A-Level Chemistry

Paper 5

Unsolved Topical

Past Papers with Marking Schemes

All Variants

2014-2021

Title A-LEVEL TOPICAL CHEMISTRY PAPER 5

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PREFACE

Excellence in learning cannot be claimed without application of concepts in a dexterous way. In this regard one of the logical approach is to start in chunks; like chapter wise learning and applying the concept on exam based questions.

This booklet provides an opportunity to candidates to practice topic wise questions from previous years to the latest. Extensive working of Team MS Books has tried to take this booklet to perfection by collaborating with top of the line teachers.

We have added answer key / marks scheme at the end of each topic for the candidate to compare the his/her answer to the best.

MS Books strives to maintain actual spacing between consecutive questions and within options as per CAIE format which gives students a more realistic feel of attempting question.

Review, feedback and contribution in this booklet by various competent teachers of a subject belonging to renowned school chains make it most valuable resource and tool for both teachers and students.
With all belief in strength of this resource material I can confidently claim that it is worth in achieving brilliance.

Our sincere thanks and gratification to **Mr. Muhammad Ali** who took out special time to help compile and manage this booklet. We would also like to appreciate chemistry faculty for reviewing and indorsing it.

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CHEMISTRY PAPER 5

TABLE OF CONTENTS

Thermal Decomposition

Q1/53/M/J/14

1 When magnesium nitrate(V) is heated, it decomposes to form magnesium oxide, nitrogen(IV) oxide and oxygen.
Nitrogen(IV) oxide is an acidic gas that reacts readily and completely with alkalis.

You are to plan a **single** experiment to confirm that the molar quantities of magnesium oxide, nitrogen(IV) oxide and oxygen produced agree with the equation for the thermal decomposition of magnesium nitrate(V).

The following information gives some of the hazards associated with nitrogen(IV) oxide.

> **Nitrogen(IV) oxide** must not be inhaled. A large dose can be fatal and smaller quantities can have severe effects on breathing, particularly for people who suffer from asthma.

You are provided with anhydrous magnesium nitrate(V) and have access to the usual laboratory equipment and reagents.

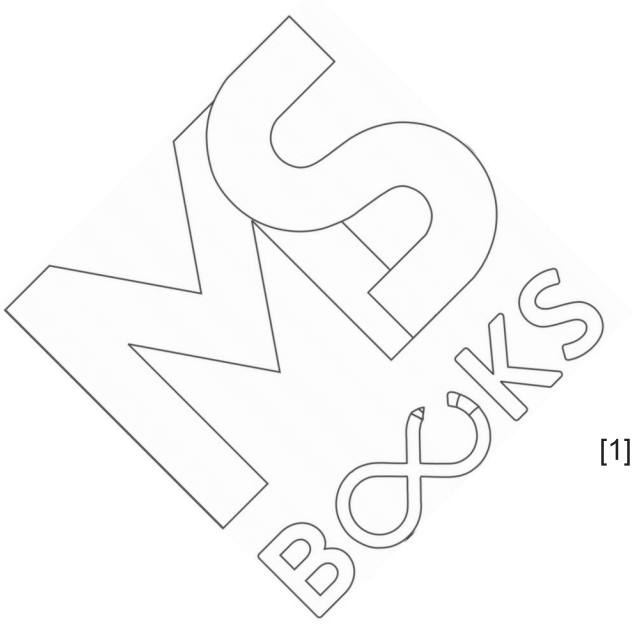
(a) (i) Write an equation for the thermal decomposition of magnesium nitrate(V).

..... [1]

(ii) Calculate the mass of magnesium oxide and volumes of nitrogen(IV) oxide and oxygen produced under room conditions when 1 mole of magnesium nitrate(V) is heated.

[A_r: O, 16.0; Mg, 24.3]

You should assume that one mole of any gas occupies 24.0 dm^3 under room conditions.



