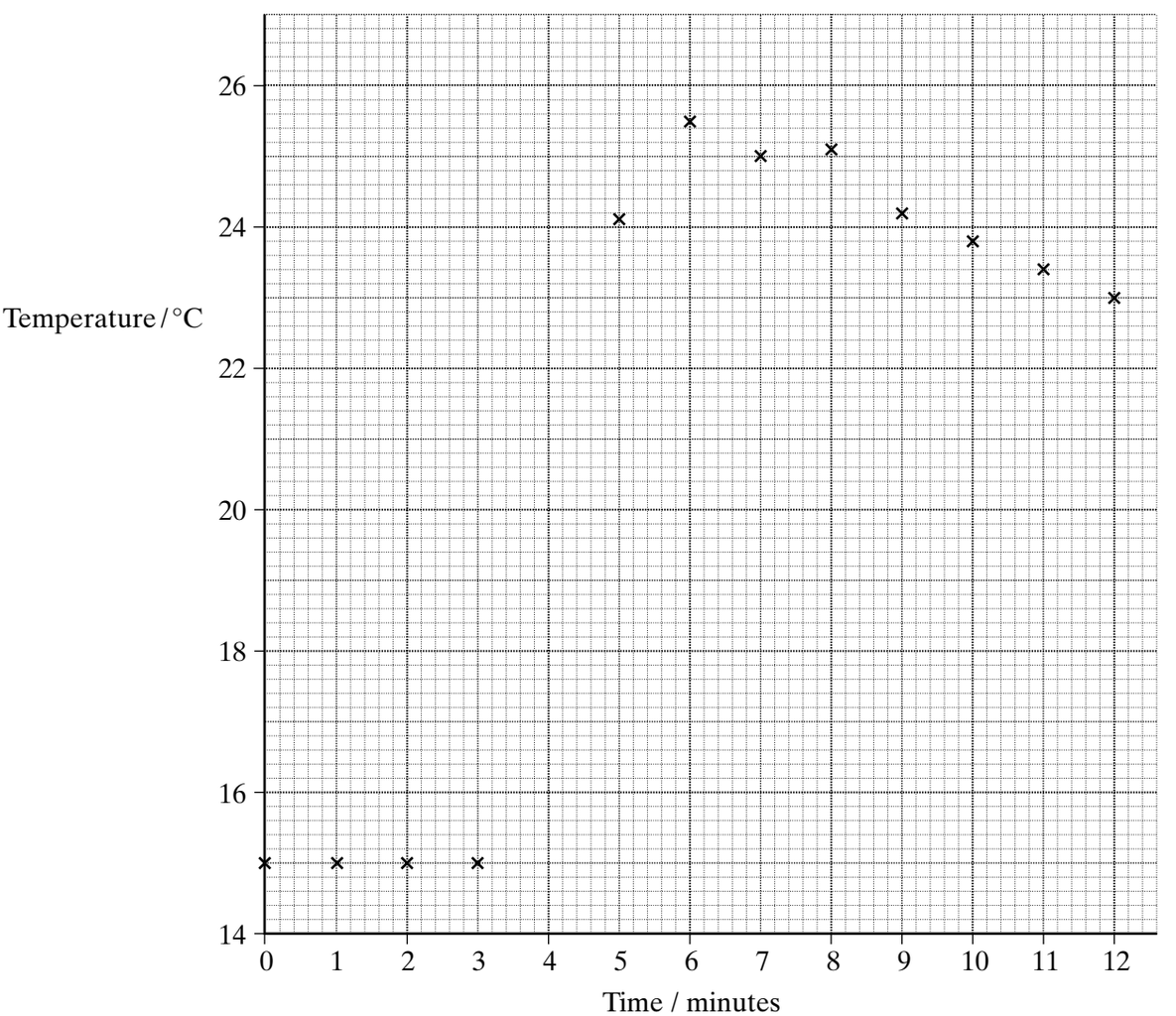
Zinc reacts with aqueous copper(II) sulphate as shown by the following equation.

$$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$$

A student weighed out 1.25 g of zinc dust. Using a pipette, the student then measured out 50.0 cm^3 of a 0.400 mol dm^{-3} solution of copper(II) sulphate and transferred it to a plastic cup, which was placed in a beaker to provide insulation. A thermometer was mounted in the cup using a clamp and stand. The bulb of the thermometer was fully immersed in the liquid.

The student recorded the temperature of the liquid in the cup every minute, stirring the liquid before reading the temperature. At the fourth minute the student added the zinc, but did not record the temperature. The student stirred the mixture thoroughly, then recorded the temperature at the fifth minute. The student continued stirring and recording the temperature at minute intervals for seven more minutes.

The student's results are shown on the graph below.



Analysis

1. Draw a line of best fit for the points before the fourth minute and a second line for the points after the fourth minute. Extrapolate both lines to the fourth minute, and hence determine the temperature rise which would have occurred at the fourth minute.

   Temperature rise from the graph after extrapolation ..... °C.

