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 11 June 2009 – 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

Candidates may use a calculator.

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature.
Check that you have the correct question paper. The paper reference is shown above.
Answer **ALL** the questions. Write your answers in the spaces provided in this question paper.
Do not use pencil. Use blue or black ink.
Show all the steps in any calculations and state the units.

Information for Candidates

The marks for individual questions and parts of questions are shown in round brackets: e.g. **(2)**.
The total mark for this paper is 75. There are 20 pages in this question paper. Any blank pages are indicated.
A Periodic Table is printed on the back cover of this paper.

Advice to Candidates

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

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

1. (a) Sodium oxide, Na_2O, and phosphorus(V) oxide, P_4O_{10}, are both hydrolysed by water.

(i) When water is added to sodium oxide, a solution of sodium hydroxide is formed.

Write the equation for the reaction of sodium oxide with excess water. State symbols are **not** required.

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(1)

(ii) Write the equation, **including state symbols**, for the reaction of phosphorus(V) oxide with water.

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(2)

(iii) State the type of bonding in these two compounds and explain in terms of the bonds present the action of water on each.

Bonding in sodium oxide .....

Bonding in phosphorus(V) oxide .....

Explanation .....

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(4)

Leave blank

(b) Potassium forms a superoxide, KO_2, which reacts with water as follows

$$2KO_2(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2O_2(aq) + O_2(g)$$

Calculate the maximum volume of oxygen produced when 1.2 g of potassium superoxide is added to excess water.

[The molar volume of oxygen under the conditions of the experiment = 24 $dm^3\,mol^{-1}$]

(2) **Q1**

(Total 9 marks)

Leave blank

2. (a) Define the terms

(i) lattice energy

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(2)

(ii) enthalpy of atomisation of an element

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(2)

(b) Calculation of the lattice energy of an ionic compound from a purely ionic model often gives a value that is different from the experimental value obtained from a Born-Haber cycle.

(i) What causes the values to be different for some compounds?

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(1)

(ii) Stating your reasons, suggest which of the substances with formulae MgF_2 or MgI_2 would show the greater difference between the calculated and experimental values of the lattice energy.

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(2) **Q2**

(Total 7 marks)

Leave blank

3. (a) What is meant by a **Brønsted-Lowry acid**?

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(1)

(b) Propanoic acid, CH_3CH_2COOH, dissociates in water and has a K_a value of 1.30×10^{-5} mol dm^{-3} at 25 °C.

$$CH_3CH_2COOH + H_2O \rightleftharpoons CH_3CH_2COO^- + H_3O^+$$

(i) Write the expression for K_a.

(1)

(ii) Calculate the H_3O^+ ion concentration in propanoic acid of concentration 0.100 mol dm^{-3} at 25 °C.

You may assume that $[H_3O^+] = [CH_3CH_2COO^-]$.

(1)

(iii) What other assumption has to be made when calculating the H_3O^+ ion concentration in (ii)? Explain whether it is justified.

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(2)

Leave blank

(c) A solution of sodium propanoate in water is alkaline.

(i) Write an **ionic** equation to show why a solution of sodium propanoate is alkaline.

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(1)

(ii) The pH of a solution of sodium propanoate of concentration 0.100 mol dm^{-3} is 8.94 at 25 °C. Calculate the concentration of the hydroxide ions in this solution.

[$K_w = 1.00 \times 10^{-14}$ mol^2 dm^{-6} at 25 °C]

(2)

(d) An aqueous mixture of propanoic acid and sodium propanoate is a **buffer**.

(i) Explain, using suitable equations, how this mixture acts as a buffer.

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(4)

Leave blank

(ii) Calculate the pH of the buffer obtained when 100 cm^3 of sodium propanoate of concentration 0.150 mol dm^{-3} is mixed with 200 cm^3 of propanoic acid of concentration 0.100 mol dm^{-3}.

[K_a for propanoic acid = 1.30×10^{-5} mol dm^{-3} at 25 °C]

(4)

(iii) Explain why the pH of this buffer does **not** change when it is diluted with water.

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(1)

Q3

(Total 17 marks)

