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 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	
Total	

Materials required for examination	Items included with question papers
Nil	Nil

Instructions to Candidates

In the boxes above, write your centre number and 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. All 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.
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) Define the term **standard electrode potential**.

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(2)

(b) (i) When a metal is placed in a solution of its ions, the electrical potential set up between the metal and the solution cannot be measured without using a reference electrode. Explain why this is so.

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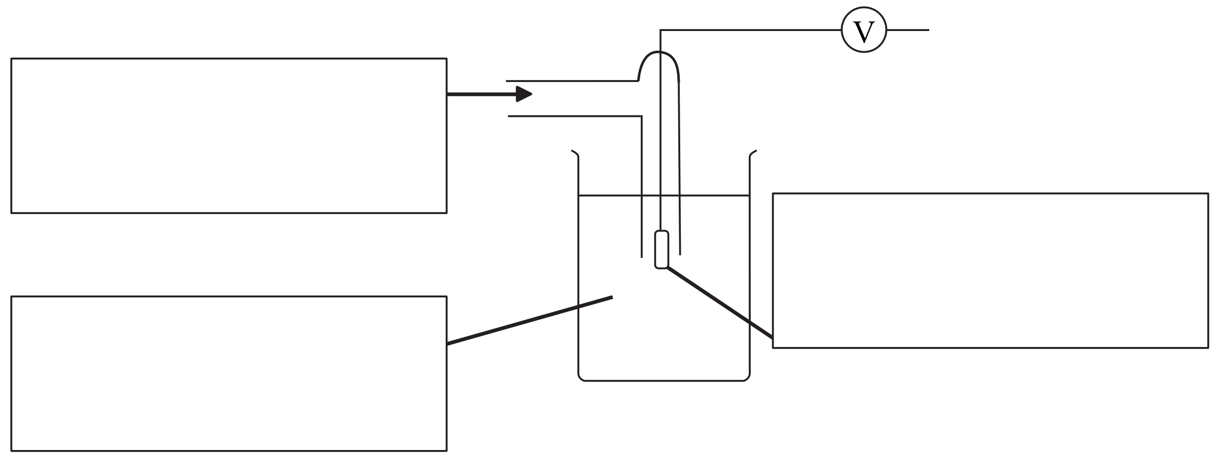
(1)

(ii) Label the diagram of the **standard** hydrogen electrode by putting the correct words in the boxes.



(3)

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(c) The following data will be required in this part of the question.

	$E^\ominus$/V
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	–0.76
$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$	–0.44
$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	–0.14
$O_2(g) + 2H_2O(l) + 4e^- \rightleftharpoons 4OH^-(aq)$	+0.40

(i) Write an overall equation for the first stage in the rusting of iron.

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(2)

(ii) Calculate $E^\ominus$ for the reaction in (i) and show that it is feasible.

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(2)

(iii) Use the $E^\ominus$ values above to explain why zinc is used in preference to tin for preventing corrosion of steel car bodies.

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(3)

Q1

(Total 13 marks)

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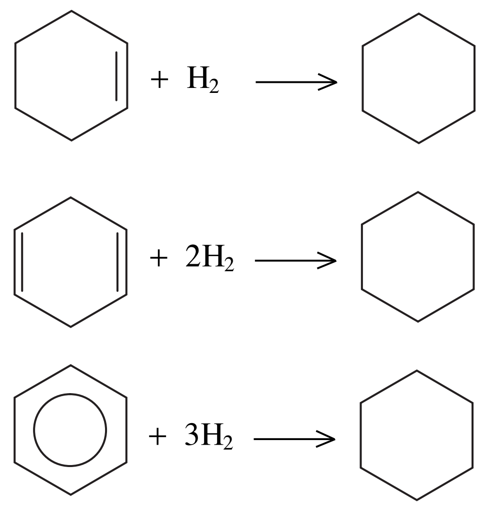
2. (a) Equations for the hydrogenation of three compounds are given below, together with the corresponding enthalpy changes.



