

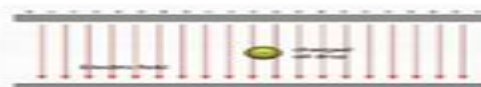
1 of 3

HOMEWORK 4

Mastering Physics HW due online on Friday, 2/17/2023 at 11:59PM.

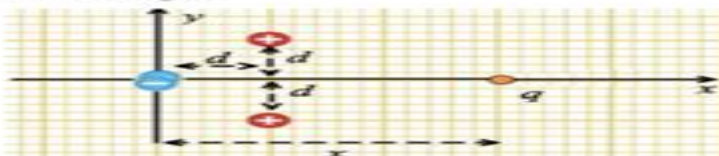
Hand-written solutions to the following questions are due on Wednesday 2/15/2023, on paper, at the beginning of your recitation session.

- 1) (40 pts) In the "Millikan oil drop experiment", an atomizer (a sprayer with a fine nozzle) is used to introduce many tiny droplets of oil between two oppositely charged parallel metal plates held in a vacuum chamber. The original apparatus and a simplified schematic are shown. The two plates are just above and below the small magnifying scope sticking out on the right of the apparatus. The entire apparatus is about 1 meter high.



Some of the droplets pick up one or more excess electrons as they are sprayed into the chamber. The charge on the plates is adjusted so that the electric force on these excess electrons exactly balances the weight of the whole droplet. The idea is to look for a droplet that requires the smallest electric force, and assume that it has only one excess electron. This lets the observer measure the charge on the electron. Estimate the radius of an oil drop that would be balanced by a voltage difference of 10 kV (10,000 Volts). Draw a **free body diagram** to support your answer, and **do not use a calculator**! Hint: you may find it useful to know that the density of water is 1 g/cm^3 . Oil is not water, however. . . .

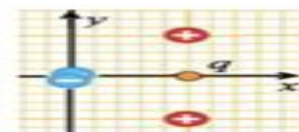
- 2) (50 pts total) In this problem we will explore the electric effects produced by a neutral molecule on charges nearby. We will consider a "toy" (very simple) model of a water molecule that has charge $-2e$ localized on the oxygen atom and charges of $+e$ localized on each hydrogen atom. In addition, for simplicity of calculations, we will consider the OH bonds to be perpendicular to each other as shown in the figure.



- A. (20 pts) First consider the electrostatic potential, V , produced by this molecule along its line of symmetry (aka the x-axis). A positive test charge, q , is exploring the electrostatic potential along the positive x axis. If the locations of the charges in the water molecule are located as shown, which of the following equations could correctly represent the potential measured by the test charge? For each option that doesn't work, explain why it doesn't work, and identify the electrostatic property it could represent instead.

- a. $V = 2 \frac{kqe}{\sqrt{(x-d)^2 + d^2}} - 2 \frac{kqe}{\sqrt{x^2}}$
 b. $V = 2 \frac{ke}{\sqrt{(x-d)^2 + d^2}} - 2 \frac{ke}{\sqrt{x^2}}$
 c. $V = 2 \frac{kqe}{(x-d)^2 + d^2} - 2 \frac{kqe}{x^2}$
 d. $V = 2 \frac{ke}{(x-d)^2 + d^2} - 2 \frac{ke}{x^2}$

- B. (10 pts) Now consider the electric field that the test charge would measure. Suppose that the test charge is negative and is moved to the position between the H atoms shown in the figure at right. What can you say about the electric potential and the electric field measured by the negative test charge? **Explain your reasoning.** Support your answer by treating the three water molecule atoms as *individual point sources* and calculating the total electric potential V at the test charge's location. (Note: this is not the same situation as in the previous question, but it's very possible to leverage



