Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	2	4	5	/	0	1	Signature	

Paper Reference(s)

6245/01

Edexcel GCE

Chemistry

Advanced

Unit Test 5

(including synoptic assessment)

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	
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 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. All 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.
You will be assessed on your Quality of Written Communication in this paper.

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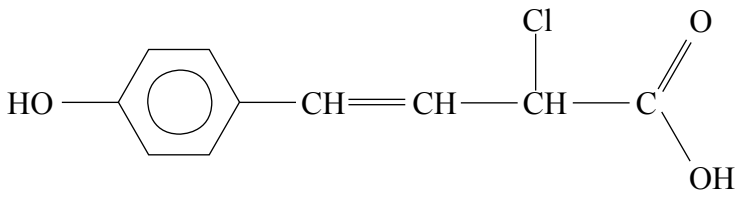
Answer ALL the questions. Write your answers in the spaces provided.

1. A chemist has synthesised a compound **W** believed to be



(a) State and **explain** what you would **see** if **W** is reacted with:

(i) sodium carbonate solution

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(2)

(ii) bromine water.

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(3)

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(b) **W** shows both types of stereoisomerism.

(i) How many stereoisomers of **W** are there? Briefly explain your answer.

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(2)

(ii) Explain why **W** shows optical isomerism.

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(2)

(c) Describe how you would show that **W** contains chlorine.

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(5)

Q1

(Total 14 marks)

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2. Two gases, **A** and **B**, react according to the equation

$$\mathbf{A}(g) + 2\mathbf{B}(g) \rightarrow \mathbf{AB_2}(g)$$

A series of kinetics experiments performed at constant temperature gave the following results:

Experiment	Initial concentration of **A**/mol dm^{-3}	Initial concentration of **B**/mol dm^{-3}	Initial rate /mol dm^{-3} s^{-1}
1	0.0500	0.100	1.00×10^{-4}
2	0.0500	0.200	3.92×10^{-4}
3	0.1000	0.100	1.95×10^{-4}

(a) (i) Calculate, showing your working, the order of reaction with respect to **A** and to **B**.

(3)

(ii) Write the rate equation for the reaction.

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(1)

(iii) Calculate the rate constant, *k*, for the reaction in **experiment 3**, stating its units.

(2)

Leave blank

(b) (i) Explain, in terms of collision theory, why the rate of reaction increases with an increase in temperature.

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(3)

(ii) Suggest, with an explanation, the least number of steps which is *likely* to exist in the mechanism of the reaction between **A** and **B**.

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(2)

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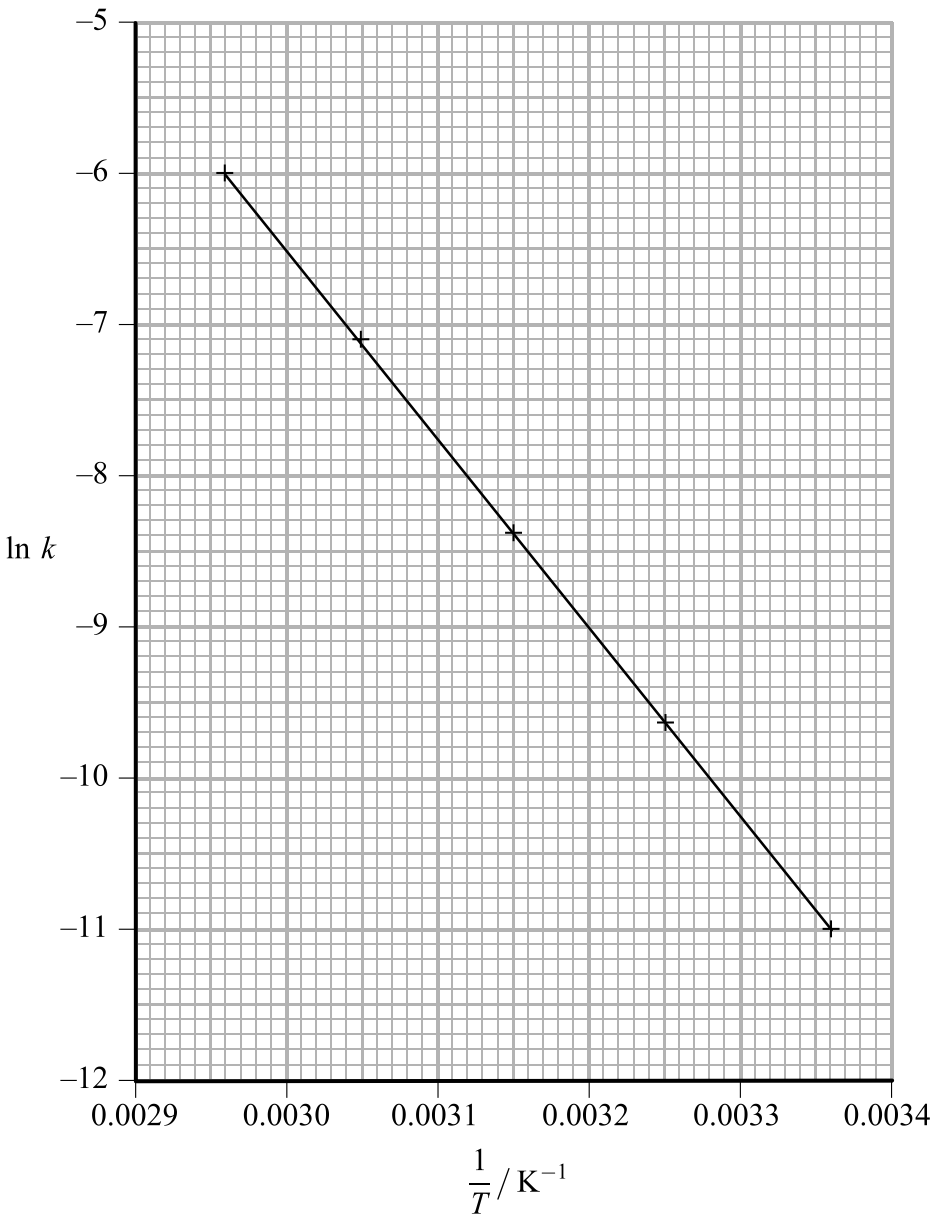
(c) The variation of the rate constant, k, with change in temperature is given by the Arrhenius equation:

