Millikan Oil Drop Lab Activity Answers

Steve and Susan Zumdahl's texts focus on helping students build critical thinking skills through the process of becoming independent problem-solvers. They help students learn to think like a chemists so they can apply the problem solving process to all aspects of their lives. In CHEMISTRY: AN ATOMS FIRST APPROACH, the Zumdahls use a meaningful approach that begins with the atom and proceeds through the concept of molecules, structure, and bonding, to more complex materials and their properties. Because this approach differs from what most students have experienced in high school courses, it encourages them to focus on conceptual learning early in the course, rather than relying on memorization and a plug and chug method of problem solving that even the best students can fall back on when confronted with familiar material. The atoms first organization provides an opportunity for students to use the tools of critical thinkers: to ask questions, to apply rules and models and to evaluate outcomes. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.

How fixed are the happenings in Nature and how are they fixed? These lectures address what our scientific successes at predicting and manipulating the world around us suggest in answer. One—very orthodox—account teaches that the sciences offer general truths that we combine with local facts to derive our expectations about what will happen, either naturally or when we build a device to design, be it a laser, a washing machine, an anti-malarial bed net, or an auction for the airwaves. In these three 2017 Carus Lectures Nancy Cartwright offers a different picture, one in which neither we, nor Nature, have such nice rules to go by. Getting real predictions about real happenings is an engineering enterprise that makes clever use of a great variety of different kinds of knowledge, with few real derivations in sight anywhere. It takes artful modeling. Orthodoxy would have it that how we do it is not reflective of how Nature does it. It is, rather, a consequence of human epistemic limitations. That, Cartwright argues, is to put our reasoning just back to front. We should read our image of what Nature is like from the way our sciences work when they work best in getting us around in it, non plump for a pre-set image of how Nature must work to derive what an ideal science, freed of human failings, would be like. Putting the order of inference right way around implies that like us, Nature too is an artful modeler. Lecture 1 is an exercise in description. It is a study of the practices of science when the sciences intersect with the world and, then, of what that world is most likely like given the successes of these practices. Millikan's famous oil drop experiment, and the range of knowledge pieced together to make it work, are used to illustrate that events in the world do not occur in patterns that can be properly described in so-called "laws of nature." Nevertheless, they yield to artful modeling. Without a huge leap of faith, that, it seems, is the most we can assume about the happenings in Nature. Lecture 2 is an exercise in metaphysics. How could the arrangements of happenings come to be that way? In answer, Cartwright urges an ontology in which powers act together in different ways depending on the arrangements they find themselves in to produce what happens. It is a metaphysics in which possibilia are real because powers and arrangement are permissive—they constrain but often do not dictate outcomes (as we see in contemporary quantum theory). Lecture 3, based on Cartwright's work on evidence-based policy and randomized controlled trials, is an exercise in the philosophy of social technology: How we can put our knowledge of powers and our skills at artful modeling to work to build more decent societies and how we can use our knowledge and skills to evaluate when our attempts are working. The lectures are important because: They offer an original view on the age-old question of scientific realism in which our knowledge is genuine, yet our scientific principles are neither true nor false but are, rather, templates for building good models. Powers are center-stage in metaphysics right now. Back-reading them from the successes of scientific practice, as Lecture 2 does, provides a new perspective on what they are and how they function. There is a loud call nowadays to make philosophy relevant to "real life." That's just what happens in Lecture 3, where Cartwright applies the lesson of Lectures 1 and 2 to argue for a serious rethink of the way that we are urged—and in some places mandated—to use evidence to predict the outcomes of our social policies.

Memories of a high school teacher and coach of three sports - a "ham radio" operator since 1953 who is Net Control of the Military All-Services Net and Faculty Adviser for student Club Stations. He becomes Chair of a University's Civil Engineering Department, and for thirty years teaches Physics and Math at another college winning a "Teacher of the Year" Award. Reads like another "Good-bye Mr. Chips!" script. "You tricked us into learning physics by telling our all male high school class, 'Every normal, teenage American male is inherently interested in automobiles.' That was certainly true in the 1950's, and then you proceeded to teach all of physics - sound, mechanics, electricity, light, fuel systems, etc. - by applications to autos." - M. Posa, High school student. "Your Memoirs recall for many of us the joys and rewards of teaching.. You are so lucky to have had a long life in the teaching profession. - B. F., your colleague at Broward Community College "Congratulations ! We honor you as "A Golden Poet of 1991 for your poem, "Lost and Found: ". - Contest Judge. "Your Memoirs are interesting, enjoyable reading, even though I did have to occasionally pull out the dictionary. You are STILL the teacher!." - F. K., e-mail contact.

not provided

The original accounts of twenty-four experiments that created modern physics, retaining the original illustrations where possible.

