Write your name here

Surname	Other names

Centre Number	Candidate Number

Edexcel GCE

Chemistry

Advanced Subsidiary

Unit 3B: Chemistry Laboratory Skills I Alternative

Friday 15 May 2009 – Morning
Time: 1 hour 15 minutes

Paper Reference
6CH07/01

Candidates may use a calculator.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*

Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Answer ALL the questions. Write your answers in the spaces provided.

1 (a) A student carries out a series of tests on **X**, a white powder known to be either calcium carbonate or magnesium carbonate. Complete the table below.

(6)

	Test	Observation	Inference
(i)	Carry out a flame test on **X**.	....	Cation is magnesium.
(ii)	Add dilute hydrochloric acid to **X**.	.... **and** a solution **Y** is formed.	A gas is evolved.
(iii)	Pass the gas evolved in test (ii) through limewater.	....	Gas evolved in (ii) is ....
(iv)	Add dilute sodium hydroxide to solution **Y** until there is no further change.	....	The **new** substance observed is ....

N 3 4 4 7 3 A 0 2 1 6

(b) A student carries out a series of tests on a white solid **Z** which contains one cation and one anion. Complete the table below.

(6)

	Test	Observation	Inference
(i)	Carry out a flame test on **Z**.	Red flame	Cation is either .... or ....
(ii)	Acidify an aqueous solution of **Z** with dilute nitric acid. Then add a few drops of aqueous silver nitrate followed by **concentrated** aqueous ammonia until there is no further change.	Cream precipitate which	Anion is probably bromide.
(iii)	Add concentrated sulfuric acid to solid **Z**.	Steamy fumes **and** .... vapour seen.	Probably hydrogen bromide **and** .... formed. Bromide confirmed.
(iv)	Test the gases formed in (iii) with a piece of filter paper soaked in potassium dichromate(VI) solution.	Colour change from .... to	Sulfur dioxide present.

(v) Explain, in terms of the redox processes occurring, how sulfur dioxide is produced in (b)(iii).

(2)

....

....

....

(Total for Question 1 = 14 marks)

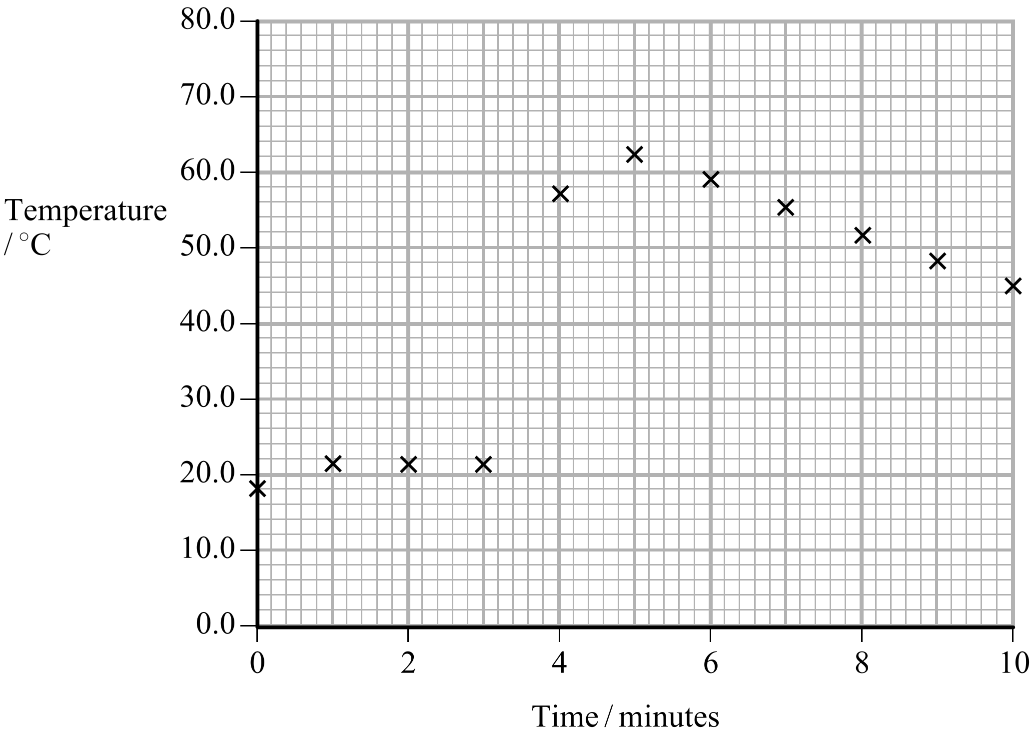
2 The enthalpy change for the reaction between zinc and copper(II) sulfate solution was determined using the procedure below. The ionic equation for the reaction is

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

Procedure

1. Weigh about 5 g of zinc powder.
2. Measure 50.0 cm^3 of 1.00 mol dm^{-3} copper(II) sulfate solution into a polystyrene cup.
3. Stir the solution continuously with a thermometer and measure the temperature of the solution each minute for 3 minutes.
4. At **exactly** 3.5 minutes add the zinc powder to the copper(II) sulfate solution.
5. Continue to stir the solution and read the temperature each minute from 4 to 10 minutes.

