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 22 January 2008 – 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.
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.

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) State the type of bonding in

(i) sodium oxide, Na_2O .....

(1)

(ii) silicon dioxide, SiO_2 .....

(1)

(b) State the acid-base character of

(i) sodium oxide, Na_2O .....

(1)

(ii) silicon dioxide, SiO_2 .....

(1)

(c) Write an equation for the reaction between

(i) sodium oxide, Na_2O, and phosphoric acid, H_3PO_4.
State symbols are **not** required.

.....

(1)

(ii) silicon dioxide, SiO_2, and sodium hydroxide, NaOH.
State symbols are **not** required.

.....

(1)

(d) Aluminium oxide, Al_2O_3, is amphoteric and so reacts with solutions of acids and alkalis.

Write **ionic** equations, **including state symbols**, to show the amphoteric nature of this oxide.

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(3)

Leave blank

(e) Lead(IV) oxide, PbO_2, is a strong oxidising agent.

Give the equation for the reaction between lead(IV) oxide and hot concentrated hydrochloric acid. State symbols are **not** required.

.....

(1)

(f) An aqueous solution of tin(II) ions reacts with an aqueous solution of iodine to produce iodide ions, whereas there is no reaction between aqueous lead(II) ions and iodine.

Explain the difference in behaviour between aqueous tin(II) ions and lead(II) ions.

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(2)

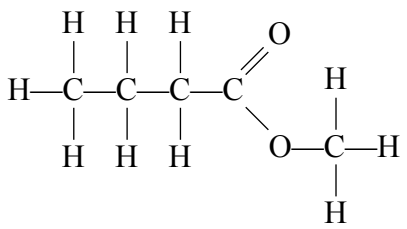
Q1

(Total 12 marks)

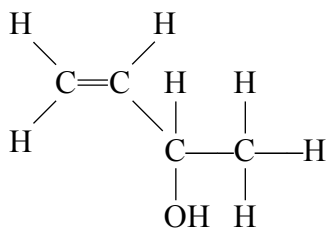
Leave blank

2. Consider the following compounds.

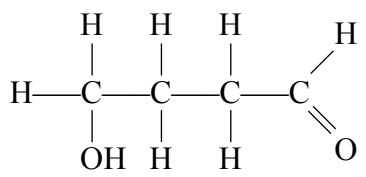
Compound X



Compound Y



Compound Z



(a) Name the functional groups present in the three compounds **X**, **Y** and **Z**.

Compound	Functional groups present
X	
Y	
Z	

(3)

Leave blank

(b) Compounds **X**, **Y** and **Z** are heated separately with alkaline ammoniacal silver nitrate solution.

Draw the full structural formula, showing all bonds, of any **organic product** formed.

If a reaction does **not** occur, write **'no reaction'**.

Product from X

Product from Y

Product from Z

(3)

Leave blank

(c) Draw the formulae of the organic products formed by the reaction of

(i) **X**, $CH_3CH_2CH_2COOCH_3$, with aqueous sodium hydroxide solution.

(2)

(ii) **Y**, $CH_2CHCH(OH)CH_3$, with iodine in the presence of aqueous sodium hydroxide solution.

(2)

(iii) **Z**, $CH_2(OH)CH_2CH_2CHO$, with hydrogen cyanide.

(1)

Q2

(Total 11 marks)

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3. (a) The equilibrium between hydrogen iodide, hydrogen and iodine was investigated by sealing hydrogen iodide in glass tubes and heating the tubes at 698 K until equilibrium was reached.

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g) \qquad \Delta H = +\ 9.4\ kJ\ mol^{-1}$$

The glass tubes were cooled rapidly and then opened in a solution of potassium iodide so that the concentration of iodine at equilibrium could be determined by titration.

(i) Suggest why the reaction mixture was **cooled rapidly**.

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(2)

(ii) The expression for the equilibrium constant, K_c, for the above reaction is

$$K_c = \frac{[H_2(g)][I_2(g)]}{[HI(g)]^2}$$

One of the tubes was found to contain iodine at a concentration of 5.0×10^{-4} mol dm^{-3}.

