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)

Friday 23 January 2009 – 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	Items included with question papers
Nil	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 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 a question, 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 marks for individual questions and parts of questions are shown in round brackets: e.g. **(2)**.
The total mark for this paper is 50. There are 20 pages in this question paper. Any 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 sample of an alloy of gold, silver and copper, used to make jewellery, was analysed according to the following instructions:

- React a known mass of alloy with excess concentrated nitric acid. The gold does **not** react but the copper and silver react as follows:

$$2Ag + 4HNO_3 \rightarrow 2AgNO_3 + 2NO_2 + 2H_2O$$
$$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$$

- Dilute the solution produced and filter off the gold.

- React the filtrate with excess hydrochloric acid.

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

- Filter the precipitate of silver chloride. Wash, dry and weigh it.

- To the remaining solution, add excess potassium iodide solution. Titrate the liberated iodine with standard sodium thiosulphate solution.

$$2Cu^{2+} + 4I^- \rightarrow 2CuI + I_2$$
$$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$$

Results

Mass of alloy	1.40 g
Mass of silver chloride precipitate	0.244 g
Concentration of sodium thiosulphate solution	0.100 mol dm^{-3}
Mean titre of sodium thiosulphate solution	38.45 cm^3

(a) Starch is used as the indicator in the iodine-thiosulphate titration. State at what point in the titration the starch is added and explain why it is not added earlier. Describe the colour change at the end-point.

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(3)

Leave blank

(b) Use the information to calculate the percentage of silver, copper and gold in the alloy.

(7) **Q1**

(Total 10 marks)

TOTAL FOR SECTION A: 10 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. (a) (i) Draw a fully-labelled Hess's Law cycle to show the enthalpy changes involved in dissolving a Group 2 salt, MX, in water.

(3)

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(ii) Show how the enthalpy changes in your cycle and a knowledge of the size of the cations of Group 2 metals, explain the trend in the solubility of the metal sulphates in the table below.

	Solubility / mol per 1000 g of water
$MgSO_4$	3.6
$CaSO_4$	1.1×10^{-2}
$SrSO_4$	6.2×10^{-4}
$BaSO_4$	9.2×10^{-6}

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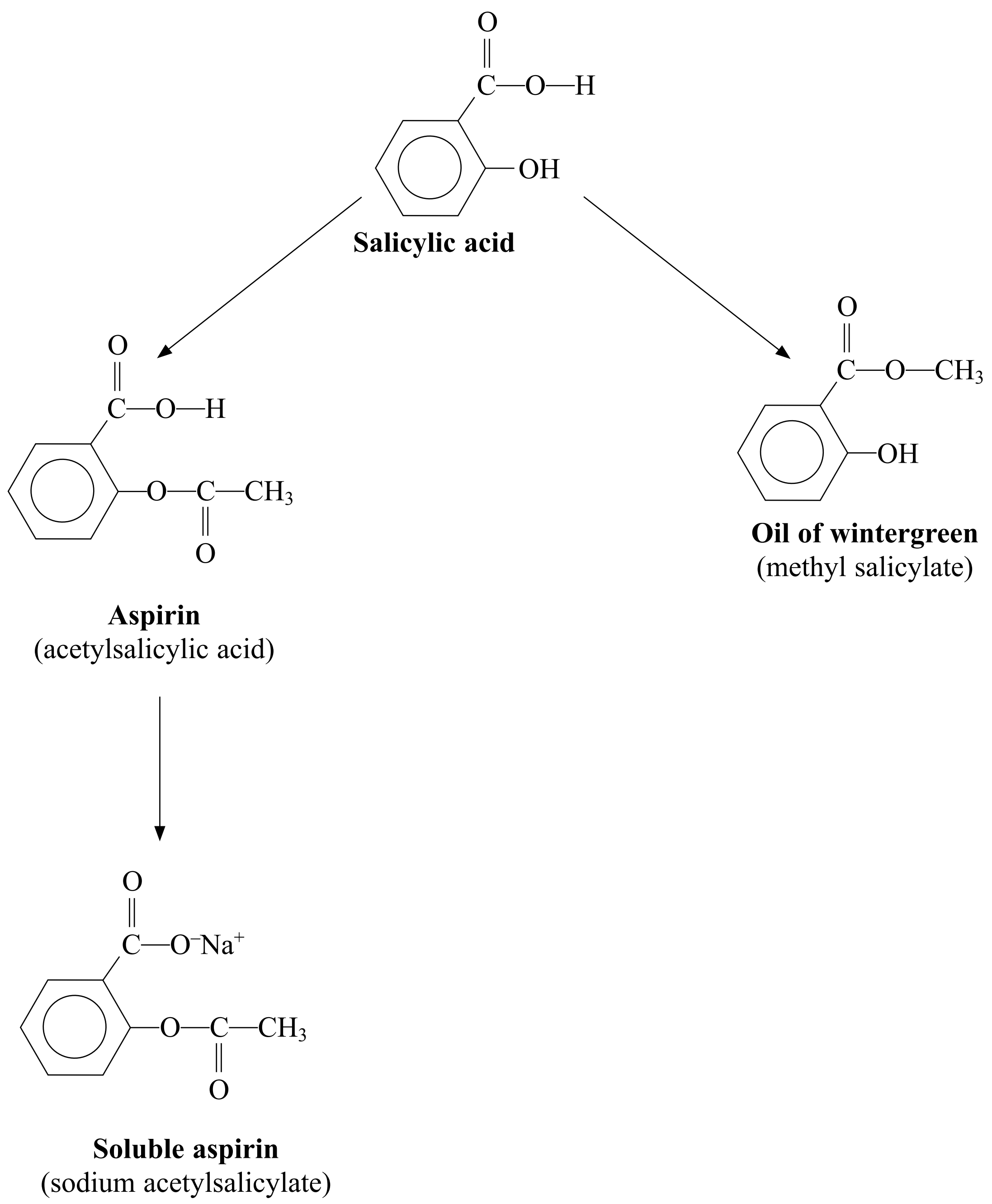
(4)