The results obtained are shown in the graph below.



(a) (i) Use the graph to estimate the maximum temperature change, ΔT, for the reaction. Show your working on the graph.

(2)

ΔT = ... °C

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(ii) Calculate the number of moles of copper(II) sulfate in 50.0 cm^3 of 1.00 mol dm^{-3} solution.

(1)

(iii) The 5 g of zinc powder used is an excess. Calculate the mass of zinc that reacts exactly with 50.0 cm^3 of 1.00 mol dm^{-3} copper(II) sulfate solution.

(1)

(iv) Explain why the mass of zinc is **not** used in the calculation of the heat energy for the reaction.

(1)

....

....

(v) Use the value you have obtained for ΔT to calculate the heat energy produced in the reaction between zinc and copper(II) sulfate. Include units with your answer.

Use the expression

energy produced (J) = mass of solution × specific heat capacity of solution × temperature rise

[Assume the specific heat capacity of the solution to be 4.18 J g^{-1} $°C^{-1}$ and the density of the solution to be 1.00 g cm^{-3}.]

(2)

(vi) Calculate the enthalpy change, ΔH, for this reaction. Your answer should be in units of kJ mol^{-1}, expressed to **two** significant figures and include a sign.

(2)

ΔH = ... kJ mol^{-1}

(b) (i) Explain why the temperature of the solution is measured for 3 minutes **before** adding the zinc.

(1)

....

....

(ii) Explain why the temperature of the solution is measured over a period of time **after** adding the zinc.

(1)

....

....

(iii) A polystyrene cup is used, rather than a glass beaker, to reduce heat loss. Explain why a polystyrene cup is a good choice.

(1)

....

....

....

(iv) Explain why the solutions are **continuously** stirred in this experiment.

(1)

....

....

....

(v) Suggest a piece of apparatus suitable for measuring the 50.0 cm^3 of copper(II) sulfate solution in this experiment.

(1)

....

(vi) Suggest ONE change in the apparatus used (other than using more accurate measuring equipment) that would improve the accuracy of the results.

(1)

....

....

(c) In two further experiments, using more accurate equipment and an improved method, the ΔH for the reaction between zinc and copper(II) sulfate was determined to be –216.8 kJ mol^{-1} while that for the reaction between zinc and lead(II) nitrate was found to be –154.0 kJ mol^{-1}.

Place the three metals (copper, lead and zinc) in order of **decreasing** reactivity and justify your answer by using these ΔH values.

(2)

....

....

....

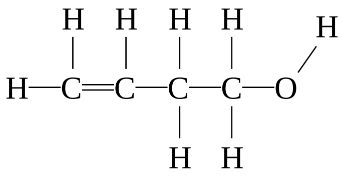
....

....

....

(Total for Question 2 = 17 marks)

3 An organic compound **A** has the structure shown below.



(a) Give the observations that you would expect to make when each of the tests below is carried out. Give a brief chemical explanation of each reaction that occurs. Mechanisms are **not** required.

(i) A small amount of phosphorus(V) chloride is added to 2 cm^3 of **A** in a test tube.

(2)

Observation ....

Explanation ....

....

(ii) A few drops of potassium manganate(VII) solution and 2 cm^3 of dilute sulfuric acid are added to 2 cm^3 of **A** in a test tube and the mixture is gently warmed.

(2)

Observation ....

Explanation ....

....

(iii) A few drops of bromine water are added to 2 cm^3 of **A** in a test tube and the mixture is shaken.

(2)

Observation ....

Explanation ....

....

(b) In the box below, draw the displayed formula of the product formed in (a)(iii).

(1)

(Total for Question 3 = 7 marks)

4 2-chloro-2-methylbutane may be prepared by reacting 2-methylbutan-2-ol with concentrated hydrochloric acid:

$$(CH_3)_2C(OH)CH_2CH_3 + HCl \rightarrow (CH_3)_2C(Cl)CH_2CH_3 + H_2O$$

The steps of the experimental procedure are as follows.