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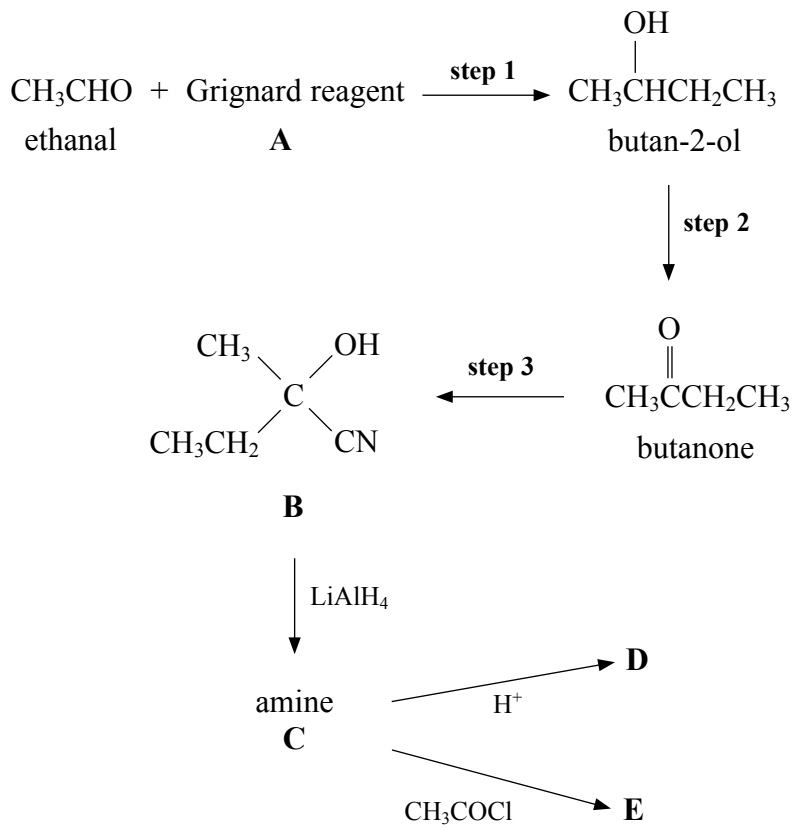
4. This question concerns the following reaction scheme.



(a) Give the formula of a Grignard reagent, **A**, that could be used in **step 1**.

(1)

(b) (i) Give the reagents required for the conversion of butan-2-ol into butanone in **step 2**.

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(1)

Leave blank

(ii) Draw an apparatus suitable for performing **step 2**.

(3)

(c) (i) Identify the reagent needed to convert butanone into compound **B** in **step 3**.

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(1)

(ii) On treating **B** with lithium aluminium hydride in dry ether, followed by acid hydrolysis, a compound **C** containing an amine group is obtained.

Give the structural formula of compound **C**.

(1)

Leave blank

(d) (i) Give the structural formula of compound **D**, obtained when compound **C** is treated with a dilute acid.

(1)

(ii) Give the structural formula of compound **E**, obtained when compound **C** is treated with ethanoyl chloride, CH_3COCl.

(2)

Leave blank

(e) Butan-2-ol molecules are chiral.

(i) What is meant by a **chiral molecule**?

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(1)

(ii) How is chirality detected experimentally?

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(1)

(iii) When ethanal reacts with a Grignard reagent to give butan-2-ol, the product mixture does **not** give a positive result with the test in (ii) above. By considering the shape of the ethanal molecule, suggest why this is so.

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(3)

Q4

(Total 15 marks)

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5. (a) The chemistry of the elements of Group 4 changes from non-metallic to metallic as the atomic number of the element increases.

State how this change affects:

(i) the acid-base properties of CO_2 and PbO.

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(2)

(ii) the physical state at room temperature and the bonding in each of $SiCl_4$ and $PbCl_2$.

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(2)

(b) Give the equation for the reaction between silicon dioxide and molten sodium hydroxide. State symbols are **not** required.

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(1)

Leave blank

(c) (i) Draw and explain the shape of a carbon tetrachloride, CCl_4, molecule.

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(3)

(ii) Explain why carbon tetrachloride is a covalent rather than an ionic compound, using the following information.

$C(graphite) \rightarrow C^{4+}(g)$ $\Delta H = +15\,000\ kJ\ mol^{-1}$

Ionic radius: $C^{4+} = 0.015$ nm

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(3)

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(d) Tin(IV) oxide and lead(IV) oxide react with concentrated hydrochloric acid as follows

Reaction I $SnO_2 + 4HCl \rightarrow SnCl_4 + 2H_2O$

Reaction II $PbO_2 + 4HCl \rightarrow PbCl_2 + Cl_2 + 2H_2O$

(i) What type of reaction is **reaction I**?

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(1)

(ii) What type of reaction is **reaction II**? Justify your answer.

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(2)

(iii) Explain the reason for the difference in the behaviour of tin(IV) oxide and lead(IV) oxide with concentrated hydrochloric acid.

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(2)

Q5

(Total 16 marks)

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6. When ethanol and ethanoic acid are heated under reflux in the presence of a little concentrated sulphuric acid catalyst, the following equilibrium is set up:

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

(a) (i) What is meant by the term **concentration** of a substance as used in the expression for K_c?

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(1)

(ii) Write the expression for the equilibrium constant in terms of concentration, K_c, for the equilibrium given above.

(1)

(b) In an experiment to determine K_c, 5.00 mol of ethanoic acid and 3.00 mol of ethanol were heated under reflux until equilibrium was established.

At equilibrium, 2.43 mol of ester was obtained. The total volume of the liquid, V dm^3, remained unchanged during the reaction.

(i) What is the concentration of the ester at equilibrium?

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(1)

(ii) How many moles of water are produced in the reaction?

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(1)

Leave blank

(iii) Calculate the value of K_c.

(4)

(iv) Explain whether K_c has units.

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(1)

(c) ΔH for the reaction is zero. What is the effect, if any, on the value of K_c of

(i) an increase in temperature?

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(1)

(ii) the absence of a catalyst?

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(1) **Q6**

(Total 11 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