[1]

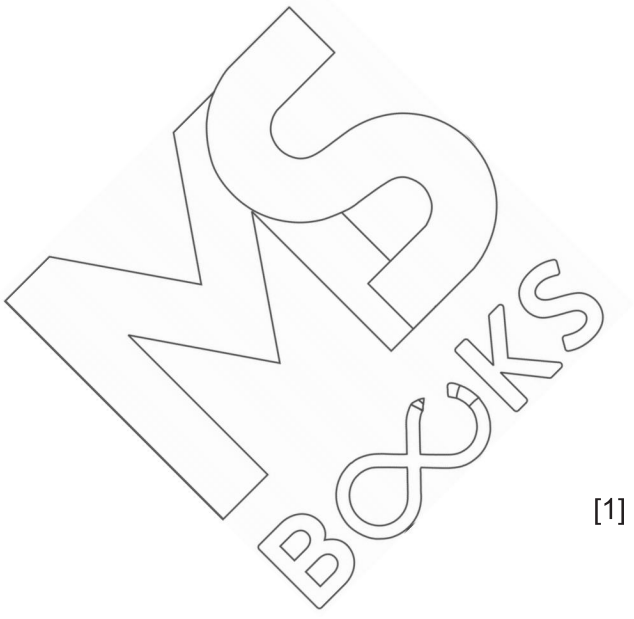
(b) (i) Draw and label a diagram of the apparatus and experimental set-up you would use. The set-up needs to be capable of absorbing the nitrogen(IV) oxide and collecting the oxygen separately and in sequence.

[4]

(ii) State the volume of the gas collector to be used to collect oxygen in **(i)**. Calculate a mass of magnesium nitrate(V) to be heated that would produce a stated volume of oxygen appropriate for the collector.

[A_r: N, 14.0; O, 16.0; Mg, 24.3]

You should assume that one mole of any gas occupies 24.0 dm^3 under room conditions.



[1]

(c) List the measurements you would make when carrying out the experiment.

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..... [3]

(d) **(i)** How could you make sure that the magnesium nitrate(V) had completely decomposed in the experiment?

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..... [1]

(ii) To make sure that the volume of gas measured is accurate, what should you do before taking the measurement?

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..... [1]

(e) Explain how you would use the results of the experiment to confirm that the decomposition had occurred according to the molar ratios in the equation.

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..... [2]

(f) What precautions would you take to make sure that the experiment could be performed safely?

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..... [1]

[Total: 15]

Q1/53/M/J/14 **Q 1**

Question	Expected Answer	Mark
1 (a) (i)	$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$ allow correct multiples	[1]
(ii)	40.3 g MgO, 48.0 dm^3 NO_2, 12.0 dm^3 O_2 **Units must be given** allow ecf from equation in **(i)**	[1]
(b) (i)	Directly heated vessel labelled (magnesium) nitrate(V) with tube at exit Gas stream led into a liquid labelled alkali which will absorb the nitrogen(IV) oxide / NO_2 Collects a gas in a syringe or over a liquid, provided it is properly connected All parts of the apparatus are connected and air-tight **AND** nitrogen(IV) oxide absorption precedes oxygen collection.	[1] [1] [1] [1]
(ii)	States a collector volume with unit **AND** Correct calculation of mass of magnesium nitrate(V) to a volume that would fit the stated volume of collector. allow ecf on **(a)(i)** Units of volume and mass required.	[1]
(c)	Mass of magnesium nitrate(V) (at start) and mass of magnesium oxide (at end). **Or** Mass of heated tube and contents before and after heating and mass of empty tube Mass of container (+ alkali) at start and mass at end Volume of oxygen	[1] [1] [1]
(d) (i)	Heat to constant mass **OR** heat to constant volume	[1]
(ii)	Let the apparatus cool (to room temperature)	[1]
(e)	Use experimental results to produce moles of magnesium nitrate(V) **AND** moles of **one** of the three products. compare with molar ratio in **equation** as given in **(a)(i)**	[1] [1]
(f)	Make sure all apparatus is airtight / no leakage before heating allow other sensible suggestions regarding exposure to nitrogen(IV) oxide or use of apparatus	[1]

Water of Crystallization

Q2/52/M/J/13

1 Hydrated copper(II) sulfate can be represented as $CuSO_4.xH_2O$ where x is the number of molecules of H_2O for each $CuSO_4$. When the compound is heated, it loses the molecules of water leaving anhydrous copper(II) sulfate.

A suggested equation is:

$$CuSO_4.xH_2O(s) \rightarrow CuSO_4(s) + xH_2O(g)$$

An experiment is carried out to attempt to determine the value of x.

- An open crucible is weighed and the mass recorded.
- A sample of hydrated copper(II) sulfate is added to the crucible and the new mass recorded.
- The crucible with hydrated copper(II) sulfate is heated strongly for five minutes and allowed to cool back to room temperature.
- The crucible with the contents is then reweighed and the mass recorded.

