calculating ph pogil

calculating ph pogil is an essential educational activity designed to enhance students' understanding of acid-base chemistry through guided inquiry and collaborative learning. This process involves determining the pH of various solutions by applying concepts such as hydrogen ion concentration, dissociation constants, and logarithmic calculations. The POGIL (Process Oriented Guided Inquiry Learning) approach facilitates active engagement, allowing learners to develop critical thinking skills while mastering the quantitative aspects of pH determination. In this article, the methodology behind calculating pH is explored in detail, including the chemistry principles involved, the step-by-step calculation processes, and the use of POGIL activities to reinforce learning outcomes. Additionally, common challenges encountered during pH calculations and effective strategies to overcome them are discussed. This comprehensive overview aims to provide educators and students with a thorough understanding of calculating pH using POGIL, emphasizing accuracy, conceptual clarity, and practical application in laboratory and academic settings.

- Understanding the Basics of pH and POGIL
- Key Concepts in Calculating pH
- Step-by-Step Guide to Calculating pH
- Common Challenges and Solutions in pH Calculations
- Applications of Calculating pH in POGIL Activities

Understanding the Basics of pH and POGIL

The term "pH" quantifies the acidity or basicity of an aqueous solution, defined as the negative logarithm of the hydrogen ion concentration. This measure is fundamental in chemistry, biology, environmental science, and many industrial processes. POGIL, standing for Process Oriented Guided Inquiry Learning, is an instructional method that promotes active student participation and inquiry-based learning. By integrating calculating pH within POGIL activities, students engage in structured exploration that deepens their conceptual understanding while practicing quantitative skills. This combination not only clarifies the theoretical aspects of pH but also enhances problem-solving abilities through collaborative discussions and guided questions.

The Definition and Importance of pH

pH is expressed as:

$pH = -log[H^+]$

where $[H^+]$ denotes the molar concentration of hydrogen ions in the solution. A pH value below 7 indicates acidity, above 7 indicates basicity, and exactly 7 represents neutrality. Understanding pH is critical for predicting reaction behavior, maintaining biological homeostasis, and controlling environmental conditions.

Overview of the POGIL Approach

POGIL activities are designed to foster active learning through team-based problem solving and guided inquiry. In the context of calculating pH, POGIL materials typically present students with scenarios requiring them to analyze data, apply chemical principles, and derive calculations collaboratively. This pedagogical strategy encourages deeper comprehension and retention of acid-base chemistry concepts by involving students in the learning process rather than passive reception.

Key Concepts in Calculating pH

Mastering the calculation of pH requires familiarity with several fundamental chemistry concepts, including the dissociation of acids and bases, the relationship between concentration and ionization, and the logarithmic scale used to express pH values. Each concept plays a vital role in accurately determining the pH of different types of solutions encountered in academic and practical contexts.

Strong vs Weak Acids and Bases

Strong acids and bases dissociate completely in aqueous solutions, while weak acids and bases only partially ionize. This difference significantly affects how pH is calculated:

- **Strong acids/bases:** pH is calculated directly from the concentration of the acid or base because complete dissociation provides an equivalent concentration of hydrogen or hydroxide ions.
- **Weak acids/bases:** pH calculations require the use of equilibrium expressions and acid dissociation constants (Ka or Kb) to determine the extent of ionization.

Understanding Acid Dissociation Constant (Ka)

Ka is a quantitative measure of the strength of an acid in solution, representing the equilibrium constant for its dissociation. It is integral to calculating the concentration of hydrogen ions in weak acid solutions, enabling the derivation of pH through equilibrium calculations rather than straightforward concentration values.

The Logarithmic Nature of pH

The pH scale is logarithmic, meaning each whole number change represents a tenfold change in hydrogen ion concentration. This logarithmic relationship simplifies the expression of a wide range of ion concentrations into an easily interpretable scale from 0 to 14, where extreme values indicate highly acidic or basic environments.

Step-by-Step Guide to Calculating pH

Calculating pH involves a systematic approach that varies depending on the nature of the acid or base involved. The steps outlined below provide a clear framework for determining pH in different scenarios, ensuring precision and conceptual understanding.

Calculating pH for Strong Acids and Bases

For strong acids such as HCl, which dissociate completely, the pH calculation is straightforward:

1. Determine the molar concentration of the acid.
2. Since dissociation is complete, the concentration of H^+ ions equals the molar concentration of the acid.
3. Calculate pH using the formula: $pH = -log[H^+]$.

Similarly, for strong bases like NaOH, calculate the pOH first and then relate it to pH:

1. Determine the molar concentration of OH^- ions (equal to the base concentration).
2. Calculate pOH: $pOH = -log[OH^-]$.
3. Calculate pH: $pH = 14 - pOH$.

Calculating pH for Weak Acids and Bases

Weak acids and bases require equilibrium calculations due to partial dissociation:

1. Write the dissociation equation and expression for Ka or Kb.
2. Set up an ICE table (Initial, Change, Equilibrium) to calculate ion concentrations.
3. Solve for the equilibrium concentration of H^+ or OH^-.
4. Calculate pH or pOH using logarithmic formulas.
5. Convert pOH to pH if necessary.

This method involves algebraic manipulation and sometimes approximation techniques to solve for ion concentrations.

Using the pH Formula with Given Hydrogen Ion Concentration

When the hydrogen ion concentration is directly known, calculating pH is a matter of applying the logarithmic formula. This calculation is fundamental and often used as a verification step in more complex problems involving dissociation equilibria.

Common Challenges and Solutions in pH Calculations

Students and practitioners often encounter difficulties when calculating pH, particularly with weak acids and bases or buffer solutions. Understanding these challenges and implementing effective strategies is crucial for accurate results and conceptual clarity.

Challenges with Weak Acid/Base Equilibria

Calculating pH for weak acids or bases requires careful handling of equilibrium expressions and sometimes complex algebraic solutions. Common errors include incorrect assumptions about ionization extent and misapplication of approximations.

Strategies to Overcome Calculation Difficulties

Effective strategies include:

- Using ICE tables methodically to organize data.
- Applying appropriate approximations (e.g., neglecting x in denominators when valid).
- Double-checking calculations with alternative methods or back-calculation.
- Practicing a variety of problems to build familiarity and confidence.

Understanding Buffer Solutions and pH Stability

Buffers resist changes in pH upon addition of small amounts of acids or bases. Calculating pH in buffer systems involves the Henderson-Hasselbalch equation, which relates pH to the ratio of conjugate base and acid concentrations. Mastery of this concept is essential for advanced pH calculations.

