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 18 June 2007 – 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.
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 16 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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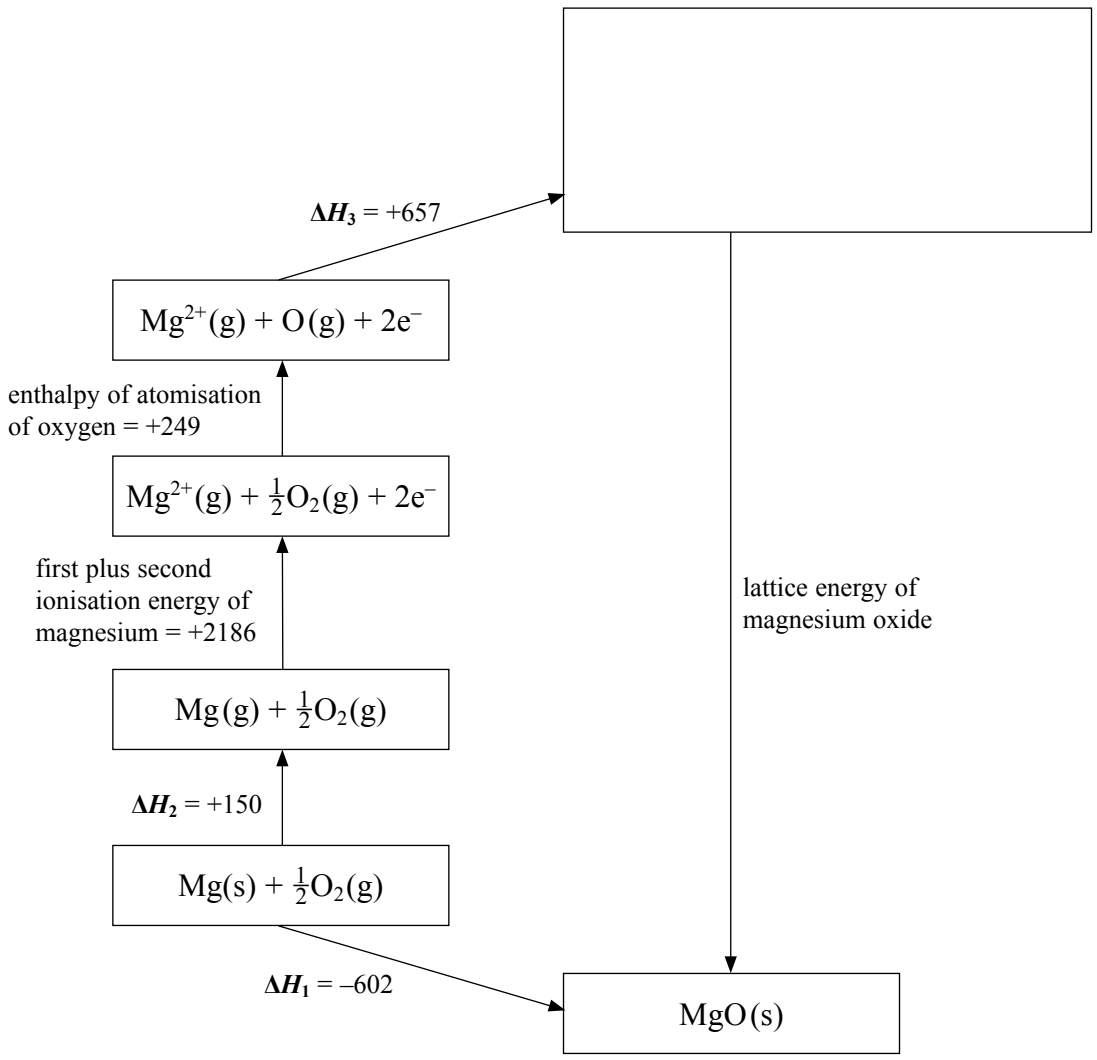
Answer ALL the questions. Write your answers in the spaces provided.

