

Centre Number						Candidate Number					
Surname						Other Names					
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Candidate Signature						Date					

For Teacher's Use	
Section	Mark
PSA	
Task	
Section A	
Section B	
TOTAL (max 50)	



General Certificate of Education
Advanced Subsidiary Examination
June 2014

Chemistry

CHM3T/Q14/test

Unit 3T AS Investigative Skills Assignment

Written Test

For submission by 15 May 2014

For this paper you must have: <ul style="list-style-type: none"> the Periodic Table/Data Sheet provided at the end of this paper your Task Sheet and your Candidate Results Sheet a ruler with millimetre measurements a calculator. 	Time allowed <ul style="list-style-type: none"> 1 hour
Instructions <ul style="list-style-type: none"> Use black ink or black ball-point pen. Fill in the boxes at the top of this page. Answer all questions. You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages. Do all rough work in this book. Cross through any work you do not want to be marked. 	Information <ul style="list-style-type: none"> The marks for questions are shown in brackets. The maximum mark for this paper is 30. You are expected to use a calculator, where appropriate. You will be marked on your ability to: <ul style="list-style-type: none"> organise information clearly use scientific terminology accurately.

Details of additional assistance (if any). Did the candidate receive any help or information in the production of this work? If you answer yes give the details below or on a separate page.

Yes No

Teacher Declaration:

I confirm that the candidate's work was conducted under the conditions laid out by the specification. I have authenticated the candidate's work and am satisfied that to the best of my knowledge the work produced is solely that of the candidate.

Signature of teacher Date

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There are no questions printed on this page

**DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED**

Section A

These questions are about the task, an investigation of Group 2 compounds.

You should use your Task Sheet and your Candidate Results Sheet to answer these questions.

Answer **all** questions in the spaces provided.

1 In Part 1 of the task, compound **X** was reacted with solution **A**. An excess of one of these reagents was used.

1 (a) Use your results from Part 1 to state the reagent, compound **X** or solution **A**, that was in excess. Give a reason for your choice.

[1 mark]

Reagent

Reason

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1 (b) Suggest why the preparation of solution **Y** used an excess of this reagent and **not** the other reagent.

[1 mark]

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2 Solutions **Y** and **Z** contain compounds of different Group 2 metals.

Use your results from the task and your knowledge of Group 2 chemistry to determine whether solution **Y** contains calcium ions or magnesium ions. Give a reason for your choice.

[2 marks]

Metal ion in **Y**

Reason

.....

Turn over ►

- 3 Use your results from the task and your knowledge of Group 2 and Group 7 chemistry to identify the negative ion in each of the solutions **Y** and **Z**. For each negative ion, give a reason for your choice.

[4 marks]

Negative ion in **Y**

Reason

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Negative ion in **Z**

Reason

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- 4 Strontium chloride is used in toothpaste for sensitive teeth.
Both strontium carbonate and strontium sulfate are white solids that are insoluble in water.

- 4 (a) Write an equation for the reaction between strontium chloride solution and sodium sulfate solution.
Include state symbols in your equation.

[1 mark]

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- 4 (b) Strontium carbonate reacts with nitric acid to produce a solution of strontium nitrate.
Strontium sulfate does not react with nitric acid.

Describe briefly how you could obtain strontium sulfate from a mixture of strontium carbonate and strontium sulfate.

You are **not** required to describe the purification of the strontium sulfate.

[2 marks]

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- 5** A solution of magnesium sulfate is sometimes given as first aid to someone who has swallowed barium chloride.

Explain why drinking magnesium sulfate solution is effective in the treatment of barium poisoning.

[1 mark]

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- 6** Medicines for the treatment of nervous disorders often contain calcium bromide. Silver nitrate, acidified with dilute nitric acid, can be used together with another reagent to test for the presence of bromide ions in a solution of a medicine.

Describe briefly how you would carry out this test and state what you would observe.

[3 marks]

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15

Turn over for the next question

Turn over ►

Section B

Answer **all** questions in the spaces provided.