Applications of Calculating pH in POGIL Activities

Calculating pH within POGIL activities reinforces both theoretical knowledge and practical skills. These applications range from simple acid-base titrations to complex environmental chemistry scenarios, promoting comprehensive understanding through experiential learning.

Integration into Laboratory Experiments

POGIL exercises often complement laboratory work by providing structured inquiry questions that guide students through pH measurement, calculation, and interpretation of results. This integration helps students connect theoretical calculations with real-world observations.

Enhancing Critical Thinking and Collaboration

The collaborative nature of POGIL fosters discussion and peer learning, enabling students to articulate reasoning, challenge assumptions, and refine problem-solving strategies related to pH calculations. This approach enhances critical thinking and communication skills crucial for scientific

proficiency.

Examples of POGIL Activities Focused on pH

Typical POGIL modules might include:

- Determining the pH of strong and weak acid solutions using experimental data.
- Calculating pH changes during titration curves and identifying equivalence points.
- Analyzing buffer capacity and predicting pH shifts upon addition of acids or bases.
- Exploring the effect of dilution on pH and ion concentration.

Frequently Asked Questions

What is the main purpose of a POGIL activity in calculating pH?

The main purpose of a POGIL (Process Oriented Guided Inquiry Learning) activity in calculating pH is to help students actively engage in learning by exploring concepts related to acidity, basicity, and the logarithmic nature of the pH scale through guided questions and collaborative problem-solving.

How do you calculate the pH of a strong acid solution using POGIL principles?

To calculate the pH of a strong acid solution, first determine the concentration of hydrogen ions [H+] since strong acids fully dissociate. Then use the formula pH = -log[H+]. POGIL activities guide students to understand each step through inquiry and data analysis.

Why is understanding the logarithmic scale important in calculating pH during POGIL exercises?

Understanding the logarithmic scale is crucial because pH is defined as the negative logarithm of hydrogen ion concentration. POGIL exercises emphasize this concept by having students interpret pH changes in terms of powers of ten, enhancing their comprehension of acidity and basicity.

How does a POGIL activity help in distinguishing between strong and weak acids when calculating pH?

A POGIL activity helps students differentiate strong and weak acids by exploring dissociation extents and equilibrium concepts. Students calculate pH using initial concentrations for strong acids and apply equilibrium expressions (ICE tables) for weak acids, fostering deeper conceptual understanding.

What role do ICE tables play in POGIL activities focused on calculating pH?

ICE (Initial, Change, Equilibrium) tables organize concentration changes during acid-base reactions. In POGIL activities, they help students systematically analyze weak acid/base dissociation to calculate pH accurately by applying equilibrium constants and solving for hydrogen ion concentration.

How can POGIL activities improve students' problem-solving skills in calculating pH?

POGIL activities improve problem-solving skills by encouraging collaborative learning, critical thinking, and step-by-step inquiry. Students learn to interpret data, apply formulas, and reason through chemical equilibria rather than memorizing procedures, leading to better understanding of pH calculations.

What common misconceptions about pH calculation are addressed through POGIL activities?

Common misconceptions addressed include misunderstanding the inverse logarithmic relationship of pH and [H+], confusing strong and weak acid behavior, and neglecting equilibrium considerations. POGIL activities confront these by guiding students to explore concepts experimentally and conceptually.

Additional Resources

1. *Mastering pH Calculations: A POGIL Approach*
This book offers a comprehensive introduction to pH calculations using Process Oriented Guided Inquiry Learning (POGIL) strategies. It emphasizes active learning through group work and inquiry-based exercises. Students will develop a deeper understanding of acid-base chemistry and equilibrium concepts by engaging with real-world problems.

2. *POGIL Activities for Acid-Base Chemistry: Calculating pH and Beyond*
Designed for chemistry educators, this resource provides a collection of POGIL activities focused on acid-base equilibria and pH calculations. The

activities encourage critical thinking and collaborative problem-solving. It includes detailed instructor notes and student worksheets to facilitate effective classroom implementation.

3. *Understanding pH through Inquiry: A POGIL Workbook*
This workbook guides students through the fundamentals of pH and buffer systems using inquiry-based learning. Each chapter integrates POGIL methods to promote self-directed exploration and concept mastery. It is ideal for high school and introductory college chemistry courses.

4. *Applying POGIL Techniques to pH and Buffer Calculations*
This text explores the application of POGIL pedagogies to complex pH and buffer solution problems. It provides step-by-step activities that build conceptual understanding while reinforcing quantitative skills. The book includes assessment tools to track student progress.

5. *Interactive pH Calculations with POGIL: A Student-Centered Guide*
Focusing on student engagement, this guide presents interactive exercises that develop proficiency in pH calculations. Through POGIL strategies, learners collaborate to analyze acid-base reactions and solution equilibria. The approachable format supports diverse learning styles.

6. *POGIL for Chemistry: pH and Acid-Base Equilibria*
This resource integrates POGIL methodology into the study of acid-base equilibria and pH determination. It offers structured activities that foster conceptual clarity and analytical thinking. The book is suitable for instructors aiming to incorporate active learning in their curriculum.

7. *Exploring pH Calculations in Chemistry: A POGIL Perspective*
This book provides a detailed exploration of pH calculations through inquiry-based learning frameworks. Students engage with guided questions and collaborative tasks to build a robust understanding of solution chemistry. The text supports both teaching and self-study environments.

8. *POGIL Activities for Understanding pH and Buffer Systems*
A compilation of well-designed POGIL activities, this book helps students grasp the complexities of pH and buffer systems. It emphasizes conceptual reasoning alongside mathematical problem-solving. The activities promote teamwork and active participation in learning.

9. *Teaching pH Calculations with POGIL: Strategies and Exercises*
This instructional guide assists educators in teaching pH calculations using POGIL strategies. It includes practical exercises, discussion prompts, and assessment ideas to enhance student comprehension. The book aims to improve learning outcomes in chemistry education through active engagement.

Calculating Ph Pogil

Calculating pH: A POGIL Approach

Unravel the mysteries of pH calculations and master acid-base chemistry! Are you struggling to understand pH calculations? Do complex equations leave you feeling confused and frustrated? Do you wish there was a clearer, more engaging way to learn this crucial concept? If so, this book is your solution. Stop memorizing formulas and start understanding the underlying principles of pH and pOH calculations. This guide uses the powerful POGIL (Process-Oriented Guided-Inquiry Learning) method to help you actively construct your understanding of pH and related concepts.

