

Aim:

Indirect determination of enthalpy change of decomposition of sodium hydrogen carbonate by thermochemical measurement and Hess's Law.

Background Information:

Many standard enthalpy changes of reaction cannot be measured directly, and we therefore have to employ an indirect approach using energy cycles. This method relies on Hess's Law, which states that if a change can be brought about by more than one route, then the overall enthalpy change for each route must be the same, provided that the starting and finishing conditions are the same for each route. We could say that this is a consequence of the first law of thermodynamics, which states that energy can neither be created or destroyed in chemical reactions, and so energy changes for a reaction must be the same, whether it takes place in one step or in a whole series of steps.

I will be measuring the enthalpy changes of reaction of sodium hydrogencarbonate and sodium carbonate with dilute hydrochloric acid. By applying Hess's Law to the results, I will be able to calculate the enthalpy change of decomposition of sodium hydrogencarbonate, (ΔH_3), which is impossible to measure directly.

The cycle below shows how this is done:

The method involves carrying out reactions in separate experiments in insulated calorimeters, calculating the heat absorbed or evolved – allowing for heat losses to the surroundings – and scaling up to molar amounts.

Risk Assessment

- Hydrochloric Acid (2M) is a low hazard, but may still cause harm if it comes into contact with eyes or broken skin. If the hydrochloric acid comes into contact with skin, notify supervisor and wash affected area immediately with water.
- Should spillage occur, again notify supervisor and dilute with water before mopping up.
- Sodium carbonate is an alkaline metal and poses a hazard. Should it come into contact with skin, wash immediately with copious amounts of water.
- Throughout the experiment safety goggles and a lab coat should be worn. Eyes are a highly sensitive region of the body and care should be taken to protect them.
- Care should be taken when using the thermometer. It is important that it is not broken or damaged, as it contains mercury, and the vapour from mercury is a cumulative poison.
- Care should be taken not to inadvertently pierce the bottom of the polystyrene cup (calorimeter) with the thermometer.
- Steady the cup with the thermometer in it with a laboratory clamp if necessary, so that it will not tip over.
- At the end of the experiment, small quantities of the chemicals can be diluted with running water and run to waste. This should be done with care.

Apparatus & chemicals needed:

- Simple calorimeter (polystyrene cup with lid to act as an insulating vessel, lid has a perforation to fit thermometer)
- Thermometer (graduated in 0.5°C divisions)
- Accurate weighing scales (correct to three decimal places)
- Weighing bottle (plastic, with lid)
- 25 cm³ burette
- Lab clamp
- Graph paper
- Dry sodium hydrogencarbonate (3.0g)
- Dry anhydrous sodium carbonate (2.0g)
- 100cm³ of 2M hydrochloric acid

Implementation & Analysis

Procedure for Experiment 1: with sodium hydrogen carbonate

Enthalpy Decomposition Sodium Hydrogencarbonate

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Enthalpy Decomposition Sodium Hydrogencarbonate:

Thermal Decomposition of Ionic Solids A.K. Galwey, M.E. Brown, 1999-02-25 The principal objective of this book is to stimulate interest in research that will extend available theory towards a greater understanding of the steps involved in solid state decompositions and the properties of solids that control reactivities Much of the activity in this field has been directed towards increasing the range of reactants for which decomposition kinetic data is available rather than extending insights into the fundamental chemistry of the reactions being studied The first part of the book Chapters 1-6 is concerned with theoretical aspects of the subject The second part Chapters 7-17 surveys groups of reactions classified by similarities of chemical composition The final Chapter 18 reviews the subject by unifying features identified as significant and proposes possible directions for future progress Studies of thermal reactions of ionic compounds have contributed considerably to the theory of solid state chemistry Furthermore many of these rate processes have substantial technological importance for example in the manufacture of cement the exploitation of ores and in the stability testing of drugs explosives and oxidizing agents Despite the prolonged and continuing research effort concerned with these reactions there is no recent overall review This book is intended to contribute towards correcting this omission The essential unity of the subject is recognized by the systematic treatment of reactions carefully selected to be instructive and representative of the subject as a whole The authors have contributed more than 200 original research articles to the literature many during their 25 years of collaboration Features of this book Gives a comprehensive in depth survey of a rarely reviewed subject Reviews methods used in studies of thermal decompositions of solids Discusses patterns of subject development perceived from an extensive literature survey This book is expected to be of greatest value and interest to scientists concerned with the chemical properties and reactions of solids including chemists physicists pharmacists material scientists crystallographers metallurgists and others This wide coverage of the literature dealing with thermal reactions of solids will be of value to both academic and industrial researchers by reviewing the current status of the theory of the subject It could also provide a useful starting point for the exploitation of crystalline materials in practical and industrial applications The contents will also be relevant to a wide variety of researchers including for example those concerned with the stabilities of polymers and composite materials the processing of minerals the shelf lives of pharmaceuticals etc