1. (a) An incomplete Born-Haber cycle for the formation of magnesium oxide, MgO, from its constituent elements is shown below. All numerical values are in kJ mol^{-1}.



(i) Complete the empty box on the cycle by writing in the formulae of the missing species. State symbols are required.

(1)

(ii) Identify each of the following enthalpy changes by name:

ΔH_1 .....

ΔH_2 .....

ΔH_3 .....

(3)

Leave blank

(iii) Use the Born-Haber cycle to calculate the lattice energy of magnesium oxide.

(2)

(b) Magnesium iodide is another compound of magnesium. The radius of the magnesium ion is 0.072 nm, whereas the radius of the iodide ion is much larger and is 0.215 nm.

(i) Describe the effect that the magnesium ion has on an iodide ion next to it in the magnesium iodide lattice.

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(1)

(ii) What TWO quantities must be known about the ions in a compound in order to calculate a theoretical lattice energy?

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(2)

(iii) Suggest how the value of the theoretical lattice energy would compare with the experimental value from a Born-Haber Cycle for magnesium iodide.

Give a reason for your answer.

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(2)

Leave blank

(c) (i) Define the term **enthalpy of hydration**, ΔH_{hyd}, of an ion.

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(2)

(ii) The table below gives some information about the sulphates of the Group 2 elements magnesium and barium.

sulphate	**lattice energy / kJ mol^{-1}**	**hydration enthalpy of cation / kJ mol^{-1}**	**solubility / mol dm^{-3}**
$MgSO_4$	–2874	–1920	1.83
$BaSO_4$	–2374	–1360	9.43×10^{-6}

Use the lattice energy and hydration enthalpy values to explain the difference in the solubility of the two salts.

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(4)

Q1

(Total 17 marks)

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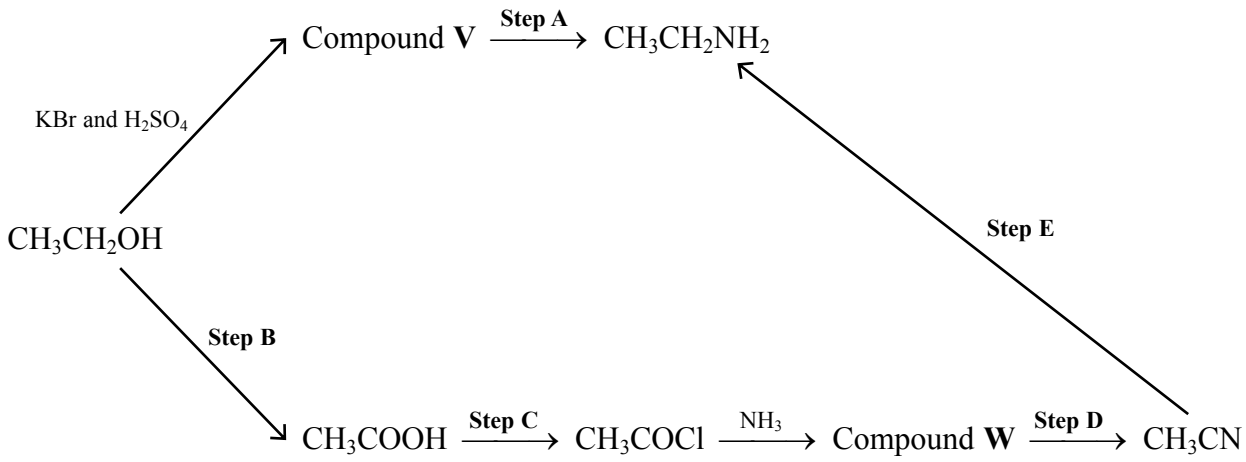
2. **Ethanol** can be converted into **ethylamine** by two different routes.



(a) Identify organic compounds **V** and **W** by writing their full structural formulae showing all bonds.

V

W

(2)

(b) Identify the reagents used in Steps A to E.

Step A .....

Step B .....