$\Delta H = -120$ kJ mol^{-1}

$\Delta H = -240$ kJ mol^{-1}

$\Delta H = -208$ kJ mol^{-1}

Explain, in terms of the bonding in benzene, why the enthalpy change of hydrogenation of benzene is **not** -360 kJ mol^{-1}.

....

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(3)

(b) Benzene can be converted into phenylamine, $C_6H_5NH_2$, in two stages. Give the reagents needed for each step and identify the intermediate compound formed.

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(4)

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(c) Benzene, C_6H_6, reacts with bromoethane, CH_3CH_2Br, in the presence of a catalyst, to form ethylbenzene, $C_6H_5CH_2CH_3$, and hydrogen bromide.

(i) Give the formula of a catalyst for this reaction.

....

(1)

(ii) Give the mechanism for the reaction between benzene and bromoethane, including the formation of the species that reacts with the benzene molecule.

(4)

(iii) Name the type of mechanism involved in this reaction.

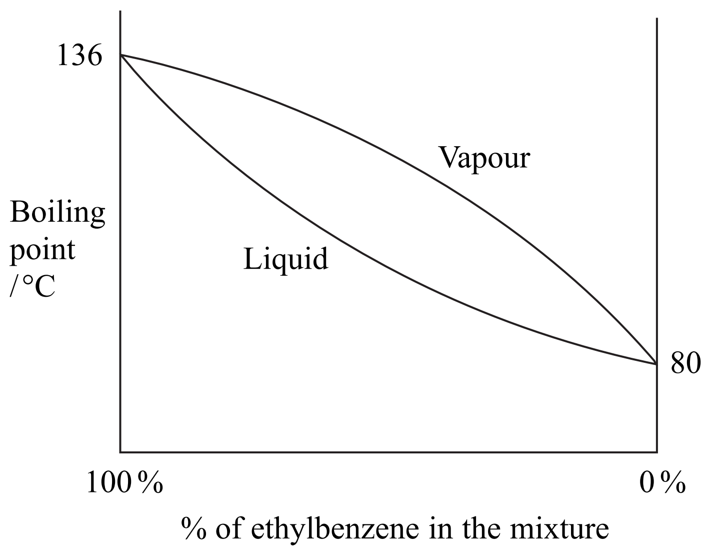
....

(1)

Leave blank

(d) A mixture of ethylbenzene (boiling point 136 °C) and benzene (boiling point 80 °C) can be separated by fractional distillation.

A labelled boiling point/composition diagram for this mixture is shown below.



Use the diagram to explain what happens when a mixture containing 60 % ethylbenzene and 40 % benzene is fractionally distilled.

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(4)

Q2

(Total 17 marks)

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3. (a) The elements from scandium to zinc belong to the *d*-block. Some, but not all, of these elements are transition elements.

(i) What is meant by the term **transition element**?

....

....
(1)

(ii) Which of the elements, from scandium to zinc inclusive, are in the *d*-block but are **not** transition elements?

....
(1)

(b) (i) Complete the electronic configurations of the Fe^{2+} and Mn^{2+} ions below.

Fe^{2+} [Ar] ....

Mn^{2+} [Ar] ....
(1)

(ii) Suggest why Fe^{2+} ions are readily oxidised to Fe^{3+} ions, but Mn^{2+} ions are **not** readily oxidised to Mn^{3+} ions.

....

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....
(2)

(c) Draw a diagram to show the three-dimensional structure of the $[Fe(CN)_6]^{4-}$ complex ion.

(2)

N 2 3 4 3 4 A 0 8 1 6

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(d) A solution of potassium manganate(VII), $KMnO_4$, can be standardised by titration with arsenic(III) oxide, As_2O_3. In this reaction, 5 mol of arsenic(III) oxide are oxidised to arsenic(V) oxide, As_2O_5, by 4 mol of manganate(VII) ions, MnO_4^-.

Calculate the final oxidation number of the manganese.

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(4)

(e) Ammonium vanadate(V), NH_4VO_3, reacts with dilute sulphuric acid to form a solution containing yellow VO_2^+ ions.