QUESTION 2 CONTINUES ON THE NEXT PAGE

(b) Many drugs are water soluble. Their solubility depends upon the functional groups present in the compound.

Aspirin and its derivatives are made from salicylic acid.



(i) State the intermolecular forces that exist in solid aspirin.

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(2)

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(ii) State and explain which functional group in aspirin makes it slightly soluble in water.

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(2)

(iii) Suggest why aspirin has a low solubility in water.

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(1)

(iv) Explain why soluble aspirin is more soluble in water than aspirin.

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(1)

(c) Identify reagents that could be used under appropriate conditions to convert

(i) salicylic acid into oil of wintergreen ....
(1)

(ii) salicylic acid into aspirin ....
(1)

(iii) aspirin into soluble aspirin ....
(1)

QUESTION 2 CONTINUES ON THE NEXT PAGE

Leave blank

(d) Soluble aspirin is used by some children and some adults. The effectiveness of the drug is **not** altered as it is converted back into aspirin by hydrochloric acid in the stomach.

Write an equation to show this reaction and explain why it occurs.
State symbols are **not** required.

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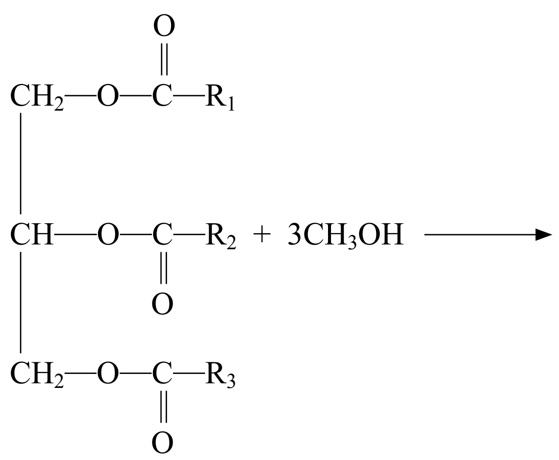
(2)

(e) Some natural oils are esters. These can be converted into bio-diesel by heating with methanol and a catalyst. The product is a mixture of three esters (bio-diesel) and a trihydroxy compound. In the formula below, R_1, R_2 and R_3 represent alkyl groups.

Complete the equation.



(2)

Q2

(Total 20 marks)

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

3. Hydrogen cyanide, HCN, is a very weak acid.

(a) Draw a 'dot and cross' diagram for HCN. Show only the outer shell electrons.

(1)

(b) (i) Calculate the pH of a solution of hydrogen cyanide of concentration 0.220 mol dm^{-3} at 25 °C.

[K_a of HCN = 4.90×10^{-10} mol dm^{-3} at 25 °C]

(3)

(ii) The percentage dissociation of an acid in solution is the **ratio** of the hydrogen ion concentration in the solution to that produced by **100% dissociation**, expressed as a percentage.

Use the concentration of hydrogen ions, [H^+], calculated in (i), to calculate the percentage dissociation of a solution of hydrogen cyanide, HCN, of concentration 0.220 mol dm^{-3} at 25 °C. Give your answer to **three** significant figures.

(2)

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(c) (i) Write the mechanism for the nucleophilic addition of hydrogen cyanide to ethanal, CH_3CHO, in the presence of a catalyst of cyanide ions.

(3)

Leave blank

(ii) Define the term **nucleophile**.

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(1)

(iii) Identify the nucleophile in the reaction in (c)(i). Explain why the first step of the reaction is very slow in the presence of hydrogen ions.

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(2)

(d) Halogenoalkanes such as chloromethane, CH_3Cl, undergo reactions with potassium cyanide to give nitriles.

Write the equation for the reaction between chloromethane and potassium cyanide and classify this reaction. State symbols are **not** required.

