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 25 June 2007 – 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

Candidates may use a calculator.

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.

Printer's Log. No.
N26035A
W850/R6246/57570 7/7/7/3/14,200

N 2 6 0 3 5 A 0 1 1 6

Turn over

edexcel
advancing learning, changing lives

Leave blank

SECTION A

Answer ALL parts of this question in the spaces provided.

1. When solid lead(II) sulphate is added to a solution of sodium iodide, the following equilibrium is established:

$$PbSO_4(s) + 2I^-(aq) \rightleftharpoons PbI_2(s) + SO_4^{2-}(aq)$$

The equilibrium constant, K_c, for this reaction may be found by adding an excess of solid lead(II) sulphate to a known volume of a standard solution of sodium iodide. The mixture is left to reach equilibrium at a constant temperature, *T*.

Ice-cold water is added to freeze the position of equilibrium and the mixture is then titrated with standard silver nitrate solution.

In a typical experiment, excess lead(II) sulphate was added to 50.0 cm^3 of 0.100 mol dm^{-3} sodium iodide solution. The whole equilibrium mixture required 31.0 cm^3 of 0.100 mol dm^{-3} silver nitrate solution to react with the aqueous iodide ions.

The expression for K_c for this reaction is

$$K_c = \frac{[SO_4^{2-}]}{[I^-]^2}$$

(a) Why is it **not** necessary to know the mass of the lead(II) sulphate used in the experiment?

.....

.....

.....

(1)

(b) Give the ionic equation for the reaction between silver nitrate solution and aqueous iodide ions to produce a precipitate of silver iodide, AgI.

.....

(1)

Leave blank

(c) From the data given above, calculate the equilibrium amounts of the iodide and of the sulphate ions in solution. Hence calculate the equilibrium concentration of these ions, and the value of K_c for the reaction at temperature T, including the units, if any.

(8) **Q1**

(Total 10 marks)

TOTAL FOR SECTION A: 10 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. This question concerns the reactions of some compounds of nitrogen.

(a) The ammonium ion reacts with water and behaves as an acid.

$$NH_4^+(aq) + H_2O(l) \rightleftharpoons NH_3(aq) + H_3O^+(aq)$$

(i) Identify the TWO conjugate acid-base pairs in the spaces provided.

acid 1 ..... base 1 .....

acid 2 ..... base 2 .....

(1)

(ii) Write the expression for the acid dissociation constant, K_a, of the ammonium ion.

(1)

(iii) A solution of ammonium chloride has a pH of 5.00 at 25 °C.
K_a for the ammonium ion is 5.62×10^{-10} mol dm^{-3} at 25 °C.

Calculate the concentration of this solution. State any assumptions you have made.

(4)

Leave blank

(iv) Use the following table and your answer from part (iii) to suggest a suitable indicator for the titration of ammonia solution with hydrochloric acid. Justify your answer.

Indicator	pK_{In}
thymol blue	1.7
methyl red	5.1
phenolphthalein	9.3

.....

.....

(2)

(b) Hydrogen cyanide is a weak acid in aqueous solution.

Write an equation to show why aqueous solutions of cyanide ions are alkaline.

.....

(1)

Leave blank

(c) Hydrogen cyanide reacts with propanal as follows:

$$CH_3CH_2CHO + HCN \rightarrow CH_3CH_2CH(OH)CN$$

Propanal is reacted with a solution of potassium cyanide, KCN, containing a little dilute sulphuric acid.

(i) What **type** of reaction is this?

.....

(1)

(ii) Give the mechanism for the reaction.

(3)

(iii) It is important that the pH is neither too acidic nor too alkaline if a good yield of the product is to be obtained. Explain why this is so.

.....

.....

.....

.....

(2)

Leave blank

(d) In an investigation of the kinetics of the nucleophilic substitution reaction between 1-chloropropane and potassium cyanide in aqueous ethanolic solution, the reaction was found to be first order with respect to 1-chloropropane and first order with respect to cyanide ions.

(i) Give the rate equation for the reaction.

.....

(1)

(ii) Write a mechanism for the reaction that is consistent with this rate equation.

(3)

(e) Suggest why reactions using cyanide ions are particularly useful in synthetic organic chemistry.

.....

.....

.....

(1)

Q2

(Total 20 marks)

Leave blank

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

3. Ammonia can be oxidised with oxygen in two ways.

Reaction I: $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$,

Reaction II: $4NH_3(g) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(g)$

The first reaction is used in the conversion of ammonia to nitric acid.

(a) Define the term **enthalpy of formation**.

.....

.....

.....

.....

(2)

(b) The following enthalpies of formation are needed for this question.

	ΔH_f / kJ mol^{-1}
$NH_3(g)$	– 46.1
$NO(g)$	+ 90.2
$H_2O(g)$	– 242

(i) Calculate the enthalpy change for Reaction I.