2. Use the temperature rise from your graph to calculate the heat given out during this experiment. Assume that the solution has a density of $1.00\,g\,cm^{-3}$ and a specific heat capacity of $4.18\,J\,K^{-1}\,g^{-1}$.

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3. (a) Calculate the number of moles of zinc present in 1.25 g (Zn A_r = 65.4).

   .....

   (b) Calculate the number of moles of copper(II) sulphate present in $50.0\,cm^3$ of a $0.400\,mol\,dm^{-3}$ solution.

   .....

4. Calculate the molar enthalpy change for the reaction between zinc and copper(II) sulphate.

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5. Assume that the maximum errors for the apparatus used in this experiment were

balance	± 0.01 g
$50\,cm^3$ pipette	± $0.1\,cm^3$
thermometer	± 0.1 °C

   Calculate the maximum percentage error in using each piece of apparatus, and hence the maximum overall apparatus error. Use the temperature rise from the graph to calculate the error in using the thermometer.

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Evaluation

1. Comment on the quality of the student's results.

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2. The data book value for the molar enthalpy change is $-219\,kJ\,mol^{-1}$. Calculate the difference between the student's value and this data book value. Express this difference as a percentage of the data book value.
   (If you could not complete the calculation in part 4 of the **Analysis** section, you should assume that the student's enthalpy change is $-135\,kJ\,mol^{-1}$. This is **not** the correct value.)

   Difference .....

   Percentage .....

3. Identify the main source of error in this experiment. Suggest **one** improvement to minimise this main source of error.

   .....

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   .....

4. Identify one other source of error in this experiment. Suggest **one** improvement to minimise this other source of error.

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Exercise 3 Determination of the concentration of a solution of lactic acid.

Skill assessed: **Planning** (8 marks)

Write your answer to this exercise in the space provided on pages 11 to 14 of this booklet.

Introduction

Lactic acid is a monoprotic acid which reacts with sodium hydroxide. Using HA to represent lactic acid, the equation for neutralisation is

$$HA + NaOH \rightarrow NaA + H_2O$$

Phenolphthalein is a suitable indicator for the reaction.

Question

You are provided with a solution of lactic acid, the concentration of which is approximately $0.05\,mol\,dm^{-3}$. Using the information given above, describe how you would determine the exact concentration of the acid. Assume that you have access to an appropriate standard solution of sodium hydroxide.

Your answer must include

1. The choice of a suitable concentration of the sodium hydroxide solution to be used, and your reasons for choosing this concentration.
2. A **detailed** description of the experiments you would perform.
3. A clear explanation of how you would use your results to calculate the concentration of the lactic acid solution.
4. Details of the potential hazards, and the relevant safety precautions you would take.

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Turn over ▶

Version 1.1

General Certificate of Education
June 2003
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

CHEMISTRY PRACTICAL EXAMINATION **CHM3/PTN**
Instructions to Supervisors

CONFIDENTIAL

1 The practical examination will be held on Wednesday 14 May 2003, 9.00 am to 11.00 am.

Centres are permitted to run more than one session for the Practical Examination provided that the following conditions are met:

- all candidates to be examined must be present in the centre by 9.30 am at the latest;
- all candidates who are waiting to be examined must be supervised until their session begins;
- candidates who are released at the end of their session must have no contact with any candidate yet to be examined.

2 **The strictest possible precautions are to be taken to prevent these exercises becoming known to the candidates in advance, either directly or indirectly. AQA emphasises the need to preserve the absolute fairness and integrity of this examination. This copy of Instructions to Supervisors is to be kept at the centre under secure conditions when not in use; it is not to be removed from the centre.**

3 A combined question paper/answer book will be supplied. If an answer book is badly damaged, e.g. by spillage, a candidate may be given a fresh book, **but both books must be sent to the Examiner**, together with a statement of the reasons for issuing a duplicate answer book. The damaged book must be sealed in a polythene bag.

The Periodic Table/Data Sheet will be provided as a perforated sheet on pages 3 and 4 of the question paper/answer book. Candidates will be instructed to detach this sheet at the start of the examination.

4 The use of books and laboratory notebooks is **not** permitted.

5 The attention of candidates must be drawn to the requirement that all rough work must be done in the answer book. **Extra paper is not to be supplied for this purpose**. Candidates' attention should also particularly be drawn to the instructions contained in the question paper.

6 As far as possible, apparatus and special materials should not be put away until the end of the examination period; an Inspector who arrives late will thus be able to see the preparations that have been made.

7 If a candidate fails with the material allotted to him/her and asks to be allowed a second opportunity, he/she may be allowed it at the discretion of the Supervisor. **Under no circumstances may materials from other sources be used**. Supervisors should bear this in mind as well as the availability of apparatus and the amount of time remaining when exercising this discretion. No extra time is to be allowed to such a candidate and he/she must hand in his/her script at the same time as other candidates at the centre. A full report, in writing, of any such incident must be sent to the Examiner together with the scripts. **Supervisors must not allow extra time to candidates** unless specific permission is given by AQA. Any circumstance which leads to a shortage of time should be reported to the Examiner.