- 7** Anhydrous strontium chloride is not used in toothpaste because it absorbs water from the atmosphere. The hexahydrate, $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$, is preferred.

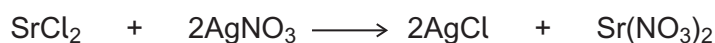
A chemist was asked to determine the purity of a sample of strontium chloride hexahydrate. The chemist weighed out 2.25 g of the sample and added it to 100 cm^3 of water. The mixture was warmed and stirred for several minutes to dissolve all of the strontium chloride in the sample. The mixture was then filtered into a conical flask. An excess of silver nitrate solution was added to the flask and the contents swirled for 1 minute to make sure that the precipitation was complete.

The silver chloride precipitate was separated from the mixture by filtration. The precipitate was washed several times with deionised water and dried carefully. The chemist weighed the dry precipitate and recorded a mass of 1.55 g.

- 7 (a)** Calculate the amount, in moles, of AgCl in 1.55 g of silver chloride ($M_r = 143.4$). **[1 mark]**

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- 7 (b)** The equation for the reaction between strontium chloride and silver nitrate is



Use your answer from Question **7 (a)** and this equation to calculate the amount, in moles, of SrCl_2 needed to form 1.55 g of silver chloride.

[1 mark]

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- 7 (c)** Use data from the Periodic Table to calculate the M_r of strontium chloride hexahydrate. Give your answer to 1 decimal place.

[1 mark]

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- 7 (d)** Use your answers from Questions **7 (b)** and **7 (c)** to calculate the percentage by mass of strontium chloride hexahydrate in the sample. Show your working. Give your answer to the appropriate precision.

[2 marks]

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- 7 (e)** Several steps in the practical procedure were designed to ensure an accurate value for the percentage by mass of strontium chloride hexahydrate in the sample.

- 7 (e) (i)** Explain why the solution of strontium chloride was filtered to remove insoluble impurities before the addition of silver nitrate.

[1 mark]

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- 7 (e) (ii)** Explain why the precipitate of silver chloride was washed several times with deionised water.

[1 mark]

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- 8** Magnesium hydroxide and magnesium carbonate are used to reduce acidity in the stomach. Magnesium hydroxide can be prepared by the reaction of solutions of magnesium chloride and sodium hydroxide.

- 8 (a)** Write the **simplest ionic** equation for the reaction that occurs between magnesium chloride and sodium hydroxide. Include state symbols in your equation.

[1 mark]

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- 8 (b)** Other than cost, explain **one** advantage of using magnesium hydroxide rather than magnesium carbonate to reduce acidity in the stomach.

[1 mark]

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Turn over ►

- 9** Calcium ethanoate, $(\text{CH}_3\text{COO})_2\text{Ca}$, is used in the treatment of kidney disease. Thermal decomposition of calcium ethanoate under certain conditions gives propanone and **one** other product.

Write an equation for the thermal decomposition of calcium ethanoate.

[1 mark]

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- 10** Salts containing the chromate(VI) ion are usually yellow in colour.
Calcium chromate(VI) is soluble in water.
Strontium chromate(VI) is insoluble in water, but will dissolve in a solution of ethanoic acid.
Barium chromate(VI) is insoluble in water and is also insoluble in a solution of ethanoic acid.

Describe a series of tests using solutions of sodium chromate(VI) and ethanoic acid that would allow you to distinguish between separate solutions of calcium chloride, strontium chloride and barium chloride.

State what you would observe in each test.

[3 marks]

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- 11** The strontium salt of ranelic acid is used to promote bone growth. Analysis of a pure sample of ranelic acid showed that it contained 42.09% of carbon, 2.92% of hydrogen, 8.18% of nitrogen, 37.42% of oxygen and 9.39% of sulfur by mass.

Use these data to calculate the empirical formula of ranelic acid.
Show your working.

