Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Education
June 2005
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

CHEMISTRY CHM6/P
Unit 6(b) Practical Examination

Thursday 26 May 2005 9.00 am to 11.00 am

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

Time allowed: 2 hours

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 5 per cent of the total marks for Advanced Level.
- 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**	Reactions of some organic compounds
Exercise 2	**Analysing and Evaluating**	Determination of the equilibrium constant, K_c, for an esterification reaction
Exercise 3	**Planning**	Determination of the concentration of a solution of hydrogen peroxide

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

TURN OVER FOR THE FIRST EXERCISE

Exercise 1 Reactions of some organic compounds

Skill assessed **Implementing** (8 marks)

Introduction

You are provided with **three** liquids labelled **A**, **B** and **C**, respectively. Use a separate sample of each liquid in each of the following tests.

Carry out the tests described opposite on each liquid in turn, recording what you **observe** in the Table. Where no visible change is observed, write "no visible change".

You are not required to identify the liquids or any of the reaction products.
Wear suitable eye protection at all times.
Assume that all of the reagents and liquids are toxic, corrosive and flammable.

LEAVE MARGIN BLANK

Table

	Test	Observation with **A**	Observation with **B**	Observation with **C**
1	Place about 10 drops of **A** in a labelled test tube. Add 10 drops of Reagent 1 and shake the mixture. Half fill a 250 cm^3 beaker with the hot water provided. Stand the test tube in the beaker for about ten minutes. Repeat the test with **B**, and then **C**. **While you are waiting, you may begin Test 2.**			
2	Place about 10 drops of **A** in a labelled test tube. Add two drops of Reagent 2 and shake the mixture. Half fill a second 250 cm^3 beaker with the hot water provided. Stand the test tube in the beaker for about five minutes. Repeat the test with **B**, and then **C**. **While you are waiting, you may begin Test 3.**			
3	Place about 10 drops of **A** in a test tube. Add a small amount of solid Reagent 3. Repeat the test with **B**, and then **C**.			
4	Place about 10 drops of Reagent 4 in a test tube. Add a few drops of **A** and shake the mixture. Repeat the test with **B**, and then **C**.			

For Examiner's use only	M		R		A	

8

Turn over ▶

Exercise 2 Determination of the equilibrium constant, K_c, for an esterification reaction

Skills assessed **Analysing** (8 marks) **and Evaluating** (6 marks)

Introduction

Ethanoic acid and ethanol react reversibly to form ethyl ethanoate and water according to the following equation.

$$CH_3COOH + CH_3CH_2OH \rightleftharpoons CH_3COOCH_2CH_3 + H_2O$$

A mixture of 0.420 g of ethanoic acid and 0.0100 mol of ethanol was allowed to reach equilibrium at 20 °C. The ethanoic acid remaining in the equilibrium mixture reacted exactly with 3.00 cm^3 of 0.500 mol dm^{-3} sodium hydroxide solution added from a burette.

Analysis **Full marks can only be scored in calculations if you show all of your working**.

1 Write an expression for the equilibrium constant, K_c, for the reaction between ethanoic acid and ethanol.

.....

.....

2 Calculate the number of moles present in 0.420 g of ethanoic acid (M_r = 60.0).

.....

.....

3 Calculate the number of moles of sodium hydroxide in 3.00 cm^3 of 0.500 mol dm^{-3} sodium hydroxide solution. Hence calculate the number of moles of ethanoic acid present in the equilibrium mixture.

Moles of sodium hydroxide .....

.....

Moles of ethanoic acid .....

.....

4 Use your answers from parts 2 and 3 to calculate the number of moles of acid that have reacted with the ethanol. State the number of moles of ester and of water present in the equilibrium mixture.

Moles of acid reacted .....

.....

Moles of ester .....

Moles of water .....

5 Calculate the number of moles of ethanol present in the equilibrium mixture and hence calculate the value of K_c.

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.....

.....

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

balance total error	± 0.001 g
burette total error	± 0.15 cm^3 (from two readings and an end-point error)

Calculate the maximum percentage error in using each piece of apparatus, and hence the maximum overall percentage error.

.....

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.....

8

EXERCISE 2 CONTINUES ON THE NEXT PAGE

Turn over ▶

Evaluation **Full marks can only be scored in calculations if you show all of your working.**

1 A data book value for K_c for this reaction is 3.92 at 20 °C. Calculate the difference between the value calculated in part 5 of the **Analysis** section and the data book value. Express this difference as a percentage of the data book value.