8 A Supervisor must not give any advice to candidates about the way they are conducting experiments unless it is to prevent personal injury to the candidates or damage to apparatus. If any such incident occurs, the Supervisor should report details, in writing, to the Examiner when scripts are sent. Unless specific mention to the contrary is made in the instructions, Supervisors must not give any advice or information to candidates, whether it is asked for or not.

APPARATUS AND MATERIALS

Exercise 1

This exercise involves the determination of the temperature rise during a neutralisation reaction.

Materials

Each candidate will require two volumetric solutions:

1 (a) A **sodium hydroxide** solution of concentration between 0.900 and 1.000 mol dm^{-3}.

This solution may be made up in the centre. Wherever possible, the centre should prepare one bulk batch only of this solution. It is essential that the concentration of this solution should be in the range specified. It must be stressed that the accuracy of this solution is the responsibility of the centre **alone**.

Each candidate will require 60 cm^3 of this solution, in a closed container labelled sodium hydroxide.

(b) A solution of **hydrochloric acid**, of concentration between 0.900 and 1.000 mol dm^{-3}.

This solution may be made up in the centre. Wherever possible, the centre should prepare one bulk batch only of this solution. It is essential that the concentration of this solution should be within the range specified. It must be stressed that the accuracy of this solution is the responsibility of the centre **alone**.

Each candidate will require 60 cm^3 of this solution, in a closed container labelled hydrochloric acid.

2 Reagents of good analytical quality should be used in preparing the solutions, and they should be carefully stored in bottles fitted with air-tight stoppers. Great care must be taken in the storage and dispensing of each solution to ensure that its concentration is unaltered. Wherever possible, centres are advised to check that the reagents used do work.

3 Supervisors are required in every instance to carry out the practical exercise and to report the results to the Examiner on the form provided on page 5 of this booklet. A Supervisor result is required for **each** group of candidates. The Supervisor results must be entered with the list of candidates supervised in the group on the form provided. The accuracy of the candidates' results will be assessed against the Supervisor's results for the temperature rise. Supervisors must **not** carry out the exercise in the presence of the candidates.

Supervisors are also required to keep a sample (not less than 100 cm^3) of each volumetric solution used in a small stoppered bottle. These samples should be kept for a period of four weeks after the examination and should be available to the Examiners if called for.

It is essential that orders for solutions which are not to be made up in the centre or apparatus that is not available in the centre should be placed without delay.

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

4 Supervisors are required to assess the manipulative skills of candidates and to complete the grid on page 5 of this booklet. This form must be sent to the Examiner with the scripts.

If a centre needs to conduct the examination in two or more separate sessions, the form on page 5 must be completed and sent to the Examiner with each group of scripts. This form may be photocopied if centres have large numbers of candidates.

Apparatus

The apparatus specified below represents the minimum requirement. Candidates will be advised to carry out Exercise 1 first.

Each candidate will require:

one 50 cm^3 burette and stand
one funnel
one thermometer, measuring to a minimum accuracy of 0.2 °C and a minimum range of 0–50 °C
one stirrer
two plastic or polystyrene cups (of a size suitable to fit into a 250 cm^3 beaker)
one 250 cm^3 beaker
one 25 cm^3 pipette
one pipette filler
one stand, clamp and boss
one wash bottle
a plentiful supply of purified water (either distilled or de-ionised)
tissue for drying thermometer.

Centres may wish to consider the following suppliers if requiring to order the above apparatus:

Philip Harris Education	Tel 0845 120 4520
The Consortium for Purchasing and Distribution	Tel 0845 3307780
Griffin Education (Fisher Industrial Catalogue)	Tel 01509 233344
Scientific & Chemical Supplies Ltd	Tel 01902 402402

CHEMISTRY PRACTICAL EXAMINATION CHM3/P June 2003

Centre Number _____

Supervisor _____ Date _____

Exercise 1

Plot a graph of **temperature** (y-axis) against **time** on the graph overleaf. Draw a line of best fit for the points before the fourth minute and a second line for the points after the fourth minute. Extrapolate both lines to the fourth minute, and hence determine the temperature rise which would have occurred at the fourth minute.

Temperature rise from the graph after extrapolation ……°C

Name of Candidate	1 Correct use of burette	2 Pipette empties under gravity	3 Transfers from pipette without spillage	4 Touches surface with pipette	5 Bulb immersed	6 Stirs mixture	7 Does not need additional reagent		TOTAL (7)

Notes for the assessment of Manipulative Skills listed 1–7 above.

1 The candidate loses this mark if the technique used is obviously incorrect, e.g. leaves the funnel in the burette, overfills the burette, does not fill the jet space, etc.

2–4 Candidates will reach this stage at roughly the same time. Centres may need some additional supervisors for this section.

5–6 The Supervisor can check these points at an appropriate time during the exercise. The candidate scores the mark if the correct technique is used **once**.

7 The candidate loses this mark if an extra supply of either acid or alkali is needed.

Record your results in the table below and then plot the graph of temperature against time.

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

Temperature of the hydrochloric acid solution in the plastic cup …… °C