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 19 June 2006 – Afternoon

Time: 1 hour 30 minutes

Examiner's use only

Team Leader's use only

Materials required for examination
Nil

Items included with question papers
Nil

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. All blank pages are indicated.
A Periodic Table is printed on the back cover of this question paper.
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 question paper.

Question Number	Leave Blank
1	
2	
3	
4	
5	
Total	

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edexcel

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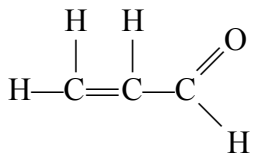
Answer ALL questions. Write your answers in the spaces provided.

1. The structural formula of the compound propenal is shown below.



In this question, assume that the functional groups in the molecule behave independently.

(a) (i) State what is observed when propenal reacts with 2,4-dinitrophenylhydrazine.

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(1)

(ii) Give the structural formula of the compound formed in the reaction in (a)(i).

(2)

(b) Explain why propenal has three peaks in its low-resolution n.m.r. spectrum. Suggest the relative areas under these peaks.

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(3)

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(c) Propenal reacts with hydrogen cyanide as shown by the following equation

$$CH_2{=}CHCHO + HCN \longrightarrow CH_2{=}CHCH(OH)CN$$

(i) Write the mechanism for the reaction.

(4)

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

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(1)

Leave blank

(d) Propenal reacts with hydrogen bromide as shown by the following equation

$$CH_2{=}CHCHO + HBr \longrightarrow CH_3CHBrCHO$$

(i) Write the mechanism for the reaction.

(3)

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

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(1)

(e) The C=O and C=C bonds have the same electronic structure but their reactions occur by different mechanisms. Explain why this is so.

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(3)

Q1

(Total 18 marks)

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2. (a) Complete the following electronic configurations.

Ni

	3d	4s
[Ar]	☐ ☐ ☐ ☐ ☐	☐

Ni^{2+}

	3d	4s
[Ar]	☐ ☐ ☐ ☐ ☐	☐

(2)

(b) Explain why nickel is classified as a **transition metal**.

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(1)

(c) Consider the following reaction scheme.

Step 1: $[Ni(H_2O)_6]^{2+}(aq) \xrightarrow{\text{a few drops of } NH_3(aq)}$ pale green precipitate

Step 2: pale green precipitate $\xrightarrow{\text{excess } NH_3(aq)}$ blue solution **X**

(i) What **types** of bond are present in the $[Ni(H_2O)_6]^{2+}$ ion?

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(2)

(ii) Write an equation for the formation of the pale green precipitate.

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(1)

Leave blank

(iii) Explain why **Step 1** is a **deprotonation** reaction.

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(2)

(iv) Name the type of reaction occurring in **Step 2**.

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(1)

(v) Give an equation for the reaction in **Step 2**.

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(2)

(d) Explain why the hexaaquanickel(II) ion, $[Ni(H_2O)_6]^{2+}$, is coloured.

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(3)

Q2

(Total 14 marks)

Leave blank

3. (a) Explain what is meant by the following terms.

Rate of reaction .....

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Overall order of a reaction .....

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(2)

(b) Two gases, A and B, react according to the equation

$$A + 3B \longrightarrow AB_3$$

A series of experiments carried out at 298 K gave the following results.

Experiment	Initial concentration of A /mol dm^{-3}	Initial concentration of B /mol dm^{-3}	Initial rate of reaction /mol dm^{-3} min^{-1}
1	0.100	0.100	0.00200
2	0.100	0.200	0.00798
3	0.200	0.100	0.00399

(i) State the order of reaction with respect to each of the reactants. Justify your answer.

Reactant A .....

.....

.....

Reactant B .....

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(3)

(ii) Write the rate equation for the reaction between A and B.

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(1)

Leave blank

(iii) Use the experimental data from **Experiment 1** to calculate the rate constant, including units.

(2)

(iv) Suggest a possible mechanism for the reaction between A and B, leading to the formation of AB_3. Identify the rate-determining step.