(i) Write an **ionic** equation for the reaction of the anion in NH_4VO_3 with dilute sulphuric acid.

....

(1)

(ii) Is the reaction in (i) a redox reaction? Justify your answer.

....

....

(1)

(iii) Addition of zinc to the solution containing VO_2^+ ions causes the colour to change from yellow to green then to blue, followed by green again and finally violet. State the formulae of the ions responsible for each of these colours.

The first green colour ....

The second green colour ....

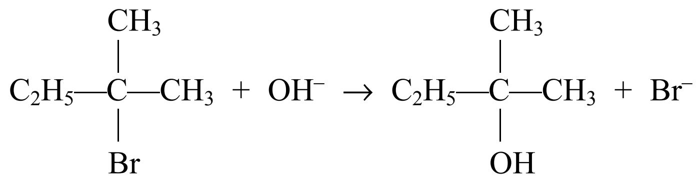
The violet colour ....

(3)

Q3

(Total 16 marks)

4. 2-bromo-2-methylbutane reacts with aqueous sodium hydroxide in a substitution reaction.

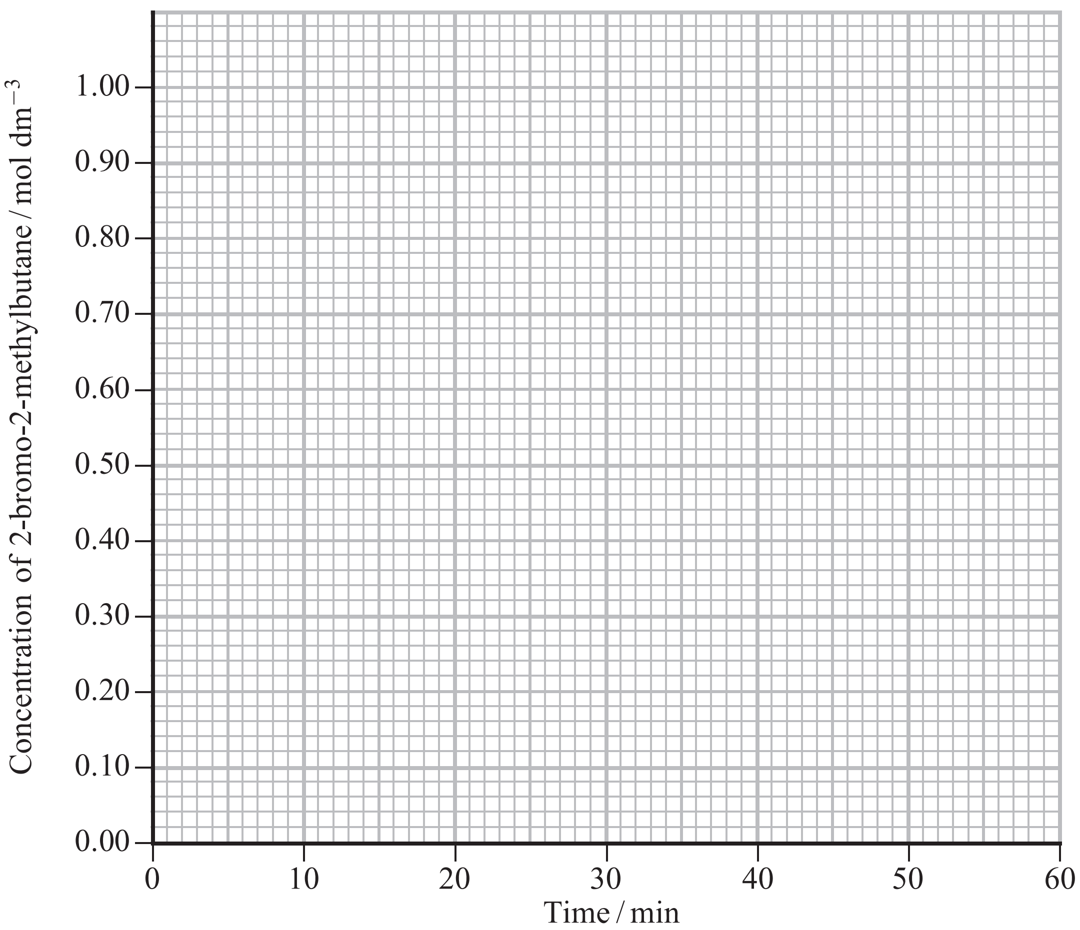


(a) The rate of reaction can be followed by measuring the concentration of 2-bromo-2-methylbutane at various times.

