Centre No.						Paper Reference						Surname	Initial(s)
Candidate No.						6	2	4	4	/	0	1	Signature

Paper Reference(s)

6244/01

Edexcel GCE

Chemistry

Advanced Level

Unit Test 4

Friday 23 January 2004 – Afternoon

Time: 1 hour 30 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
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, initials and signature.
Answer ALL the questions in the spaces provided in this question paper.
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 75. The marks for the various parts of questions are shown in round brackets: e.g. (**2**).
A Periodic Table is printed on the back cover of this booklet.

Advice to Candidates

You are reminded of the importance of clear English and careful presentation in your answers.

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Answer ALL questions in the spaces provided.

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1. Aluminium and sulphur are elements in the third period of the Periodic Table. They both burn when heated in oxygen.

(a) Give the equations for the reactions of these elements with oxygen. State the type of bonding present in the oxides formed.

(i) Aluminium

Equation .....

Type of bonding .....

(2)

(ii) Sulphur

Equation .....

Type of bonding .....

(2)

(b) The oxides produced have different acid/base properties. State these properties, illustrating your answers with suitable **ionic** equations.

(i) Aluminium oxide

Acid/base nature .....

Ionic equations .....

.....

(4)

(ii) Sulphur oxide

Acid/base nature .....

Ionic equation .....

(2)

(c) (i) Phosphorus trichloride, PCl_3, is a covalent liquid which reacts rapidly with water. Write the equation for this reaction.

Leave blank

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(2)

(ii) Carbon tetrachloride, CCl_4, is also covalently bonded but it does not react with water. Explain why it does not react.

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(4)

(d) Tin and lead also form tetrachlorides, but their reactions as oxidising agents differ. Which of the reactions **I** or **II** is likely to take place? Explain your answer.

I $SnCl_4 + PbCl_2 \rightarrow PbCl_4 + SnCl_2$
II $PbCl_4 + SnCl_2 \rightarrow SnCl_4 + PbCl_2$

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(2)

Q1

(Total 18 marks)

2. (a) Consider the following reaction scheme

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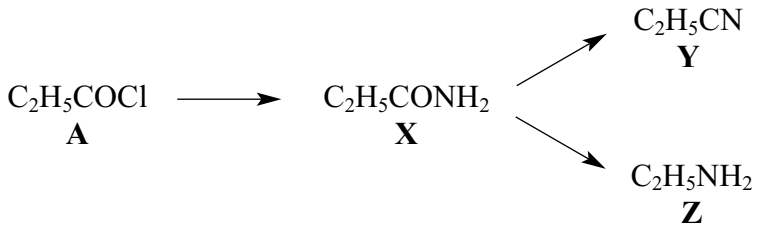

(i) Name compound **A**.

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(1)

(ii) Identify the reagent needed to convert:

A to **X** .....

X to **Y** .....

(2)

(iii) Identify the reagents and the conditions needed to convert **X** to **Z**.

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(3)

(b) Two of the substances **A**, **X**, **Y** and **Z** react with cold water to give solutions that are **not** neutral.

(i) State which substance reacts with cold water to give a solution with a pH **less** than 7. Write the equation for this reaction.

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(2)

(ii) State which substance reacts with cold water to give a solution with a pH **greater** than 7. Write the equation for this reaction.

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(2)

Q2

(Total 10 marks)

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3. Geraniol is a fragrance obtained from rose petals. Its formula is

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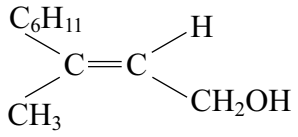

(a) Explain why geraniol exhibits geometric isomerism.

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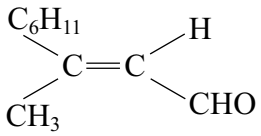
(2)

(b) Geraniol can be oxidised to citral, which is the main ingredient of lemon grass oil. Citral's formula can be written as:



Identify the reagents and suggest conditions necessary for the preparation of citral from geraniol.

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(3)

(c) State what you would **see** when citral reacts with:

(i) bromine dissolved in water;

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(1)

(ii) a solution of 2,4-dinitrophenylhydrazine;

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(1)

(iii) Fehling's solution.

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(1)

(d) Give the structural formula of the organic product of the reaction of citral with:

Leave blank

(i) hydrogen bromide gas;

(1)

(ii) a solution of hydrogen cyanide, HCN, containing a trace of base;

(1)

(iii) a solution in ethoxyethane (ether) of methyl magnesium iodide, CH_3MgI, followed by dilute acid.

(1)

Q3

(Total 11 marks)

4. (a) (i) Define the term **enthalpy of atomisation**.

Leave blank

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(2)

(ii) Write the equation, with state symbols, which represents the change occurring when the enthalpy of atomisation of chlorine is measured.

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(1)

(iii) Draw a Born-Haber cycle and use it to determine the lattice energy of strontium chloride, $SrCl_2(s)$, using the following data:

	Enthalpy change/kJ mol^{-1}
enthalpy of formation of $SrCl_2(s)$	–829
enthalpy of atomisation of strontium	+164
enthalpy of atomisation of chlorine	+122
1st ionisation energy of strontium	+550
2nd ionisation energy of strontium	+1064
electron affinity of chlorine	–349

(5)

(b) In fireworks, the thermal decomposition of strontium(II) chloride, $SrCl_2$, gives the covalent molecule of strontium(I) chloride, SrCl(g), which is responsible for the red colour of the fireworks.