Learning by Doing" is about the history of experimentation in science education. The teaching of science through experiments and observation is essential to the natural sciences and its pedagogy. These have been conducted as both demonstration or as student exercises. The experimental method is seen as giving the student vital competence, skills and experiences, both at the school and at the university level. This volume addresses the historical development of experiments in science education, which has been largely neglected so far. The contributors of "Learning by Doing" pay attention to various aspects ranging from economic aspects of instrument making for science teaching, to the political meanings of experimental science education from the 17th to the 20th century. This collected volume opens the field for further debate by emphasizing the importance of experiments for both, historians of science and science educators. [Présentation de l'éditeur].

Originally published between 1973 and 1993 the 14 books in this set discuss a number of themes such as: policy, practice and evaluation in schools; dealing with disruptive behaviour; issues regarding the teaching of arts and sciences; ethnographic studies of life in primary and secondary schools and critical events in teaching and learning.

This work has been selected by scholars as being culturally important and is part of the knowledge base of civilization as we know it. This work is in the public domain in the United States of America, and possibly other nations. Within the United States, you may freely copy and distribute this work, as no entity (individual or corporate) has a copyright on the body of the work. Scholars believe, and we concur, that this work is important enough to be preserved, reproduced, and made generally available to the public. To ensure a quality reading experience, this work has been proofread and republished using a format that seamlessly blends the original graphical elements with text in an easy-to-read typeface. We appreciate your support of the preservation process, and thank you for being an important part of keeping this knowledge alive and relevant.

Intended for science and engineering students with a background in introductory physics and calculus, this textbook creates a bridge between classical and modern physics, filling the gap between descriptive elementary texts and formal graduate textbooks. The book presents the main topics and concepts of special relativity and quantum mechanics, starting from the basic aspects of classical physics and analysing these topics within a modern physics frame. The classical experiments that gave rise to modern physics are also critically discussed, and special emphasis is devoted to solid state physics and its relationship with modern physics. Key Features Creates a bridge between classical and modern physics, filling the gap between elementary and formal/theoretical texts Takes a critical approach, arguing that the difficulty with describing modern physics phenomena can be transformed into cultural challenges which require new forms of reasoning Discusses solid-state physics and its relationship with modern physics Includes details of classic experiments, including computer?assisted experiments that can help demonstrate modern physics principles Includes practice exercises and applets that simulate key concepts

Why is it that, while women in the United States have generally made great strides in establishing parity with their male counterparts in educational attainment, they remain substantially underrepresented in the fields of science, technology, engineering, and mathematics (STEM)? Why is it that, in proportion to the PhDs they obtain in STEM, they attain fewer administrative and managerial positions in academia and industry than their numbers warrant and, moreover, are more likely leave the field once started in their careers? In the culture and context of women’s advancement and satisfaction with careers in STEM, the data show that many challenges and obstacles remain. By showcasing the stories of eight women scientists who have achieved successful careers in the academy, industry and government, Breaking In offers vivid insights into the challenges and barriers that women face in entering STEM while also describing these women’s motivations, the choices they made along their paths, and the intellectual satisfactions and excitement of scientific discovery they derive from their work. Breaking In underscores issues aspiring women scientists will encounter on their journeys and what they can do to forestall potential obstacles, advocate for change, and fulfill their ambitions. And it speaks to the question: What can be done to encourage more women to specialize in science, mathematics, and engineering? In doctoral granting institutions, where women must start if they hope to earn advanced degrees, Breaking In can serve both as a student text and as guide for department chairs and deans who are concerned about organizational climate and culture and their impact on retention in STEM fields. At a broader level, this book offers advice and inspiration to women contemplating entering STEM fields, as well to the teachers, researchers, and administrators responsible for nurturing these women, growing enrollments in their disciplines, and developing creative and intellectual capital that the nation needs to compete in the global marketplace.

A dazzling, irresistible collection of the ten most groundbreaking and beautiful experiments in scientific history. With the attention to detail of a historian and the storytelling ability of a novelist, New York Times science writer George Johnson celebrates these groundbreaking experiments and re-creates a time when the world seemed filled with mysterious forces and scientists were in awe of light, electricity, and the human body. Here, we see Galileo staring down gravity, Newton breaking apart light, and Pavlov studying his now famous dogs. This is science in its most creative, hands-on form, when ingenuity of the mind is the most useful tool in the lab and the rewards of a well-considered experiment are on exquisite display.

This textbook for a calculus-based physics course for non-physics majors includes end-of-chapter summaries, key concepts, real-world applications, and problems.

