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 23 January 2006 – Morning

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 20 pages in this question paper. Any 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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edexcel

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

1. (a) Write the equation to show the combustion of each of the following elements in **excess** oxygen. State symbols are **not** required.

(i) Sodium

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(1)

(ii) Phosphorus

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(2)

(b) Aluminium reacts with oxygen to form aluminium oxide, Al_2O_3, which is amphoteric. Write **ionic** equations to show the amphoteric behaviour of this oxide.

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(3)

Leave blank

(c) Magnesium hydroxide, $Mg(OH)_2$, is sparingly soluble in water, where it establishes the equilibrium:

$$Mg(OH)_2(s) + aq \rightleftharpoons Mg^{2+}(aq) + 2OH^-(aq)$$

The expression for the equilibrium constant, K, is given by the equation

$$K = [Mg^{2+}] [OH^-]^2$$

(i) State the units of this expression for K.

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(1)

(ii) Several grams (an excess) of magnesium hydroxide are added to 1 dm^3 of water at 298 K. The solution becomes saturated when 1.31×10^{-4} moles of magnesium hydroxide has dissolved.

Calculate the pH of this solution, given that $K_w = 1.00 \times 10^{-14}$ mol^2 dm^{-6} at 298 K.

(3)

Leave blank

(d) Magnesium hydroxide is a basic solid which readily reacts with acids to form an aqueous salt.

(i) Give the equation, including state symbols, for the reaction between magnesium hydroxide and dilute sulphuric acid.

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(2)

(ii) Explain why the reaction between solid barium hydroxide and excess dilute sulphuric acid does **not** give a good yield.

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(2)

Q1

(Total 14 marks)

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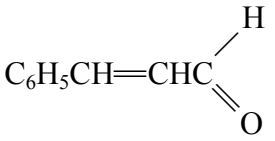
2. Cinnamaldehyde is the chief constituent of oil of cinnamon.

The structural formula of the molecule is 

(a) To show the presence of the carbonyl group, a few drops of a solution of 2,4-dinitrophenylhydrazine are added to a sample of cinnamaldehyde.

(i) What observation is made in the reaction above?

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(1)

(ii) Give the structure of the organic product of this reaction.

(2)

(iii) Suggest a further reaction, including the result, to show that cinnamaldehyde contains an aldehyde group.

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(2)

(iv) Why does the reaction you have given in (iii) **not** give a positive result with a ketone?

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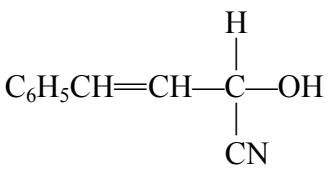
(1)

Leave blank

(b) Cinnamaldehyde can be converted into compound **A**



(i) Give the reagents and conditions which bring about this conversion.

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(2)

(ii) State, with a reason, how many stereoisomers exist for compound **A**.

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(2)

(c) Compound **A** reacts with lithium tetrahydridoaluminate(III), $LiAlH_4$. The mixture is then treated with dilute acid to give the final organic product.

(i) Name the type of reaction occurring between compound **A** and $LiAlH_4$.

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(1)

(ii) Draw the structural formula of the final organic product.

(1)

Leave blank

(d) Cinnamaldehyde reacts with the Grignard reagent ethyl magnesium bromide, C_2H_5MgBr.

(i) Name the solvent used to prepare the Grignard reagent.

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(1)

(ii) Why is it important to keep the solvent dry?

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(1)

(iii) Draw the structural formula of the organic product formed when cinnamaldehyde reacts with C_2H_5MgBr, and the intermediate is hydrolysed.

(1)

(iv) State the type of alcohol formed in (d)(iii).

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(1)

Q2

(Total 16 marks)

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3. The colourless gas dinitrogen tetroxide, N_2O_4, dissociates into the brown gas nitrogen dioxide, NO_2.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H = +58.1 \text{ kJ mol}^{-1}$$

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

(1)

(b) At 400 K and a pressure of 6.75 atm, dinitrogen tetroxide is 80% dissociated.

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

(5)

Leave blank

(c) A sealed vessel containing an equilibrium mixture of the gases is warmed gently.

(i) By considering the change, if any, in the value of K_p, explain what happens to the equilibrium mixture as the temperature is increased.

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(3)

(ii) What would you observe as the equilibrium mixture is heated?

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(1)

Q3

(Total 10 marks)

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4. (a) Define the term **enthalpy of atomisation** and give an equation to show the change which occurs when it is measured for iodine.

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Equation .....

(3)

(b) (i) Construct a Born-Haber cycle for the formation of lithium iodide, LiI(s).

(2)

Leave blank

(ii) Use your cycle and the data below to calculate the lattice energy of lithium iodide.

Enthalpy of atomisation of lithium	+159 kJ mol^{-1}
Enthalpy of atomisation of iodine	+107 kJ mol^{-1}
First ionisation energy of lithium	+520 kJ mol^{-1}
Electron affinity of iodine	–295 kJ mol^{-1}
Enthalpy of formation of lithium iodide, LiI(s)	–270 kJ mol^{-1}

(2)

(c) The theoretical value of the lattice energy of magnesium iodide, MgI_2, is –1944 kJ mol^{-1}.

The actual value calculated from a Born-Haber cycle is –2327 kJ mol^{-1}.

