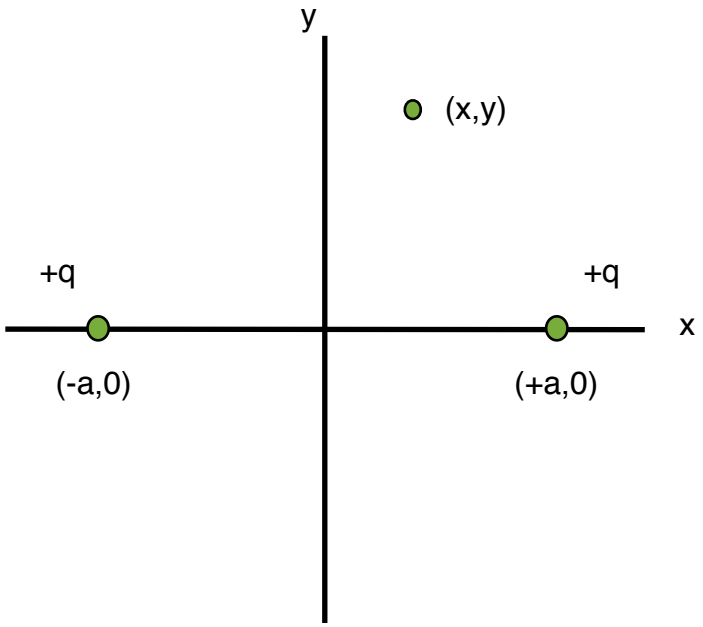
Exam 1
Physics 132

Short Answer Section. Please answer all of the questions.

1. 1. What magnitude force do the "up" quarks and "down" quarks in a proton exert on each other? Assume that the "up" quark has charge $q = +\frac{2}{3}e$ and the "down" quark has a charge $q = -\frac{1}{3}e$. The separation of the quarks is $0.5 \times 10^{-15} m$. Is the force attractive or repulsive?

2. What is the electric field at the location (x, y) shown below? Hint: You will need to write out $\vec{r}, r, \hat{r}$ for each charge.



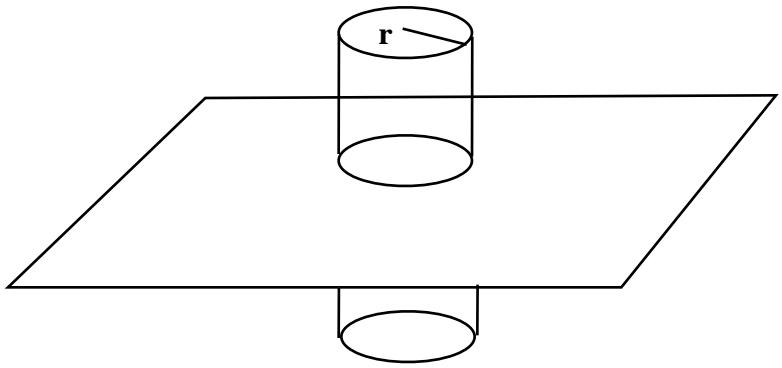
3. What is the electric field inside a conductor and why?

4. A particle experiences an acceleration of $2.0 \times 10^{6} m/s^2$. If the particle's charge is $q = 2.0 \times 10^{-6} m/s^2$ and its mass is $m = 1.0 \times 10^{-8} kg$, what electric field caused this acceleration?

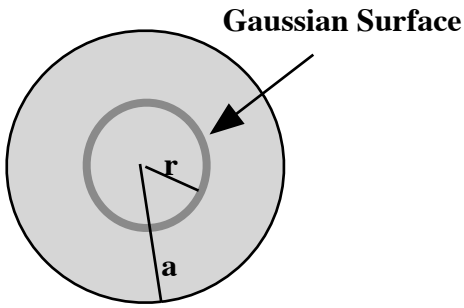
5. A positive point charge charge +10e is placed at the center of a cube. What is the electric flux through the right face of the cube?

6. Using Gauss' law, show that the field due to an infinite plane of charge is $E = \frac{\sigma}{2\varepsilon_0}$ where σ.

Use the Gaussian Surface shown below.



