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

Paper Reference(s)

6246/02

Edexcel GCE

Chemistry

Advanced

Unit Test 6B (Synoptic)

Thursday 25 January 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

A calculator may be used.

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature.
Answer Section A in the spaces provided in this question paper.
Answer **TWO** questions in Section B in the spaces provided in this question paper. Indicate which question you are answering by marking the box (☒). If you change your mind about an answer, put a line through the box (~~☒~~) and then mark your new question with a cross (☒).
Show all the steps in any calculations and state the units.

Information for Candidates

The total mark for this paper is 50. 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 question paper.

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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SECTION A

Answer ALL parts of this question in the spaces provided.

1. (a) A batch of impure copper was analysed as follows: a sample of 0.800 g of the impure copper was heated with 50.0 cm^3 of acidified 0.150 mol dm^{-3} potassium dichromate(VI) solution, $K_2Cr_2O_7(aq)$. It was found that 0.00342 mol of potassium dichromate(VI) was left unreacted after the reaction was complete.

(i) Write the half-equation for the reduction of $Cr_2O_7^{2-}$ to Cr^{3+} under acidic conditions, and the half-equation for the oxidation of Cu to Cu^{2+}.

Combine these two half-equations to produce the redox equation for the oxidation of copper by dichromate(VI) ions under acidic conditions.

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(3)

(ii) Calculate the percentage of copper in this sample. Give your answer to **three** significant figures.

(5)

Leave blank

(iii) After the reaction the solution was neutralised and a few drops of sodium hydroxide solution were added. A precipitate formed which consisted of two different substances.

Give the formulae of these substances.

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(2)

(iv) Excess sodium hydroxide was then added and the solution became coloured due to the formation of a soluble complex ion.

Give the formula and the colour of this ion.

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(2)

(b) Describe how an impure sample of solid copper(II) sulphate could be purified by recrystallisation.

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(4) **Q1**

(Total 16 marks)

TOTAL FOR SECTION A: 16 MARKS

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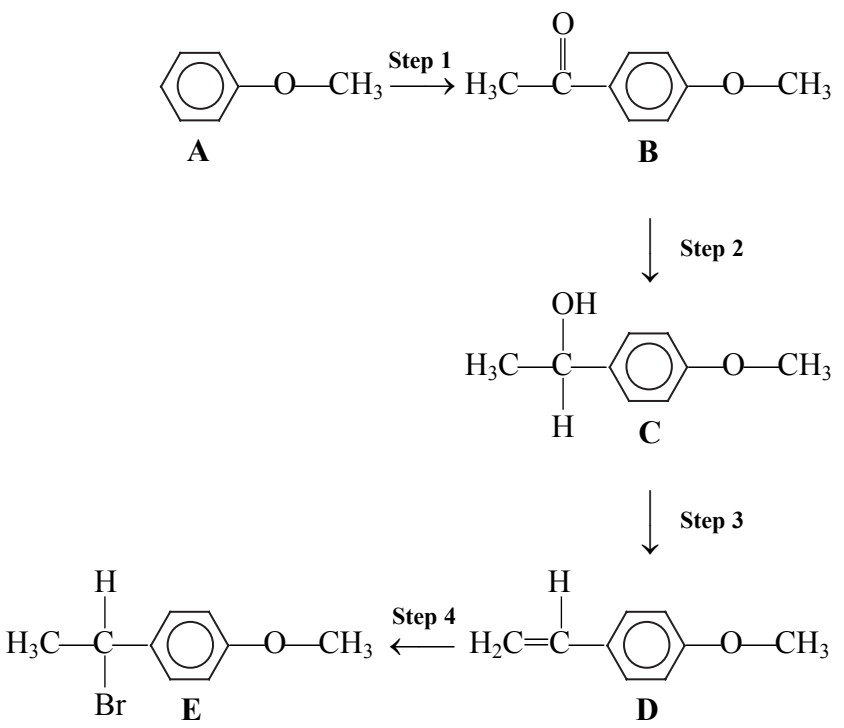
SECTION B

Answer any TWO questions from this section in the spaces provided.

If you answer Question 2 put a cross in this box ☒.

2. This question concerns the following reaction scheme, which shows the synthesis of compound **B** and some subsequent reactions.



(a) A structural isomer of **B** is also obtained in **Step 1**. Suggest a possible structure for this isomer.

(1)

(b) (i) Give the number of peaks you would expect in the low resolution proton n.m.r. spectrum of **B** and the relative areas of these peaks.

