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)

Tuesday 28 June 2005 – 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 (☒).
You may use a calculator. **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 12 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.

Printer's Log. No.
N17086A
W850/R6246/57570 8/7/7/7/4/2

N 1 7 0 8 6 A 0 1 1 2

Turn over

edexcel

Leave blank

SECTION A

Answer ALL parts of this question in the spaces provided.

1. Persulphate ions, $S_2O_8^{2-}$ slowly oxidise arsenic(III) acid, H_3AsO_3 in aqueous solution according to the equation

$$S_2O_8^{2-} + H_3AsO_3 + H_2O \rightarrow 2SO_4^{2-} + H_3AsO_4 + 2H^+$$

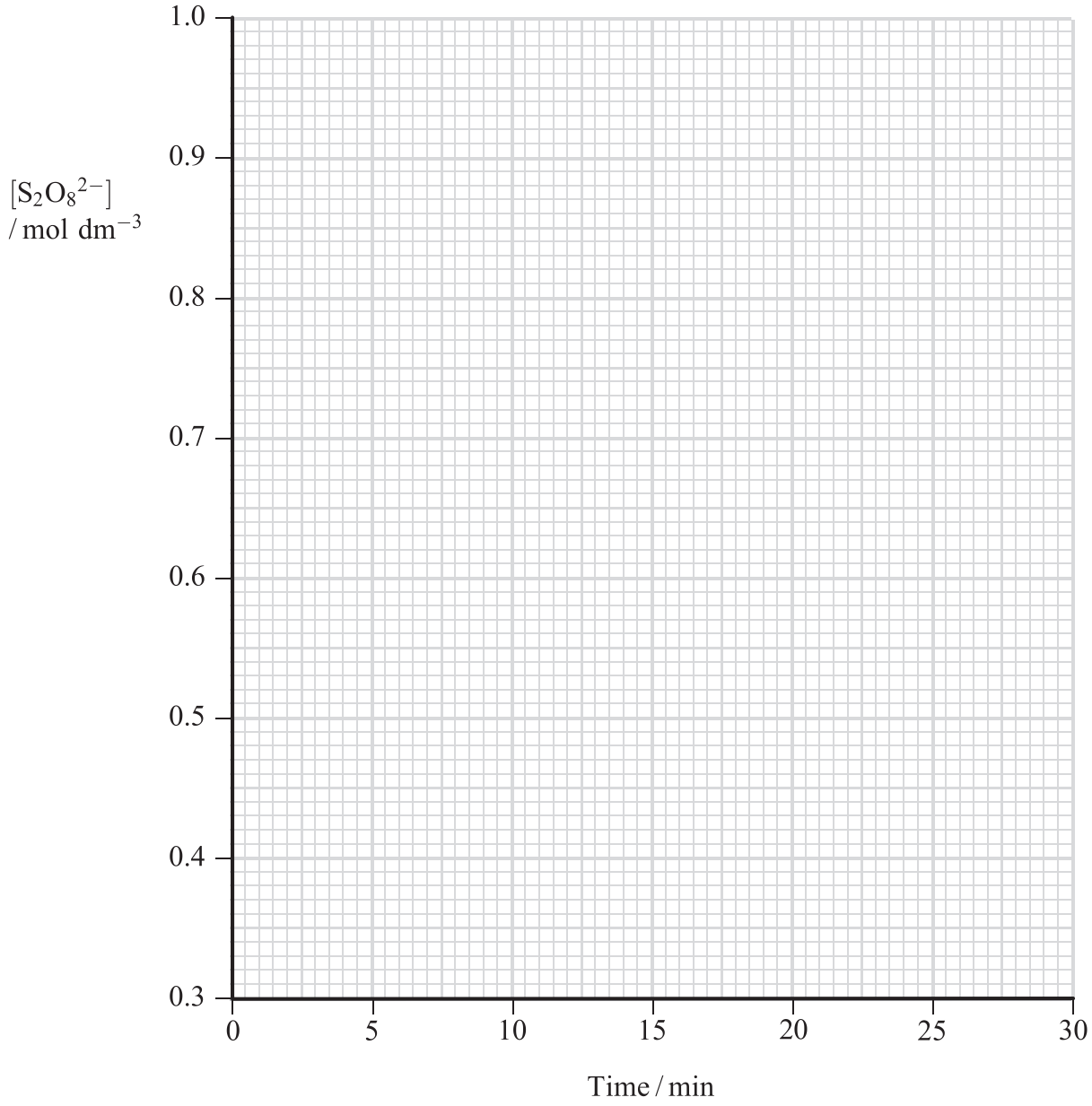
- 25 cm^3 of a 1.0 mol dm^{-3} solution of potassium persulphate was mixed with 25 cm^3 of a solution of arsenic(III) acid of the same concentration.
- At timed intervals, small portions of the reaction mixture were analysed to determine the concentration of persulphate ion, $[S_2O_8^{2-}]$.

