CT Publications

Surviving Maths in AS Chemistry

by

Dr Robert Mitchell

www.SurvivingMathsinASchemistry.co.uk

A catalogue record for this book is available from the British Library

ISBN 978-1-907769-01-6
First published in August 2010 by
CT Publications

Published by
CT Publications*
40 Higher Bridge Street
Bolton
Greater Manchester
BL1 2HA

First printing August 2010
10 9 8 7 6 5 4 3 2 1

*CT Publications is owned by *Chemistry Tutorials* located at the same address.

Contents

Contents 3
Acknowledgements 4
About the author 4
Other books by the author 5
Preface 6
Student resources 7
How to use this book 8
Section 1: Mathematical Requirements 9
Arithmetical and Numerical Computation 11
Handling Data 14
Algebra 16
Graphs 21
Geometry 24
End of Section 1 Test 26
Section 2: Calculations in AS Chemistry Specifications 31
Mole Calculations 32
Moles and numbers 32
Moles and mass 33
Moles and solution volumes and concentrations 42
Moles and gas volumes 44
Putting it all together 46
Energetics 53
Bond Enthalpy Calculations 53
Hess' Law Calculations 55
Calorimetric Calculations 60
Half-life (WJEC only) 64
Number of particles 64
Time taken 65
Half-life determination 66
End of Section 2 Test 67
Mole questions 67
Energetics Questions 72
Half-life questions 74

Section 3: Examination-style Questions 75

Questions involving Moles 76

Questions involving Energy 83

Questions involving half-life 88

Section 4: Answers to the Questions 89

End of Section 1 Test Answers 90

End of Section 2 Test Answers 95

Mole questions 95

Energetics Questions 101

Half-life questions 104

Answers to examination-style questions 105

Mole Questions 105

Energetics Questions 109

Half life 111

Index 112

Acknowledgements

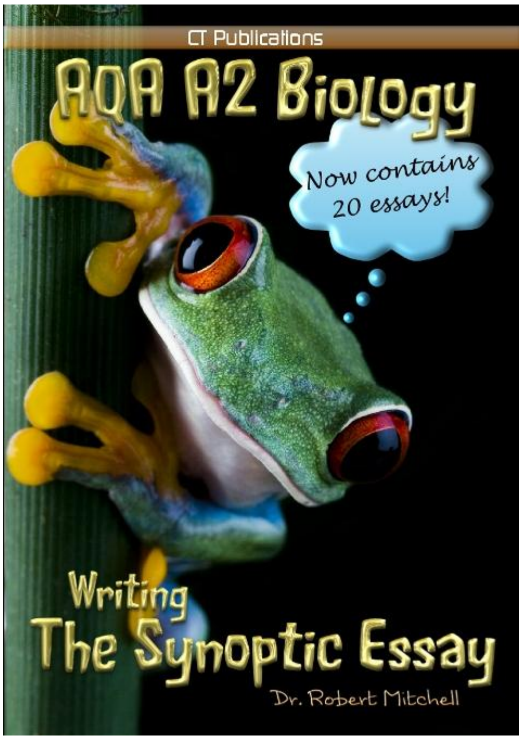
I would like to thank Denise for her infinite patience, her reading and proofing skills and having the unending ability to encourage and support the production of this work. Thanks also to my Mummy, Joyce and Brother, Colin for not getting too mithered about it all.

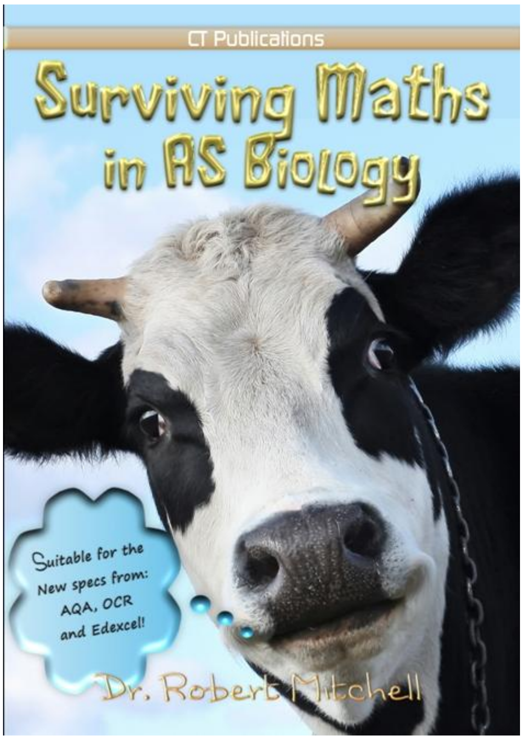
About the author

Rob is a private tutor in chemistry and biology in Bolton. He's formerly worked in medical research as technician, research assistant and post-doctoral researcher and has contributed to the publication of over 40 research papers. During a varied career in science, he's been a project leader in industry, a lecturer and examiner and blogs daily as *Chemicalguy*. He likes dogs, and pies, going to the movies and walking!