[2 marks]

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END OF QUESTIONS

Turn over ►

GCE Chemistry Data Sheet

Table A

Infrared absorption data

Bond	Wavenumber /cm ⁻¹
N-H (amines)	3300 – 3500
O-H (alcohols)	3230 – 3550
C-H	2850 – 3300
O-H (acids)	2500 – 3000
C≡N	2220 – 2260
C=O	1680 – 1750
C=C	1620 – 1680
C-O	1000 – 1300
C-C	750 – 1100


Table B

¹H n.m.r. chemical shift data

Type of proton	δ/ppm
ROH	0.5 – 5.0
RCH ₃	0.7 – 1.2
RNH ₂	1.0 – 4.5
R ₂ CH ₂	1.2 – 1.4
R ₃ CH	1.4 – 1.6
$\begin{array}{c} \\ \text{R}-\text{C}-\text{C}- \\ \quad \\ \text{O} \quad \text{H} \end{array}$	2.1 – 2.6
$\begin{array}{c} \\ \text{R}-\text{O}-\text{C}- \\ \\ \text{H} \end{array}$	3.1 – 3.9
RCH ₂ Cl or Br	3.1 – 4.2
$\begin{array}{c} \\ \text{R}-\text{C}-\text{O}-\text{C}- \\ \quad \\ \text{O} \quad \text{H} \end{array}$	3.7 – 4.1
$\begin{array}{c} \text{H} \\ \\ \text{R}-\text{C}=\text{C}- \\ \end{array}$	4.5 – 6.0
$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{H} \end{array}$	9.0 – 10.0
$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{O}-\text{H} \end{array}$	10.0 – 12.0

Table C

¹³C n.m.r. chemical shift data

Type of carbon	δ/ppm
$\begin{array}{c} \\ -\text{C}-\text{C}- \\ \end{array}$	5 – 40
$\begin{array}{c} \\ \text{R}-\text{C}-\text{Cl or Br} \\ \end{array}$	10 – 70
$\begin{array}{c} \\ \text{R}-\text{C}-\text{C}- \\ \quad \\ \text{O} \end{array}$	20 – 50
$\begin{array}{c} \\ \text{R}-\text{C}-\text{N}- \\ \end{array}$	25 – 60
$\begin{array}{c} \\ -\text{C}-\text{O}- \\ \end{array}$	alcohols, ethers or esters 50 – 90
$\begin{array}{c} \diagup \\ \text{C}=\text{C} \\ \diagdown \end{array}$	90 – 150
R-C≡N	110 – 125
	110 – 160
$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}- \end{array}$	esters or acids 160 – 185
$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}- \end{array}$	aldehydes or ketones 190 – 220

The Periodic Table of the Elements

1 2 3 4 5 6 7 0

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
6.9 Li lithium 3	9.0 Be beryllium 4	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	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	4.0 He helium 2
23.0 Na sodium 11	24.3 Mg magnesium 12	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	96.0 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	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	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	96.0 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	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	96.0 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	[267] Rf rutherfordium 104	[268] Db dubnium 105	[271] Sg seaborgium 106	[272] Bh bohrium 107	[270] Hs hassium 108	[276] Mt meitnerium 109	[281] Ds darmstadtium 110	[280] Rg roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

1.0 H hydrogen 1

Key
relative atomic mass
symbol
name
atomic (proton) number

* 58 – 71 Lanthanides

† 90 – 103 Actinides

140.1 Ce cerium 58	140.9 Pr praseodymium 59	144.2 Nd neodymium 60	[145] Pm promethium 61	150.4 Sm samarium 62	152.0 Eu europium 63	157.3 Gd gadolinium 64	158.9 Tb terbium 65	162.5 Dy dysprosium 66	164.9 Ho holmium 67	167.3 Er erbium 68	168.9 Tm thulium 69	173.1 Yb ytterbium 70	175.0 Lu lutetium 71
232.0 Th thorium 90	231.0 Pa protactinium 91	238.0 U uranium 92	[237] Np neptunium 93	[244] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[247] Bk berkelium 97	[251] Cf californium 98	[252] Es einsteinium 99	[257] Fm fermium 100	[258] Md mendelevium 101	[259] No nobelium 102	[262] Lr lawrencium 103