Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	2	4	4	/	0	1	Signature	

Paper Reference(s)

6244/01

Edexcel GCE

Chemistry

Advanced

Unit Test 4

Monday 19 June 2006 – Afternoon

Time: 1 hour 30 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
Total	

Materials required for examination
Nil

Items included with question papers
Nil

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature.
Answer **ALL** the questions. Write your answers in the spaces provided in this question paper.
Show all the steps in any calculations and state the units.

Information for Candidates

The total mark for this paper is 75. The marks for individual questions and parts of questions are shown in round brackets: e.g. (**2**). There are 16 pages in this question paper. All blank pages are indicated.
A Periodic Table is printed on the back cover of this booklet.
You may use a calculator.

Advice to Candidates

You are reminded of the importance of clear English and careful presentation in your answers.

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Turn over

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Leave blank

Answer ALL the questions. Write your answers in the spaces provided.

1. (a) Aluminium chloride, Al_2Cl_6, is formed when dry chlorine is passed over heated aluminium.

(i) Write the equation for the reaction between aluminium and chlorine.

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(1)

(ii) What types of bonding exist in aluminium chloride, Al_2Cl_6?

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(2)

(b) Silicon tetrachloride, $SiCl_4$, is vigorously hydrolysed by water.

(i) Write an equation for this hydrolysis reaction.

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(1)

(ii) Suggest, with a reason, a specific safety precaution when **this reaction** is carried out.

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(2)

(c) Carbon also forms a tetrachloride, CCl_4.

(i) State the shape of the CCl_4 molecule.

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(1)

(ii) Explain why carbon tetrachloride is **not** hydrolysed by water.

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(3)

Leave blank

(d) When lead(IV) oxide is added to concentrated hydrochloric acid at room temperature, the following reaction occurs:

$$PbO_2(s) + 4HCl(aq) \rightarrow PbCl_2(s) + Cl_2(g) + 2H_2O(l)$$

What property of lead(IV) oxide is shown by this reaction?

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(1)

(e) A student suggested two possibilities for the reaction between tin(IV) oxide and concentrated hydrochloric acid:

I $SnO_2 + 4HCl \rightarrow SnCl_2 + Cl_2 + 2H_2O$
II $SnO_2 + 4HCl \rightarrow SnCl_4 + 2H_2O$

Use your knowledge of the chemistry of Group 4 to predict which of the above reactions is the more likely. Explain your reasoning.

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(2)

Q1

(Total 13 marks)

Leave blank

2. An organic compound, **A**, with molecular formula $C_5H_{10}O$ contains a carbonyl group.

(a) Compound **A** is reacted with iodine in the presence of alkali. A pale yellow precipitate forms.

(i) What is the **formula** of this precipitate?

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(1)

(ii) What does this reaction indicate about the structure of **A**?

.....

(1)

(iii) Compound **A** has a branched carbon chain.
Draw the structural formula and give the name of **A**.

Formula

Name .....

(2)

(b) Pentanal is a structural isomer of **A**.
When heated with Fehling's solution, it reacts to produce sodium pentanoate and a red precipitate.

(i) Identify the homologous series to which pentanal belongs.

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(1)

(ii) Suggest the identity of the red precipitate formed in this reaction.

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(1)

(c) State a reagent which could be used to convert the sodium pentanoate made in the reaction above into pentanoic acid.

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(1)

Leave blank

(d) Solid sodium hydrogencarbonate, $NaHCO_3$, is reacted with excess concentrated pentanoic acid solution.

(i) State what you would see as this reaction proceeds.

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(1)

(ii) Write a balanced chemical equation for this reaction.

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(2)

Q2

(Total 10 marks)

Leave blank

3. (a) (i) Calculate the pH of 0.050 mol dm^{-3} hydrochloric acid.

(1)

(ii) Calculate the concentration of hydroxide ions, in mol dm^{-3}, in this solution.
At this temperature, $K_w = 1.00 \times 10^{-14}$ mol^2 dm^{-6}.