Mastering Physics Answers Exercise 45

**Paula Heron, Laura McCullough, Jeffrey
Marx**



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Mastering Mathematics Richard Manning Smith, 1998 Providing solid tips for every stage of study Mastering Mathematics stresses the importance of a positive attitude and gives you the tools to succeed in your math course This practical guide will help you avoid mental blocks during math exams identify and improve your areas of weakness get the most out of class time study more effectively overcome a perceived low math ability be successful on math tests get back on track when you are feeling lost and much more *Introductory Physics with Algebra as a Second Language* Stuart E. Loucks, 2006-08-04 Many students find it difficult to master the fundamental skills that are essential to succeeding in physics Now with this helpful book they ll quickly learn how to break physics down into basic steps Author Stuart Loucks presents the material in a way that will motivate and empower them He offers clear explanations of key concepts while examining the fundamental topics and approaches needed to solve algebra based physics problems Understand the basic language of physics *Introductory Physics with Algebra as a Second Language*™ will help you make sense of your textbook and class notes so that you can use them more effectively The text explains key topics in algebra based physics in clear easy to understand language Break problems down into simple steps *Introductory Physics with Algebra as a Second Language*™ teaches you to recognize details that tell you how to begin new problems You will learn how to effectively organize the information decide on the correct equations and ultimately solve the problem Learn how to tackle unfamiliar physics problems Stuart Loucks coaches you in the fundamental concepts and approaches needed to set up and solve the major problem types As you learn how to deal with these kinds of problems you will be better equipped to tackle problems you have never seen before Improve your problem solving skills You ll learn timesaving problem solving strategies that will help you focus your efforts and avoid potential pitfalls **Controlling Mental Chaos** Jaime A. Pineda, 2023-07-21 Readers will learn how to use simple time tested techniques to control anxiety and recover their creative nature For centuries spirituality has told us that the answer to life s problems lies within us if only we would realize that we are more than what we imagine Now scientific understanding is showing us the way For humans anxiety is the background fever that never breaks but can often get much worse Whether the causes are individual relational cultural or pandemic problems when they occur they affect our ability to live a joyful and creative life This often means getting mired in uncontrolled mind loops and incessant circular thinking making us feel helpless and stuck In this book Jaime Pineda shows how the dynamics of anxiety and incessant rumination reflect uncontrolled creativity and how using simple time tested techniques we can learn to control the chaos and recover our creative nature The key to the solution is to understand that the intellect only helps to some extent but by itself cannot solve its own problem What we need is a mind that can in a nonjudgmental way distance itself from the thought patterns that trap us We are born with an incredible original mind that quickly becomes obscured by the fever of fear and anxiety But we can recover this mind quickly Pineda teaches us how to recognize the basic problem and find the solution

through a series of steps and techniques that help bring us out of the loops and recover a cleaner mindset that enables us to move beyond the static of anxiety **Announcer** ,2004 Particles and Waves in Electron Optics and Microscopy ,2016-05-27 Advances in Imaging and Electron Physics merges two long running serials Advances in Electronics and Electron Physics and Advances in Optical and Electron Microscopy The series features extended articles on the physics of electron devices especially semiconductor devices particle optics at high and low energies microlithography image science digital image processing electromagnetic wave propagation electron microscopy and the computing methods used in all these domains Contains contributions from leading authorities on the subject matter Informs and updates all the latest developments in the field of imaging and electron physics Provides practitioners interested in microscopy optics image processing mathematical morphology electromagnetic fields electron and ion emission with a valuable resource Features extended articles on the physics of electron devices especially semiconductor devices particle optics at high and low energies microlithography image science and digital image processing Mathematical Reviews ,2005 The Collected Works of L. S. Vygotsky Lev Semenovich Vygotskiĭ,1987 Journal of the Audio Engineering Society Audio Engineering Society,1997 Directory of members published as pt 2 of Apr 1954 issue Current Index to Journals in Education ,2002 *Taps* ,2004 This publication lists names and biographical information on graduates and former cadets who have died THE Journal ,1997 **Nature** Sir Norman Lockyer,1891 2005 Physics Education Research Conference Paula Heron,Laura McCullough,Jeffrey Marx,2006-03-08 The papers included in these proceedings have been peer reviewed The 2005 Physics Education Research Conference covered a broad spectrum of current research directions including student learning of specific topics student attitudes and the effectiveness of various teaching methods The emphasis was on undergraduate instruction The theme of this conference was Connecting Physics Education Research Teacher Education at All Levels K 20

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