In one such experiment, a known amount of 2-bromo-2-methylbutane was added to a **large** excess of aqueous sodium hydroxide. The following results were obtained.

Time / min	Concentration of 2-bromo-2-methylbutane / mol dm^{-3}
0	0.96
10	0.61
20	0.38
30	0.24
40	0.15
50	0.10

(i) Plot a graph of the concentration of 2-bromo-2-methylbutane on the *y* (vertical) axis against time on the *x* (horizontal) axis.



(2)

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(ii) Show TWO successive half-life measurements on your graph and write their values below.

First half-life ....

Second half-life ....

(2)

(iii) What is the order of reaction with respect to 2-bromo-2-methylbutane? Give a reason for your answer.

Order ....

Reason ....

....

(2)

(b) When the reaction is repeated using equal concentrations of 2-bromo-2-methylbutane and aqueous sodium hydroxide, the same results are obtained.

(i) What is the order of reaction with respect to hydroxide ions?

....

(1)

(ii) Write the rate equation for the reaction.

....

(1)

(iii) Write a mechanism for the reaction which is consistent with your rate equation.

(3)

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(c) The reaction between 2-bromobutane, $C_2H_5CHBrCH_3$, and aqueous sodium hydroxide proceeds by the same mechanism as in (b)(iii).

Use the mechanism to explain why the reaction of a single optical isomer of 2-bromobutane produces a mixture that is no longer optically active.

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(3)

Q4

(Total 14 marks)

N 2 3 4 3 4 A 0 1 2 1 6

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5. Consider the reaction scheme below, which shows how the compound methyl methacrylate, $CH_2{=}C(CH_3)COOCH_3$, is prepared industrially from propanone.

$$(CH_3)_2C{=}O \;+\; HCN \xrightarrow{\text{Step 1}} (CH_3)_2C(OH)CN \xrightarrow{\text{Step 2}} CH_2{=}C(CH_3)CN$$

$$\downarrow \text{Step 3}$$

$$CH_2{=}C(CH_3)COOH$$

$$\downarrow \text{Step 4}$$

$$CH_2{=}C(CH_3)COOCH_3$$

(a) (i) State the type of reaction which occurs in **Step 2**.

....

(1)

(ii) Name the reagent in **Step 2**.

....

(1)

(iii) State the type of reaction which occurs in **Step 3**.

....

(1)

(iv) State the type of reaction which occurs in **Step 4**.

....

(1)

(v) Give the organic reagent required for **Step 4**.

....

(1)

(b) (i) Give the mechanism for the reaction in **Step 1** between the hydrogen cyanide and propanone.

(4)

(ii) The reaction in (b)(i) is carried out at a carefully controlled pH. Given that hydrogen cyanide is a weak acid, suggest why this reaction occurs more slowly at both high and low concentrations of hydrogen ions.

High H^+ concentration

....

....

Low H^+ concentration

....

....

(2)

Leave blank

(c) Methyl methacrylate polymerises in a homolytic addition reaction to form the industrially important plastic, Perspex.

(i) Identify the type of species that initiates this polymerisation.

....

(1)

(ii) Draw a sufficient length of the Perspex polymer chain to make its structure clear.

(2)

(iii) Suggest why it is **not** possible to quote an exact value for the molar mass of Perspex, but only an average value.

....

....

....

(1)

Q5

(Total 15 marks)

TOTAL FOR PAPER: 75 MARKS

END

THE PERIODIC TABLE

Key

Molar mass g mol⁻¹
Symbol
Name
Atomic number

Period	1	2											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															

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