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(2)

Leave blank

(ii) The mass spectrum of **B** (molar mass 150 g mol^{-1}), has a major peak at *m/e* 135. Identify the structure of a species responsible for this peak.

(1)

(c) (i) **C** contains an alcohol group.

Give the reagent(s) required to carry out **Step 2**, classify the type of reaction occurring and state the type of alcohol produced.

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(3)

(ii) **C** exists as a mixture of two optical isomers. Why can **C** exist as two optical isomers?

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(1)

(d) (i) Give the reagent(s) required for **Step 3**. Name the type of reaction occurring.

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(2)

(ii) Explain why **D** does **not** exhibit geometrical isomerism.

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(1)

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(e) The reagent for **Step 4**, to produce **E**, is hydrogen bromide, HBr.

Draw the mechanism for this reaction.

(3)

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(f) Explain, in terms of **all** the intermolecular forces present, why **C**, $CH_3CH(OH)C_6H_4OCH_3$, has a higher boiling temperature than **A**, $C_6H_5OCH_3$.

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(3)

Q2

(Total 17 marks)

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If you answer Question 3 put a cross in this box ☒ .

3. (a) The following equation shows the production of nitrogen monoxide, NO, which is the first step in the manufacture of nitric acid, HNO_3.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

(i) Use the data below to calculate the enthalpy change for this reaction. Include a sign and units in your answer.

Substance	**Enthalpy of formation / kJ mol^{-1}**
$NH_3(g)$	–46.2
$NO(g)$	+90.4
$H_2O(g)$	–242

(2)

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(ii) The manufacturer needs to convert as much ammonia into nitrogen monoxide as possible, in the shortest time.

Describe and **explain** the effects of temperature and the use of a catalyst on the rate and yield of this reaction.

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(b) In a laboratory experiment to determine the molar enthalpy of neutralisation, 25.0 cm^3 of nitric acid and 25.0 cm^3 of sodium hydroxide, each of concentration 1.00 mol dm^{-3}, and each at a temperature of 21.0 °C, were mixed together in a beaker. The final temperature of the mixture was 27.5 °C, and the following reaction occurred:

$$NaOH(aq) + HNO_3(aq) \rightarrow NaNO_3(aq) + H_2O(l)$$

Calculate the molar enthalpy of neutralisation from the above data.
[You may assume that all solutions have a density of 1.00 g cm^{-3} and a specific heat capacity of 4.18 J $°C^{-1}$ g^{-1}].

(3)

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(c) (i) Describe chemical tests to show that a solution does **not** contain ammonium ions but does contain nitrate ions. Give the results of these tests.

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(3)

(ii) Explain why the thermal stability of the nitrates of Group 1 increases as the atomic number of the Group 1 element increases.

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(3)

Q3

(Total 17 marks)

Leave blank

If you answer Question 4 put a cross in this box ☒.

4. (a) (i) Draw a dot and cross diagram of a molecule of hydrogen fluoride, HF, showing outer electrons only.

(1)

(ii) Explain the hydrogen bonding in hydrogen fluoride.

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(3)

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(b) (i) Hydrogen fluoride forms the weak acid hydrofluoric acid, HF(aq), when dissolved in water.

Write an equation to show the partial dissociation of hydrofluoric acid in water and write the expression for the acid dissociation constant, K_a, for this reaction.

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(2)

(ii) When sodium hydroxide solution is added to hydrofluoric acid, the following reaction occurs:

$$HF + OH^- \rightarrow F^- + H_2O$$

A 10.0 cm^3 portion of 0.120 mol dm^{-3} sodium hydroxide solution was added to 25.0 cm^3 of 0.100 mol dm^{-3} hydrofluoric acid.

Calculate the concentrations of HF and of F^- in the resulting mixture, and hence the pH of this mixture.
[The value of K_a for HF is 5.62×10^{-4} mol dm^{-3}]

(6)

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(iii) The mixture formed in (b)(ii) is a buffer solution.

Explain why a solution of hydrofluoric acid on its own is **not** a buffer solution.

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(2)

(c) Fluorine reacts with boron to form boron trifluoride, BF_3.

(i) Draw the shape of a boron trifluoride molecule.

(1)

(ii) Boron trifluoride reacts with ammonia to form the molecule $H_3N \rightarrow BF_3$.

State and explain the **change** in the FBF bond angle when this compound is formed.

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(2)

Q4

(Total 17 marks)

TOTAL FOR SECTION B: 34 MARKS

TOTAL FOR PAPER: 50 MARKS

END

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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