Centre Number						Candidate Number				
Surname						Other Names				

Notice to Candidate. The work you submit for assessment must be your own. If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified.

Candidate Declaration. I have read and understood the Notice to Candidate and can confirm that I have produced the attached work without assistance other than that which is acceptable under the scheme of assessment.

Candidate Signature		Date	

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

General Certificate of Education
Advanced Level Examination
June 2014

Chemistry CHM6T/Q14/test

Unit 6T A2 Investigative Skills Assignment

Written Test

For submission by 15 May 2014

For this paper you must have:	**Time allowed**
• 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.	• 1 hour
Instructions	**Information**
• 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.	• 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: – 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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Section A

These questions are about the task, an investigation of some redox reactions.

You should use your Task Sheet, including your own Candidate Results Sheet, to answer these questions.

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

1 In **Test 1**, the vanadate(V) ion (VO_3^-) is reduced, in the presence of hydrogen (H^+) ions, to the oxovanadium(IV) ion (VO^{2+}). The zinc metal is oxidised.

1 (a) Construct half-equations for these reduction and oxidation processes.

[2 marks]

Vanadate(V) half-equation .....

Zinc half-equation .....

1 (b) Use your answers from Question **1 (a)** to deduce an overall equation for the reaction.

[1 mark]

.....

.....

2 The reaction between zinc and hydrochloric acid in Part 2 of **Test 1** produces hydrogen in the boiling tube. This gas helps to provide the conditions needed for the formation of the final vanadium-containing product.

Suggest why a cotton wool plug is used in this tube and why a rubber bung is less suitable.

[2 marks]

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Do not write outside the box

3 In **Test 2**, solution **B** (potassium manganate(VII) solution) was mixed with solution **C**, which contains a reducing agent.

Use your observations from the Task to suggest the identity of the main manganese-containing species after Part 2 of **Test 2**.

[1 mark]

.....

4 In Part 1 of **Test 3**, sodium hydroxide was added to a solution of iron(II) ions. In Part 2 of **Test 3**, the mixture was shaken in air.

State what you would have observed if an excess of hydrochloric acid had been added to the final mixture in the test tube.

[1 mark]

.....

.....

5 The equations for the reactions occurring in **Test 4** are

$$2Cu^{2+}(aq) + 4I^{-}(aq) \longrightarrow 2CuI(s) + I_2(s)$$

$$I_2(s) + I^{-}(aq) \longrightarrow I_3^{-}(aq)$$

Use these equations to explain your observations in this test.

[2 marks]

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Turn over ▶

Do not write outside the box

6 In **Test 5**, aqueous iron(III) ions are reduced to aqueous iron(II) ions by iodide ions. This reaction could be used to provide electrical energy in a cell.

6 (a) The standard electrode potential for the reduction of iron(III) ions into iron(II) ions can be measured by connecting a suitable electrode to a standard hydrogen electrode.
Draw a clearly labelled diagram to show the components and reagents, including their concentrations, in this Fe(III)/Fe(II) electrode.
Do **not** draw the salt bridge or the standard hydrogen electrode.

[3 marks]

6 (b) A salt bridge is used to complete the cell. This could be prepared using potassium nitrate solution and filter paper.

State the purpose of the salt bridge. State **one** essential requirement of the soluble ionic compound used to make the salt bridge.

[2 marks]

Purpose of salt bridge .....

.....

Requirement .....

.....

Do not write outside the box

7 In Part 2 of **Test 6**, chromium(III) ions were oxidised.

7 (a) Use your observations to deduce the formula of the final chromium-containing species in the solution.

[1 mark]

.....

7 (b) State what you would observe if excess sulfuric acid is added to the final solution obtained from Part 2 of **Test 6**.

[1 mark]

.....

.....

8 Solution **C** (hydrogen peroxide solution) was used in **Tests 2** and **6**.
In **Test 2**, it reacted with manganate(VII) ions and oxygen was formed.
In **Test 6**, it reacted with chromium(III) ions and hydroxide ions were formed.