Calculate the equilibrium concentration of hydrogen iodide, in mol dm^{-3}.
The equilibrium constant, K_c, for the above reaction is 0.019 at 698 K.

(3)

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(b) In a different experiment, 1.0 mol of hydrogen and 1.0 mol of iodine were allowed to reach equilibrium at 698 K.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

At equilibrium, 80% of the hydrogen was converted to hydrogen iodide at a total pressure of 1.1 atm.

(i) Write an expression for the equilibrium constant, K_p, for the reaction as shown.

(1)

(ii) Calculate the value of K_p.

(4)

(iii) Explain why, in this case, K_p has no units.

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(1)

Q3

(Total 11 marks)

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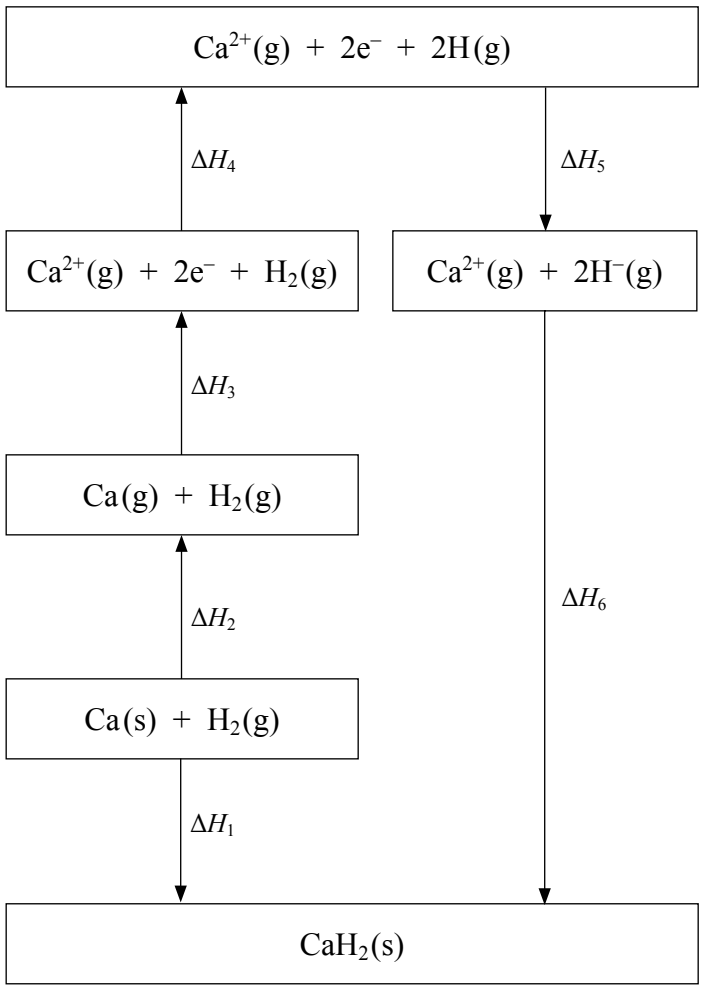
4. The Born-Haber cycle below represents the enthalpy changes when calcium hydride, CaH_2, is formed from its elements.



(a) Write down in terms of **one** of the symbols ΔH_1 to ΔH_6

(i) the lattice energy of calcium hydride .....

(1)

(ii) the first electron affinity of hydrogen .....

(1)

Leave blank

(b) Use the data below to calculate the standard enthalpy of formation of calcium hydride, $CaH_2(s)$.

	value / kJ mol^{-1}
enthalpy of atomisation of calcium	+178
first plus second ionisation energies of calcium	+1735
enthalpy of atomisation of hydrogen	+218
first electron affinity of hydrogen	–73
lattice energy of calcium hydride	–2389

Calculation:

(2)

(c) Explain why the lattice energy of magnesium hydride, $MgH_2(s)$, is more exothermic than the lattice energy of calcium hydride, $CaH_2(s)$.

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(3)

Leave blank

(d) (i) In order to calculate the enthalpy of solution of an ionic compound, the lattice energy of the compound and the enthalpies of hydration of the ions present must be known.

Define the term **enthalpy of hydration**, ΔH_{hyd}.