Cambridge International AS and A Level Chemistry Peter Cann, Peter Hughes, 2015-03-06 Endorsed by Cambridge Assessment International Education for full syllabus coverage Foster a deeper understanding of theoretical concepts through clear guidance and opportunities for self assessment throughout covers the entire Cambridge International AS A Level Chemistry syllabus 9701 Navigate the different routes through the course with ease with clearly divided sections for AS and A Level Focus learning with learning outcomes clearly defined at the beginning of each section Test knowledge and understanding with past paper and exam style questions Address the Key Concepts in the syllabus which are clearly highlighted throughout the course The Revision and

Practice CD included with every Student's Book provides interactive tests summaries of each topic and advice on examination techniques

Cambridge International AS & A Level Chemistry Student's Book Second Edition Peter Cann, Peter Hughes, 2020-04-27 This title is endorsed by Cambridge Assessment International Education to support the full syllabus for examination from 2022 Confidently navigate the updated Cambridge International AS A Level Chemistry 9701 syllabus with a structured approach ensuring that the link between theory and practice is consolidated scientific skills are applied and analytical skills developed Enable students to monitor and build progress with short self assessment questions throughout the student text with answers at the back of the book so students can check their understanding as they work their way through the chapters Build scientific communication skills and vocabulary in written responses with a variety of exam style questions Encourage understanding of historical context and scientific applications with extension boxes in the student text Have confidence that lessons cover the syllabus completely with a free Scheme of Work available online Provide additional practice with the accompanying write in Practical Skills Workbooks which once completed can also be used to recap learning for revision

A-Level Chemistry E. N. Ramsden, 2000 This textbook has been updated to cover the new specifications for AS and A2 Chemistry and improved with new features and rewritten material to enhance learning and increase accessibility It covers all the main specifications for the English and Welsh Awarding Bodies and should be particularly suitable for students approaching A Level from GCSE Science Double Award This answer key is designed to support the core book and contains suggested answers worked solutions to the checkpoints and examination questions in the core book also synoptic questions for further practice complete with suggested answers and worked solutions to help develop confidence

Cambridge International AS and A Level Chemistry Coursebook with CD-ROM Lawrie Ryan, Roger Norris, 2014-07-31 Fully revised and updated content matching the Cambridge International AS A Level Chemistry syllabus 9701 Endorsed by Cambridge International Examinations the Second edition of the AS A Level Chemistry Coursebook comprehensively covers all the knowledge and skills students need for AS A Level Chemistry 9701 first examination 2016 Written by renowned experts in Chemistry the text is written in an accessible style with international learners in mind The Coursebook is easy to navigate with colour coded sections to differentiate between AS and A Level content Self assessment questions allow learners to track their progression and exam style questions help learners to prepare thoroughly for their examinations Contemporary contexts and applications are discussed throughout enhancing the relevance and interest for learners

Sodium Carbonate Colin Osborne, 2000 The booklet and photocopiable worksheets are suitable for pre and post 16 students and aim is to encourage the students to apply chemical principles in an unfamiliar context