$$\ln k = \left(\frac{-E_a}{R}\right)\frac{1}{T} + \ln A$$

where A is a constant.

In a series of experiments performed at various temperatures T to determine the rate constant, k, for the decomposition of a gas **X**, a graph of ln k against $1/T$ gave a straight line of slope $\frac{-E_a}{R}$:



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Use the graph to calculate the value of the activation energy, in kJ mol^{-1}, for the decomposition of **X**. The value of the gas constant R = 8.31 J K^{-1} mol^{-1}.

(4)

Q2

(Total 15 marks)

Leave blank

3. Brass is a widely-used alloy that contains copper and zinc. There are many varieties of brass with different compositions.

In the volumetric analysis of the composition of brass, the first step is to react a weighed sample of the alloy with nitric acid. This gives a greenish-blue solution.

(a) The following standard electrode potentials are needed for this question:

	$E^{\ominus}$/V
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	– 0.76
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0.34
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2 + H_2O$	+ 0.81

(i) Use the **half equations given above** and the values of $E^{\ominus}$ to calculate the standard electrode potential for the reaction between zinc and nitric acid and derive the equation.

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(2)

(ii) Suggest why zinc does **not** produce hydrogen with nitric acid.

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(2)

(iii) If the greenish-blue solution is diluted with water it turns light blue and contains hydrated copper(II) ions.

Name the light blue complex ion and draw its structure so as to show its shape.

Name.....

Structure:

(2)

Leave blank

(iv) If concentrated hydrochloric acid is added to a portion of the light blue solution it turns green.

State the type of reaction that occurs and give an equation for the reaction.

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(2)

(b) The light blue solution from (a)(iii) is then neutralised, and reacted with an excess of potassium iodide solution.

The following standard electrode potentials are needed:

	$E^{\ominus}$/V
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0.15
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0.54

(i) Use these $E^{\ominus}$ values to explain why you would **not** expect the following reaction to occur.

$$2Cu^{2+}(aq) + 4I^-(aq) \rightarrow 2CuI(s) + I_2(aq)$$

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(1)

(ii) Explain why, in practice, the reaction in (i) does occur and iodine is liberated.

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(2)

Leave blank

(iii) When the precipitate formed in the reaction in (i) is filtered off and then dissolved in concentrated aqueous ammonia, a colourless solution is produced.

Suggest the formula of the cation in this solution.

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(1)

(iv) If the colourless solution from (iii) is left to stand in air for some time, it turns blue.

State why this is so, naming the reactant responsible for the change.

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(2)

(c) In a determination of the composition of a sample of brass, 1.50 g of the alloy was treated to give 250 cm^3 of a neutral solution of copper(II) nitrate and zinc nitrate.