Explain why this difference occurs.

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(3)

Q4

(Total 10 marks)

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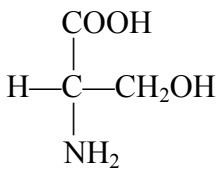
5. (a) Silk contains the amino acid, serine.



(i) Draw the structure of the species present in solid serine which causes it to be a solid at room temperature.

(1)

(ii) Explain why this structure causes serine to have a high melting temperature.

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(2)

Leave blank

(b) Draw the structural formula of the organic product formed when serine reacts with:

(i) hydrogen ions

(1)

(ii) hydroxide ions

(1)

(iii) ethanoyl chloride.

(1)

Leave blank

(c) Terylene, a polyester, can be made from the dicarboxylic acid, HOOC–C_6H_4–COOH, and ethane-1,2-diol.

(i) Draw the structural formula of ethane-1,2-diol.

(1)

(ii) Draw the repeat unit of the polyester formed from these monomers, showing all the bonds in the ester link.

(2)

Leave blank

(d) Methanol is produced when the ester, methyl ethanoate, reacts with sodium hydroxide solution.

$$CH_3COOCH_3 + NaOH \longrightarrow CH_3COONa + CH_3OH$$

It is also produced when methyl ethanoate reacts with an acid such as hydrochloric acid.

(i) Classify the type of reaction taking place between methyl ethanoate and sodium hydroxide solution.

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(1)

(ii) Explain why it is better to make methanol by reacting methyl ethanoate with sodium hydroxide solution, rather than with hydrochloric acid.

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(2)

Q5

(Total 12 marks)

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6. The weak acid methanoic acid, HCOOH, sets up the following equilibrium in water at 298 K:

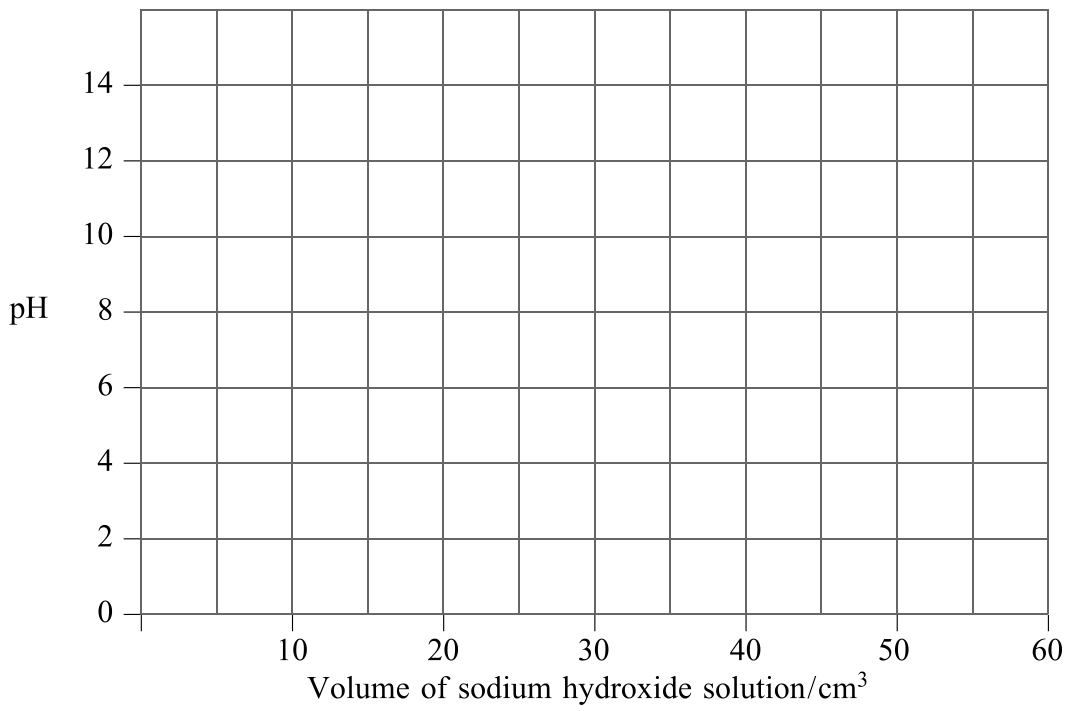
$$HCOOH(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + HCOO^-(aq)$$

The acid dissociation constant, K_a, for methanoic acid at 298 K is 1.78×10^{-4} mol dm^{-3}.

(a) A 0.200 mol dm^{-3} solution of methanoic acid has a pH of 2.2 at 298 K.

20.0 cm^3 of this solution is titrated with 0.100 mol dm^{-3} sodium hydroxide solution until excess alkali has been added.

On the grid below, sketch the titration curve you would expect for this reaction.



(4)

(b) Equal volumes of 0.500 mol dm^{-3} methanoic acid and 0.250 mol dm^{-3} sodium methanoate solution are mixed to make a buffer solution.

(i) Define the term **buffer solution**.

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(2)

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(ii) Calculate the pH of this buffer solution.

(3)

(iii) Explain, with the aid of equations, how this mixture acts as a buffer solution.

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(4) **Q6**

(Total 13 marks)

TOTAL FOR PAPER: 75 MARKS

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THE PERIODIC TABLE

Period	1	2											3	4	5	6	7	0
	Group																	
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