(If you could not complete the calculation in part 5 of the **Analysis** section, you should assume a value of 3.40 for K_c. This is not the correct value.)

Difference .....

Percentage .....

2 Comment on the quality of the experimental result for K_c.

.....

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.....

3 The volume of the sodium hydroxide solution used in this titration was very small. Suggest an alternative concentration for the sodium hydroxide solution, and explain how this would improve the accuracy of the experiment.

.....

.....

4 State why it is necessary to maintain a constant temperature in this experiment. Suggest **one** method for maintaining a constant temperature in this experiment.

.....

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.....

6

Exercise 3 Determination of the concentration of a solution of hydrogen peroxide

Skill assessed **Planning** (8 marks)

Introduction

The concentration of a solution of hydrogen peroxide can be determined by titration with aqueous potassium manganate(VII) in the presence of dilute sulphuric acid. The half-equations for the reaction are given below.

$$H_2O_2 \longrightarrow O_2 + 2H^+ + 2e^-$$

$$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$$

Hydrogen peroxide is sold commercially as an aqueous solution containing approximately $40\,g\,dm^{-3}$ of hydrogen peroxide. This solution is too concentrated for use in a titration, and must be diluted before use.

Hydrogen peroxide solution is a skin irritant, and potassium manganate(VII) is a powerful oxidising agent.

Question

You are provided with a $0.0200\,mol\,dm^{-3}$ solution of potassium manganate(VII). Describe an experiment you could perform to determine the concentration of a solution containing approximately $40\,g\,dm^{-3}$ of hydrogen peroxide.

Your answer must include the following

1 A balanced equation for the reaction between hydrogen peroxide and potassium manganate(VII) in the presence of dilute sulphuric acid.

2 A calculation of the approximate concentration, in $mol\,dm^{-3}$, of the hydrogen peroxide solution provided.

3 A calculation of an appropriate dilution factor for the hydrogen peroxide solution to give a titre of about $25\,cm^3$ of $0.0200\,mol\,dm^{-3}$ potassium manganate(VII) solution.

4 Essential practical details of how you would perform the titration. You do **not** need to describe the preparation of the diluted solution.

5 A clear explanation of how you would use your results to calculate the concentration of the **original** hydrogen peroxide solution.

6 Details of the potential hazards and the relevant safety precautions.

8

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THERE ARE NO QUESTIONS PRINTED ON THIS PAGE

General Certificate of Education
June 2005
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

CHEMISTRY PRACTICAL EXAMINATION **CHM6/P/TN**
Instructions to Supervisors

CONFIDENTIAL

1 The practical examination will be held on Thursday 26 May 2005, 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 AQA. **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 AQA.

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 a qualitative investigation of the reactions of solutions of three organic compounds with solutions of Benedict's reagent, potassium manganate(VII), phenol red indicator and solid sodium hydrogencarbonate.

Materials

1 Each candidate will require the following reagent solutions:

Benedict's reagent	centres unused to preparing this reagent will find CLEAPSS preparation for qualitative reagent of assistance
potassium manganate(VII)	for each dm^3 of reagent solution add 250 cm^3 of approximately 0.02 mol dm^{-3} potassium manganate(VII) to 750 cm^3 of approximately 1.0 mol dm^{-3} sulphuric acid
phenol red indicator	normal laboratory reagent

These solutions may be made up in the centre or purchased from a reputable manufacturer at the discretion of the centre. Wherever possible the centre should prepare one bulk batch only of each solution. It must be stressed that the accuracy of these solutions is the responsibility of the centre **alone**.

Each candidate will require 5 cm^3 of each solution, in a labelled container marked as follows:

Benedict's reagent	labelled **Reagent 1**
potassium manganate(VII)	labelled **Reagent 2**
phenol red indicator	labelled **Reagent 4**

2 Each candidate will require about 1 g of solid **sodium hydrogencarbonate** in a labelled container marked **Reagent 3**.

The strictest possible precautions are to be taken to prevent the identities of these reagents becoming known to the candidates, either directly or indirectly.

3 Each candidate will require the following (concentrations are approximate):

aqueous **D-glucose** solution	100 g dm^{-3}
cyclohexene	pure liquid
aqueous **methanoic acid**	3 mol dm^{-3} centres unused to preparing this reagent will find CLEAPSS preparation of qualitative reagents (Table 7.8 in the 1997 handbook) or the CD-ROM of assistance.