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(3)

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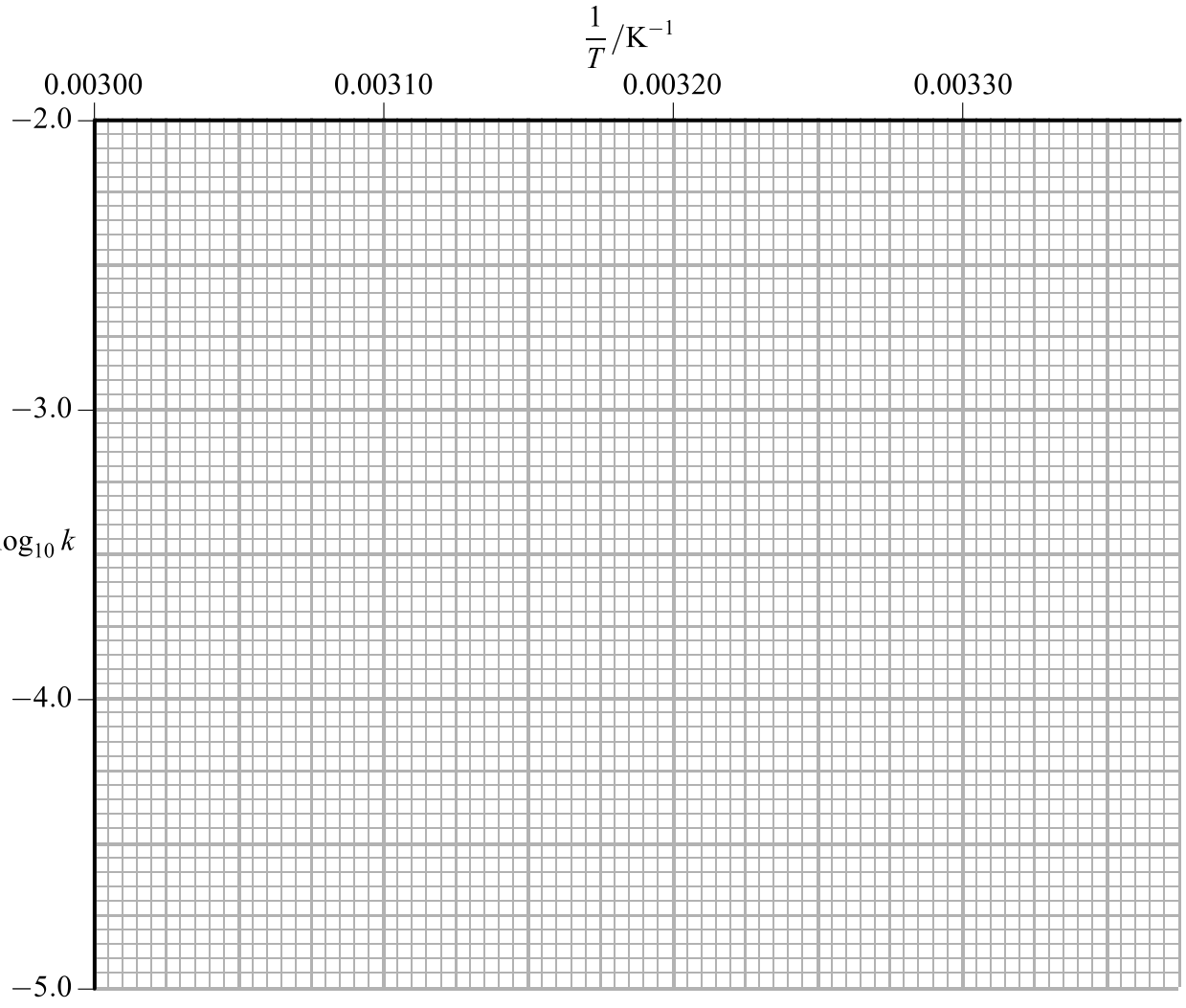
Leave blank

(c) The rate constant, k, for the reaction in (b) was measured at different temperatures.

The following data were obtained.

$\log_{10} k$	$\frac{1}{T}$ /K^{-1}
–2.70	0.00303
–3.39	0.00315
–4.09	0.00327
–4.43	0.00333

(i) Plot a graph of $\log_{10} k$ against $\frac{1}{T}$, on the grid below.