Step C .....

Step D .....

Step E .....

(6)

Leave blank

(c) (i) What **type** of organic compound would be formed when ethylamine, $CH_3CH_2NH_2$ reacts with ethanoyl chloride, CH_3COCl?

.....

(1)

(ii) A polymer is formed when the two monomers **X** and **Y** shown below react together under suitable conditions.

$H_2N(CH_2)_6NH_2$ **X**

$ClOC(CH_2)_4COCl$ **Y**

Draw sufficient of the polymer chain to make its structure clear.

(2)

(d) The compound $CH_3CH_2NH_2$ has a distinctive smell. When dilute hydrochloric acid is added to an aqueous solution of $CH_3CH_2NH_2$, the distinctive smell disappears. On the addition of excess aqueous sodium hydroxide, the smell returns.

Give an equation to explain each of these observations.

Loss of smell:

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Return of smell:

.....

(2)

Q2

(Total 13 marks)

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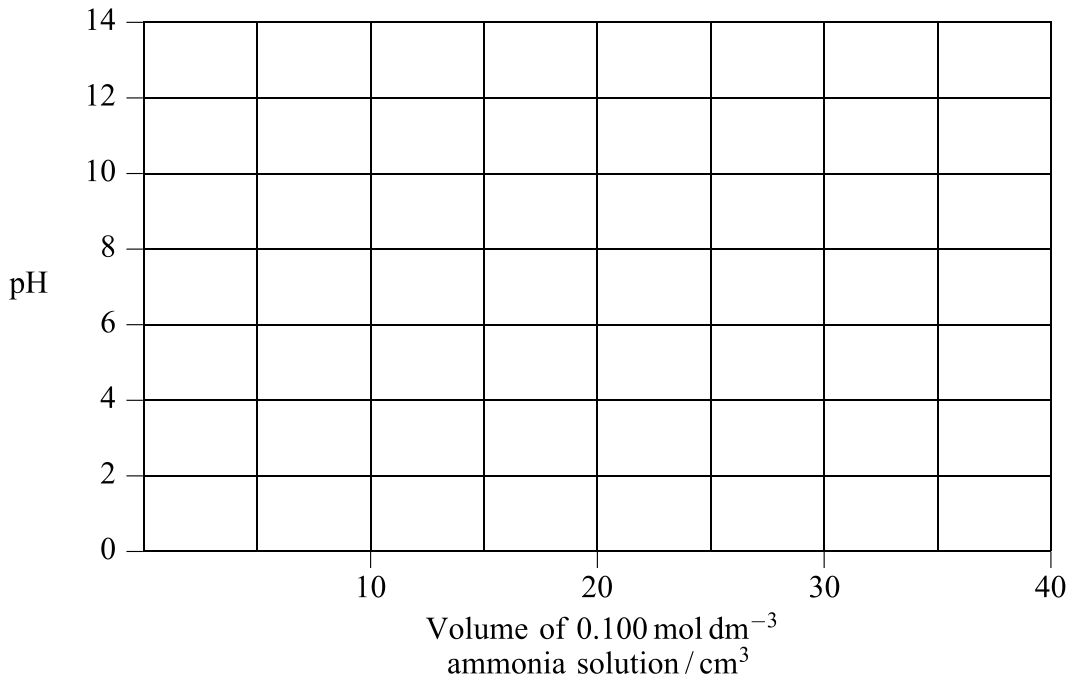
3. (a) Sketch the titration curve that you would expect if 25.0 cm^3 of 0.100 mol dm^{-3} hydrochloric acid, HCl, is titrated with 40.0 cm^3 of 0.100 mol dm^{-3} ammonia solution, NH_3.



(4)

(b) Using your answer to (a), select a suitable indicator for this titration. Put a tick in the appropriate box in the table below.

Indicator	pK_{Ind}	(✓)
thymol blue	1.7	
bromocresol green	4.7	
phenol red	7.9	
phenolphthalein	9.3	

(1)

(c) Suggest why there is no suitable indicator for the titration of ethanoic acid with ammonia.