Volume 2 of COLLEGE PHYSICS, Eleventh Edition, is comprised of chapters 15-30 of Serway/Vuille’s proven textbook. Designed throughout to help students master physical concepts, improve their problem-solving skills, and enrich their understanding of the world around them, the text's logical presentation of concepts, a consistent strategy for solving problems, and an unparalleled array of worked examples help students develop a true understanding of physics. Volume 2 is enhanced by a streamlined presentation, new problems, Interactive Video Vignettes, new conceptual questions, new techniques, and hundreds of new and revised problems. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.

Resources in EducationCollege Physics for AP® CoursesPart 1: Chapters 1-17

Citizenship Across the Curriculum advocates the teaching of civic engagement at the college level, in a wide range of disciplines and courses. Using "writing across the curriculum" programs as a model, the contributors propose a similar approach to civic education. In case studies drawn from political science and history as well as mathematics, the natural sciences, rhetoric, and communication studies, the contributors provide models for incorporating civic learning and evaluating pedagogical effectiveness. By encouraging faculty to gather evidence and reflect on their teaching practice and their students' learning, this volume contributes to the growing field of the scholarship of teaching and learning.

"Sourcebook of teaching aids and activities ..."--Page iii.

A falling apple inspired the law of gravity—or so the story goes. Is it true? Perhaps not. But why do such stories endure as explanations of how science happens? Newton’s Apple and Other Myths about Science brushes away popular misconceptions to provide a clearer picture of scientific breakthroughs from ancient times to the present.

Doing Science is unique in seeking to make explicit the links between science education and science studies. These fields of study and their respective academic communities, whilst appearing to have many potential points of contact, remain surprisingly separate, with little apparent recognition of the relevance to the interests of each of the work done within the other tradition. Presenting detailed accounts of current research, the book highlights the significance of modern science studies for classroom practice and, conversely, the importance of the classroom and teaching laboratory as a context for science studies. The thread which runs through the collection as a whole is children's experience of doing science and the image of science which learners pick up along with the science knowledge, understanding and skills they require.

The critical analysis of science textbooks is vital in improving teaching and learning at all levels in the subject, and this volume sets out a range of academic perspectives on how that analysis should be done. Each chapter focuses on an aspect of science textbook appraisal, with coverage of everything from theoretical and philosophical underpinnings, methodological issues, and conceptual frameworks for critical analysis, to practical techniques for evaluation. Contributions from many of the most distinguished scholars in the field give this collection its sure-footed contemporary relevance, reflecting the international standards of UNESCO as well as leading research organizations such as the American Association for the Advancement of Science (whose Project 2061 is an influential waypoint in developing protocols for textbook analysis). Thus the book shows how to gauge aspects of textbooks such as their treatment of controversial issues, graphical depictions, scientific historiography, vocabulary usage, accuracy, and readability. The content also covers broader social themes such as the portrayal of women and minorities. "Despite newer, more active pedagogies, textbooks continue to have a strong presence in classrooms and to embody students' socio-historical inheritance in science. Despite their ubiquitous presence, they have received relatively little on-going empirical study. It is imperative that we understand how textbooks influence science learning. This book presents a welcome and much needed analysis." Tina A. Grotzer Harvard University, Cambridge, Massachusetts, USA The present book provides a much needed survey of the current state of research into science textbooks, and offers a wide range of perspectives to inform the 'science' of writing better science textbooks. Keith S Taber University of Cambridge, Cambridge, United Kingdom

Writing History in the Digital Age began as a “what-if” experiment by posing a question: How have Internet technologies influenced how historians think, teach, author, and publish? To illustrate their answer, the contributors agreed to share the stages of their book-in-progress as it was constructed on the public web. To facilitate this innovative volume, editors Jack Dougherty and Kristen Nawrotzki designed a born-digital, open-access, and open peer review process to capture commentary from appointed experts and general readers. A customized WordPress plug-in allowed audiences to add page- and paragraph-level comments to the manuscript, transforming it into a socially networked text. The initial six-week proposal phase generated over 250 comments, and the subsequent eight-week public review of full drafts drew 942 additional comments from readers across different parts of the globe. The finished product now presents 20 essays from a wide array of notable scholars, each examining (and then breaking apart and reexamining) if and how digital and emergent technologies have changed the historical profession.