(a) Calculate the relative formula masses, M_r, of $CuSO_4$ and H_2O.
[A_r: H, 1.0; O, 16.0; S, 32.1; Cu, 63.5]

[1]

(b) The results of several of these experiments are recorded below.

Process the results in the table to calculate both the number of moles of anhydrous copper(II) sulfate and the number of moles of water.

Record these values in the additional columns of the table.
You may use some or all of the columns.

Masses should be recorded to **two decimal places**, while the numbers of moles should be recorded to **three significant figures**.

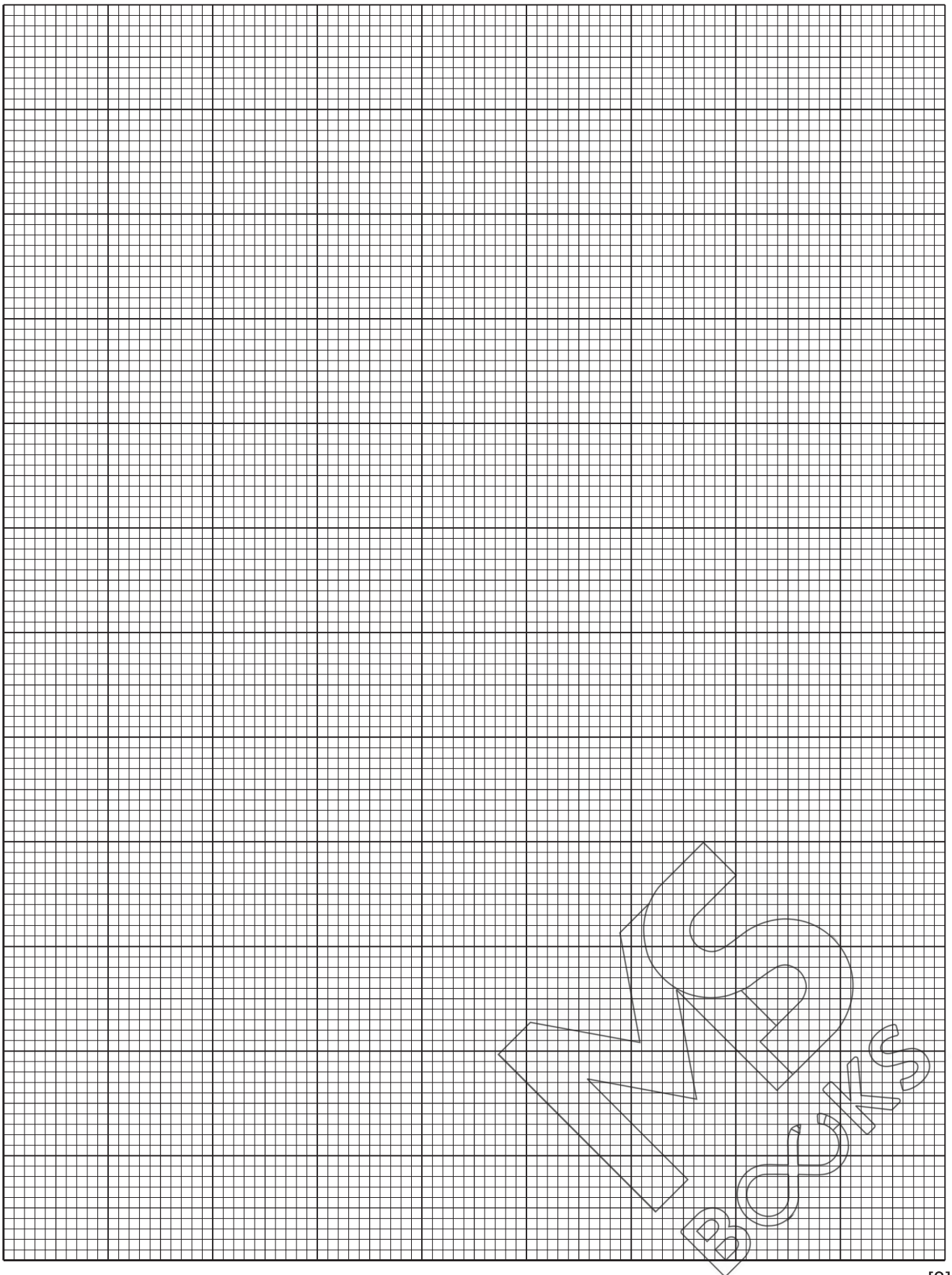
Label the columns you use. For each column you use include units where appropriate and an expression to show how your values are calculated.