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(2)

Q3

(Total 7 marks)

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4. Methanoic acid and ethanol react together to form ethyl methanoate, $HCOOC_2H_5$, and water. This reaction is reversible and can be allowed to reach equilibrium.

$$HCOOH(l) + C_2H_5OH(l) \rightleftharpoons HCOOC_2H_5(l) + H_2O(l) \qquad \Delta H = +45 \text{ kJ mol}^{-1}$$

(a) Draw the **full** structural formula of ethyl methanoate, showing all bonds.

(1)

(b) What type of organic compound is ethyl methanoate?

.....

(1)

(c) In an experiment, 3.00 mol methanoic acid, HCOOH, and 6.25 mol ethanol, C_2H_5OH, were mixed together. A small quantity of catalyst was added. The mixture was left for several days in a water bath to reach equilibrium at constant temperature.

(i) Complete the table.

Number of moles in the reaction mixture				
	HCOOH	C_2H_5OH	$HCOOC_2H_5$	H_2O
at start of experiment	3.00	6.25	0.00	0.00
at equilibrium	0.50			

(2)

(ii) Write an expression for the equilibrium constant, K_c, for the reaction.

(1)

Leave blank

(iii) Calculate K_c for the reaction at the temperature of the experiment. The total volume of the equilibrium mixture was 485 cm^3.

(2)

(iv) State and explain whether K_c for this reaction has units.

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(1)

(d) (i) The temperature of this equilibrium mixture is **lowered**.

Explain the effect of this on the value of the equilibrium constant and **hence** on the yield of ethyl methanoate.

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(4)

(ii) A student added more catalyst to the mixture.

State, giving a reason, what would happen to the composition of the equilibrium mixture.

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(1)

Q4

(Total 13 marks)

Leave blank

5. (a) (i) Write the equation for the reaction between sodium oxide, Na_2O, and water.

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(1)

(ii) State the type of bonding present in sodium oxide.

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(1)

(b) (i) Write the equation for the reaction between phosphorus(V) oxide and water.

.....

(1)

(ii) State the type of bonding present in phosphorus(V) oxide.

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(1)

(c) Relate the acid-base character of the oxides in (a) and (b) to the variation in metallic character of the elements in Period 3 of the Periodic Table (sodium to argon).

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(2)

Leave blank

(d) (i) Give an equation to show why solutions of carbon dioxide in water are acidic.

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(1)

(ii) Lead(II) oxide, PbO, is an amphoteric compound.

Give TWO equations to show how lead(II) oxide exhibits amphoteric character.

Lead(II) oxide with dilute nitric acid

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(1)

Lead(II) oxide with dilute sodium hydroxide

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(1)

(e) State how the metallic character of the Group 4 elements changes with an increase in atomic number. Justify your answer.

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(2)

Q5

(Total 11 marks)

Leave blank

6. (a) Draw the **structural** formula of the organic product of each of the following reactions of propanal. Classify the type of reaction in each case.

(i) Propanal with sodium tetrahydridoborate(III) (sodium borohydride) in water.

Type of reaction .....

(2)

(ii) Propanal with Fehling's solution, followed by acidification of the product.

Type of reaction with Fehling's solution.....

(2)

(iii) Propanal with hydrogen cyanide.

Type of reaction .....

(2)

(b) Magnesium reacts with bromoethane to form a Grignard reagent.

(i) Write the equation for this reaction.

.....

(1)

(ii) State the necessary conditions for the reaction.

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(1)

Leave blank

(c) (i) Give the structural formula and name of the final organic product formed when the Grignard reagent produced in (b)(i) is reacted with the following reagents and the intermediate is hydrolysed.

Reagent	Structural formula of final organic product	Name of final organic product
propanone		
butanal		

(4)

(ii) Explain why a racemic mixture and **not** a single optical isomer is obtained when butanal reacts.

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(2)

Q6

(Total 14 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