Lotus Press

Most recent work on the nature of experiment in physics has focused on "big science"—the large-scale research addressed in Andrew Pickering's Constructing Quarks and Peter Galison's How Experiments End. This book examines small-scale experiment in physics, in particular the relation between theory and practice. The contributors focus on interactions among the people, materials, and ideas involved in experiments—factors that have been relatively neglected in science studies. The first half of the book is primarily philosophical, with contributions from Andrew Pickering, Peter Galison, Hans Radder, Brian Baigrie, and Yves Gingras. Among the issues they address are the resources deployed by theoreticians and experimenters, the boundaries that constrain theory and practice, the limits of objectivity, the reproducibility of results, and the intentions of researchers. The second half is devoted to historical case studies in the practice of physics from the early nineteenth to the early twentieth century. These chapters address failed as well as successful experimental work ranging from Victorian astronomy through Hertz's investigation of cathode rays to Trouton's attempt to harness the ether. Contributors to this section are Jed Z. Buchwald, Giora Hon, Margaret Morrison, Simon Schaffer, and Andrew Warwick. With a lucid introduction by Ian Hacking, and original articles by noted scholars in the history and philosophy of science, this book is poised to become a significant source on the nature of small-scale experiment in physics.

"What is experimental knowledge, and how do we get it? There is general agreement that experiment is a crucial source of scientific knowledge, much less about how experiment generates that knowledge. In this book, philosopher of science James Mattingly explains how experiments function. Specifically, he discusses what it is about experimental practice that transforms observations of what may be very sharply localized, very particular, very isolated systems into what may be global, general, integrated empirical knowledge. This involves showing how several activities that are sometimes thought merely to go under the name of experiment-natural experiment, analogical experiment, thought experiment, simulated experiment-really should count as generating experimental knowledge. To do this, he constructs a general model of experimentation and shows how these various practices fit into that model. Mattingly's premise is that the purpose of experimentation is the same as the purpose of any other knowledge generating enterprise--to change the state of information of the knower. This trivial-seeming point has a non-trivial consequence: to understand a knowledge generating enterprise, we should follow the flow of information. Therefore, the account of experimental knowledge Mattingly provides is based on understanding how information flows in experiments: what facilitates that flow, what hinders it, what the characteristics of different practices are with respect to how they allow information to flow from system to system, into the heads of researchers, and finally into our store of scientific knowledge"--

This book explores the relationship between the content of chemistry education and the history and philosophy of science (HPS) framework that underlies such education. It discusses the need to present an image that reflects how chemistry developed and progresses. It proposes that chemistry should be taught the way it is practiced by chemists: as a human enterprise, at the interface of scientific practice and HPS. Finally, it sets out to convince teachers to go beyond the traditional classroom practice and explore new teaching strategies. The importance of HPS has been recognized for the science curriculum since the middle of the 20th century. The need for teaching chemistry within a historical context is not difficult to understand as HPS is not far below the surface in any science classroom. A review of the literature shows that the traditional chemistry classroom, curricula, and textbooks while dealing with concepts such as law, theory, model, explanation, hypothesis, observation, evidence and idealization, generally ignore elements of the history and philosophy of science. This book proposes that the conceptual understanding of chemistry requires knowledge and understanding of the history and philosophy of science. “Professor Niaz’s book is most welcome, coming at a time when there is an urgently felt need to upgrade the teaching of science. The book is a huge aid for adding to the usual way - presenting science as a series of mere facts - also the necessary mandate: to show how science is done, and how science, through its history and philosophy, is part of the cultural development of humanity.” Gerald Holton, Mallinckrodt Professor of Physics & Professor of History of Science, Harvard University “In this stimulating and sophisticated blend of history of chemistry, philosophy of science, and science pedagogy, Professor Mansoor Niaz has succeeded in offering a promising new approach to the teaching of fundamental ideas in chemistry. Historians and philosophers of chemistry --- and above all, chemistry teachers --- will find this book full of valuable and highly usable new ideas” Alan Rocke, Case Western Reserve University “This book artfully connects chemistry and chemistry education to the human context in which chemical science is practiced and the historical and philosophical background that illuminates that practice. Mansoor Niaz deftly weaves together historical episodes in the quest for scientific knowledge with the psychology of learning and philosophical reflections on the nature of scientific knowledge and method. The result is a compelling case for historically and philosophically informed science education. Highly recommended!” Harvey Siegel, University of Miami “Books that analyze the philosophy and history of science in Chemistry are quite rare. ‘Chemistry Education and Contributions from History and Philosophy of Science’ by Mansoor Niaz is one of the rare books on the history and philosophy of chemistry and their importance in teaching this science. The book goes through all the main concepts of chemistry, and analyzes the historical and philosophical developments as well as their reflections in textbooks. Closest to my heart is Chapter 6, which is devoted to the chemical bond, the glue that holds together all matter in our earth. The chapter emphasizes the revolutionary impact of the concept of the ‘covalent bond’ on the chemical community and the great novelty of the idea that was conceived 11 years before quantum mechanics was able to offer the mechanism of electron pairing and covalent bonding. The author goes then to describe the emergence of two rival theories that explained the nature of the chemical bond in terms of quantum mechanics; these are valence bond (VB) and molecular orbital (MO) theories. He emphasizes the importance of having rival theories and interpretations in science and its advancement. He further argues that this VB-MO rivalry is still alive and together the two conceptual frames serve as the tool kit for thinking and doing chemistry in creative manners. The author surveys chemistry textbooks in the light of the how the books preserve or not the balance between the two theories in describing various chemical phenomena. This Talmudic approach of conceptual tension is a universal characteristic of any branch of evolving wisdom. As such, Mansoor’s book would be of great utility for chemistry teachers to examine how can they become more effective teachers by recognizing the importance of conceptual tension”. Sason Shaik Saeree K. and Louis P. Fiedler Chair in Chemistry Director, The Lise Meitner-Minerva Center for Computational Quantum Chemistry, The Hebrew University of Jerusalem, ISRAEL