(1)

(b) Phosphoric(V) acid, H_3PO_4, is a weak acid, forming the following equilibrium in water:

$$H_3PO_4(aq) + H_2O(l) \rightleftharpoons H_2PO_4^-(aq) + H_3O^+(aq)$$

(i) Write an expression for the acid dissociation constant, K_a, for phosphoric(V) acid.

(1)

(ii) Given that a 0.500 mol dm^{-3} solution of phosphoric(V) acid has a pH of 1.20, calculate the value of K_a, stating its units.
Assume that there is no further dissociation of the $H_2PO_4^-$ ion.

(4)

Leave blank

(c) The $H_2PO_4^-$ ion formed when phosphoric(V) acid is added to water can dissociate further into HPO_4^{2-} .

$$H_2PO_4^-(aq) + H_2O(l) \rightleftharpoons HPO_4^{2-}(aq) + H_3O^+(aq)$$

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(i) In the spaces below the equation, identify the acid base conjugate pairs.

(2)

(ii) Explain why very little dissociation of the $H_2PO_4^-$ ion occurs in solutions of phosphoric(V) acid.

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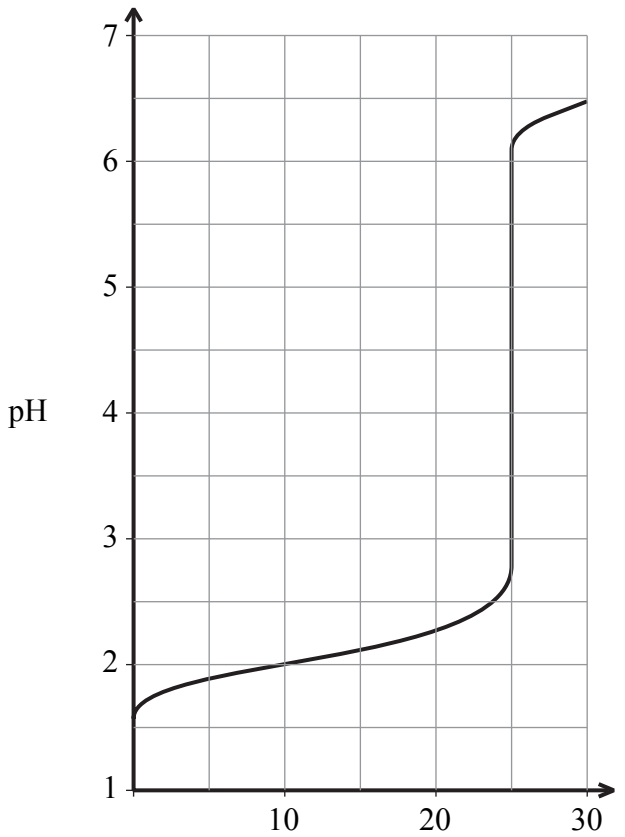
(1)

Leave blank

(d) The change in pH when 25.0 cm^3 of 0.100 mol dm^{-3} phosphoric(V) acid is titrated with sodium hydroxide solution of the same concentration can be seen on the graph below.



From the list below, select a suitable indicator for this titration. Justify your choice.

	pK_{In}
bromocresol green	4.7
bromothymol blue	7.0
phenolphthalein	9.3

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(2)

Q3

(Total 12 marks)

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4. The following data relate to the thermodynamic changes which occur when Group 2 hydroxides dissolve in water.

Enthalpy of hydration of Mg^{2+}	–1890 kJ mol^{-1}
Enthalpy of hydration of Ba^{2+}	–1275 kJ mol^{-1}
Enthalpy of hydration of OH^-	–550 kJ mol^{-1}
Lattice energy of $Mg(OH)_2$	–2995 kJ mol^{-1}
Lattice energy of $Ba(OH)_2$	–2320 kJ mol^{-1}

(a) (i) Define the term **enthalpy of hydration**.

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(2)

(ii) Explain why this enthalpy change is always exothermic.

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(2)

(b) Why is the lattice energy of magnesium hydroxide more exothermic than that of barium hydroxide?

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(3)

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(c) (i) Draw a labelled Hess's law cycle to show how the lattice energy and the enthalpies of hydration are related to the enthalpy of solution of magnesium hydroxide, $Mg(OH)_2(s)$.