These reagents should be prepared in the centre, no more than one day before the examination. Wherever possible the centre should prepare one bulk batch only of each reagent. It must be stressed that the accuracy of these reagents is the responsibility of the centre **alone**.

Each candidate will require 5 cm^3 of each of the samples, in a labelled container marked as follows:

aqueous D-glucose solution	labelled **A**
cyclohexene	labelled **B**
aqueous methanoic acid	labelled **C**

The strictest possible precautions are to be taken to prevent the identities of these solutions becoming known to the candidates, either directly or indirectly.

4 Reagents of good quality should be used in preparing the solutions, and they should be carefully stored in glass 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.

5 Supervisors are required, in every instance, to carry out the observation exercises and to report the results to the Examiner on the grid provided on page 7 of this booklet. A supervisor result is required for **each** group of candidates. The accuracy of the candidates' results will be assessed against the Supervisor's results. Supervisors must **not** carry out the exercises in the presence of the candidates.

If a centre needs to conduct the examination in two or more separate sessions a photocopy of the Supervisor's results, written on page 7, must be sent to the Examiner with each group of scripts.

Supervisors are also asked to keep a sample (at least 100 cm^3) of each 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 should be placed without delay.

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

6 Supervisors are required to assess the manipulative skills of candidates and to complete the grid on page 8 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 8 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:

test tubes; the number per candidate is at the centre's discretion, but a minimum of 9 test tubes will be needed; at least three test tubes must be labelled "**A**", at least three test tubes must be labelled "**B**", at least three test tubes must be labelled "**C**". The following is recommended

four test tubes labelled **A**
four test tubes labelled **B**
four test tubes labelled **C**

dropping pipettes; the number per candidate is at the centre's discretion, to a maximum of 6
small spatula
test tube rack
two 250 cm^3 beakers
one wash bottle
a plentiful supply of purified water (either distilled or de-ionised)
suitable eye protection.

The candidates require hot water for Tests 1 and 2. As cyclohexene is flammable, centres are advised to provide an electric kettle to provide a convenient and quick supply of hot water. The water should be kept close to its boiling point but boiling water is not necessary.

Candidates may use disposable gloves if these are available.

Candidates are asked to warm some of the reaction mixtures for either five or ten minutes. Each working area will need a clock clearly visible to the candidates.

THERE ARE NO INSTRUCTIONS PRINTED ON THIS PAGE

Supervisor's Results

Centre No. ..... **Supervisor's name** ..... **Group** .....

	Test	Observation with **A**	Observation with **B**	Observation with **C**
1	Place about 10 drops of **A** in a labelled test tube. Add 10 drops of Reagent 1 and shake the mixture. Half fill a 250 cm^3 beaker with the hot water provided. Stand the test tube in the beaker for about ten minutes. Repeat the test with **B**, and then **C**. **While you are waiting, you may begin Test 2.**			
2	Place about 10 drops of **A** in a labelled test tube. Add two drops of Reagent 2 and shake the mixture. Half fill a second 250 cm^3 beaker with the hot water provided. Stand the test tube in the beaker for about five minutes. Repeat the test with **B**, and then **C**. **While you are waiting, you may begin Test 3.**			
3	Place about 10 drops of **A** in a test tube. Add a small amount of solid Reagent 3. Repeat the test with **B**, and then **C**.			
4	Place about 10 drops of Reagent 4 in a test tube. Add a few drops of **A** and shake the mixture. Repeat the test with **B**, and then **C**.			

CHEMISTRY PRACTICAL EXAMINATION CHM6/P June 2005

Centre Number _____

Supervisor _____ Date _____

Name of Candidate	1 Uses appropriate quantities	2 No spillages	3 Shakes mixture	4 Water bath set up correctly	5 Appropriate volume of water	6 Does not need additional sample	7 Works safely	TOTAL (7)

Notes for the Assessment of Manipulative Skills listed 1–7 above

1, 3 The Supervisor should observe the candidate in the use of the correct quantities, with shaking, at an appropriate time during the exercise. The candidate scores the mark if the correct technique is used **once**.

2 The candidate scores the mark if there are no major spillages during the exercise.

4–5 These marks can be assessed at any time during the exercise. Volumes of water which are too small, or present a safety risk, should be penalised.

6 The candidate loses this mark if an extra supply of any reagent or liquid is needed, when the reason for the additional sample is clearly the fault of the candidate, e.g. spillage, careless measurement of volumes or using the wrong solution.

7 The candidate loses this mark if he/she does not wear eye protection, or does anything which the Supervisor regards as potentially hazardous.

This sheet may be photocopied