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$$SrCl_2(s) \rightleftharpoons SrCl(g) + Cl(g) \qquad \Delta H = +737 \text{ kJ mol}^{-1}$$

(i) Calculate the enthalpy of formation of SrCl(g) using the ΔH given above, the enthalpy of formation of $SrCl_2(s)$ (-829 kJ mol^{-1}) and the enthalpy of atomisation of chlorine ($+122$ kJ mol^{-1}).

(2)

(ii) Explain what would be the effect of a lowering in the temperature of the exploding firework on the value of the equilibrium constant and on the position of this equilibrium.

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(3)

(iii) Some solid $SrCl_2$ was heated at 1500 °C and equilibrium was reached. The total pressure of the gases produced was found to be 4.2 atm.

Write the expression for K_p and calculate its value with units.

(5)

Q4

(Total 18 marks)

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5. (a) Ammonia reacts with water as below:

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

A 0.100 mol dm^{-3} solution of ammonia has a pH of 11.13.

(i) Identify the Brønsted–Lowry acid/base conjugate pairs in the equation. Clearly label which are acids and which are bases.

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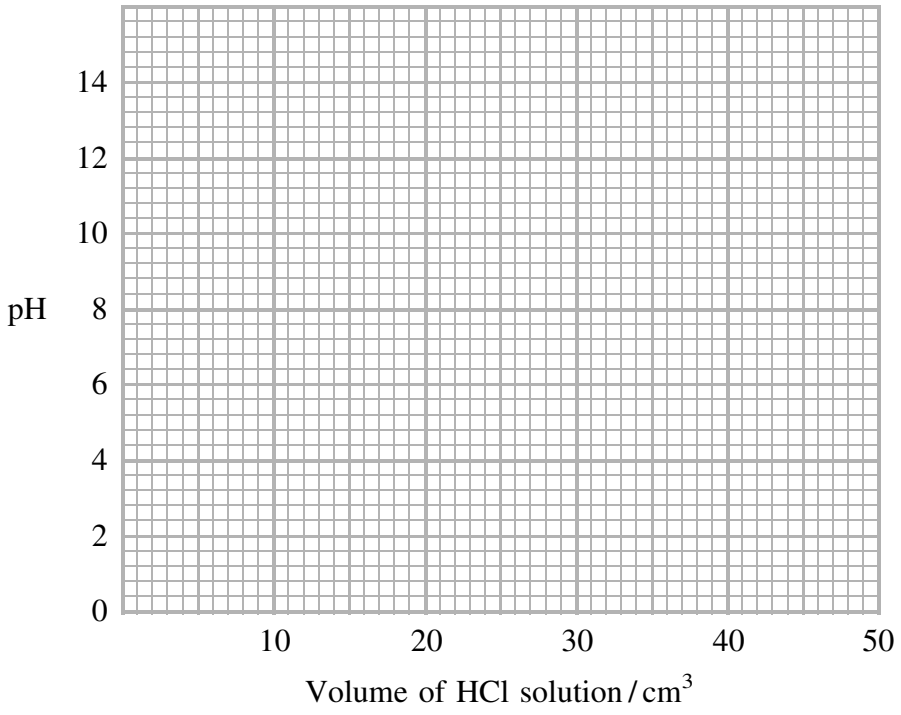
(2)

(ii) Draw, on the axes below, a graph to show how the pH of the solution varies as 40 cm^3 of 0.100 mol dm^{-3} hydrochloric acid (a strong acid) is added slowly to 20 cm^3 of the ammonia solution.



(4)

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(iii) Select, from the following list, the indicator which would be the most suitable for this titration. Give a reason for your choice.

Indicator	pK_{ind}	Range
methyl red	5.1	4.2 – 6.3
bromothymol blue	7.0	6.0 – 7.6
phenolphthalein	9.3	8.2 – 10.0

Indicator: .....

Reason: .....

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(2)

(b) Nitrous acid, HNO_2, is a weak acid with an acid dissociation constant $K_a = 4.70 \times 10^{-4}$ mol dm^{-3} at 4 °C.

$$HNO_2(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + NO_2^-(aq)$$

(i) Write the expression for K_a.

(1)

(ii) Calculate the pH of a 0.120 mol dm^{-3} solution of nitrous acid.

(3)

QUESTION 5 CONTINUES ON THE NEXT PAGE

(iii) Calculate the pH of a buffer solution made by adding 1.38 g of sodium nitrite, $NaNO_2$, to 100 cm^3 of the 0.120 mol dm^{-3} solution of nitrous acid ($K_a = 4.70 \times 10^{-4}$ mol dm^{-3}).

Leave blank

(4)

(iv) Suggest why a mixture of nitrous acid and sodium nitrite can act as a buffer solution whereas a solution of sodium nitrite on its own does not.

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(2)

Q5

(Total 18 marks)

TOTAL FOR PAPER: 75 MARKS

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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