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(2)

QUESTION 3 CONTINUES ON THE NEXT PAGE

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(e) A polyamide can be synthesised from the monomers 1,4-diaminobutane, $NH_2(CH_2)_4NH_2$, and butandioyl dichloride, $ClOC(CH_2)_2COCl$. **Both** of these can be synthesised from ethene, C_2H_4.

Devise a reaction pathway for the conversion of **ethene** (as the only organic starting material) to the two monomers. The reaction pathways will involve the conversion of ethene into a dinitrile which can then be converted to each monomer.

You must show the structural formula of all the compounds and identify the reagents needed for each step. Equations are **not** required.

(6)

Q3

(Total 20 marks)

Leave blank

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

4. This question concerns the industrial manufacture and the properties of sulphuric acid.

The manufacture involves the following equilibrium:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \quad \Delta H = -192 \text{ kJ mol}^{-1}$$

(a) State the change, if any, in the value of the equilibrium constant and **hence** explain the effect on the equilibrium yield of sulphur trioxide caused by:

(i) increasing the temperature of the system.

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(2)

(ii) increasing the overall pressure on the system at constant temperature.

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(3)

(iii) the addition of a catalyst.

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(b) Explain, in terms of the collision theory, why increasing temperature increases the rate at which the equilibrium is reached.

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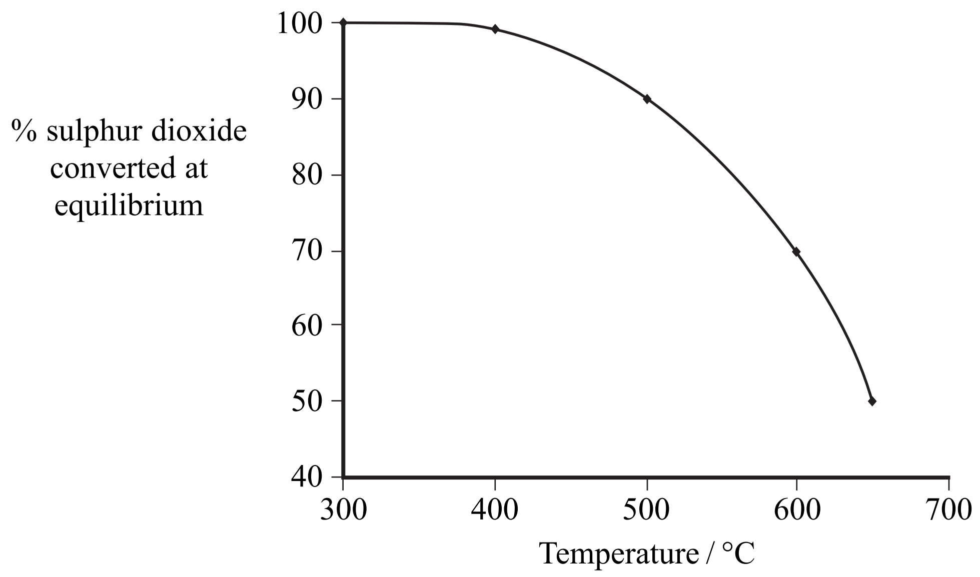
(3)

(c) The conditions used in the manufacture are **not** those that might be expected from application of theory to the equilibrium

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \quad \Delta H = -192 \text{ kJ mol}^{-1}$$

The graph below shows the percentage of sulphur dioxide converted into sulphur trioxide at different temperatures and at a pressure of 2 atmospheres.



The typical conditions used in the process are a temperature of about 425 °C and a pressure of 2 atmospheres.

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(i) Explain why a temperature of 425 °C is used.

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(2)

(ii) Explain why a higher pressure than 2 atm is **not** used.

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(1)

(iii) In the manufacture, the mixture of air and sulphur dioxide gas is passed through a chamber containing the catalyst. The resulting gas mixture is then cooled before it is passed through a second catalyst chamber.

Explain why the cooling is necessary to help increase the yield of sulphur trioxide.

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(2)

QUESTION 4 CONTINUES ON THE NEXT PAGE

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(d) Methylbenzene, $C_6H_5CH_3$, undergoes electrophilic substitution when warmed with a mixture of concentrated nitric and sulphuric acids to produce 2-nitromethylbenzene.

(i) Write an equation to show the formation of the electrophile in the mixture of concentrated nitric and sulphuric acids.

(1)

(ii) Explain, in terms of acid strength, the function of the sulphuric acid.

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(1)

(iii) Write the mechanism for the reaction of the electrophile with methylbenzene.

(3)

Leave blank

(iv) Suggest the structure of another product that might be produced in this reaction.

(1)

Q4

(Total 20 marks)

TOTAL FOR SECTION B: 40 MARKS

TOTAL FOR PAPER: 50 MARKS

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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

H 3 3 9 2 0 A 0 2 0 2 0