(2)

(ii) Calculate the enthalpy change for Reaction II.

(1)

Leave blank

(c) Whenever ammonia is oxidised, the two reactions occur at the same time: they are competing reactions.

(i) Suggest, with a reason, which reaction you would expect to be more likely **thermodynamically**.

.....

.....

.....

.....

(1)

(ii) Explain how the use of a catalyst can favour Reaction I over Reaction II.

.....

.....

.....

(2)

(d) In the nitration of benzene, a mixture of concentrated nitric and sulphuric acids is used at a temperature not exceeding 55 °C.

(i) What is the reason for using sulphuric as well as nitric acid? Support your answer with an equation.

.....

.....

.....

(2)

(ii) On the basis of your answer to (d)(i), which of nitric and sulphuric acid is the stronger acid? Give a reason.

.....

.....

.....

(1)

Leave blank

(iii) Give the mechanism for the nitration of benzene.

(3)

(iv) If the temperature of the reaction mixture rises much above 55 °C, other compounds are formed in addition to nitrobenzene.

Suggest the structural formulae of ONE of these compounds.

(1)

(v) Explain, in terms of structure and energetics, why benzene usually reacts via substitution rather than addition.

.....

.....

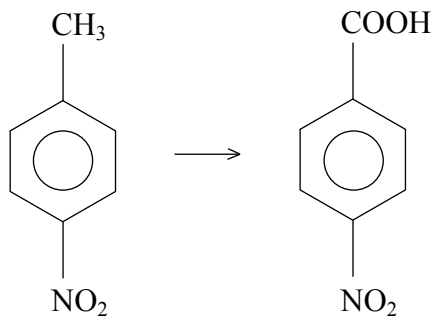
.....

.....

(3)

Leave blank

(e) Give the reagents needed to convert 4-nitromethylbenzene into 4-nitrobenzoic acid.



.....

.....

(2)

Q3

(Total 20 marks)

Leave blank

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

4. (a) Give the electronic configuration of:

Cu : [Ar] .....

Cu^+: [Ar] .....

(1)

(b) (i) Explain why Cu^+ ions are colourless.

.....

.....

.....

(2)

(ii) Copper(I) ions disproportionate in aqueous solution. Give the equation for the reaction and use the standard electrode potentials given below to explain why the reaction occurs.

	$E^{\ominus}$/V
$Cu^{2+}(aq) + e^- \rightleftharpoons Cu^+(aq)$	+ 0.15
$Cu^+(aq) + e^- \rightleftharpoons Cu(s)$	+ 0.52

.....

.....

.....

(2)

(iii) Explain why your answer to (ii) does **not** rule out the existence of $Cu^+(aq)$ under standard conditions.

.....

.....

.....

(1)

Leave blank

(c) (i) When a **small** amount of dilute ammonia solution is added to a solution of copper(II) sulphate, a turquoise blue precipitate, **F**, is formed.

F has the composition Cu 49.4%, S 12.5%, O 37.4%, H 0.78% by mass. Calculate its empirical formula.

(2)

(ii) When **F** is dissolved in dilute hydrochloric acid, the resulting blue solution gives a white precipitate with barium chloride solution.

Suggest a formula for **F**, given that all the hydrogen is present in hydroxide ions.

.....

(2)

(iii) When excess concentrated ammonia is added to **F**, a deep blue solution is formed. Give the formula of the ion responsible for this colour.

.....

(1)

(iv) What **type** of reaction is occurring in (iii)?

.....

(1)

Leave blank

(d) Copper metal can be used as a catalyst. When propan-1-ol vapour is passed over heated copper, the following reaction occurs:

$$CH_3CH_2CH_2OH \rightarrow CH_3CH_2CHO + H_2$$

(i) **Outline** how, by the use of 2,4-dinitrophenylhydrazine and suitable tables of data, you could show that the product is propanal.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(ii) When propan-1-ol is oxidised with a solution of potassium dichromate(VI) in dilute sulphuric acid care must be taken to avoid further oxidation of the aldehyde product. How is this achieved?

.....

.....

.....

(1)

(iii) What is the further oxidation product of the aldehyde?

.....

(1)

(iv) Suggest why the oxidation of the alcohol by passing it over heated copper does **not** lead to further oxidation of the aldehyde.

.....

.....

(1)

Leave blank

(v) There are a few places on the surface of the metal where catalysis can occur. These are called ‘active sites’.

Suggest why this leads to the rate of reaction being independent of the gas pressure unless this pressure is extremely low.

.....

.....

.....

(1)

Q4

(Total 20 marks)

TOTAL FOR SECTION B: 40 MARKS

TOTAL FOR PAPER: 50 MARKS

END

THE PERIODIC TABLE

Period	1	2											3	4	5	6	7	0
																		4 He Helium 2
1	1 H Hydrogen 1																	
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