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 ISA MARK (max 50)	

General Certificate of Education
Advanced Subsidiary Examination
June 2011

Chemistry CHM3T/Q11/test

Unit 3T AS Investigative Skills Assignment

For submission by 15 May 2011

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 space 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 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 .....

Section A

These questions are about the task, the determination of the enthalpy change for the reaction between copper(II) sulfate solution and iron.

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

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

1 Plot a graph of temperature (*y*-axis) against time on the grid opposite.
Draw a line of best fit for the points before the fourth minute.
Draw a second line of best fit for the points after the maximum temperature has been reached.
Extrapolate both lines to the fourth minute. *(5 marks)*

2 Use your graph to determine an accurate value for the temperature of the copper(II) sulfate solution at the fourth minute (**before** mixing).

Temperature before mixing .....
(1 mark)

3 Use your graph to determine an accurate value for the temperature of the reaction mixture at the fourth minute (**after** mixing).

Temperature after mixing .....
(1 mark)

4 Use your answers from Questions **2** and **3** to determine an accurate value for the temperature rise at the fourth minute.
Give your answer to the appropriate precision.

Temperature rise .....
(1 mark)

5 Use your answer from Question **4** to calculate the heat given out during this experiment. Assume that the reaction mixture has a density of $1.00\,g\,cm^{-3}$ and a specific heat capacity of $4.18\,J\,K^{-1}\,g^{-1}$.

.....

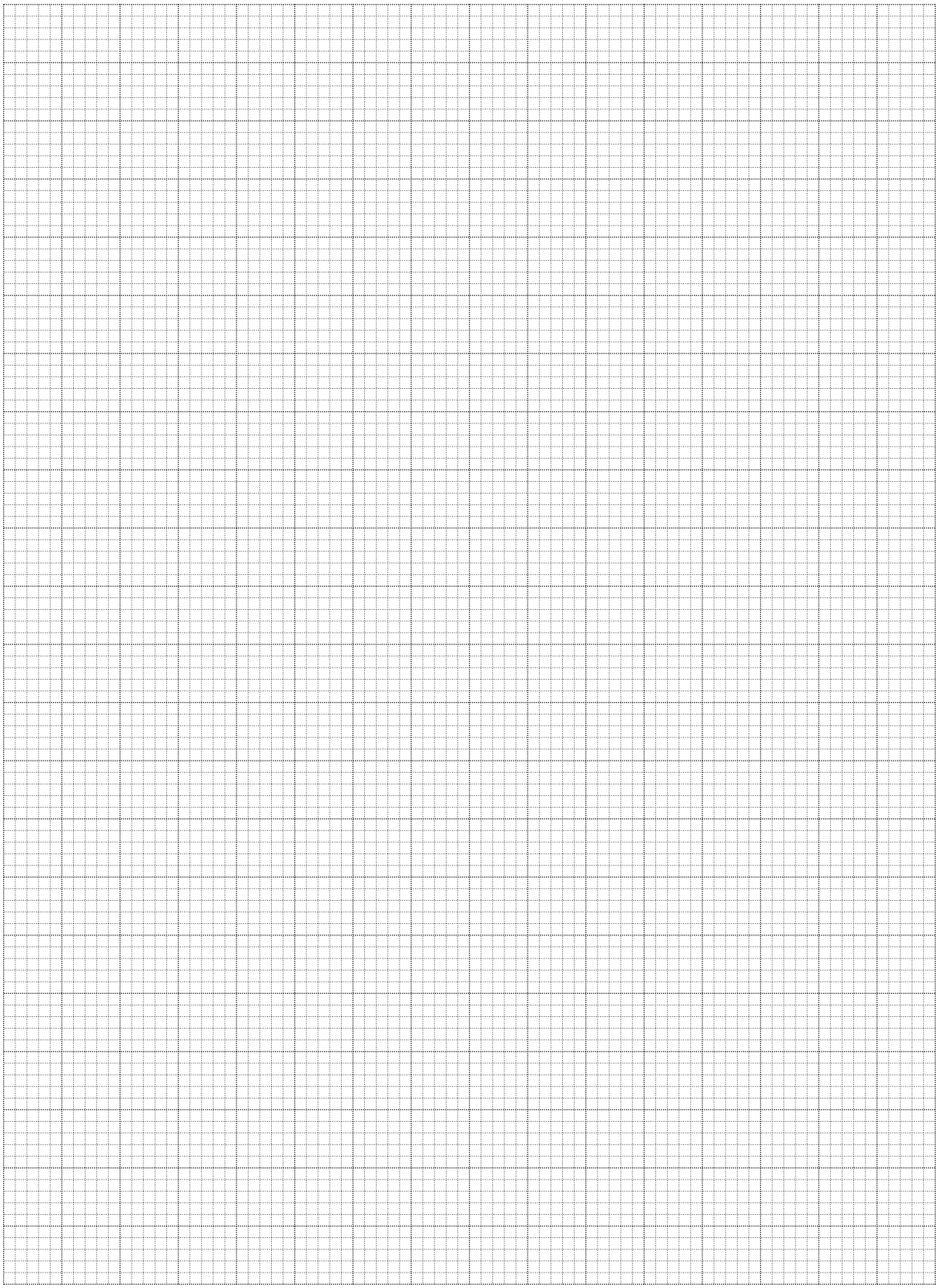
.....

