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

Thursday 23 June 2005 – Afternoon

Time: 1 hour 30 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
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 in the spaces provided in this question paper.
You may use a calculator. **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.

Advice to Candidates

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

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Answer ALL questions in the spaces provided.

1. (a) (i) State the type of bonding in:

magnesium oxide, MgO .....

sulphur dioxide, SO_2 .....

(2)

(ii) When water is added to magnesium oxide, a solution of pH 11 is formed. When sulphur dioxide is bubbled into water a solution of pH 2 is formed.

Write the equation for each reaction and explain why each solution is **not** neutral.

Magnesium oxide + water

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Sulphur dioxide + water

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(4)

(iii) Explain why silicon dioxide does **not** react with water.

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(3)

Leave blank

(b) Hydrated aluminium chloride, which is ionic, and silicon tetrachloride, which is covalent, both form acidic solutions in water.

(i) Write an ionic equation for the reaction of hydrated aluminium ions with water.

.....

(1)

(ii) Write an equation for the reaction of silicon tetrachloride with water.

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(1)

(c) (i) Tin(IV) chloride is stable to heat, but lead(IV) chloride decomposes at room temperature to lead(II) chloride and chlorine.

What trend in Group 4 does this illustrate?

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(1)

(ii) Suggest how, if at all, tin(II) chloride and lead(II) chloride would react with a solution containing Fe^{3+} ions.

Tin(II) chloride

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Lead(II) chloride

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(3)

Q1

(Total 15 marks)

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2. (a) Electron affinities of an element, such as iodine, can be calculated using a Born-Haber cycle.

	Value/kJ mol^{-1}
Enthalpy of atomisation of calcium, ΔH_a(calcium)	+193
1st ionisation energy of calcium, IE_1	+590
2nd ionisation energy of calcium, IE_2	+1150
Enthalpy of atomisation of iodine, ΔH_a(iodine)	+107
Lattice energy of calcium iodide, ΔH_{latt}	–2074
Enthalpy of formation of calcium iodide, ΔH_f	–534

(i) Define the term **first electron affinity**, EA_1.

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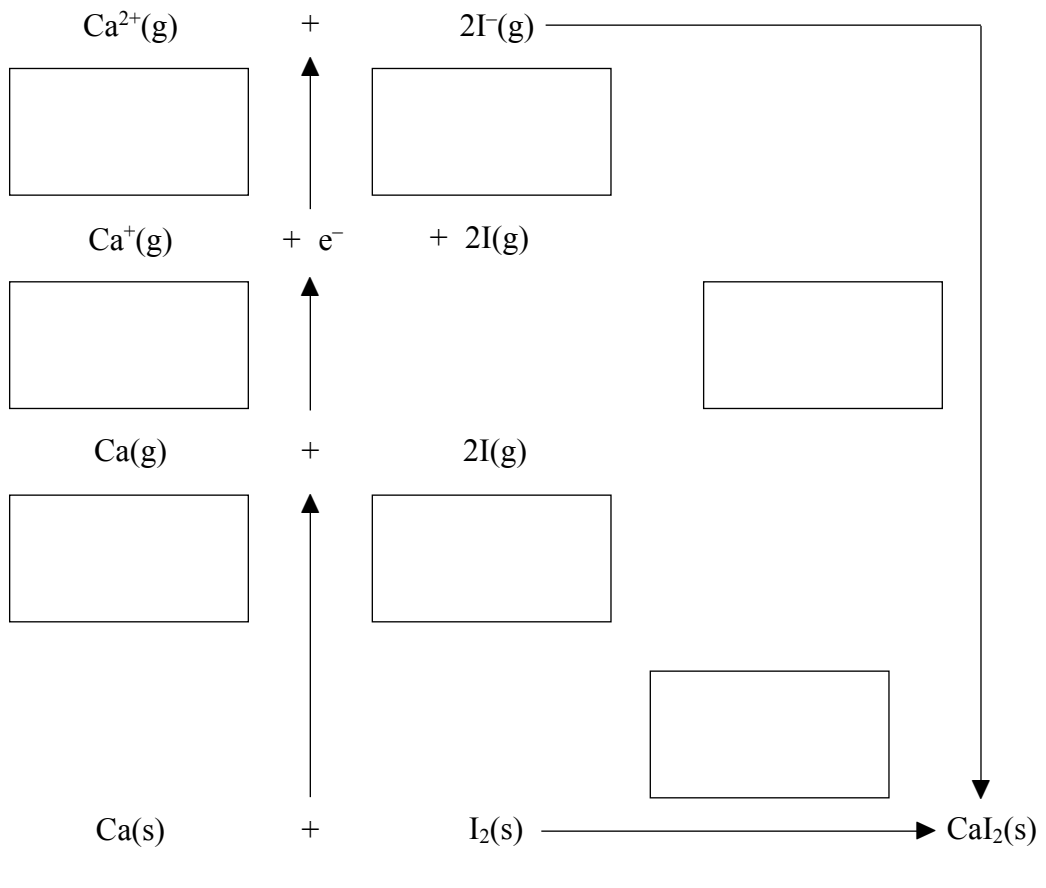
(2)

Leave blank

(ii) Write suitable symbols or values in the boxes to label the Born-Haber cycle below.



(3)

(iii) Use the data to calculate the first electron affinity of iodine, EA_1.

(2)

Leave blank

(b) The values of the lattice energies of potassium iodide and calcium iodide experimentally determined from Born-Haber cycles and theoretically calculated from an ionic model are shown below.