(2)

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(ii) The Arrhenius equation can be written

$$\log_{10} k = \text{constant} - \frac{E_a}{2.30R}\left(\frac{1}{T}\right)$$

where $R = 8.31$ J mol^{-1} K^{-1}.

A graph of $\log_{10} k$ against $\frac{1}{T}$ has a gradient of $\frac{-E_a}{2.30R}$.
Calculate the gradient of the graph and hence calculate the value of activation energy, E_a.

(2)

Q3

(Total 15 marks)

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4. (a) (i) Describe the appearance of the organic product obtained when an aqueous solution of bromine is added to aqueous phenol.

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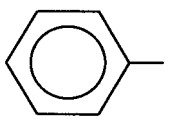
(1)

(ii) Give the equation for the reaction in (a)(i).

(2)

(iii) Phenol reacts with ethanoyl chloride to form an ester. Complete the structural formula to show the ester produced in this reaction.



(1)

(iv) Suggest, in terms of the bonding in ethanoyl chloride, why the reaction in (a)(iii) proceeds without the need for heat or a catalyst.

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(2)

(b) Phenylamine, $C_6H_5NH_2$, is formed by the reduction of nitrobenzene, $C_6H_5NO_2$.

Give the reagents which are used.

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(1)

(c) Phenylamine is used to prepare azo dyes.

(i) State the reagents needed to convert phenylamine into benzenediazonium chloride.

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(2)

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(ii) The reaction in (c)(i) is carried out at a temperature maintained between 0 °C and 5 °C. Explain why this is so.

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(2)

(iii) Addition of benzenediazonium chloride solution to an alkaline solution of phenol gives a precipitate of the brightly coloured dye, 4-hydroxyazobenzene.
Give the structural formula of 4-hydroxyazobenzene.

(1)

(iv) Describe how recrystallisation is used to purify a sample of the solid dye formed in (c)(iii).

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(5)

Q4

(Total 17 marks)

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5. This question concerns redox chemistry.

Consider the following data

	$E^{\ominus}$/V
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	+0.77
$Cl_2(aq) + 2e^- \rightleftharpoons 2Cl^-(aq)$	+1.36
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightleftharpoons Mn^{2+}(aq) + 4H_2O(l)$	+1.51

(a) (i) Use the data to explain why dilute hydrochloric acid is **not** used to acidify solutions of potassium manganate(VII).

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(2)

(ii) Explain why titrations involving potassium manganate(VII) solution do **not** require the addition of an indicator.

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(1)

(b) (i) The ionic equation for the oxidation of iron(II) ions by manganate(VII) ions in acidic solution is

$MnO_4^-(aq) + 5Fe^{2+}(aq) + 8H^+(aq) \rightarrow Mn^{2+}(aq) + 4H_2O(l) + 5Fe^{3+}(aq)$

Explain, in terms of the half equations listed above, why the ratio of manganate(VII) ions to iron(II) ions is 1 : 5 in this reaction.

(1)

Leave blank

(ii) Patients suffering from iron deficiency are often prescribed tablets containing hydrated iron(II) sulphate, $FeSO_4.7H_2O$.

Some tablets, of total mass 6.00 g, were dissolved in distilled water and made up to 200 cm^3 in a volumetric flask. 25.0 cm^3 portions of this solution were titrated against a 0.0200 mol dm^{-3} solution of acidified potassium manganate(VII). The mean titre was 20.10 cm^3.

Calculate the percentage of hydrated iron(II) sulphate in the tablets.

[Molar mass $FeSO_4.7H_2O$ = 278 g mol^{-1}]

(5)

QUESTION 5 CONTINUES ON PAGE 16

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(c) An important application of redox reactions is in car batteries. The electrolyte is aqueous sulphuric acid and the standard electrode potentials involved are shown below.

	$E^{\ominus}$/V
$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$	–0.13
$PbO_2(s) + 4H^+(aq) + 2e^- \rightleftharpoons Pb^{2+}(aq) + 2H_2O(l)$	+1.46

(i) Calculate the standard e.m.f. of the cell.

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(1)

(ii) A single cell in a car battery has an e.m.f. of 2.00 V. Suggest why this value is different from the answer calculated in (i).

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(1)

Q5

(Total 11 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