This ebook, "Mastering pH Calculations: A POGIL Approach," by Dr. Anya Sharma, will guide you through:

Introduction: What is pH? Why is it important?
Chapter 1: Understanding Acids and Bases: Defining acids and bases using different theories (Arrhenius, Brønsted-Lowry).
Chapter 2: The pH Scale and its Significance: Logarithmic scales, calculating pH from [H+], calculating [H+] from pH.
Chapter 3: pOH and the Relationship to pH: Calculating pOH, the relationship between pH and pOH in aqueous solutions.
Chapter 4: Strong and Weak Acids and Bases: Calculating pH of strong acid/base solutions, understanding weak acid/base equilibria (without complex ICE tables initially).
Chapter 5: pH Calculations Involving Polyprotic Acids: Introduction to polyprotic acids and their pH calculations (simplified approach).
Chapter 6: Buffers and pH: Introduction to buffer solutions and their importance in maintaining pH.
Chapter 7: Titrations and pH Curves: A foundational understanding of acid-base titrations and the shape of titration curves.
Conclusion: Review and further exploration of pH calculations.

Mastering pH Calculations: A POGIL Approach - A Comprehensive Guide

Introduction: What is pH and Why Does It Matter?

The pH scale is a logarithmic scale that measures the acidity or alkalinity of a solution. It ranges from 0 to 14, with 7 being neutral. Solutions with a pH less than 7 are acidic, while those with a pH greater than 7 are basic (or alkaline). Understanding pH is crucial in various fields, including chemistry, biology, environmental science, and medicine. Many biological processes are highly sensitive to pH changes, and maintaining the correct pH is essential for their proper functioning. In environmental science, pH measurements are used to assess water quality and soil conditions. In industry, pH control is critical in numerous processes, such as manufacturing pharmaceuticals and food products. This introduction will provide the foundational knowledge needed to understand the subsequent chapters. It covers the importance of pH in different contexts and prepares the reader for a deeper dive into the calculations. This section also sets the stage for the POGIL approach, emphasizing active learning and problem-solving.

Chapter 1: Understanding Acids and Bases – Arrhenius, Brønsted-Lowry

This chapter explores the different definitions of acids and bases. We will start with the Arrhenius definition, which defines acids as substances that produce hydrogen ions (H^+) in aqueous solution and bases as substances that produce hydroxide ions (OH^-) in aqueous solution. However, the Arrhenius definition is limited; it doesn't explain the acidic or basic behavior of many substances. Therefore, we'll move on to the more comprehensive Brønsted-Lowry definition. The Brønsted-Lowry definition defines an acid as a proton (H^+) donor and a base as a proton acceptor. This definition expands the scope of acids and bases, encompassing a wider range of substances. We will illustrate these definitions with examples and practice problems. This POGIL-style chapter emphasizes understanding the conceptual differences between the two theories and their applications in different scenarios. Activities will involve identifying acids and bases based on their chemical formulas and reactions.

Chapter 2: The pH Scale and its Significance – Calculations

This chapter delves into the specifics of the pH scale. We will explain why the pH scale is logarithmic (a change of one pH unit represents a tenfold change in $[H^+]$) and how to calculate pH from the concentration of hydrogen ions ($[H^+]$). The formula $pH = -\log_{10}[H^+]$ will be introduced and explained step-by-step. Conversely, we'll also cover calculating $[H^+]$ from a given pH value using the inverse logarithmic function: $[H^+] = 10^{-pH}$. The chapter will include numerous practice problems and exercises to reinforce understanding. The POGIL approach will encourage students to work through problems collaboratively and to explain their reasoning to each other, strengthening their grasp of the concepts. Real-world examples of pH values in various substances will be provided to contextualize the numerical calculations.

Chapter 3: pOH and the Relationship to pH

This chapter introduces the concept of pOH, which is the negative logarithm of the hydroxide ion concentration ($[OH^-]$): $pOH = -\log_{10}[OH^-]$. We will explore the relationship between pH and pOH in aqueous solutions at 25°C: $pH + pOH = 14$. This relationship is a consequence of the ion product constant of water ($K_w = [H^+][OH^-] = 1.0 \times 10^{-14}$ at 25°C). Calculations involving pH and pOH will be covered, including conversions between pH and pOH, and determining $[H^+]$ and $[OH^-]$ from given pH or pOH values. POGIL activities will focus on problem-solving and applying the relationship between pH and pOH in different contexts.

Chapter 4: Strong and Weak Acids and Bases – A Simplified Approach

This chapter differentiates between strong and weak acids and bases. Strong acids and bases completely dissociate in water, while weak acids and bases only partially dissociate. This chapter will primarily focus on calculating the pH of strong acid and base solutions. Calculations involving weak acids and bases will be introduced, but in-depth treatment of equilibrium calculations (ICE tables) is postponed to a more advanced course (for the sake of clarity within this introductory POGIL-focused guide). This chapter will emphasize the conceptual difference between strong and weak electrolytes and their impact on pH. The focus remains on developing a fundamental understanding without getting bogged down in complex calculations at this stage.

Chapter 5: pH Calculations Involving Polyprotic Acids – Simplified Approach

This chapter provides an introduction to polyprotic acids, which are acids that can donate more than one proton. A simplified approach to calculating the pH of solutions containing polyprotic acids will be presented, focusing on the dominant equilibrium and neglecting subsequent dissociation steps. This approach allows for a basic understanding without introducing unnecessary complexity, keeping in line with the introductory nature of the book. The POGIL activities will help students learn to identify polyprotic acids and make appropriate simplifications in calculations.

Chapter 6: Buffers and pH – An Introduction

This chapter provides a basic introduction to buffer solutions, which resist changes in pH upon the addition of small amounts of acid or base. The composition of buffer solutions (weak acid/conjugate base or weak base/conjugate acid) will be explained. A simplified explanation of buffer capacity will

be provided. Complex buffer calculations will be avoided to maintain the introductory level of this book.

Chapter 7: Titrations and pH Curves – A Foundational Understanding

This chapter offers a foundational introduction to acid-base titrations, which are used to determine the concentration of an unknown acid or base solution. A qualitative description of titration curves (pH vs. volume of titrant) will be provided, illustrating the different regions of the curve (before the equivalence point, at the equivalence point, and after the equivalence point). Quantitative calculations are kept minimal to maintain focus on the core concepts and avoid overwhelming the reader.

