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)

Thursday 12 June 2008 – Afternoon

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
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.
Check that you have the correct question paper. The paper reference is shown above.
Answer **ALL** the questions in the spaces provided in this question paper.
Do not use pencil. Use blue or black ink.
One of the questions in this paper must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (~~☒~~) and then mark your new answer with a cross (☒).
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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Turn over

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Leave blank

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

1. (a) Define the term **standard electrode potential**, making clear the meaning of *standard*.

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(2)

(b) Explain why a reference electrode is needed whenever a standard electrode potential is measured.

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(1)

(c) Hydrogen peroxide decomposes in a disproportionation reaction.

(i) Explain the meaning of **disproportionation**.

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(2)

Leave blank

(ii) Use the following information to derive the equation for the disproportionation of hydrogen peroxide.

Calculate $E^{\ominus}_{cell}$ and explain whether the reaction is thermodynamically feasible.

$$O_2 + 2H^+ + 2e^- \rightleftharpoons H_2O_2 \qquad E^{\ominus} = +\,0.68\ V$$

$$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O \qquad E^{\ominus} = +\,1.77\ V$$

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(3)

(iii) Explain why your answer to (ii) does not necessarily show that hydrogen peroxide will disproportionate under standard conditions.

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(1)

Q1

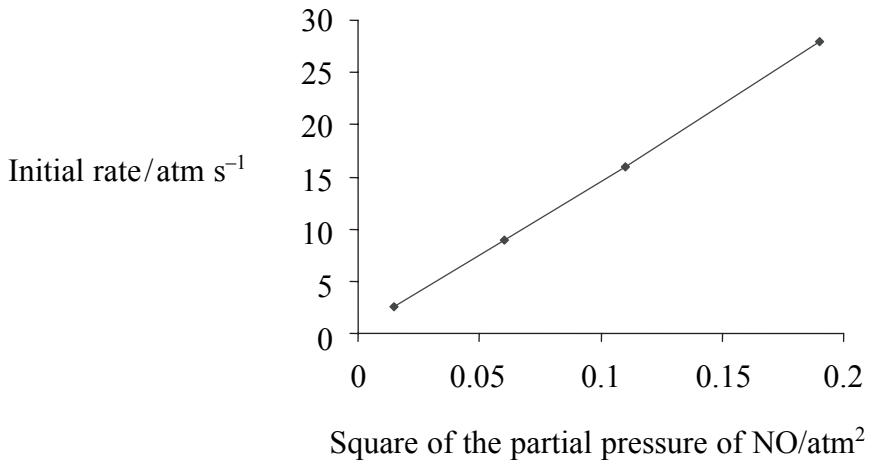
(Total 9 marks)

Leave blank

2. This question concerns the reaction between nitrogen monoxide and oxygen:

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

(a) In a series of experiments designed to find the rate equation for this reaction, the following data were obtained. In each experiment the partial pressure of oxygen was the same.



(i) What is the order of reaction with respect to nitrogen monoxide?

Justify your answer.

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(2)

(ii) A new series of readings is taken with the partial pressure of oxygen doubled. The gradient of the line doubles.

State, with a reason, the order of reaction with respect to oxygen.

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(1)

Leave blank

(iii) Hence write the rate equation for the reaction.

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(1)

(iv) State the units of the rate constant.

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(1)

(v) Thunderstorms generate a small amount of nitrogen monoxide.

Suggest why it remains in the air for a considerable time, given that the activation energy for the reaction between oxygen and nitrogen monoxide is low at room temperature.

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(1)

QUESTION 2 CONTINUES ON THE NEXT PAGE

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(b) The rate of the decomposition of nitrous oxide

$$2N_2O(g) \rightarrow 2N_2(g) + O_2(g)$$

has been studied at different temperatures. The rate constant k was determined at each temperature.

The relationship between the rate constant and the temperature T is given by the Arrhenius equation:

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

where E_a is the activation energy for the reaction, R is the gas constant, and k is the rate constant at temperature T.

(i) Given values of k at different temperatures T, what graph would you plot and how would you use it to determine the activation energy?

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(2)

(ii) A plot of the data gave a straight line with gradient $-2.95 \times 10^4\ K^{-1}$.

Find the activation energy for the reaction, in kJ mol^{-1}, to **three** significant figures.
[The value of R is 8.314 J K^{-1} mol^{-1}]

(2)

Leave blank

(iii) What is the oxidation number of nitrogen in nitrous oxide, N_2O?

Put a cross (☒) in the box of the correct answer. If you change your mind about an answer, put a line through the box (~~☒~~) and then mark your new answer with a cross (☒).

A	+2	☒
B	+1	☒
C	–1	☒
D	–2	☒

(1)

Q2

(Total 11 marks)

Leave blank

3. Cyanide ions react with 2-bromo-2-methylpropane in the following way:

$$(CH_3)_3CBr + CN^- \rightarrow (CH_3)_3CCN + Br^-$$

The rate equation for this reaction is

$$\text{rate} = k[(CH_3)_3CBr]$$

(a) Which solvent would be used for this reaction?

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(1)

(b) (i) What information does this rate equation give about the mechanism of this reaction?

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(2)

Leave blank

(ii) Give the mechanism for this reaction consistent with the rate equation.

(3)

(c) Explain whether it would be possible, using low-resolution proton nmr spectra **alone**, to tell whether $(CH_3)_3CBr$ had been converted into $(CH_3)_3CCN$.

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(1)

Leave blank

(d) How do you show that bromine atoms are present in a bromoalkane?

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(4)

(e) The nitrile, $(CH_3)_3CCN$, can be converted into $(CH_3)_3CCOOCH_2CH_3$ in **two** steps.

