Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
June 2006
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

CHEMISTRY **CHM6/P**
Unit 6(b) Practical Examination

Thursday 25 May 2006 9.00 am to 11.00 am

For this paper you must have
- 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.
- Answer 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
- You must not use note books and laboratory books.
- 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)
- 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 about 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 metal ions
Exercise 2	**Analysing and Evaluating**	Analysis of a hydrogen peroxide solution
Exercise 3	**Planning**	Finding the order of a chemical reaction

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** Radium 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

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

Turn over for the first exercise

Exercise 1 Reactions of some metal ions

Skill assessed **Implementing** (8 marks)

Introduction

You are provided with **four** solutions labelled **A**, **B**, **C** and **D**.
Perform the tests described on the opposite page on each solution in turn. Record what you **observe** in the table.
When no visible change is observed, write "no change".

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

Use a separate sample of each solution in each of the following tests	Observation with solution **A**	Observation with solution **B**	Observation with solution **C**	Observation with solution **D**
Tests with Reagent 1 (a) Place about 10 drops of **A** in a labelled test tube. Add Reagent **1**, dropwise with shaking, until in excess. **Do not discard this mixture**. Repeat this test with **B**, then **C** and then **D**. **Retain each mixture for use in part (b)**.				
(b) Half fill a 250 cm^3 beaker with the hot water provided. Stand the test tubes containing the mixtures from **part (a)** in the beaker for 15 minutes. **While you are waiting, begin the tests below**.				
Tests with Reagent 2 Place about 10 drops of **A** in a labelled test tube. Add 10 drops of Reagent **2** and shake the mixture. Allow the mixture to stand for a few minutes at room temperature. Repeat this test with **B**, then **C** and then **D**.				
Tests with Reagent 3 Place about 10 drops of **A** in a labelled test tube. Add 10 drops of Reagent **3** and shake the mixture. Repeat this test with **B**, then **C** and then **D**.				

For Examiner's use only	M		R		A	

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Exercise 2 Analysis of a hydrogen peroxide solution

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

Introduction

Hydrogen peroxide is sold commercially as an aqueous solution. Hydrogen peroxide solution decomposes slowly under normal conditions. A student was asked to carry out an experiment to find the concentration of a given aqueous solution.

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

$$H_2O_2 \longrightarrow O_2 + 2H^+ + 2e^-$$
$$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$$

The student diluted the commercial hydrogen peroxide by transferring a 25.0 cm^3 sample to a 250 cm^3 volumetric flask using a pipette and filler. The sample in the flask was made up to the mark with deionised water and shaken well to ensure complete mixing.

A 25.0 cm^3 portion of the diluted hydrogen peroxide solution was transferred to a conical flask using a pipette and filler. This solution was acidified with dilute sulphuric acid and titrated with a 0.0200 mol dm^{-3} solution of potassium manganate(VII). The titration was repeated three times and the results are shown in the table.

Titration number	1	2	3	4
Final burette reading / cm^3	28.10	46.10	27.90	48.75
Initial burette reading / cm^3	0.00	18.20	0.05	20.90

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

1 Deduce an overall equation for the reaction between hydrogen peroxide and manganate(VII) ions in the presence of dilute sulphuric acid.

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2 Identify **all** the concordant results in the table and use these to determine the mean titre.

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3 Use your answers from part (1) and part (2) to calculate the number of moles of hydrogen peroxide in 25.0 cm^3 of the diluted solution.

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4 Use your answer from part (3) to calculate the concentration of hydrogen peroxide in the undiluted commercial solution.
(If you could not complete the calculation in part (3), you should assume a value of 1.45×10^{-3} mol. This is not the correct value.)

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5 Use your answer from part (4) to calculate the concentration, in g dm^{-3}, of hydrogen peroxide in the undiluted commercial solution.

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

volumetric flask	± 1 cm^3	
pipette	± 0.1 cm^3	(from dilution and titration)
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 apparatus error. Use the mean titre to calculate the error in using the burette.

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

1 Comment on the consistency of the titration results given in the table on page 8.

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2 According to the supplier, the commercial solution of hydrogen peroxide had a concentration of 0.815 mol dm^{-3}. Calculate the difference between the value calculated in part (4) of the **Analysis** section and the supplier's value. Express this as a percentage of the supplier's value.
(If you could not complete the calculation in part (4) of the **Analysis** section, you should assume a value of 0.515 mol dm^{-3}. This is not the correct value.)

Difference .....

Percentage .....

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3 Comment on the magnitude of the difference between the supplier's value and the student's value.

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4 Apart from apparatus error, suggest **two** reasons why the student's value is lower than the supplier's value. Assume that the supplier's figure is correct.

Reason 1 .....

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Reason 2 .....

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Exercise 3 Finding the order of a chemical reaction

Skill assessed **Planning** (8 marks)

Introduction

The benzenediazonium ion, $C_6H_5N_2^+$, reacts with water as shown in the equation.

$$C_6H_5N_2^+(aq) + H_2O(l) \longrightarrow C_6H_5OH(aq) + N_2(g) + H^+(aq)$$

Below 10 °C the reaction is very slow, but at 20 °C nitrogen is evolved at a measurable rate. The volume can be measured by collecting the gas over water or in a gas syringe.

Phenol, C_6H_5OH, is toxic and corrosive.

Question

You are provided with a solution containing 0.100 mol dm^{-3} of the benzenediazonium ion at a temperature below 10 °C. Describe how, by experiment, you would confirm that the decomposition of the benzenediazonium ion in aqueous solution at 20 °C is first order with respect to the benzenediazonium ion.

Your answer must include

1 A suitable volume of nitrogen to be collected.

2 A suitable volume of the 0.100 mol dm^{-3} benzenediazonium ion solution to be used. Assume that in this experiment the nitrogen collected is at a temperature of 20 °C and a pressure of 100 kPa. (The gas constant $R = 8.31\ J\ K^{-1}\ mol^{-1}$)

3 A labelled diagram of the apparatus you would use.

4 A detailed description of the measurements you would make.

5 An explanation of how you would use your results to confirm that this decomposition is first order with respect to the benzenediazonium ion.

6 Details of the potential hazards, and the relevant safety precautions you would take.

END OF QUESTIONS

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