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)

Monday 26 June 2006 – Morning

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

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature.
Answer **ALL** questions in 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.
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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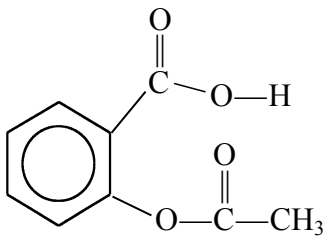
SECTION A

Answer ALL parts of this question in the spaces provided.

1. The formula of aspirin is:



It is hydrolysed in alkaline solution. The reaction is

$$CH_3COOC_6H_4COOH + 2NaOH \rightarrow CH_3COO^-Na^+ + HOC_6H_4COO^-Na^+ + H_2O$$

The following procedure was carried out to analyse some aspirin tablets.

- 1.50 g of tablets were put into a conical flask with 25.0 cm^3 of 1.00 mol dm^{-3} sodium hydroxide solution (an excess).
- The mixture was heated to hydrolyse the aspirin.
- After cooling, the mixture was transferred to a 250 cm^3 volumetric flask and made up to the mark with distilled water.
- 25.0 cm^3 portions of this solution were pipetted into a conical flask, a few drops of phenolphthalein were added and the unreacted sodium hydroxide was titrated against 0.100 mol dm^{-3} hydrochloric acid.
- The mean titre was 8.80 cm^3.

(a) (i) What colour change is seen at the end point of this titration?

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(1)

(ii) Methyl orange cannot be used as the indicator in this titration, as the sodium salts formed are not neutral. Suggest the pH value of these salt solutions.

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(1)

Leave blank

(b) (i) Calculate the initial amount (moles) of sodium hydroxide taken and the amount (moles) in excess. Hence, calculate the amount (moles) used to hydrolyse the aspirin.

(5)

(ii) Calculate the percentage, by mass, of aspirin in these tablets.
[The molar mass of aspirin is 180 g mol^{-1}]

(3)

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(c) Apart from the benzene ring, there are two other functional groups present in aspirin. Draw these functional groups and name them.

(2) **Q1**

(Total 12 marks)

TOTAL FOR SECTION A: 12 MARKS

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SECTION B

Answer TWO questions from this section in the spaces provided.

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

2. (a) An ester, **D**, has a molar mass of 102 g mol^{-1} and composition by mass: 58.8% carbon, 9.8% hydrogen and the remainder is oxygen.

- When **D** is heated under reflux with aqueous sodium hydroxide, it produces two compounds **E** and **F**.
- **E** has molecular formula C_3H_8O.
- **E** reacts when warmed with iodine in sodium hydroxide solution to give, **G**, a pale yellow precipitate with an antiseptic smell.

Use all the information above to identify **D**, **E**, **F** and **G**. Explain your reasoning, and include in your answer the equation for the reaction of the ester, **D**, with sodium hydroxide solution.

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(9)

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(b) Suggest how a sample of benzoic acid could be formed from benzene. Give the reagents and conditions needed for each step. Identify the organic product formed in the first step.

(6)

(c) Give the full mechanism, including the generation of the electrophile, for the nitration of benzene.

(4)

Q2

(Total 19 marks)

Leave blank

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

3. (a) The first step in the production of nitric acid is the catalytic oxidation of ammonia.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g) \quad \Delta H = -900 \text{ kJ mol}^{-1}$$

State and justify the conditions used in this reaction.

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(6)

QUESTION 3 CONTINUES ON THE NEXT PAGE

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(b) Hydrogen peroxide reacts slowly with tartrate ions, $C_4H_4O_6^{2-}$, in a solution of potassium tartrate.

When a few drops of pink cobalt(II) chloride solution are added to a solution containing hydrogen peroxide and potassium tartrate solutions, the solution turns green and there is rapid effervescence. As the effervescence stops, the solution turns back to pink.

These are the ionic half equations for the reduction processes.

$$4CO_2 + 8H^+ + 10e^- \rightleftharpoons C_4H_4O_6^{2-} + 2H_2O$$
$$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$$

(i) Write the overall **ionic** equation for this reaction.

(2)

(ii) Give TWO observations which support the idea that cobalt(II) ions are acting as a catalyst and state why these ions are able to act as a catalyst.

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(3)

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(iii) Sketch a Maxwell-Boltzmann distribution of molecular energies. Use your sketch to explain how catalysts increase the rate of a reaction at a given temperature.

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(5)

(c) Calculate the volume of a solution of hydrogen peroxide of concentration 0.500 mol dm^{-3} that would be needed to produce 100 cm^3 of oxygen, when it is decomposed.
[The molar volume of gas is 24 000 $cm^3\,mol^{-1}$ under the conditions of the experiment]

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

(3) **Q3**

(Total 19 marks)

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

4. Iron is produced from the ore haematite, which contains iron(III) oxide.

Some standard enthalpies of formation are given below.

Compound	$\Delta H_f^{\ominus}$/kJ mol^{-1}
Fe_2O_3 (s)	–822
CO (g)	–110
CO_2 (g)	–394

(a) (i) Write the equation for the complete reduction of iron(III) oxide by carbon monoxide.

Calculate the enthalpy change for this reaction.

(3)

(ii) Iron(III) oxide can also be reduced by carbon

$$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO \qquad \Delta H^{\ominus} = +492 \text{ kJ mol}^{-1}$$

Explain whether the reduction process in (i) or (ii) is more likely to occur.

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(1)

Leave blank

(b) On heating, the following exothermic reaction occurs

$$3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$$

At 600 °C, a mixture of iron and steam is allowed to reach equilibrium. The equilibrium partial pressures of hydrogen and steam are 1.6 atm and 1.2 atm respectively.

(i) Write the expression for the equilibrium constant, K_p, for the reaction. Calculate its value and state the units.

(2)

(ii) State the effect, if any, on the value of K_p when the temperature is increased. Justify your answer.

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(2)

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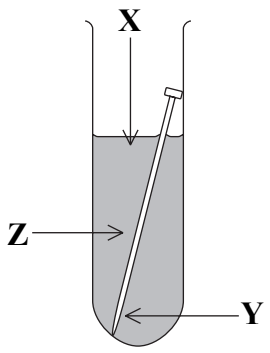
(c) When an iron nail is left in a test tube of water containing a little phenolphthalein, it starts to react and region **X** becomes pink, due to the formation of OH^- ions.



Write the half-equations for the reactions taking place in regions **X** and **Y**.

Name the green precipitate that forms in region **Z**.

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(3)

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(d) Anhydrous iron(III) chloride is made by passing dry chlorine gas over heated iron. It is formed as a dark red covalent gas with formula Fe_2Cl_6 and has a similar structure and reactions to aluminium chloride.

Draw a diagram to show the structure of the Fe_2Cl_6 molecule. Label the types of bonding present.

State the shape around each iron atom.

(3)

(e) Hydrated iron(III) chloride is ionic and soluble in water.

(i) Describe a test for aqueous Fe^{3+} ions.

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(2)

(ii) Explain why an aqueous solution of hydrated iron(III) chloride is acidic.

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(3)

Q4

(Total 19 marks)

TOTAL FOR SECTION B: 38 MARKS

TOTAL FOR PAPER: 50 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