Other books by the author

AQA A2 Biology; Writing the Synoptic Essay	May 2010
Surviving Maths in AS Biology	September 2010
Ultimate Exam Preparation; AQA Chemistry Unit 1	October 2010 (in press)
Ultimate Exam Preparation; AQA Biology Unit 1	November 2010 (in press)
Uprooting the Tree of Life (Popular Science)	January 2011 (in prep)
Biofuelishness (Popular Science)	March 2011 (in prep)





RAM and mass spectrometry

Relative atomic masses are calculated from the data generated by mass spectrometers. In your AS studies you will learn mass spectrometers generate two numbers, the *abundance* and *the mass to charge ratio*, or m/z of isotopes of elements. These can be used to determine the RAM of the element using the equation:

$$RAM = \frac{\Sigma \left(abundance \text{ x} \frac{m}{z}\right)}{total\ abundance}$$

Regardless of whether the data in the question is in the form of text, a table or a graph the calculation is always the same.

- Be careful to **always** write out the substituted equation.
- Check whether the abundance data is given as a percentage, % or numerical values.
- Make sure the value calculated is within the range of the m/z ratios of the isotopes.
- Check how many decimal places or significant figure the question demands.
- Remember a correct answer *does not always* guarantee all the method marks.
- The correct unit for RAM is g mol^{-1} but **only** volunteer this if they ask you to.

? **Worked Example 1:** Using mass spectrometry a sample of copper was found to be composed of 33.4% ^{63}Cu and 66.6% ^{65}Cu. Use the data to determine the relative atomic mass of the copper in the sample. Give your answer to **one** decimal pace.

$$RAM = \frac{(33.4 \text{ x } 63) + (66.6 \text{ x } 65)}{100} = 64.33$$

$$RAM = \underline{64.3} \text{ (1 dp)}$$

The data may also be presented in the form of a table or graph. Try to look beyond the *way* in which the data is presented. It is *not* trying to confuse you. The *How Science Works* component of the A-level expects you to be able to process and use information in different formats.

In the worked examples below you will notice that although the information looks different, the way in which the question is **always** answered is the same.

10. Cyclohexene, C_6H_{10} can be prepared by the dehydration of cyclohexanol. A student reacted 8.75 g of cyclohexanol, $C_6H_{12}O$, and obtained 0.0348 mol of cyclohexene.

(a) What is the relative molecular mass of cyclohexene? *(1 mark)*

(b) What is the percentage by mass of carbon in cyclohexene. *(1 mark)*

(c) Calculate the percentage yield of cyclohexene. *(1 mark)*

11. What is the empirical formula of the liquid that contains 38.4 % carbon, 4.80 % hydrogen and 56.8 % chlorine by mass? *(1 mark)*

A CH_3Cl
B C_2H_5Cl
C C_2H_3Cl
D $C_3H_5Cl_3$

12. Calcium oxide reacts with dilute hydrochloric acid as shown in the following equation: $CaO(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l)$
How many moles of Calcium oxide, CaO, are required to neutralize 40 cm^3 of 0.250 mol dm^{-3} hydrochloric acid, HCl? *(1 mark)*

A 0.020
B 0.0010
C 0.010
D 0.0050

13. Which of the following contains the greatest number of hydrogen atoms?
(1 mark)
A 1.5 moles of ammonia, C_2H_2
B 0.5 moles of methane, CH_4
C 1 mole of hydrogen gas, H_2
D 2 moles of water, H_2O

14. The following data were obtained from the mass spectrum of a sample of chromium.

Mass/charge ratio	% abundance
50.0	6.3
52.0	82.2
53.0	9.1
54.0	2.4

Calculate the relative atomic mass of chromium in this sample, giving your answer to three significant figures. *(1 mark)*

87. Using the enthalpy of combustion data given below, calculate the standard enthalpy change for the formation of methane.

$$C(s) + 2H_2(g) \rightarrow CH_4(g)$$

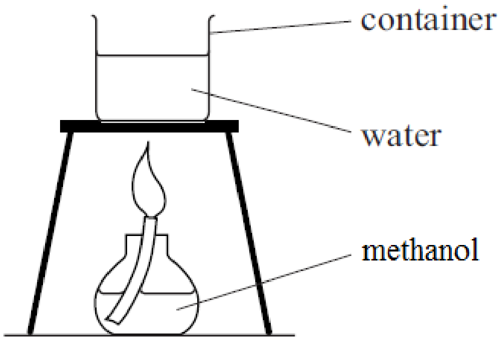
ΔH_C (kJ mol^{-1}) C(s) = –394 H_2O(g) = –286 CH_4(g) = –896

ΔH *reaction* **= Σ ΔH_C *(reactants)* - Σ ΔH_C *(products)***

ΔH *reaction* ***= [(1 x –394) + (2 x –286)] – [(–896)]***

= –70 kJ mol^{-1}

88. An experiment was carried out to determine a value for the enthalpy of combustion of liquid methanol using the apparatus shown in the diagram.



Burning 3.5 g of methanol caused the temperature of 150 g of water to rise by 50 °C. Use this information to calculate a value for the enthalpy of combustion of methanol, CH_3OH.

$q = mc\Delta T$ = 150 x 4.18 x 50 = 31350 J

Since the temperature increased, $Q = \frac{q}{1000}$ = – 31.35 kJ

Moles of CH_3OH =

$$\frac{mass}{RAM} = \frac{3.5}{32} = 0.101\ mol$$

$$\Delta H = \frac{Q}{n}$$

$$\Delta H = \frac{-31.5}{0.101}$$

= - 310 kJ mol^{-1} (3 sig fig)