

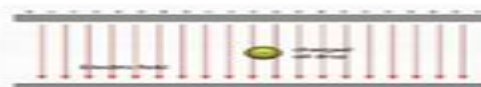
## 1 of 3

## HOMEWORK 4

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

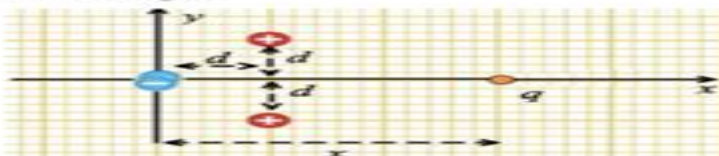
Hand-written solutions to the following questions are due on Wednesday 2/15/2023, on paper, at the beginning of your recitation session.

- 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  $1 \text{ g/cm}^3$ . Oil is not water, however. . . .

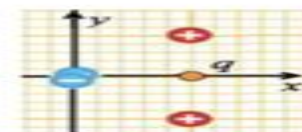
- 2) (50 pts total) In this problem we will explore the electric effects produced by a neutral molecule on charges nearby. We will consider a "toy" (very simple) model of a water molecule that has charge  $-2e$  localized on the oxygen atom and charges of  $+e$  localized on each hydrogen atom. In addition, 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 Solutions Chapter 22

**Yijin Wang**



## **Mastering Physics Solutions Chapter 22:**

## **Mastering Physics Solutions Chapter 22** Book Review: Unveiling the Magic of Language

In an electronic era where connections and knowledge reign supreme, the enchanting power of language has become more apparent than ever. Its capability to stir emotions, provoke thought, and instigate transformation is actually remarkable. This extraordinary book, aptly titled "**Mastering Physics Solutions Chapter 22**," written by a highly acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound effect on our existence. Throughout this critique, we shall delve into the book's central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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web oct 30 2023 the university of south africa unisa has honoured st engenas zion christian church zcc spiritual leader bishop dr engenas joseph lekganyane for outstanding leadership and for promoting african spirituality and values the revered bishop the head of one of the two z c c churches was also recognised for his

joseph engenas matlhakanye lekganyane south african - Aug 13 2023

web 21 january 1931 date of death 11 november 1972 joseph lekganyane was born in 21 january 1931 in moria his father is the founder of the zion christian church zcc in 1910 he attended school up to standard six and later a junior certificate standard nine

**zcc leader ignores offer of unisa honorary degree sunday world** - Jan 26 2022

web nov 12 2023 zion christian church leader bishop barnabas lekganyane whose symbol is the star of david snubbed unisa s invitation to be awarded an honorary degree at the university s spring

**zcc bishop s nephew parties up r186k storm eyewitness news** - Jun 30 2022

web oct 20 2014 zcc bishop s nephew parties up r186k storm club sway says the bill was picked up by rumo lekganyane s

friends the bill was apparently run up during rumo s birthday party at a popular sandton

**zcc bishop snubs unisa degree sunday world 2023 11** - Oct 03 2022

web nov 12 2023 according to a source bishop barnabas lekganyane may have been offended that unisa recommended him for an honorary degree along with his estranged younger brother bishop engenas joseph lekganyane who leads the smaller branch of the zcc known as the st engenas branch whose symbol is the dove the way the

**engenas barnabas lekganyane is buried in morija** - Feb 07 2023

web mar 16 2011 engenas barnabas lekganyane also called enginasi or ignatius ambitious and charismatic founder of the zion christian church zcc was laid to rest in moria pietersburg now polokwane district this date has since been sanctified by the zcc the largest of the african independent churches sources verwey e j ed 1995