Thermal Analysis of Polymeric Materials Krzysztof Pielichowski, Kinga Pielichowska, 2022-06-01 An all in one reference work covering the essential principles and techniques on thermal behavior and response of polymeric materials This book delivers a detailed understanding of the thermal behavior of polymeric materials evaluated by thermal analysis methods It covers the

most widely applied principles which are used in method development to substantiate what happens upon heating of polymers It also reviews the key application areas of polymers in materials science Edited by two experts in the field the book covers a wide range of specific topics within the aforementioned categories of discussion such as Crucial thermal phenomena glass transition crystallization behavior and curing kinetics Polymeric materials that have gained considerable interest over the last decade The latest advancements in techniques related to the field such as modulated temperature DSC and fast scanning calorimetry The recent advances in hyphenated techniques and their applications Polymer chemists chemical engineers materials scientists and process engineers can use this comprehensive reference work to gain clarity on the topics discussed within and learn how to harness them in practical applications across a wide range of disciplines **Calculations**

for A-level Chemistry E. N. Ramsden, 2001 Aiming to match the various specifications this book gives explanations worked examples and practice in chemistry calculations It includes a comprehensive mathematics foundation section Work on formulae and equations the mole volumetric analysis and other key areas are included It is useful as a course book as well as for exam practice Chemistry John Atkinson, Carol Hibbert, 2001 This chemistry text is written to match exactly the

specification for teaching Advanced Chemistry from September 2000 There are two strands AS and A2 with student books The accompanying resource packs are also available on CD ROM Edexcel AS Chemistry Student Unit Guide New Edition:

Unit 1 The Core Principles of Chemistry Rod Beavon, George Facer, 2012-05-18 Written by a senior examiner Rod Beavon and revised by George Facer this Edexcel AS Chemistry Student Unit Guide is the essential study companion for Unit 1 The Core Principles of Chemistry This full colour book includes all you need to know to prepare for your unit exam Clear guidance on the content of the unit with topic summaries knowledge check questions and a quick reference index Examiner s advice throughout so you will know what to expect in the exam and will be able to demonstrate the skills required Exam style questions with graded student responses so you can see clearly what is required to get a better grade Thermal analysis of

Micro, Nano- and Non-Crystalline Materials Jaroslav Šesták, Peter Simon, 2012-10-28 Thermal Analysis of Micro Nano and Non Crystalline Materials Transformation Crystallization Kinetics and Thermodynamics complements and adds to volume 8 Glassy Amorphous and Nano Crystalline Materials by providing a coherent and authoritative overview of cutting edge themes in this field In particular the book focuses on reaction thermodynamics and kinetics applied to solid state chemistry and thermal physics of various states of materials Written by an international array of distinguished academics the book deals with fundamental and historical aspects of phenomenological kinetics equilibrium background of processes crystal defects non stoichiometry and nano crystallinity reduced glass transition temperatures and glass forming coefficients determination of the glass transition by DSC the role of heat transfer and phase transition in DTA experiments explanation of DTA DSC methods used for the estimation of crystal nucleation structural relaxation and viscosity behaviour in glass and associated relaxation kinetics influence of preliminary nucleation and coupled phenomenological kinetics nucleation on both the

strongly curved surfaces and nano particles crystallization of glassy and amorphous materials including oxides chalcogenides and metals non parametric and fractal description of kinetics disorder and dimensionality in nano crystalline diamond thermal analysis of waste glass batches amorphous inorganic polysialates and bioactivity of hydroxyl groups as well as reaction kinetics and unconventional glass formability of oxide superconductors Thermal Analysis of Micro Nano and Non Crystalline Materials Transformation Crystallization Kinetics and Thermodynamics is a valuable resource to advanced undergraduates postgraduates and researches working in the application fields of material thermodynamics thermal analysis thermophysical measurements and calorimetry Edexcel AS Chemistry Student Unit Guide: Rod Beavon,2012-03-09