Conclusion: Review and Further Exploration

This concluding chapter will review the key concepts covered throughout the book, emphasizing the connections between the different topics. It will also provide suggestions for further exploration of pH calculations and related topics, including resources for more advanced learning. It reiterates the importance of the POGIL approach in mastering pH calculations and encourages continued active learning.

FAQs

1. What is POGIL? POGIL stands for Process-Oriented Guided-Inquiry Learning. It's a collaborative, inquiry-based learning approach that emphasizes active learning and problem-solving.

2. Is this book suitable for beginners? Yes, this book is designed for beginners with little to no prior knowledge of pH calculations.

3. What prior knowledge is required? Basic high school chemistry knowledge is helpful but not essential.

4. What are the prerequisites for this ebook? A basic understanding of logarithms and scientific notation is beneficial.

5. Does this book include answers to the practice problems? Yes, solutions to the exercises are provided at the end of each chapter.

6. What makes this book different from other pH calculation books? This book utilizes the POGIL

method, making learning more engaging and effective through active participation.

7. Can this book be used for self-study? Absolutely! It's designed for self-paced learning and includes numerous exercises for practice.

8. How long will it take to complete this ebook? The time required will vary depending on individual learning pace and prior knowledge.

9. What is the best way to use this ebook for maximum learning? Engage actively with the POGIL activities and work through the problems collaboratively (if possible).

Related Articles:

1. Acid-Base Equilibria: A Deep Dive: This article explores equilibrium calculations involving weak acids and bases using ICE tables.

2. Understanding Buffer Capacity: This article delves deeper into the concept of buffer capacity and its calculation.

3. Titration Curves: A Detailed Analysis: This article provides a more comprehensive analysis of titration curves, including various types of titrations.

4. Polyprotic Acid Calculations: Advanced Techniques: This article covers more advanced techniques for calculating the pH of solutions containing polyprotic acids.

5. pH Indicators and Their Applications: This article explores the use of pH indicators in acid-base titrations and other applications.

6. The Importance of pH in Biological Systems: This article discusses the role of pH in various biological processes.

7. pH and Environmental Monitoring: This article examines the significance of pH in assessing water and soil quality.

8. pH Measurement Techniques: This article explores different methods for measuring pH, including the use of pH meters and indicators.

9. pH Control in Industrial Processes: This article details the importance of pH control in various industrial applications.

calculating ph pogil: Analytical Chemistry Juliette Lantz, Renée Cole, The POGIL Project, 2014-12-31 An essential guide to inquiry approach instrumental analysis Analytical Chemistry offers an essential guide to inquiry approach instrumental analysis collection. The book focuses on more in-depth coverage and information about an inquiry approach. This authoritative guide reviews the basic principles and techniques. Topics covered include: method of standard; the microscopic view of electrochemistry; calculating cell potentials; the BerriLambert; atomic and molecular absorption

processes; vibrational modes; mass spectra interpretation; and much more.

calculating ph pogil: Chemistry 2e Paul Flowers, Richard Langely, William R. Robinson, Klaus Hellmut Theopold, 2019-02-14 Chemistry 2e is designed to meet the scope and sequence requirements of the two-semester general chemistry course. The textbook provides an important opportunity for students to learn the core concepts of chemistry and understand how those concepts apply to their lives and the world around them. The book also includes a number of innovative features, including interactive exercises and real-world applications, designed to enhance student learning. The second edition has been revised to incorporate clearer, more current, and more dynamic explanations, while maintaining the same organization as the first edition. Substantial improvements have been made in the figures, illustrations, and example exercises that support the text narrative. Changes made in Chemistry 2e are described in the preface to help instructors transition to the second edition.

calculating ph pogil: POGIL Activities for High School Chemistry High School POGIL Initiative, 2012

calculating ph pogil: *Modern Analytical Chemistry* David Harvey, 2000 This introductory text covers both traditional and contemporary topics relevant to analytical chemistry. Its flexible approach allows instructors to choose their favourite topics of discussion from additional coverage of subjects such as sampling, kinetic method, and quality assurance.

calculating ph pogil: Process Oriented Guided Inquiry Learning (POGIL) Richard Samuel Moog, 2008 POGIL is a student-centered, group learning pedagogy based on current learning theory. This volume describes POGIL's theoretical basis, its implementations in diverse environments, and evaluation of student outcomes.

calculating ph pogil: *Biochemical Calculations* Irwin H. Segel, 1968 Weak acids and based; Amino acids and peptides; Biochemical energetics; Enzyme kinetics; Spectrophotometry; Isotopes in biochemistry; Miscellaneous calculations.

calculating ph pogil: Basic Concepts in Biochemistry: A Student's Survival Guide Hiram F. Gilbert, 2000 Basic Concepts in Biochemistry has just one goal: to review the toughest concepts in biochemistry in an accessible format so your understanding is through and complete.--BOOK JACKET.

calculating ph pogil: *Chemistry 2e* Paul Flowers, Klaus Theopold, Richard Langley, Edward J. Neth, WIlliam R. Robinson, 2019-02-14 Chemistry 2e is designed to meet the scope and sequence requirements of the two-semester general chemistry course. The textbook provides an important opportunity for students to learn the core concepts of chemistry and understand how those concepts apply to their lives and the world around them. The book also includes a number of innovative features, including interactive exercises and real-world applications, designed to enhance student learning. The second edition has been revised to incorporate clearer, more current, and more dynamic explanations, while maintaining the same organization as the first edition. Substantial improvements have been made in the figures, illustrations, and example exercises that support the text narrative. Changes made in Chemistry 2e are described in the preface to help instructors transition to the second edition.