1. Place 5.00 cm^3 of 2-methylbutan-2-ol and about 20 cm^3 of concentrated hydrochloric acid into a separating funnel.
2. Continuously shake the mixture for 10 minutes.
3. Remove the aqueous layer and slowly add about 10 cm^3 of dilute sodium hydrogencarbonate solution to the separating funnel.
4. Shake the mixture gently, inverting the separating funnel and opening the tap at regular intervals.
5. Remove the aqueous layer and transfer the organic layer to a conical flask.
6. Add a few pieces of anhydrous calcium chloride to the conical flask and shake the mixture.
7. Decant the liquid into a distillation flask and distil it to collect the pure 2-chloro-2-methylbutane.

Data

	2-methylbutan-2-ol	2-chloro-2-methylbutane
Density / g cm^{-3}	0.805	0.866
Molar mass / g mol^{-1}	88	106.5
Boiling temperature / °C	102	85.5

(a) Draw a diagram of the separating funnel, clearly labelling the 2-methylbutan-2-ol and the concentrated hydrochloric acid layers (step 1).
[The density of concentrated hydrochloric acid is 1.18 g cm^{-3}.]

(2)

(b) (i) Why is it necessary to **continuously** shake the 2-methylbutan-2-ol and the concentrated hydrochloric acid for the reaction to occur (step 2)?

(1)

....

....

(ii) Explain the purpose of the sodium hydrogencarbonate solution (step 3).

(1)

....

....

(iii) Why is the tap of the separating funnel opened at regular intervals (step 4)?

(2)

....

....

....

(iv) What is the purpose of the calcium chloride (step 6)?

(1)

....

....

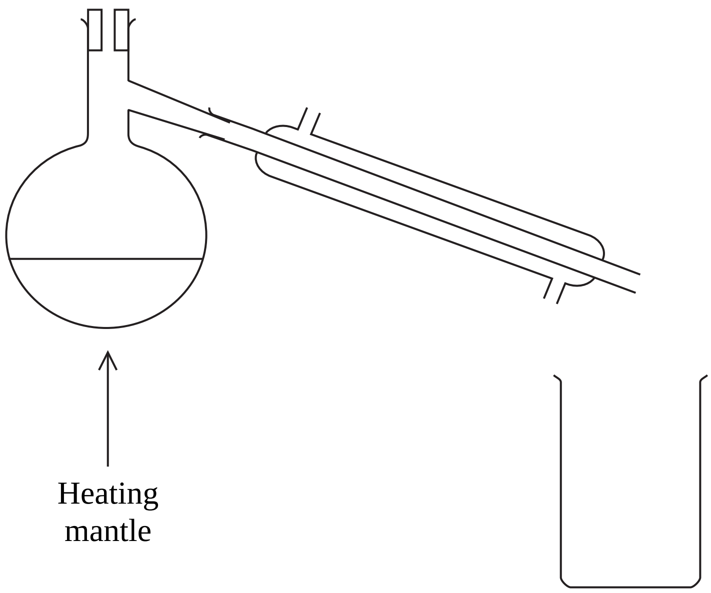
(v) What is meant by **decant** the liquid (step 7)?

(1)

....

....

(c) An incomplete diagram of the distillation apparatus is shown below.



(i) Draw a thermometer in the diagram, showing clearly where the bulb of the thermometer is placed.

(1)

(ii) Draw clearly labelled arrows on the diagram to show the flow of water into and out of the condenser.

(1)

(d) The typical yield from this preparation is 70 %. Calculate the mass of 2-chloro-2-methylbutane that would be formed from 5.00 cm^3 of 2-methylbutan-2-ol if a 70 % yield were obtained.

The equation for the reaction and the table of data are repeated below.

$$(CH_3)_2C(OH)CH_2CH_3 + HCl \rightarrow (CH_3)_2C(Cl)CH_2CH_3 + H_2O$$

	2-methylbutan-2-ol	2-chloro-2-methylbutane
Density / g cm^{-3}	0.805	0.866
Molar mass / g mol^{-1}	88	106.5
Boiling temperature / °C	102	85.5

(2)

(Total for Question 4 = 12 marks)

TOTAL FOR PAPER = 50 MARKS

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The Periodic Table of Elements

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

1	2											3	4	5	6	7	0 (8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
							1.0 **H** hydrogen 1										4.0 **He** helium 2
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12											27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	95.9 **Mo** molybdenum 42	[98] **Tc** technetium 43	101.1 **Ru** ruthenium 44	102.9 **Rh** rhodium 45	106.4 **Pd** palladium 46	107.9 **Ag** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La*** lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111							

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series	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
* Actinide series	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