(i) Identify the reagent required for the **first step**, and the formula of the organic product from this step.

(2)

(ii) Write the equation for the second step.

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(2)

Q3

(Total 15 marks)

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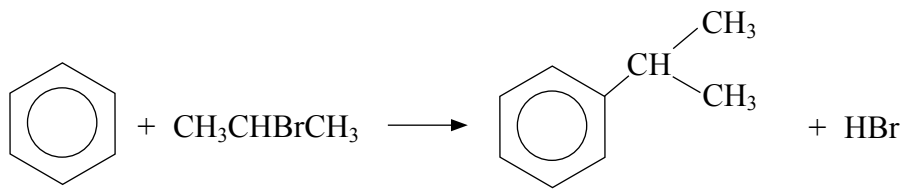
4. (a) Benzene reacts with 2-bromopropane in a Friedel-Crafts reaction to give 2-phenylpropane, $C_6H_5CH(CH_3)_2$, usually known as cumene.



cumene

Cumene is used to manufacture phenol and propanone.

(i) Identify a suitable catalyst for the reaction between benzene and 2-bromopropane.

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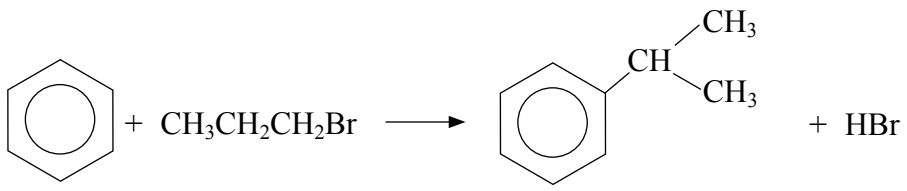
(1)

(ii) Give the mechanism for the reaction, including the formation of the electrophile.

(4)

Leave blank

(b) If benzene and 1-bromopropane, $CH_3CH_2CH_2Br$, are reacted under similar conditions to those in part (a), the product is still cumene although 1-phenylpropane $C_6H_5CH_2CH_2CH_3$ might have been the expected product.



cumene

(i) Draw the structure of the carbocation which would initially be formed.

(1)

(ii) Suggest, in terms of relative stabilities of carbocations, what happens to the carbocation in (i) which results in cumene as the product of the reaction rather than 1-phenylpropane.

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(2)

(c) Phenol reacts with the benzenediazonium cation, $C_6H_5N_2^+$, in alkaline conditions to give an azo dye.

(i) State the reagents needed to convert phenylamine into a solution containing $C_6H_5N_2^+$ ions.

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(2)

(ii) Explain why the temperature of the reaction in (c)(i) needs to be kept between 0 °C and 10 °C.

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(2)

Leave blank

(iii) Give the structural formula of the **product** from the reaction between benzenediazonium chloride and phenol.

(2)

(iv) Suggest why compounds with an N═N group, such as the product given in (iii), show geometric isomerism.

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(2)

(d) (i) How would you show that propanone is a carbonyl compound **and** is a ketone, not an aldehyde?

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(3)

Leave blank

(ii) A characteristic reaction of the carbonyl group, C═O, is nucleophilic addition. The C═C double bond reacts by electrophilic addition.

Suggest the reason for the difference.

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(2)

(iii) Give the mechanism for the nucleophilic addition reaction between propanone and hydrogen cyanide in the presence of a catalyst of cyanide ions, CN^-.

(3) **Q4**

(Total 24 marks)

Leave blank

5. (a) (i) Complete the electronic configurations of:

Cr: [Ar]…….

Cu: [Ar]……..

(1)

(ii) The electronic configurations of chromium and of copper are not readily predictable from a consideration of the elements on either side of them in the first transition series in the Periodic Table.

State how these electronic configurations differ from others in the first transition series and explain why this difference arises.

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(2)

(b) Chromium can form the ion $[Cr(H_2O)_6]^{3+}$ in aqueous solution.

(i) Draw the structure of this ion so as to clearly show its shape.

(1)

(ii) How are the bonds between the water ligands and the metal ion formed?

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(1)

Leave blank

(iii) Write an equation to show what happens initially when a solution containing hydroxide ions is added to a solution of $[Cr(H_2O)_6]^{3+}$ ions.

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(2)

(iv) State what you would **see** as dilute sodium hydroxide is gradually added to a solution of $[Cr(H_2O)_6]^{3+}$ until it is in excess.

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(2)

(v) What property of chromium(III) hydroxide is shown by the reaction in part (iv)?

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(1)

QUESTION 5 CONTINUES ON THE NEXT PAGE

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(c) (i) A 1.00 g sample of a metal alloy that contains chromium was converted into 250 cm^3 of an acidified solution of potassium dichromate(VI).

25.0 cm^3 of this solution was added to an excess of potassium iodide solution.

$$Cr_2O_7^{2-} + 6I^- + 14H^+ \rightarrow 2Cr^{3+} + 3I_2 + 7H_2O$$

The iodine liberated was titrated with 0.100 mol dm^{-3} sodium thiosulphate solution.

$$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$$

The mean (average) titre was 37.2 cm^3.

Calculate the amount (moles) of iodine liberated and hence the percentage, by mass, of chromium in the alloy.

(5)

(ii) In titrations involving iodine, starch is usually added near the end-point to make the colour change clearer, although in many cases it is not really necessary.

Suggest why starch **is** necessary in the titration in (i).

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(1)

Q5

(Total 16 marks)

TOTAL FOR PAPER: 75 MARKS

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THE PERIODIC TABLE

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															

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