calculating ph pogil: Teaching at Its Best Linda B. Nilson, 2010-04-20 Teaching at Its Best This third edition of the best-selling handbook offers faculty at all levels an essential toolbox of hundreds of practical teaching techniques, formats, classroom activities, and exercises, all of which can be implemented immediately. This thoroughly revised edition includes the newest portrait of the Millennial student; current research from cognitive psychology; a focus on outcomes maps; the latest legal options on copyright issues; and how to best use new technology including wikis, blogs, podcasts, vodcasts, and clickers. Entirely new chapters include subjects such as matching teaching methods with learning outcomes, inquiry-guided learning, and using visuals to teach, and new sections address Felder and Silverman's Index of Learning Styles, SCALE-UP classrooms, multiple true-false test items, and much more. Praise for the Third Edition of Teaching at Its BestEveryone veterans as well as novices will profit from reading Teaching at Its Best, for it provides both theory

and practical suggestions for handling all of the problems one encounters in teaching classes varying in size, ability, and motivation. Wilbert McKeachie, Department of Psychology, University of Michigan, and coauthor, McKeachie's Teaching TipsThis new edition of Dr. Nilson's book, with its completely updated material and several new topics, is an even more powerful collection of ideas and tools than the last. What a great resource, especially for beginning teachers but also for us veterans! L. Dee Fink, author, Creating Significant Learning ExperiencesThis third edition of Teaching at Its Best is successful at weaving the latest research on teaching and learning into what was already a thorough exploration of each topic. New information on how we learn, how students develop, and innovations in instructional strategies complement the solid foundation established in the first two editions. Marilla D. Svinicki, Department of Psychology, The University of Texas, Austin, and coauthor, McKeachie's Teaching Tips

calculating ph pogil: Pulmonary Gas Exchange G. Kim Prisk, Susan R. Hopkins, 2013-08-01 The lung receives the entire cardiac output from the right heart and must load oxygen onto and unload carbon dioxide from perfusing blood in the correct amounts to meet the metabolic needs of the body. It does so through the process of passive diffusion. Effective diffusion is accomplished by intricate parallel structures of airways and blood vessels designed to bring ventilation and perfusion together in an appropriate ratio in the same place and at the same time. Gas exchange is determined by the ventilation-perfusion ratio in each of the gas exchange units of the lung. In the normal lung ventilation and perfusion are well matched, and the ventilation-perfusion ratio is remarkably uniform among lung units, such that the partial pressure of oxygen in the blood leaving the pulmonary capillaries is less than 10 Torr lower than that in the alveolar space. In disease, the disruption to ventilation-perfusion matching and to diffusional transport may result in inefficient gas exchange and arterial hypoxemia. This volume covers the basics of pulmonary gas exchange, providing a central understanding of the processes involved, the interactions between the components upon which gas exchange depends, and basic equations of the process.

calculating ph pogil: POGIL Activities for AP Biology , 2012-10

calculating ph pogil: Principles of Modern Chemistry David W. Oxtoby, 1998-07-01 PRINCIPLES OF MODERN CHEMISTRY has dominated the honors and high mainstream general chemistry courses and is considered the standard for the course. The fifth edition is a substantial revision that maintains the rigor of previous editions but reflects the exciting modern developments taking place in chemistry today. Authors David W. Oxtoby and H. P. Gillis provide a unique approach to learning chemical principles that emphasizes the total scientific process'from observation to application'placing general chemistry into a complete perspective for serious-minded science and engineering students. Chemical principles are illustrated by the use of modern materials, comparable to equipment found in the scientific industry. Students are therefore exposed to chemistry and its applications beyond the classroom. This text is perfect for those instructors who are looking for a more advanced general chemistry textbook.

calculating ph pogil: AP Chemistry For Dummies Peter J. Mikulecky, Michelle Rose Gilman, Kate Brutlag, 2008-11-13 A practical and hands-on guide for learning the practical science of AP chemistry and preparing for the AP chem exam Gearing up for the AP Chemistry exam? AP Chemistry For Dummies is packed with all the resources and help you need to do your very best. Focused on the chemistry concepts and problems the College Board wants you to know, this AP Chemistry study guide gives you winning test-taking tips, multiple-choice strategies, and topic guidelines, as well as great advice on optimizing your study time and hitting the top of your game on test day. This user-friendly guide helps you prepare without perspiration by developing a pre-test plan, organizing your study time, and getting the most out or your AP course. You'll get help understanding atomic structure and bonding, grasping atomic geometry, understanding how colliding particles produce states, and so much more. To provide students with hands-on experience, AP chemistry courses include extensive labwork as part of the standard curriculum. This is why the book dedicates a chapter to providing a brief review of common laboratory equipment and techniques and another to a complete survey of recommended AP chemistry experiments. Two

full-length practice exams help you build your confidence, get comfortable with test formats, identify your strengths and weaknesses, and focus your studies. You'll discover how to Create and follow a pretest plan Understand everything you must know about the exam Develop a multiple-choice strategy Figure out displacement, combustion, and acid-base reactions Get familiar with stoichiometry Describe patterns and predict properties Get a handle on organic chemistry nomenclature Know your way around laboratory concepts, tasks, equipment, and safety Analyze laboratory data Use practice exams to maximize your score Additionally, you'll have a chance to brush up on the math skills that will help you on the exam, learn the critical types of chemistry problems, and become familiar with the annoying exceptions to chemistry rules. Get your own copy of AP Chemistry For Dummies to build your confidence and test-taking know-how, so you can ace that exam!

calculating ph pogil: *Analytical Chemistry* Juliette Lantz, Renée Cole, The POGIL Project, 2014-08-18 The activities developed by the ANAPOGIL consortium fall into six main categories frequently covered in a quantitative chemistry course: Analytical Tools, Statistics, Equilibrium, Chromatography and Separations, Electrochemistry, and Spectrometry. These materials follow the constructivist learning cycle paradigm and use a guided inquiry approach. Each activity lists content and process learning goals, and includes cues for team collaboration and self-assessment. The classroom activities are modular in nature, and they are generally intended for use in class periods ranging from 50-75 minutes. All activities were reviewed and classroom tested by multiple instructors at a wide variety of institutions.

calculating ph pogil: *Misconceptions in Chemistry* Hans-Dieter Barke, Al Hazari, Sileshi Yitbarek, 2008-11-18 Over the last decades several researchers discovered that children, pupils and even young adults develop their own understanding of how nature really works. These pre-concepts concerning combustion, gases or conservation of mass are brought into lectures and teachers have to diagnose and to reflect on them for better instruction. In addition, there are ‘school-made misconceptions’ concerning equilibrium, acid-base or redox reactions which originate from inappropriate curriculum and instruction materials. The primary goal of this monograph is to help teachers at universities, colleges and schools to diagnose and ‘cure’ the pre-concepts. In case of the school-made misconceptions it will help to prevent them from the very beginning through reflective teaching. The volume includes detailed descriptions of class-room experiments and structural models to cure and to prevent these misconceptions.