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(2)

(ii) Explain why the enthalpy of hydration of anions and cations are both exothermic.

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(2)

(Total 11 marks)

Q4

Leave blank

5. This question is about propanoic acid, CH_3CH_2COOH.

(a) Propanoic acid is a weak acid which dissociates as follows

$$CH_3CH_2COOH(aq) + H_2O(l) \rightleftharpoons CH_3CH_2COO^-(aq) + H_3O^+(aq)$$

(i) In the above equation there are two conjugate acid-base pairs.

Identify them by completing the sentences below

Formula of one acid is .....

The formula of its conjugate base is .....

Formula of the other acid is .....

The formula of its conjugate base is .....

(2)

(ii) Propanoic acid is a weak acid. Explain what is meant by the term **weak acid**.

Weak

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Acid

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(2)

Leave blank

(b) The acid dissociation constant, K_a, for propanoic acid is 1.30×10^{-5} mol dm^{-3} at 298 K.

(i) Write the expression for the acid dissociation constant, K_a, for propanoic acid.

(1)

(ii) A solution of propanoic acid has a pH of 3.44 at a temperature of 298 K.

Calculate the concentration, in mol dm^{-3}, of the propanoic acid solution. Show clearly **two** assumptions you have made.

Calculation:

Assumptions:

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(5)

Leave blank

(c) An aqueous solution of propanoic acid was titrated with sodium hydroxide.
At the equivalence point, the resulting solution of sodium propanoate had a pH greater than 7. Explain, with the aid of a suitable equation, why this is so.

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(2)

(d) A mixture of sodium propanoate and propanoic acid acts as a buffer solution.

(i) What is meant by a **buffer solution**?

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(2)

(ii) Calculate the pH of a buffer solution made by mixing 100 cm^3 of 0.0100 mol dm^{-3} propanoic acid solution with 300 cm^3 of 0.00500 mol dm^{-3} sodium propanoate solution at 298 K.

[K_a for propanoic acid is 1.30×10^{-5} mol dm^{-3} at 298 K]

(3) **Q5**

(Total 17 marks)

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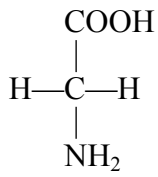
6. (a) Glycine is an amino acid.



(i) Draw the full structural formula of the zwitterion of glycine, showing **all** bonds.

(1)

(ii) Explain how the zwitterion in glycine is formed.

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(1)

(iii) Use your answer to (i) to explain why glycine has a high melting temperature of 262 °C.

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(2)

Leave blank

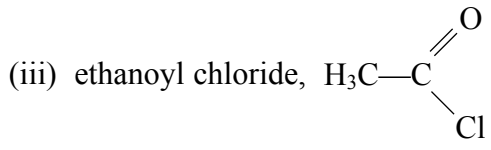
(b) Suggest the formula of the organic product formed when glycine reacts, under suitable conditions, with

(i) hydrogen ions, H^+

(1)

(ii) hydroxide ions, OH^-

(1)

(iii) ethanoyl chloride, 

(1)

(iv) methanol, CH_3OH

(1)

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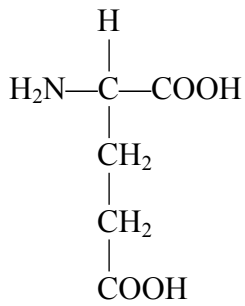
(c) Glutamic acid is also an amino acid. The formula of glutamic acid is shown below



Glutamic acid exists as two optical isomers whereas glycine does not.

(i) Why is glutamic acid chiral?

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(1)

(ii) How can the two optical isomers of glutamic acid be distinguished from each other?

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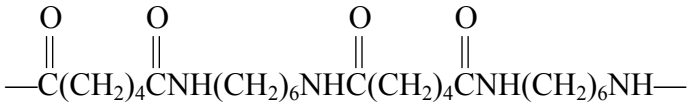
(2)

Leave blank

(d) A section of the polymer nylon-6,6 is shown below



Give the formulae of TWO monomers which could react together, under suitable conditions, to form nylon-6,6.

(2) **Q6**

(Total 13 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