You may use the column headings A to G for these expressions (e.g. A–B).

A	B	C	D	E	F	G
mass of crucible / g	mass of crucible + $CuSO_4.xH_2O$ / g	mass of crucible + $CuSO_4$ / g				
15.20	16.76	16.20				
15.10	16.90	16.25				
14.95	16.95	16.23				
15.15	17.25	16.49				
15.05	17.32	16.47				
14.90	17.24	16.43				
14.92	17.42	16.52				
15.30	17.99	17.02				
15.07	17.96	16.92				
15.01	18.09	16.98				

[2]

(c) Plot a graph to show the relationship between the number of moles of anhydrous copper(II) sulfate, $CuSO_4$ (*x*-axis), and the number of moles of water (*y*-axis).
Draw the line of best fit. It is recommended that you do not include the origin in your choice of scaling.



[3]

(d) Circle and label on the graph any point(s) you consider to be anomalous.
For each anomalous point give a different reason why it is anomalous clearly indicating which point you are describing.

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..... [3]

(e) Determine the slope of the graph. You must mark clearly on the graph any construction lines and show clearly in your calculation how the intercepts were used in the calculation of the slope.

[3]

(f) Comment on the reliability of the data provided in **(b)**.

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.....

..... [1]

(g) **(i)** Use the value of the slope of your graph calculated in **(e)** to suggest the correct formula for hydrated copper(II) sulfate.

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(ii) Explain your answer to **(i)**.

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.....

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[2]

[Total: 15]

Q2/53/M/J/13

2 Hydrated iron(II) sulfate can be represented as $FeSO_4.xH_2O$ where x is the number of molecules of H_2O for each $FeSO_4$. When the compound is heated, it loses the molecules of water leaving anhydrous iron(II) sulfate.

A suggested equation is:

$$FeSO_4.xH_2O(s) \rightarrow FeSO_4(s) + xH_2O(g)$$

An experiment is carried out to attempt to determine the value of x.

- An open crucible is weighed and the mass recorded.
- A sample of hydrated iron(II) sulfate is added to the crucible and the new mass recorded.
- The crucible with hydrated iron(II) sulfate is heated strongly for five minutes and allowed to cool back to room temperature.
- The crucible with the contents is reweighed and the mass recorded.

(a) Calculate the relative formula masses, M_r, of $FeSO_4$ and H_2O.
[A_r: H, 1.0; O, 16.0; S, 32.1; Fe, 55.8]

[1]

(b) The results of several of these experiments are recorded below.

Process the results in the table to calculate both the number of moles of anhydrous iron(II) sulfate and the number of moles of water.

Record these values in the additional columns of the table.
You may use some or all of the columns.

Masses should be recorded to **two decimal places**, while the numbers of moles should be recorded to **three significant figures**.

Label the columns you use. For each column you use include units where appropriate and an expression to show how your values are calculated.

You may use the column headings A to G for these expressions (e.g. A–B).

A	B	C	D	E	F	G
mass of crucible /g	mass of crucible + $FeSO_4.xH_2O$ /g	mass of crucible + $FeSO_4$ /g				
15.20	17.03	16.20				
15.10	17.41	16.41				
14.95	17.33	16.25				
15.15	17.70	16.54				
15.05	17.79	16.55				
14.90	17.88	16.53				
14.92	18.18	16.70				
15.30	18.67	17.14				
15.07	18.64	17.02				
15.01	18.80	17.04				

[2]

Q2/52/M/J/13 **Q 1**

2 (a) 159.6 **AND** 18.0 — **1**

(b) Columns are headed with label and correct expression and units. — **1**

mol of $CuSO_4$ **AND** mol of H_2O are correct to 3 sig figs. — **1**

ECF incorrect M_r **or** the use of incorrect expressions into data — **1**

D	E	F	G
$CuSO_4$ C – A / g	**H_2O B – C / g**	**Mol $CuSO_4$ D / 159.6 / mol**	**Mol of H_2O E / 18.0 / mol**
1.00	0.56	0.00627	0.0311
1.15	0.65	0.00721	0.0361
1.28	0.72	0.00802	0.0400
1.34	0.76	0.00840	0.0422
1.42	0.85	0.00890	0.0472
1.53	0.81	0.00959	0.0450
1.60	0.90	0.0100	0.0500
1.72	0.97	0.0108	0.0539
1.85	1.04	0.0116	0.0578
1.97	1.11	0.0123	0.0617