Excess potassium iodide solution was added to 25.0 cm^3 portions of this solution, and the liberated iodine titrated with 0.100 mol dm^{-3} sodium thiosulphate solution. The mean titre was 16.55 cm^3.

$$2Cu^{2+}(aq) + 4I^-(aq) \rightarrow 2CuI(s) + I_2(aq)$$
$$2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

(i) State which indicator you would use for the titration and the colour change seen at the end point.

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(2)

(ii) Explain why the indicator is **not** added until the reaction is nearly complete.

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(1)

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(iii) Calculate the percentage of copper by mass in this brass.

(5) **Q3**

(Total 22 marks)

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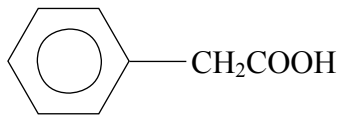
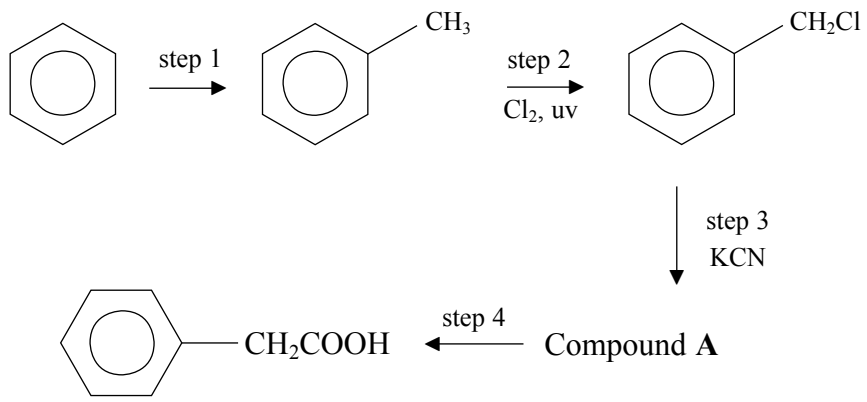
4. Phenylethanoic acid occurs naturally in honey as its ethyl ester: it is the main cause of the honey's smell.

The acid has the structure 

Phenylethanoic acid can be synthesised from benzene as follows:



(a) State the reagent and catalyst needed for **step 1**.

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(2)

Leave blank

(b) (i) What **type** of reaction is **step 2**?

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(1)

(ii) Suggest a mechanism for **step 2**. You should include the initiation step, the two propagation steps and a termination step.
You may use Ph to represent the phenyl group, C_6H_5.

(4)

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(iii) Draw an apparatus which would enable you to carry out **step 2**, in which chlorine is bubbled through boiling methylbenzene, safely.
Do **not** show the uv light source.

(3)

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(c) (i) Give the structural formula of compound **A**.

(1)

(ii) Give the reagent and the conditions needed to convert compound **A** into phenylethanoic acid in **step 4**.

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(2)

(iii) Suggest how you would convert phenylethanoic acid into its ethyl ester.

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(2)

Leave blank

(d) (i) An isomer, **X**, of phenylethanoic acid has the molecular formula $C_8H_8O_2$.

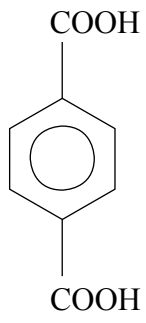
This isomer has a mass spectrum with a large peak at *m/e* 105 and a molecular ion peak at *m/e* 136.

The ring in **X** is monosubstituted.

Suggest the formula of the ion at *m/e* 105 and hence the formula of **X**.

(2)

(ii) Another isomer, **Y**, of phenylethanoic acid is boiled with alkaline potassium manganate(VII) solution and the mixture is then acidified. The substance produced is benzene-1,4-dicarboxylic acid:



Suggest with a reason the structure of **Y**.

Reason .....

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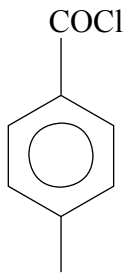
(2)

Leave blank

(e) Benzene-1,4-dicarboxylic acid can be converted into its acid chloride, the structural formula of which is



This will react with ethane-1,2-diol to give the polyester known as PET.

(i) What reagent could be used to convert benzene-1,4-dicarboxylic acid into its acid chloride?

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(1)

(ii) Give the structure of the repeating unit of PET.

(2)

(iii) Suggest, with a reason, a **type** of chemical substance which should **not** be stored in a bottle made of PET.

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(2)

Q4

(Total 24 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