.....

.....

.....
(2 marks)

Do not write outside the box



Turn over ▶

6 Calculate the amount, in moles, of $CuSO_4$ in 50.0 cm^3 of 0.400 mol dm^{-3} copper(II) sulfate solution.

.....

(1 mark)

7 Calculate the amount, in moles, of Fe in 4.00 g of iron.

.....

(1 mark)

8 The equation for the reaction between copper(II) sulfate and iron is shown below.

$$CuSO_4(aq) + Fe(s) \longrightarrow FeSO_4(aq) + Cu(s)$$

Use your answer from Question **5** and the appropriate answer from Question **6** or **7** to calculate a value for the enthalpy change, in kJ mol^{-1}, for the reaction between copper(II) sulfate and iron.

.....

.....

.....

(3 marks)

9 The maximum total errors for the measuring cylinder and the thermometer are shown below. These errors take into account multiple measurements.

Measuring cylinder	± 1.0 cm^3
Thermometer	± 0.2 °C

Estimate the percentage error in using these pieces of apparatus.
Use your answer from Question **4** to calculate the percentage error in your value for the rise in temperature.
Show your working.

Measuring cylinder .....

.....

Thermometer .....

.....

(2 marks)

10 Suggest why the error in the balance used to weigh out the iron is not important in this experiment.

.....

.....

(1 mark)

11 A data book value for the enthalpy change for the reaction between copper(II) sulfate and iron is –184 kJ mol^{-1}.

Calculate the difference between your value for the enthalpy change from Question **8** and this data book value.
Express this difference as a percentage of the data book value.
(If you could not complete the calculation in Question **8**, assume that the experimental enthalpy change is –170 kJ mol^{-1}. This is **not** the correct value.)

Difference .....

Percentage .....

.....

(2 marks)

20

Turn over for the next question

Section B

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

Introduction

Copper(II) sulfate solution, together with copper(II) carbonate ($CuCO_3$) powder, can be used to determine the identity of three solutions **A**, **B** and **C**. The three solutions are known to be hydrochloric acid, barium chloride, and sodium chloride.

In **Experiment 1** a small amount of copper(II) carbonate powder was added to each of the three solutions.

In **Experiment 2** a dropping pipette was used to add 2 cm^3 of copper(II) sulfate solution to each of the three solutions.

The results of these experiments are shown in the table below.

	Experiment 1 Addition of copper(II) carbonate powder	**Experiment 2** Addition of copper(II) sulfate solution
Solution **A**	no visible change	white precipitate
Solution **B**	no visible change	no visible change
Solution **C**	effervescence (bubbles of gas)	no visible change

12 (a) Use the observations in the table to deduce which of the solutions, **A**, **B** or **C** is

hydrochloric acid .....

barium chloride .....

(2 marks)

12 (b) Explain why a precipitate was formed when copper(II) sulfate solution was added to solution **A**.
Write an equation for the reaction that occurred.

Explanation .....

.....

Equation .....

(2 marks)

Do not write outside the box

12 (c) Suggest the identity for the colourless gas produced when copper(II) carbonate powder was added to solution **C**.

.....

(1 mark)

12 (d) Identify the two reagents that could be used in a test to confirm that the solutions contained chloride ions, **not** bromide ions. State what would be observed on addition of each reagent.

Reagent 1 .....

Observation 1 .....

.....

Reagent 2 .....

Observation 2 .....

.....

(4 marks)

12 (e) Copper(II) sulfate is toxic. Suggest **one** safety precaution you would take to minimise this hazard when wiping up a spillage of copper(II) sulfate solution.

.....

(1 mark)

10

END OF QUESTIONS

Table 1

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 2

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

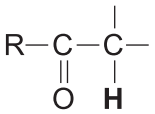
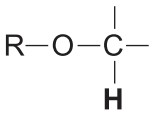
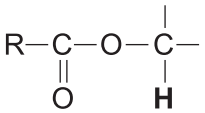
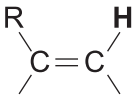
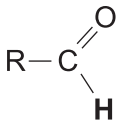
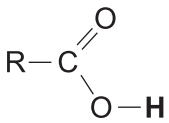
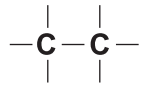
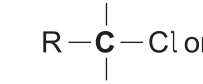
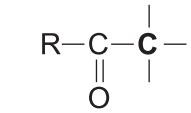
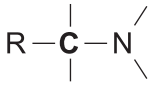
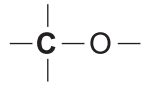
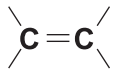
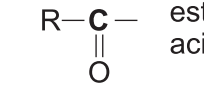
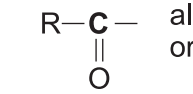
Type of proton	δ/ppm
ROH	0.5 – 5.0
RCH$_3$	0.7 – 1.2
RNH$_2$	1.0 – 4.5
R$_2$CH$_2$	1.2 – 1.4
R$_3$CH	1.4 – 1.6
	2.1 – 2.6
	3.1 – 3.9
RCH$_2$Cl or Br	3.1 – 4.2
	3.7 – 4.1
	4.5 – 6.0
	9.0 – 10.0
	10.0 – 12.0

Table 3

^{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

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
																	(18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
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