(3)

(ii) Use your cycle and the data to calculate the enthalpy of solution of magnesium hydroxide. Include a sign and units with your answer.

(2)

(d) Use the data to explain how the solubility of barium hydroxide compares with that of magnesium hydroxide.

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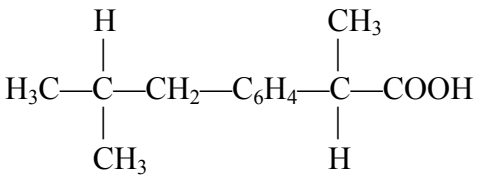
(3)

Q4

(Total 15 marks)

Leave blank

5. The painkilling drug ibuprofen has the formula



(a) (i) **On the diagram above**, circle the chiral centre.

(1)

(ii) Explain what is meant by the term **chiral**.

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(1)

(b) Ibuprofen exists as a pair of optical isomers. How can these two isomers be distinguished?

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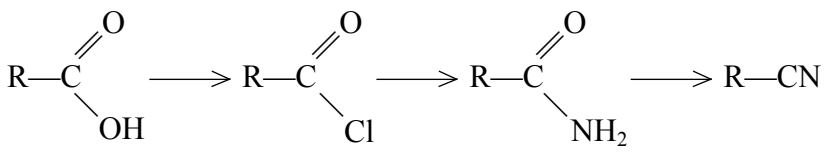
(2)

(c) The formula of ibuprofen can be represented as RCOOH.
Consider the following reaction scheme involving ibuprofen:



Ibuprofen **A** **B** **C**

(i) Suggest reagents for the conversion of:

ibuprofen to **A**,

.....

B to **C**.

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(2)

(ii) Classify the type of reaction converting **A** into **B**.

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(1)

Leave blank

(d) The amide, **B**, can be converted into a primary amine.
Give the reagents for this reaction.

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(2)

(e) Ibuprofen and compound **A** both react with ethanol to form the same organic product.

(i) Draw the structural formula of this product.

You may use R— to represent the same portion of the carbon chain as in (c).

(1)

(ii) Suggest TWO reasons why it is preferable to use **A**, rather than ibuprofen, to carry out this reaction.

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(2)

(f) Compound **C** can be converted back to ibuprofen.
Name the reagent and state the conditions for this reaction.

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(2)

Q5

(Total 14 marks)

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6. Hydrogen sulphide, H_2S, is partially decomposed when heated.

$$2H_2S(g) \rightleftharpoons 2H_2(g) + S_2(g) \qquad \Delta H = +170 \text{ kJ mol}^{-1}$$

0.500 mol of gaseous H_2S were placed in a flask of volume 20.0 dm^3 and heated until equilibrium was reached.

(a) Write an expression for the equilibrium constant, K_c, for this reaction.

(1)

(b) When equilibrium was established, there were 0.350 moles of hydrogen sulphide in the flask.

Calculate the value of K_c at this temperature **to two significant figures**. State its units.

(5)

Leave blank

(c) The pressure in the reaction vessel was increased. By considering any change in K_c, explain the effect on the equilibrium position.

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(3)

(d) State the effect, if any, on the value of K_c of:

(i) adding a catalyst,

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(1)

(ii) increasing the temperature.

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(1)

Q6

(Total 11 marks)

TOTAL FOR PAPER: 75 MARKS

END

THE PERIODIC TABLE

Period	1	2	Group										3	4	5	6	7	0
1	1 H Hydrogen 1																	4 He Helium 2
2	7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
3	23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
4	39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
5	85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
7	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key

Molar mass g mol^{-1}

Symbol

Name

Atomic number

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	(147) Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	(231) Pa Protactinium 91	238 U Uranium 92	(237) Np Neptunium 93	(242) Pu Plutonium 94	(243) Am Americium 95	(247) Cm Curium 96	(245) Bk Berkelium 97	(251) Cf Californium 98	(254) Es Einsteinium 99	(253) Fm Fermium 100	(256) Md Mendelevium 101	(254) No Nobelium 102	(257) Lr Lawrencium 103