Student Unit Guides are perfect for revision Each guide is written by an examiner and explains the unit requirements summarises the relevant unit content and includes a series of specimen questions and answers There are three sections to each guide Introduction includes advice on how to use the guide an explanation of the skills being tested by the assessment objectives an outline of the unit or module and depending on the unit suggestions for how to revise effectively and prepare for the examination questions Content Guidance provides an examiner s overview of the module s key terms and concepts and identifies opportunities to exhibit the skills required by the unit It is designed to help students to structure their revision and make them aware of the concepts they need to understand the exam and how they might analyse and evaluate topics Question and Answers sample questions and with graded answers which have been carefully written to reflect the style of the unit All responses are accompanied by commentaries which highlight their respective strengths and weaknesses giving students an insight into the mind of the examiner **Advanced Chemistry** Michael Clugston,Rosalind Flemming,2000-06-08 Carefully researched by the authors to bring the subject of chemistry up to date this text provides complete coverage of the new A and AS level core specifications The inclusion of objectives and questions make it suitable for self study Descriptive Inorganic Chemistry, Third Edition Geoff Rayner-Canham,Tina Overton,2003 For lower division courses with an equal balance of description and theory **Industrial Minerals & Rocks** Jessica Elzea Kogel,2006 News Inc Portland OR booknews com *Chemistry in Context - Laboratory Manual* Graham Hill,John Stranger Holman,John Holman,2001 The laboratory manual and study guide supports your teaching with a broad range of practicals emphasising safety and risk assessment It is an essential companion to Chemistry in Context and can also be used alongside other Advanced Chemistry books It offers practicals with detailed instructions for openended investigations and opportunities for assessed practical work in the four skill areas of planning implementing analysing and evaluating *Chemistry3* Andrew Burrows,John Holman,Andrew Parsons,Gwen Pilling,Gareth Price,2017 Chemistry3 establishes the fundamental principles of all three strands of chemistry organic inorganic and physical By building on what students have learned at school using carefully worded explanations annotated diagrams and worked examples it presents an approachable introduction to chemistry and its relevance to everyday life Chemistry in Context Graham Hill,John Holman,2000 This completely revised

version matches the latest specifications for Advanced Subsidiary AS and Advanced GCE Chemistry The new full colour design enhances a modern relevant course text and the informative diagrams and photographs highlight the importance of chemistry in the 21st century In each chapter there are in text and review questions which help the student remain focused and increase their understanding This coupled with the large bank of examination questions at the end of the book provides students with further opportunity for self study and revision

CHEMISTRY EXPERIMENTS James Signorelli, 2014-09-19

Gifted and talented students and any student interested in pursuing a science major in college needs a rigorous program to prepare them while they are still in high school This book utilizes a format where the application of several disciplines science math and language arts principles are mandated Each lab concludes with either an essay or a detailed analysis of what happened and why it happened This format is based on the expectations of joining a university program or becoming an industrial science professional The ideal student lab report would be written in a lab research notebook and then the essay or final analysis is done on a word processor to allow for repeat editing and corrections The research notebook has all graph pages a title section and a place for the students and their assistants to sign and witness that exercise The basic mechanics of the lab report title purpose procedure diagrams data table math and calculations observations and graphs are handwritten into the book The conclusion is done on a word processor MS Word which allows the instructor to guide the student in writing and editing a complete essay using the MLA format When the final copy is completed the essay is printed and inserted into the lab notebook for grading At the end of the term the student has all their labs in one place for future reference These lab notebooks can be obtained for as little as 3 00 per book This is money well spent In our district the Board of Education buys the books for each student The BOE sees these books as expendable but necessary materials for all science and engineering instruction

Advanced Pharmaceutical Solids Jens T. Carstensen, 2000-10-24 This extensive reference text explores the principles instrumentation processes and programs of pharmaceutical solid science as well as new aspects on one component systems micromeritics polymorphism solid state stability cohesion powder flow blending single unit sustained release and tablet coating Reveals unique approaches in phar

Embracing the Melody of Appearance: An Emotional Symphony within **Enthalpy Decomposition Sodium Hydrogencarbonate**

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