The results are shown below.

Time / minutes	$[S_2O_8^{2-}]$ / mol dm^{-3}
0	1.0
5	0.76
10	0.62
15	0.52
20	0.44
30	0.35

Leave blank

(a) (i) On the grid below, plot a graph of the concentration of persulphate ions against time.



(2)

(ii) Draw a tangent to the curve at the point where $[S_2O_8^{2-}] = 0.50$ mol dm^{-3} and use it to calculate the slope of the curve at that point. Give your answer to **two** significant figures.

Slope: .....

(4)

N 1 7 0 8 6 A 0 3 1 2

Leave blank

(b) The rate of the reaction at a particular concentration of reactant can be measured from the slope of the graph at that concentration.

The **initial** rate, which is the rate when the concentrations of persulphate ions, $S_2O_8^{2-}$, and arsenic(III) acid, H_3AsO_3, are both 1.0 mol dm^{-3}, was found to be 0.060 mol dm^{-3} min^{-1}.

(i) Use your answer to (a)(ii) to show that the ratio of the initial rate to the rate when $[S_2O_8^{2-}]$ and $[H_3AsO_3]$ are 0.50 mol dm^{-3} is approximately 4:1. Use this ratio to deduce the **overall** order of reaction.

(3)

(ii) Suggest TWO rate equations that agree with the order of the reaction that you have deduced in (i). How could the experiment be adapted to distinguish between these two rate equations?

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5)

Q1

(Total 14 marks)

TOTAL FOR SECTION A: 14 MARKS

Leave blank

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. But-2-enoic acid, $CH_3CH{=}CHCOOH$, can be converted into 3-oxobutanoic acid, CH_3COCH_2COOH in a three step synthesis.

Step 1	$CH_3CH{=}CHCOOH$	$\rightarrow$	$CH_3CHBrCH_2COOH$
Step 2	$CH_3CHBrCH_2COOH$	$\rightarrow$	$CH_3CH(OH)CH_2COOH$
Step 3	$CH_3CH(OH)CH_2COOH$	$\rightarrow$	CH_3COCH_2COOH

(a) (i) Identify the reagents needed for each step.

Step 1 .....

.....

Step 2 .....

.....

Step 3 .....

.....

(4)

(ii) But-2-enoic acid exists as two stereoisomers.

Draw these stereoisomers and explain why one does not convert to the other at room temperature.

.....

.....

.....

(2)

QUESTION 2 CONTINUES ON THE NEXT PAGE

Leave blank

(b) Give the structural formula of the organic products of the reaction of

(i) but-2-enoic acid with an alkaline solution of potassium manganate(VII).

(1)

(ii) 3-oxobutanoic acid with hydrogen cyanide, HCN, in the presence of a trace of hydroxide ions.

(1)

(c) 3-oxobutanoic acid is a weak acid. The value of its acid dissociation constant, K_a, is 2.63×10^{-4} mol dm^{-3}.

(i) Give the structural formula of the conjugate base of 3-oxobutanoic acid.