(c) *x*-axis labelled '$CuSO_4$' and *y*-axis 'H_2O' **AND** plotted points cover at least half the grid in both directions **AND** scales must be uniform including the origin if used. — **1**

All 10 points plotted correctly. — **1**

Best fit straight line drawn. — **1**

(d) Points 5 and 6 circled — **1**

Point 5 (mass of crucible = 15.05) The anhydrous $CuSO_4$ had decomposed **OR** prior to heating the crucible/sample was wet **OR** contained an impurity which decomposed/was removed on heating. — **1**

Allow: some mass lost (spits) on heating

Point 6 (mass of crucible = 14.90) Not all the water had been driven off the copper sulfate crystals **OR** anhydrous copper sulfate absorbed some water **OR** has an impurity that does not decompose — **1**

(e)	Appropriately drawn lines on the graph. Correctly read values from the graph. (Figures from the table allowed if no construction lines drawn providing graph does actually go through the points used.) Correctly calculated value of the slope given to 2 or more sig figs up to calculator value using the candidate's figures **AND** with no units given.	**1** **1** **1**
(f)	Most of the points are on the line **OR** only a few points are not on the line **OR** there are only a few anomalies	**1**
(g) (i)	$CuSO_4.5H_2O$ ecf on slope in **(e)**	**1**
(ii)	The graph / slope is the ratio of H_2O:$CuSO_4$ is 5 / 5:1 **OR** the slope is the value of x	**1**
		[Total: 15]

Q2/53/M/J/13 **Q 2**

2 (a)	151.9 **AND** 18.0	**1**
(b)	Columns are headed with a label, an expression and units as below. Mol of $FeSO_4$ **AND** mol of H_2O are correct to 3 sig. figs. ECF incorrect M_r. ECF the use of incorrect expressions into data.	**1** **1**

D	E	F	G
$FeSO_4$ (C – A) / g	**H_20 B – C / g**	**$FeSO_4$ (C – A) / 151.9 OR D / 151.9 mol OR mole**	**H_2O (B – C) / 18 OR E / 18 mol OR mole**
1.00	0.83	0.00658	0.0461
1.31	1.00	0.00862	0.0556
1.30	1.08	0.00856	0.0600
1.39	1.16	0.00915	0.0644
1.50	1.24	0.00987	0.0689
1.63	1.35	0.0107	0.0750
1.78	1.48	0.0117	0.0822
1.84	1.53	0.0121	0.0850
1.95	1.62	0.0128	0.0900
2.03	1.76	0.0134	0.0978

(c)	*x*-axis labelled 'mol of $FeSO_4$' and *y*-axis 'mol H_2O' **AND** plotted points cover at least half the grid in both directions. Allow a correct letter from the table as a label. All 10 points plotted correctly. Best fit **straight** line drawn.	**1** **1** **1**
(d)	Points 2 and 10 circled. (The circled points must be unambiguously referred to in the reasons.) Point 2 (mass of crucible 15.10) Not all the water had been driven off the iron sulfate crystals **OR** anhydrous $FeSO_4$ absorbed some water **OR** has an impurity that does not decompose. Allow water loss is low(er) (than expected). Point 10 (mass of crucible = 15.01) The anhydrous $FeSO_4$ had decomposed **OR** prior to heating the crucible/original sample was wet and water removed on heating **OR** contained an impurity which decomposed/was removed on heating. Allow some mass lost (spits out) on heating.	**1** **1** **1**
(e)	Appropriately drawn lines on the graph. Correctly read values from the graph. (Figures from the table allowed if no construction lines drawn providing graph drawn does actually go through the points used.) Correctly calculated value of the slope given to 2 or more sig. figs up to calculator value and using the **candidate's** figures **AND** no units given.	**1** **1** **1**
(f)	Most of the points are on the line **OR** only a few points are not on the line **OR** there are only a few anomalies.	**1**
(g) (i)	$FeSO_4.7H_2O$ (ecf on slope in **(e)**)	**1**
(ii)	The gradient/slope is the ratio of (moles) of H_2O:$FeSO_4$ (is 7 or 7:1).	**1**
		[Total: 15]