	Experimental lattice energy / kJ mol^{-1}	Theoretical lattice energy / kJ mol^{-1}
Potassium iodide, KI(s)	−651	−636
Calcium iodide, CaI_2(s)	–2074	–1905

(i) Explain why the experimental lattice energy of potassium iodide is less exothermic than the experimental lattice energy of calcium iodide.

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(3)

(ii) Explain why the experimental and theoretical values of the lattice energy are almost the same for potassium iodide, but are significantly different for calcium iodide.

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(3)

Q2

(Total 13 marks)

Leave blank

3. (a) Propanoic acid, CH_3CH_2COOH, can be prepared from carbon dioxide and an organic reagent.

Name this organic reagent and state the conditions for the preparation.

Reagent .....

Conditions .....

.....

(3)

(b) Describe what you would **see** and write the equations for the reactions of propanoic acid with:

(i) a solution of sodium carbonate

Observation .....

Equation .....

(2)

(ii) solid phosphorus pentachloride.

Observation .....

Equation .....

(2)

(c) Propanoic acid can also be prepared from propanal, CH_3CH_2CHO. State the reagents for this conversion.

Reagents .....

(2)

Leave blank

(d) 1-aminobutan-2-ol, $CH_3CH_2CH(OH)CH_2NH_2$, is an active ingredient in some deodorant sprays.

It can be prepared from propanal by the following two-step process.

$$CH_3CH_2CHO \xrightarrow{\textbf{Step 1}} CH_3CH_2CH(OH)CN \xrightarrow{\textbf{Step 2}} CH_3CH_2CH(OH)CH_2NH_2$$

(i) For **Step 1**

State the reagents and conditions.

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Name the type of reaction.

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(3)

(ii) For **Step 2**

State the reagents and conditions.

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Name the type of reaction.

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(3)

Leave blank

(e) Write the structural formula of the organic product formed when 1-aminobutan-2-ol reacts with:

(i) ethanoyl chloride, CH_3COCl

(2)

(ii) hydrochloric acid.

(1)

(f) 1-aminobutan-2-ol exists as two isomers with the same structural formula.

Identify the type of isomerism and draw the TWO isomers, showing clearly the difference between them.

Type of isomerism .....

(3)

Q3

(Total 21 marks)

Leave blank

4. (a) When silver carbonate is heated, it decomposes into silver oxide and carbon dioxide.

$$Ag_2CO_3(s) \rightleftharpoons Ag_2O(s) + CO_2(g)$$

At 227 °C, the value of the equilibrium constant, K_p, is 1.48 atm.

(i) Write the expression for the equilibrium constant, K_p.

(1)

(ii) What is the pressure of carbon dioxide gas when silver carbonate is heated to a temperature of 227 °C in a closed vessel?

(1)

(b) When nitrosyl chloride, NOCl, is heated, it dissociates reversibly into nitric oxide, NO, and chlorine, Cl_2, according to the equation

$$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g) \qquad \Delta H = +75.6\ kJ\ mol^{-1}$$

(i) Write the expression for the equilibrium constant, K_p, for this reaction.

(1)

Leave blank

(ii) 1.00 mol of nitrosyl chloride was placed in a sealed container and heated to 500 °C. Equilibrium was reached when 22.0 % of the nitrosyl chloride had dissociated. The pressure in the vessel was 5.00 atm.

Calculate the value of K_p at this temperature, stating its units.

(5)

(iii) State the effect of an increase in temperature on the value of the equilibrium constant, K_p. Justify your answer.

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(2)

(iv) Hence suggest in which direction the position of equilibrium moves when the temperature is increased. Justify your answer.

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(2)

Q4

(Total 12 marks)

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5. (a) The first step in the esterification of ethanoic acid, CH_3COOH, by ethanol in the presence of a small quantity of concentrated sulphuric acid, is the reaction

$$CH_3COOH + H_2SO_4 \rightarrow CH_3COOH_2^+ + HSO_4^-$$

In the space below the equation, identify the two acid base conjugate pairs.

(2)

(b) Ethanoic acid, CH_3COOH, is a weak acid and dissociates in water according to the equation

$$CH_3COOH(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + CH_3COO^-(aq)$$

Its acid dissociation constant, K_a, is

$$K_a = \frac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]} = 1.74 \times 10^{-5} \text{ mol dm}^{-3} \text{ (at 25 °C)}$$

(i) The concentration of a solution of ethanoic acid can be determined by titrating a 25.0 cm^3 sample in a conical flask against a standard solution of sodium hydroxide.

State whether the pH at the end point is less than 7, 7, or more than 7, and hence name a suitable indicator for this titration.

pH at end point .....

Indicator .....

(2)

(ii) Ethanoic acid is only about 1% ionised in dilute solutions. Its enthalpy of neutralisation is –55 kJ mol^{-1}, whereas the enthalpy of neutralisation of a strong acid, such as hydrochloric acid, is –57 kJ mol^{-1}.

Explain why there is so little difference between these two values.

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(3)

Leave blank

(iii) Calculate the pH of a 0.140 mol dm^{-3} solution of ethanoic acid, clearly showing the TWO assumptions that you have made.

Calculation

Assumptions

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(4)

(iv) To 50.0 cm^3 of the solution in (iii), an equal volume of a 0.200 mol dm^{-3} solution of potassium ethanoate was added. Calculate the pH of the buffer solution obtained.

(3) **Q5**

(Total 14 marks)

TOTAL FOR PAPER: 75 MARKS

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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