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

Tuesday 20 January 2009 – 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

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 question paper.

Advice to Candidates

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

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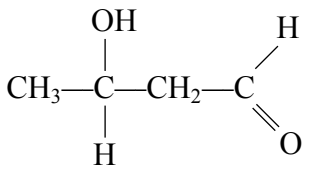
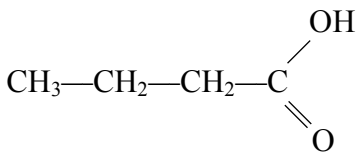
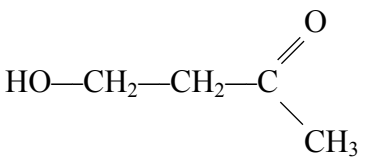
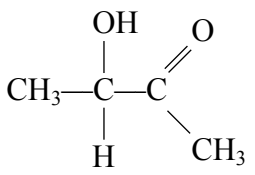
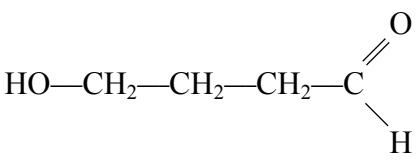
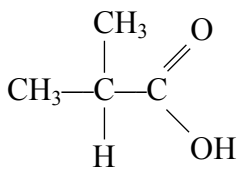
Answer ALL the questions. Write your answers in the spaces provided.

1. The table below shows the structure of six compounds with the molecular formula $C_4H_8O_2$.

 **A**	 **B**
 **C**	 **D**
 **E**	 **F**

(a) Complete the following table, **using letters A–F**, to show which of the compounds have the properties described:

	Property	Compounds
(i)	react with Fehling's solution	
(ii)	**cannot** be oxidised by acidified potassium dichromate(VI) solution	
(iii)	give a yellow precipitate when mixed with a solution of sodium hydroxide and iodine	
(iv)	are chiral	

(9)

Leave blank

(b) There are other compounds with the same molecular formula, $C_4H_8O_2$, which show geometric (cis-trans) isomerism.

Draw the cis and trans structures of an isomer of $C_4H_8O_2$.

(2)

Q1

(Total 11 marks)

Leave blank

2. Vinegar is a dilute solution of the weak acid, ethanoic acid, CH_3COOH.

(a) Explain the meaning of the terms **dilute** and **weak** as applied to ethanoic acid solutions.

Dilute .....

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Weak .....

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(2)

(b) (i) Write an expression for the acid dissociation constant, K_a, for ethanoic acid.

(1)

(ii) A solution of ethanoic acid of concentration 0.0250 mol dm^{-3} has a pH of 3.20.

Calculate the value of K_a for ethanoic acid. Include a unit in your answer.

(4)

Leave blank

(iii) **Justify** any assumptions that you made in your calculation.

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(2)

QUESTION 2 CONTINUES ON THE NEXT PAGE

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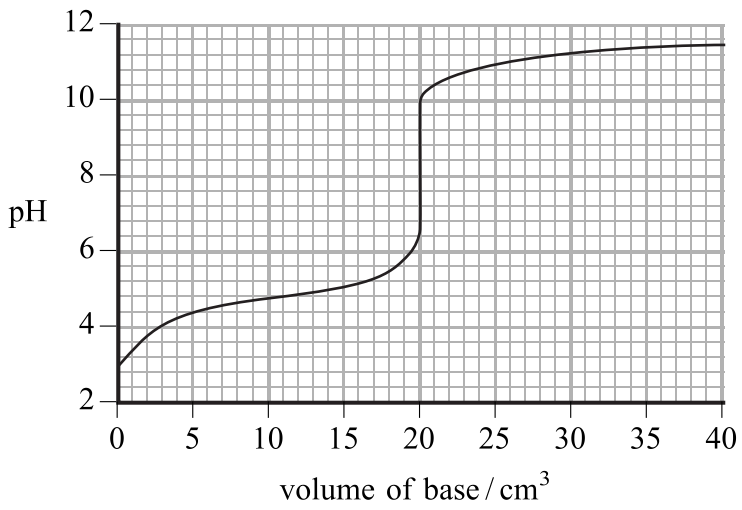
(c) The graph below shows the variation of pH during the titration of 20.00 cm^3 of 0.0250 mol dm^{-3} ethanoic acid with 0.0250 mol dm^{-3} sodium hydroxide solution.



(i) Explain, in detail, why the pH of the mixture of ethanoic acid and sodium ethanoate, produced during the titration, does **not** change very much between the addition of 5 and 15 cm^3 of the sodium hydroxide solution.

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(4)

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(ii) The pK_{Ind} value for methyl orange is 3.7 and for phenolphthalein is 9.3.

Mark on the graph the pH range over which methyl orange and phenolphthalein change colour.

Use this information, and the colours of the indicators at different pH values, to explain why methyl orange cannot be used to find the end-point of this titration whereas phenolphthalein can.

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(4)

(d) Fizzy drinks are an aqueous solution of carbon dioxide dissolved under pressure. The equilibrium involved is:

$$CO_2(aq) + H_2O(l) \rightleftharpoons HCO_3^-(aq) + H^+(aq)$$

Use this equilibrium to explain what happens to the pH of the fizzy drink when the pressure is released and carbon dioxide gas escapes.

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(2)

Q2

(Total 19 marks)

Leave blank

3. In the synthesis of ammonia, the equilibrium involved is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The equilibrium mixture, at a pressure of 160 atm and a temperature of 770 K, contained 0.900 mol of nitrogen, 2.70 mol of hydrogen and 0.200 mol of ammonia.