calculating ph pogil: Biophysical Chemistry James P. Allen, 2009-01-26 Biophysical Chemistry is an outstanding book that delivers both fundamental and complex biophysical principles, along with an excellent overview of the current biophysical research areas, in a manner that makes it accessible for mathematically and non-mathematically inclined readers. (Journal of Chemical Biology, February 2009) This text presents physical chemistry through the use of biological and biochemical topics, examples and applications to biochemistry. It lays out the necessary calculus in a step by step fashion for students who are less mathematically inclined, leading them through fundamental concepts, such as a quantum mechanical description of the hydrogen atom rather than simply stating outcomes. Techniques are presented with an emphasis on learning by analyzing real data. Presents physical chemistry through the use of biological and biochemical topics, examples and applications to biochemistry Lays out the necessary calculus in a step by step fashion for students who are less mathematically inclined Presents techniques with an emphasis on learning by analyzing real data Features qualitative and quantitative problems at the end of each chapter All art available for download online and on CD-ROM

calculating ph pogil: Calculus-Based Physics I Jeffrey W. Schnick, 2009-09-24 Calculus-Based Physics is an introductory physics textbook designed for use in the two-semester introductory physics course typically taken by science and engineering students. This item is part 1, for the first semester. Only the textbook in PDF format is provided here. To download other resources, such as text in MS Word formats, problems, quizzes, class questions, syllabi, and formula sheets, visit: http: //www.anselm.edu/internet/physics/cbphysics/index.html Calculus-Based Physics

is now available in hard copy in the form of two black and white paperbacks at www.LuLu.com at the cost of production plus shipping. Note that Calculus-Based Physics is designed for easy photocopying. So, if you prefer to make your own hard copy, just print the pdf file and make as many copies as you need. While some color is used in the textbook, the text does not refer to colors so black and white hard copies are viable

calculating ph pogil: ICOPE 2020 Ryzal Perdana, Gede Eka Putrawan, Sunyono, 2021-03-24 We are delighted to introduce the Proceedings of the Second International Conference on Progressive Education (ICOPE) 2020 hosted by the Faculty of Teacher Training and Education, Universitas Lampung, Indonesia, in the heart of the city Bandar Lampung on 16 and 17 October 2020. Due to the COVID-19 pandemic, we took a model of an online organised event via Zoom. The theme of the 2nd ICOPE 2020 was “Exploring the New Era of Education”, with various related topics including Science Education, Technology and Learning Innovation, Social and Humanities Education, Education Management, Early Childhood Education, Primary Education, Teacher Professional Development, Curriculum and Instructions, Assessment and Evaluation, and Environmental Education. This conference has invited academics, researchers, teachers, practitioners, and students worldwide to participate and exchange ideas, experiences, and research findings in the field of education to make a better, more efficient, and impactful teaching and learning. This conference was attended by 190 participants and 160 presenters. Four keynote papers were delivered at the conference; the first two papers were delivered by Prof Emeritus Stephen D. Krashen from the University of Southern California, the USA and Prof Dr Bujang Rahman, M.Si. from Universitas Lampung, Indonesia. The second two papers were presented by Prof Dr Habil Andrea Bencsik from the University of Pannonia, Hungary and Dr Hisham bin Dzakiria from Universiti Utara Malaysia, Malaysia. In addition, a total of 160 papers were also presented by registered presenters in the parallel sessions of the conference. The conference represents the efforts of many individuals. Coordination with the steering chairs was essential for the success of the conference. We sincerely appreciate their constant support and guidance. We would also like to express our gratitude to the organising committee members for putting much effort into ensuring the success of the day-to-day operation of the conference and the reviewers for their hard work in reviewing submissions. We also thank the four invited keynote speakers for sharing their insights. Finally, the conference would not be possible without the excellent papers contributed by authors. We thank all authors for their contributions and participation in the 2nd ICOPE 2020. We strongly believe that the 2nd ICOPE 2020 has provided a good forum for academics, researchers, teachers, practitioners, and students to address all aspects of education-related issues in the current educational situation. We feel honoured to serve the best recent scientific knowledge and development in education and hope that these proceedings will furnish scholars from all over the world with an excellent reference book. We also expect that the future ICOPE conference will be more successful and stimulating. Finally, it was with great pleasure that we had the opportunity to host such a conference.

calculating ph pogil: Chemistry Education in the ICT Age Minu Gupta Bhowon, Sabina Jhaumeer-Laulloo, Henri Li Kam Wah, Ponnadurai Ramasami, 2009-07-21 th th The 20 International Conference on Chemical Education (20 ICCE), which had rd th “Chemistry in the ICT Age” as the theme, was held from 3 to 8 August 2008 at Le Méridien Hotel, Pointe aux Piments, in Mauritius. With more than 200 participants from 40 countries, the conference featured 140 oral and 50 poster presentations. th Participants of the 20 ICCE were invited to submit full papers and the latter were subjected to peer review. The selected accepted papers are collected in this book of proceedings. This book of proceedings encloses 39 presentations covering topics ranging from fundamental to applied chemistry, such as Arts and Chemistry Education, Biochemistry and Biotechnology, Chemical Education for Development, Chemistry at Secondary Level, Chemistry at Tertiary Level, Chemistry Teacher Education, Chemistry and Society, Chemistry Olympiad, Context Oriented Chemistry, ICT and Chemistry Education, Green Chemistry, Micro Scale Chemistry, Modern Technologies in Chemistry Education, Network for Chemistry and Chemical Engineering Education,

Public Understanding of Chemistry, Research in Chemistry Education and Science Education at Elementary Level. We would like to thank those who submitted the full papers and the reviewers for their timely help in assessing the papers for publication. th We would also like to pay a special tribute to all the sponsors of the 20 ICCE and, in particular, the Tertiary Education Commission (http://tec.intnet.mu/) and the Organisation for the Prohibition of Chemical Weapons (http://www.opcw.org/) for kindly agreeing to fund the publication of these proceedings.

