Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Education
June 2008
Advanced Level Examination

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

Thursday 22 May 2008 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 to be 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**	Titration of a solution of iron(II) sulphate
Exercise 2	**Analysing and Evaluating**	The reaction between hydrogen peroxide and iodide ions
Exercise 3	**Planning**	Determination of the dissociation constant, K_a, of a weak 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.

Key

relative atomic mass — 6.9
Li
Lithium
atomic number — 3

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 †															

* **58 – 71** Lanthanides	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
† **90 – 103** Actinides	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

Gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

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

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Exercise 1 Titration of a solution of iron(II) sulphate

Skill assessed **Implementing** (8 marks)

Introduction

You are provided with an aqueous solution of iron(II) sulphate of concentration approximately 0.1 mol dm^{-3}. Titrate this solution, after acidification, with the 0.0200 mol dm^{-3} solution of potassium manganate(VII) provided.

Wear eye protection at all times.
Assume that all of the solutions are toxic and corrosive.

Procedure

1 Rinse the burette with the potassium manganate(VII) solution provided. Set up the burette and, using a funnel, fill it with the potassium manganate(VII) solution. Record the initial burette reading in the table below.

2 Rinse a pipette with the iron(II) sulphate solution provided. Using this pipette and a pipette filler, transfer 25.0 cm^3 of the iron(II) sulphate solution to a 250 cm^3 conical flask.

3 Using a measuring cylinder, transfer approximately 10 cm^3 of dilute sulphuric acid to the conical flask.

4 Add the potassium manganate(VII) solution from the burette until the mixture in the conical flask has a permanent pink colour. Record your final burette reading in the table below.

5 Rinse the conical flask with water and repeat the titration until you obtain **two** titres which 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 supervisor.

6 Calculate and record the average titre.

Results

Final burette reading/cm^3					
Initial burette reading/cm^3					
Volume of potassium manganate(VII) solution used/cm^3					
Tick the titres to be used in calculating the average titre					

Average titre = ………………… cm^3

For Examiner's use only					
M		C		P	
T		A			

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Turn over ►

Exercise 2 The reaction between hydrogen peroxide and iodide ions

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

Introduction

Acidified hydrogen peroxide reacts with iodide ions to form iodine according to the following equation.

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \longrightarrow I_2(aq) + 2H_2O(l)$$

In an experiment to determine the order of the reaction with respect to iodide ions, measured amounts of sodium thiosulphate solution and starch solution are added to an acidified mixture of hydrogen peroxide and potassium iodide. The **initial rate** of this reaction is investigated by measuring the time taken to produce sufficient iodine to react with the thiosulphate ions present, and then produce a blue colour with starch solution.

A series of experiments is carried out, in which the concentration of iodide ions is varied, while keeping the concentrations of all of the other reagents the same. In each experiment the time taken for the reaction mixture to turn blue is recorded. The results obtained are used to determine the order of reaction with respect to iodide ions.

The rate of the reaction can be represented as (1/time), and the concentration of iodide ions can be represented by the volume of potassium iodide solution used.

A graph of $\log_{10}$ (1/time) on the *y* axis against $\log_{10}$ (volume of KI(aq)) is a straight line. The gradient of this straight line is equal to the order of the reaction with respect to iodide ions.

A set of results is given in the table below. The volumes of potassium iodide solution were measured using a measuring cylinder. The time taken for each mixture to turn blue was recorded on a stopclock graduated in seconds.

Expt.	Volume of KI(aq)/cm^3	$\log_{10}$ (volume of KI(aq))	time/s	$\log_{10}\left(\frac{1}{\text{time}}\right)$
1	5	0.70	68	–1.83
2	8	0.90	45	–1.65
3	10	1.00	36	–1.56
4	15	1.18	25	–1.40
5	20	1.30	22	–1.34
6	25	1.40	16	–1.20

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

1 Use the results given in the table to plot a graph of $\log_{10}$ (1/time) on the *y* axis against $\log_{10}$ (volume of KI(aq)).

Draw a straight line of best fit on the graph, ignoring any anomalous points.

2 Determine the gradient of the line you have drawn.

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3 For the measuring cylinder and the clock, the maximum total errors are shown below. These errors take into account multiple measurements.

measuring cylinder	$\pm$ 0.5 cm^3
clock	$\pm$ 1 second

Estimate the maximum percentage error in using these pieces of apparatus in Experiment 3. Hence calculate the maximum overall percentage error in Experiment 3.

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

1 Consider your graph and comment on the results obtained from the experiments. Is your line of best fit good enough for you to deduce an order with confidence? Identify any anomalous results.

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2 State **two** ways in which the method used in these experiments could be improved, other than by repeating the experiments. In each case explain why the accuracy of the experiment would be improved.

Improvement 1

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Explanation

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Improvement 2

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Explanation

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Turn over ►

Exercise 3 Determining the dissociation constant, K_a, of a weak acid

Skill assessed **Planning** (8 marks)

Introduction

A suitable method for determining the dissociation constant, K_a, of a weak acid involves measuring the pH values of the solution obtained as aqueous alkali is added to a known volume of the aqueous acid, until the alkali is present in considerable excess.

A pH curve can be plotted from the results. This curve can be used to determine the volume of alkali needed at the equivalence point (end-point). When half of this volume of alkali has been added, the pH of the solution is equal to the pK_a of the acid.

Question

Describe how you could determine the dissociation constant, K_a, of the acid.

You are provided with a crystalline sample of the weak monoprotic acid HA and a 0.100 mol dm^{-3} solution of sodium hydroxide. The M_r of the acid is 150 and the acid is soluble in water.

Your answer must include

(a) the scale you would choose for the experiment and a calculation of the mass of acid you would use to prepare your solution.

(b) a detailed description of the experiment you would carry out. You do **not** need to describe how you would prepare the acid solution.

(c) a sketch of the pH curve and an explanation of how you would use this curve to determine the dissociation constant, K_a, of the acid.

(d) details of potential hazards and the relevant safety precautions you would take.

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END OF QUESTIONS

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