The book provides a novel account of laws of nature via dispositions. Laws of nature play a paramount role in philosophy, science and everyday life. Understanding laws of nature is philosophically interesting on its own right but also many important notions belonging to philosophy of science, like causation, prediction and explanation, are intimately related to the laws of nature. The book outlines the alleged characteristics of the laws of nature and introduces the main families of theories of laws of nature – neo-humean, ADT and dispositional theories. It then develops an account of dispositions the `triadic process picture of dispositions’ (TPD) and applies it to the debate about laws of nature. Finally, the (TPD) account of the necessity of the laws of nature is presented: laws of nature are naturally necessary and metaphysically contingent. Thus the book provides an introduction to the debates about laws of nature as well as dispositions, while at the same time developing a novel theory and thus is interesting for the beginner as well as expert in these fields.

This book discusses how to improve high school students’ understanding of research methodology based on alternative interpretations of data, role of controversies, creativity and the scientific method, in the context of the oil drop experiment. These aspects form an important part of the nature of science (NOS). The study reported in this volume is is based on a reflective, explicit and activity-based approach to teaching nature of science (NOS) that can facilitate high school students’ understanding of how scientists elaborate theoretical frameworks, design experiments, report data that leads to controversies and finally with the collaboration of the scientific community a consensus is reached. Most students changed their perspective and drew concept maps in which they emphasized the creative, accumulative, controversial nature of science and the scientific method.

Using firsthand accounts gleaned from notebooks, interviews, and correspondence of such twentieth-century scientists as Einstein, Fermi, and Millikan, Holton shows how the idea of the scientific imagination has practical implications for the history and philosophy of science and the larger understanding of the place of science in our culture.

Physics was the leading science of the twentieth century and the book retraces important discoveries, made between 1895 and 2001, in 100 self-contained Episodes. Each is a short story of the scientists involved, their time and their work. The book is richly illustrated by about 600 portraits, photographs and figures.

Arthur Holly Compton was one of the great leaders in physics of the twentieth century. In this volume, Robert S. Shankland, who was once a student of Compton's, has collected and edited the most important of Professor Compton's papers on X-rays—the field of his greatest achievement—and on other related topics. Compton entered the field of X-ray research in 1913 and carried on active work until the 1930s, when he began to specialize in cosmic rays. During the years when Compton was an active leader in X-ray research, he made many notable contributions which are reflected in the papers presented here. He was the first to prove several important optical properties of X-rays, including scattering, complete polarization, and total reflection. He was also the first, with his student R. L. Doan, to use ruled gratings for the production of X-ray spectra. Professor Compton's greatest discovery, for which he was awarded a Nobel Prize in 1927, was the Compton Effect. This was the outgrowth of experiments he had initiated during a year at Cambridge in 1919-20. He did the major portion of these experiments at Washington University in St. Louis during the period 1920-24. His work demonstrated that in the scattering of X-rays by electrons, the radiation behaves like corpuscles, and that the interaction between the X-ray corpuscles and the electrons in the scatter is completely described by the principles of the conservation of energy and momentum for the collisions of particles. In his introduction, Professor Shankland gives a historical account of the papers, narrates Professor Compton's early scientific career, and shows how he arrived at a quantum explanation of the Compton scattering after eliminating all classical explanations.

The College Physics for AP(R) Courses text is designed to engage students in their exploration of physics and help them apply these concepts to the Advanced Placement(R) test. This book is Learning List-approved for AP(R) Physics courses. The text and images in this book are grayscale.