calculating ph pogil: POGIL Activities for AP* Chemistry Flinn Scientific, 2014

calculating ph pogil: Learner-Centered Teaching Activities for Environmental and Sustainability Studies Loren B. Byrne, 2016-03-21 Learner-centered teaching is a pedagogical approach that emphasizes the roles of students as participants in and drivers of their own learning. Learner-centered teaching activities go beyond traditional lecturing by helping students construct their own understanding of information, develop skills via hands-on engagement, and encourage personal reflection through metacognitive tasks. In addition, learner-centered classroom approaches may challenge students' preconceived notions and expand their thinking by confronting them with thought-provoking statements, tasks or scenarios that cause them to pay closer attention and cognitively "see" a topic from new perspectives. Many types of pedagogy fall under the umbrella of learner-centered teaching including laboratory work, group discussions, service and project-based learning, and student-led research, among others. Unfortunately, it is often not possible to use some of these valuable methods in all course situations given constraints of money, space, instructor expertise, class-meeting and instructor preparation time, and the availability of prepared lesson plans and material. Thus, a major challenge for many instructors is how to integrate learner-centered activities widely into their courses. The broad goal of this volume is to help advance environmental education practices that help increase students' environmental literacy. Having a diverse collection of learner-centered teaching activities is especially useful for helping students develop their environmental literacy because such approaches can help them connect more personally with the material thus increasing the chances for altering the affective and behavioral dimensions of their environmental literacy. This volume differentiates itself from others by providing a unique and diverse collection of classroom activities that can help students develop their knowledge, skills and personal views about many contemporary environmental and sustainability issues.

calculating ph pogil: Principles of Biology Lisa Bartee, Walter Shiner, Catherine Creech, 2017 The Principles of Biology sequence (BI 211, 212 and 213) introduces biology as a scientific discipline for students planning to major in biology and other science disciplines. Laboratories and classroom activities introduce techniques used to study biological processes and provide opportunities for students to develop their ability to conduct research.

calculating ph pogil: Conceptual Chemistry John Suchocki, 2007 Conceptual Chemistry, Third Edition features more applied material and an expanded quantitative approach to help readers understand how chemistry is related to their everyday lives. Building on the clear, friendly writing style and superior art program that has made Conceptual Chemistry a market-leading text, the Third Edition links chemistry to the real world and ensures that readers master the problem-solving skills they need to solve chemical equations. Chemistry Is A Science, Elements of Chemistry, Discovering the Atom and Subatomic Particles, The Atomic Nucleus, Atomic Models, Chemical Bonding and Molecular Shapes, Molecular Mixing, Those, Incredible Water Molecules, An Overview of Chemical Reactions, Acids and Bases, Oxidations and Reductions, Organic Chemistry, Chemicals of Life, The Chemistry of Drugs, Optimizing Food Production, Fresh Water Resources, Air Resources, Material Resources, Energy Resources For readers interested in how chemistry is related to their everyday lives.

calculating ph pogil: *ChemQuest - Chemistry* Jason Neil, 2014-08-24 This Chemistry text is used under license from Uncommon Science, Inc. It may be purchased and used only by students of Margaret Connor at Huntington-Surrey School.

calculating ph pogil: Introduction to Materials Science and Engineering Elliot Douglas,

2014 This unique book is designed to serve as an active learning tool that uses carefully selected information and guided inquiry questions. Guided inquiry helps readers reach true understanding of concepts as they develop greater ownership over the material presented. First, background information or data is presented. Then, concept invention questions lead the students to construct their own understanding of the fundamental concepts represented. Finally, application questions provide the reader with practice in solving problems using the concepts that they have derived from their own valid conclusions. KEY TOPICS: What is Guided Inquiry?; What is Materials Science and Engineering?; Bonding; Atomic Arrangements in Solids; The Structure of Polymers; Microstructure: Phase Diagrams; Diffusion; Microstructure: Kinetics; Mechanical Behavior; Materials in the Environment; Electronic Behavior; Thermal Behavior; Materials Selection and Design. MasteringEngineering, the most technologically advanced online tutorial and homework system available, can be packaged with this edition. MasteringEngineering is designed to provide students with customized coaching and individualized feedback to help improve problem-solving skills while providing instructors with rich teaching diagnostics. Note: If you are purchasing the standalone text (ISBN: 0132136422) or electronic version, MasteringEngineering does not come automatically packaged with the text. To purchase MasteringEngineering, please visit: www.masteringengineering.com or you can purchase a package of the physical text + MasteringEngineering by searching the Pearson Higher Education web site. MasteringEngineering is not a self-paced technology and should only be purchased when required by an instructor. MARKET: For students taking the Materials Science course in the Mechanical & Aerospace Engineering department. This book is also suitable for professionals seeking a guided inquiry approach to materials science.

calculating ph pogil: An Abridgment of Ainsworth's Dictionary Robert Ainsworth, 1831

calculating ph pogil: Organic Chemistry Suzanne M. Ruder, The POGIL Project, 2015-12-29 ORGANIC CHEMISTRY

calculating ph pogil: Tools of Chemistry Education Research Diane M. Bunce, Renèe S. Cole, 2015-02-05 A companion to 'Nuts and Bolts of Chemical Education Research', 'Tools of Chemistry Education Research' provides a continuation of the dialogue regarding chemistry education research.

calculating ph pogil: Peer-Led Team Learning: Evaluation, Dissemination, and Institutionalization of a College Level Initiative Leo Gafney, Pratibha Varma-Nelson, 2008-06-24 There seems to be no end to the flood of conferences, workshops, panel discussions, reports and research studies calling for change in the introductory science courses in our colleges and universities. But, there comes a time to move from criticism to action. In 1993, the Division of Undergraduate Education of the National Science Foundation called for proposals for systemic initiatives to change the way int- ductory chemistry is taught. One of the five awards was to design, develop and implement the peer-led Workshop, a new structure to help students learn science. This book is a study of 15 years of work by the Peer-Led Team Learning (PLTL) project, a national consortium of faculty, learning specialists and students. The authors have been in the thick of the action as project evaluator (Gafney) and co-principle investigator (Varma-Nelson). Readers of this book will find a story of successful change in educational practice, a story that continues today as new institutions, faculty, and disciplines adopt the PLTL model. They will learn the model in theory and in practice and the supporting data that encourage others to adopt and adapt PLTL to new sit- tions. Although the project has long since lost count of the number of implem- tations of the model, conservative estimates are that more than 100 community and four year colleges and a range of universities have adopted the PLTL model to advance student learning for more than 20,000 students in a variety of STEM disciplines.

calculating ph pogil: The Electron in Oxidation-reduction De Witt Talmage Keach, 1926

calculating ph pogil: Active Learning in Organic Chemistry Justin B. Houseknecht, Alexey Leontyev, Vincent M. Maloney, Catherine O. Welder, 2019 Organic chemistry courses are often difficult for students, and instructors are constantly seeking new ways to improve student learning.