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

(1)

(ii) Calculate the partial pressures of nitrogen, hydrogen and ammonia in the equilibrium mixture.

(3)

(iii) Calculate the value of K_p at 770 K.

(1)

Leave blank

(b) The value for K_p at 500 K for this equilibrium is $3.55 \times 10^{-2}\,atm^{-2}$. Use your answer from (a)(iii) to state whether the reaction is exothermic or endothermic. Give a reason for your answer.

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(1)

(c) State the effect, if any, on the **rate** of attainment of the equilibrium when

(i) the temperature of the system is increased

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(1)

(ii) a catalyst is added.

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(1)

(d) Doubling the partial pressure of either hydrogen or nitrogen in the system (at constant temperature) increases the equilibrium yield of ammonia. Doubling the partial pressure of hydrogen has the greater effect.

Explain this using your equilibrium expression from (a)(i).

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(3)

Q3

(Total 11 marks)

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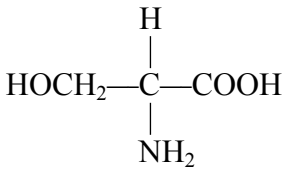
4. Serine is a naturally-occurring amino acid found in silk protein. It has the following structure



(a) Give the systematic name for serine.

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(1)

(b) Draw the structural formulae of the organic compounds produced when serine reacts with the following reagents.

(i) Lithium aluminium hydride, $LiAlH_4$

(1)

(ii) Dilute hydrochloric acid, HCl(aq)

(1)

(iii) Ethanoyl chloride, CH_3COCl

(1)

Leave blank

(c) Naturally-occurring serine is one of a pair of optical isomers.

(i) Draw diagrams to show the three-dimensional structures of the two isomers.

(2)

(ii) What physical property could be measured to distinguish between solutions of the two isomers?

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(1)

(iii) How would the measurements differ for the two isomers?

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(1)

Leave blank

(d) Under certain conditions serine can be polymerised to produce two different polymers, one a polyamide and the other a polyester.

Draw the repeating unit of each polymer **showing the double bond in the unit**.

(i) Polyamide

(2)

(ii) Polyester

(2)

Q4

(Total 12 marks)

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5. (a) Define the term **lattice energy**.

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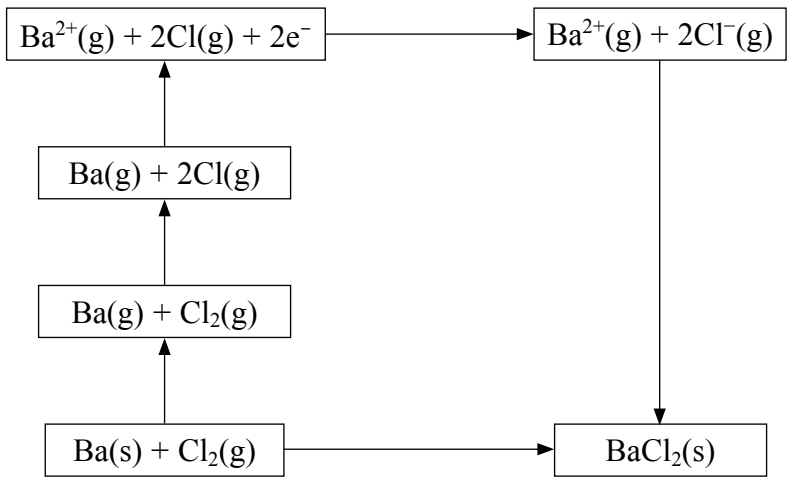
(2)

(b) Use the energy cycle and the data to calculate the lattice energy of barium chloride.



	Value / kJ mol^{-1}
Enthalpy of formation of $BaCl_2(s)$	− 859
Enthalpy of atomisation of barium	+ 180
Enthalpy of atomisation of chlorine	+ 122
1^{st} + 2^{nd} ionisation energy of barium	+ 1468
Electron affinity of chlorine	− 349

Calculation

(3)

Leave blank

(c) (i) Explain how comparison of lattice energies from the Born-Haber cycle with theoretical lattice energies provides evidence for the nature of the bonding in the chlorides of the Group 2 metals.

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(2)

(ii) Explain the difference in bonding between beryllium and chlorine and that between barium and chlorine.

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(2) **Q5**

(Total 9 marks)

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6. (a) Lead(II) oxide, PbO, is amphoteric. Write equations to show this property.

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(3)

(b) Lead(IV) oxide, PbO_2, reacts with concentrated hydrochloric acid to produce a white crystalline solid, lead(II) chloride, $PbCl_2$, and chlorine.

Tin(IV) oxide, SnO_2, reacts with concentrated hydrochloric acid to give a colourless liquid, tin(IV) chloride, $SnCl_4$.

(i) Suggest the type of bonding in lead(II) chloride and tin(IV) chloride.

$PbCl_2$ .....

$SnCl_4$ .....

(2)

(ii) Explain, in terms of the relative stability of the oxidation states of lead and tin, why lead(IV) oxide and tin(IV) oxide react in different ways with concentrated hydrochloric acid.

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(2)

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(c) (i) Write equations to show the reactions of phosphorus(III) chloride, PCl_3, and phosphorus(V) chloride, PCl_5, with water.

phosphorus(III) chloride

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phosphorus(V) chloride

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(3)

(ii) When sodium chloride and phosphorus(III) chloride are separately added to water, solutions of different pH are produced. Suggest the likely pH for each solution and explain the difference.

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(3) **Q6**

(Total 13 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