8 (a) In each Test, deduce the change in the oxidation state of the oxygen in the hydrogen peroxide.

[2 marks]

Test 2 .....

Test 6 .....

8 (b) Deduce the number of moles of hydrogen peroxide that are needed to react with one mole of chromium(III) ions in Part 2 of **Test 6**.

[1 mark]

.....

19

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Section B

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

9 One cell that has been used to provide electrical energy is the Daniell cell. This cell uses copper and zinc.

9 (a) The conventional representation for the Daniell cell is

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

The e.m.f. of this cell under standard conditions is +1.10 V.

Deduce the half-equations for the reactions occurring at the electrodes.

[2 marks]

At Zn electrode .....

At Cu electrode .....

9 (b) A Daniell cell was set up using 100 cm^3 of a 1.0 mol dm^{-3} copper(II) sulfate solution. The cell was allowed to produce electricity until the concentration of the copper(II) ions had decreased to 0.50 mol dm^{-3}.

Calculate the decrease in mass of the zinc electrode. Show your working.

[3 marks]

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Do not write outside the box

9 (c) You are provided with the Daniell cell referred to in Question **9 (b)**, including a zinc electrode of known mass.

Briefly outline how you would carry out an experiment to confirm your answer to Question **9 (b)**.

[3 marks]

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10 Copper, in the form of nanoparticles of copper(II) hexacyanoferrate(II), has recently been investigated as an efficient method of storing electrical energy in a rechargeable cell.

10 (a) Solar cells generate an electric current from sunlight. These cells are often used to provide electrical energy for illuminated road signs.

Explain why rechargeable cells are connected to these solar cells.

[2 marks]

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10 (b) Suggest **one** reason why many waste disposal centres contain a separate section for cells and batteries.

[1 mark]

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END OF QUESTIONS

11

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

^{1}H n.m.r. chemical shift data

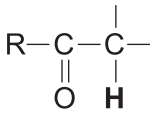
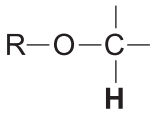
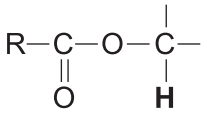
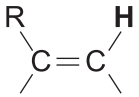
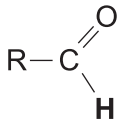
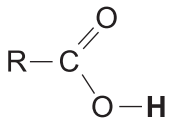
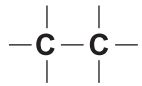
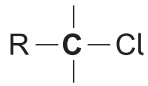
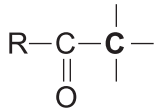
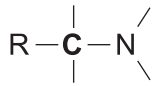
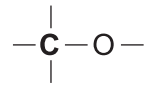
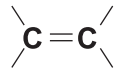
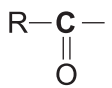
Type of proton	δ/ppm
ROH	0.5 – 5.0
RCH$_3$	0.7 – 1.2
RNH$_2$	1.0 – 4.5
R$_2$CH$_2$	1.2 – 1.4
R$_3$CH	1.4 – 1.6
	2.1 – 2.6
	3.1 – 3.9
RCH$_2$Cl or Br	3.1 – 4.2
	3.7 – 4.1
	4.5 – 6.0
	9.0 – 10.0
	10.0 – 12.0

Table C

^{13}C n.m.r. chemical shift data

Type of carbon	δ/ppm
	5 – 40
	10 – 70
	20 – 50
	25 – 60
 alcohols, ethers or esters	50 – 90
	90 – 150
	110 – 125
	110 – 160
 esters or acids	160 – 185
 aldehydes or ketones	190 – 220

WMP/Jun14/CHM6T/Q14/test

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The Periodic Table of the Elements

1	2											3	4	5	6	7	0
(1)	(2)											(13)	(14)	(15)	(16)	(17)	(18)
			Key				1.0 H hydrogen 1										4.0 He helium 2
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass **symbol** name atomic (proton) number									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	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(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	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						

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

* **58 – 71** Lanthanides

† **90 – 103** Actinides