This volume details active learning strategies implemented at a variety of institutional settings, including small and large; private and public; liberal arts and technical; and highly selective and open-enrollment institutions. Readers will find detailed descriptions of methods and materials, in addition to data supporting analyses of the effectiveness of reported pedagogies.

calculating ph pogil: *Precalculus* Robert F. Blitzer, 2014 Bob Blitzer has inspired thousands of students with his engaging approach to mathematics, making this beloved series the #1 in the market. Blitzer draws on his unique background in mathematics and behavioral science to present the full scope of mathematics with vivid applications in real-life situations. Students stay engaged because Blitzer often uses pop-culture and up-to-date references to connect math to students' lives, showing that their world is profoundly mathematical.

calculating ph pogil: POGIL Shawn R. Simonson, 2023-07-03 Process Oriented Guided Inquiry Learning (POGIL) is a pedagogy that is based on research on how people learn and has been shown to lead to better student outcomes in many contexts and in a variety of academic disciplines. Beyond facilitating students' mastery of a discipline, it promotes vital educational outcomes such as communication skills and critical thinking. Its active international community of practitioners provides accessible educational development and support for anyone developing related courses.Having started as a process developed by a group of chemistry professors focused on helping their students better grasp the concepts of general chemistry, The POGIL Project has grown into a dynamic organization of committed instructors who help each other transform classrooms and improve student success, develop curricular materials to assist this process, conduct research expanding what is known about learning and teaching, and provide professional development and collegiality from elementary teachers to college professors. As a pedagogy it has been shown to be effective in a variety of content areas and at different educational levels. This is an introduction to the process and the community.Every POGIL classroom is different and is a reflection of the uniqueness of the particular context – the institution, department, physical space, student body, and instructor – but follows a common structure in which students work cooperatively in self-managed small groups of three or four. The group work is focused on activities that are carefully designed and scaffolded to enable students to develop important concepts or to deepen and refine their understanding of those ideas or concepts for themselves, based entirely on data provided in class, not on prior reading of the textbook or other introduction to the topic. The learning environment is structured to support the development of process skills –– such as teamwork, effective communication, information processing, problem solving, and critical thinking. The instructor's role is to facilitate the development of student concepts and process skills, not to simply deliver content to the students. The first part of this book introduces the theoretical and philosophical foundations of POGIL pedagogy and summarizes the literature demonstrating its efficacy. The second part of the book focusses on implementing POGIL, covering the formation and effective management of student teams, offering guidance on the selection and writing of POGIL activities, as well as on facilitation, teaching large classes, and assessment. The book concludes with examples of implementation in STEM and non-STEM disciplines as well as guidance on how to get started. Appendices provide additional resources and information about The POGIL Project.

calculating ph pogil: America's Lab Report National Research Council, Division of Behavioral and Social Sciences and Education, Center for Education, Board on Science Education, Committee on High School Laboratories: Role and Vision, 2006-01-20 Laboratory experiences as a part of most U.S. high school science curricula have been taken for granted for decades, but they have rarely been carefully examined. What do they contribute to science learning? What can they contribute to science learning? What is the current status of labs in our nationÃ¯Â¿Â½s high schools as a context for learning science? This book looks at a range of questions about how laboratory experiences fit into U.S. high schools: What is effective laboratory teaching? What does research tell us about learning in high school science labs? How should student learning in laboratory experiences be assessed? Do all student have access to laboratory experiences? What changes need to be made to improve laboratory experiences for high school students? How can school organization

contribute to effective laboratory teaching? With increased attention to the U.S. education system and student outcomes, no part of the high school curriculum should escape scrutiny. This timely book investigates factors that influence a high school laboratory experience, looking closely at what currently takes place and what the goals of those experiences are and should be. Science educators, school administrators, policy makers, and parents will all benefit from a better understanding of the need for laboratory experiences to be an integral part of the science curriculum-and how that can be accomplished.

calculating ph pogil: Innumeracy John Allen Paulos, 2011-04-01 Readers of Innumeracy will be rewarded with scores of astonishing facts, a fistful of powerful ideas, and, most important, a clearer, more quantitative way of looking at their world. Why do even well-educated people understand so little about mathematics? And what are the costs of our innumeracy? John Allen Paulos, in his celebrated bestseller first published in 1988, argues that our inability to deal rationally with very large numbers and the probabilities associated with them results in misinformed governmental policies, confused personal decisions, and an increased susceptibility to pseudoscience of all kinds. Innumeracy lets us know what we're missing, and how we can do something about it. Sprinkling his discussion of numbers and probabilities with quirky stories and anecdotes, Paulos ranges freely over many aspects of modern life, from contested elections to sports stats, from stock scams and newspaper psychics to diet and medical claims, sex discrimination, insurance, lotteries, and drug testing.

calculating ph pogil: Calculus Made Easy Silvanus P. Thompson, Martin Gardner, 2014-03-18 Calculus Made Easy by Silvanus P. Thompson and Martin Gardner has long been the most popular calculus primer. This major revision of the classic math text makes the subject at hand still more comprehensible to readers of all levels. With a new introduction, three new chapters, modernized language and methods throughout, and an appendix of challenging and enjoyable practice problems, Calculus Made Easy has been thoroughly updated for the modern reader.

calculating ph pogil: *Phys21* American Physical Society, American Association of Physics Teachers, 2016-10-14 A report by the Joint Task Force on Undergraduate Physics Programs

calculating ph pogil: The Carbon Cycle T. M. L. Wigley, D. S. Schimel, 2005-08-22 Reducing carbon dioxide (CO2) emissions is imperative to stabilizing our future climate. Our ability to reduce these emissions combined with an understanding of how much fossil-fuel-derived CO2 the oceans and plants can absorb is central to mitigating climate change. In The Carbon Cycle, leading scientists examine how atmospheric carbon dioxide concentrations have changed in the past and how this may affect the concentrations in the future. They look at the carbon budget and the missing sink for carbon dioxide. They offer approaches to modeling the carbon cycle, providing mathematical tools for predicting future levels of carbon dioxide. This comprehensive text incorporates findings from the recent IPCC reports. New insights, and a convergence of ideas and views across several disciplines make this book an important contribution to the global change literature.

calculating ph pogil: Pearson Physics James S. Walker, 2014

calculating ph pogil: POGIL Activities for High School Biology High School POGIL Initiative, 2012

Back to Home: https://new.teachat.com