(1)

In parts (ii) and (iii) you may use HX as the formula for 3-oxobutanoic acid.

(ii) Explain how a mixture of 3-oxobutanoic acid and its sodium salt can act as a buffer solution when a small amount of alkali is added.

.....

.....

.....

.....

.....

.....

.....

(4)

Leave blank

(iii) Calculate the mass of solid sodium 3-oxobutanoate that must be added to 100 cm^3 of a 0.500 mol dm^{-3} solution of 3-oxobutanoic acid in order to make a buffer solution of pH 3.80.

(5)

Q2

(Total 18 marks)

Leave blank

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

3. (a) Carboxylic acids react reversibly with alcohols, in the presence of a catalyst, to form an ester and water.

When 24.8 g of ethane-1,2-diol, $HOCH_2CH_2OH$, was mixed with 66.0 g of ethanoic acid, CH_3COOH, in the presence of a catalyst, equilibrium was reached after 80.0 % of the ethane-1,2-diol had reacted. The total volume at equilibrium was 90.0 cm^3.

$$HOCH_2CH_2OH + 2CH_3COOH \rightleftharpoons CH_3COOCH_2CH_2OOCCH_3 + 2H_2O$$

Write the expression for the equilibrium constant, K_c, and calculate its value. You should make clear what units, if any, there are for K_c.

(7)

(b) Ethane-1,2-diol can be made from ethene in a two-stage process. The overall reaction is:

$$C_2H_4 + H_2O + \tfrac{1}{2}O_2 \rightarrow HOCH_2CH_2OH$$

1054 g of ethane-1,2-diol was obtained from 560 g of ethene.

Calculate the percentage yield of the process.

(2)

Leave blank

(c) Polyesters can be formed from compounds with two functional groups.

(i) Give the structural formula of a reagent that would react with ethane-1,2-diol to make a polyester. Draw the structure of the polymer made from this reagent and ethane-1,2-diol.

(3)

(ii) Explain whether it would be sensible for protective clothing, made from this polymer, to be used in an environment where acid spills are likely.

.....

.....

(1)

(d) Explain why the ester methyl methanoate, $HCOOCH_3$, has a much lower boiling temperature than its isomer ethanoic acid, CH_3COOH, and why ethanoic acid has a lower boiling temperature than propanoic acid, C_2H_5COOH.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5)

(Total 18 marks)

Q3

Leave blank

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

4. (a) (i) Draw a labelled Hess's Law cycle for the dissolving of solid calcium hydroxide in water, and use it and the data below to calculate the lattice energy of calcium hydroxide.

	ΔH / kJ mol^{-1}
Enthalpy of hydration of $Ca^{2+}(g)$	–1650
Enthalpy of hydration of $OH^-(g)$	–460
Enthalpy of solution of $Ca(OH)_2(s)$	–16.2

(4)

(ii) State and explain the trend in solubility in water of the Group 2 hydroxides.

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4)

Leave blank

(b) The dissolving of sparingly soluble calcium hydroxide in water can be shown by the equilibrium reaction

$Ca(OH)_2(s) + (aq) \rightleftharpoons Ca^{2+}(aq) + 2OH^-(aq)$ $\Delta H^{\ominus} = -16.2$ kJ mol^{-1}

State and explain the effect on the solubility of calcium hydroxide of

(i) increasing the temperature

.....

.....

.....

.....

(3)

(ii) adding sodium hydroxide solution.

.....

.....

.....

.....

(3)

(c) When concentrated sulphuric acid is added to solid calcium chloride, one acidic gas is given off.

When concentrated sulphuric acid is added to solid calcium bromide, three gases are given off.

Identify the three gases given off in the reaction with calcium bromide. Explain why only one gas is given off in the reaction with calcium chloride.

.....

.....

.....

.....

.....

(4)

(Total 18 marks)

Q4

TOTAL FOR SECTION B: 36 MARKS

TOTAL FOR PAPER: 50 MARKS

END

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