7. A uniformly charged sphere has a charge density ρ and radius a. How much charge is enclosed by a Gaussian surface of radius r where r< a?

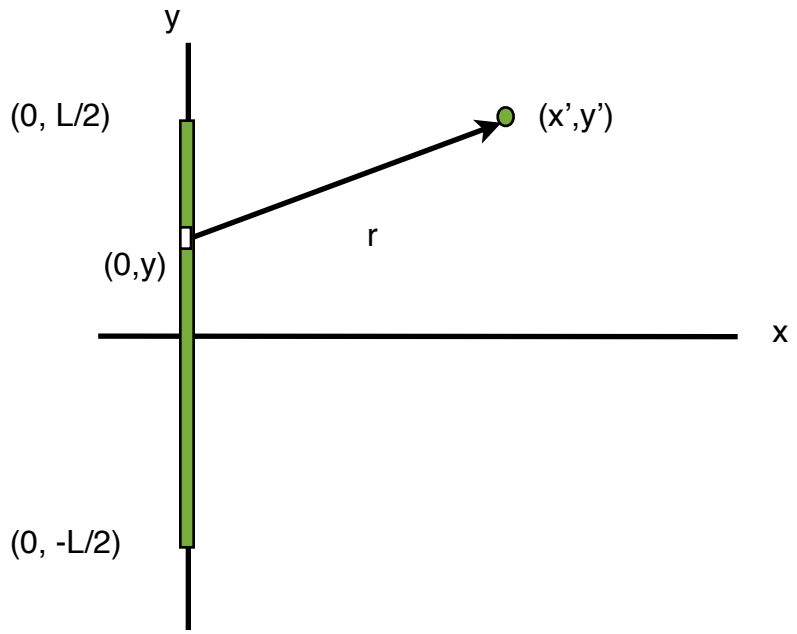


8. A dipole is composed of a charge +e and -e separated by a distance $d = 0.5 \times 10^{-10} m$. What is the electric dipole moment p of this dipole? If it is oriented at an angle $\theta = 60°$ with respect to a uniform electric field E, what is the energy U of the dipole?

9. In a beam, 100×10^9 particles by per second. If each particle has a charge of $10 \times 10^{-12} C$ what is the current of the beam?

Problems: Please work 2 of the 3 problems.

1. Consider a line of charge along the y axis as shown below and the field at a point (x', y')

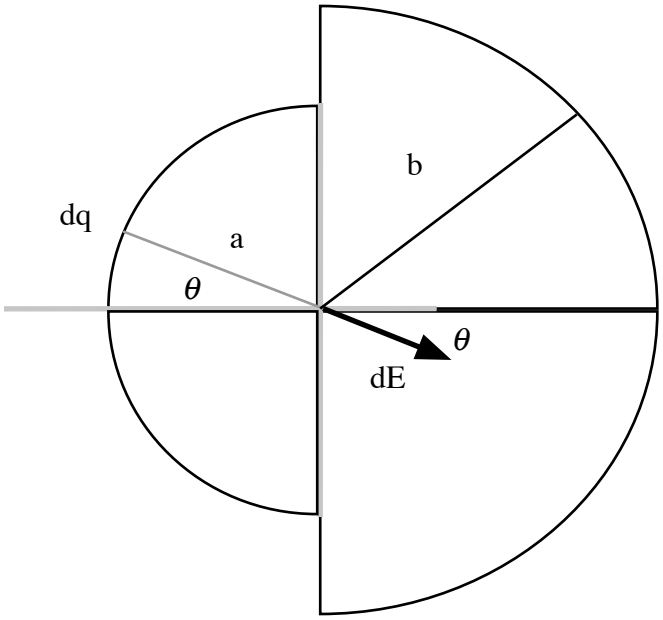


a) Write dq for a little length of charge shown.

b) Write the r, $\vec{r}$, $\hat{r}$ for the charge dq.

c) **<u>Set up</u>** the integral to calculate both the x and y components of the Electric Field but **<u>do not do the the integrals.</u>**

2. Consider the two have circles of charge below or charge below. One half circle has radius a and charge per unit length λ_a and the second has radius b charge per unit length λ_b. A little charge dq produces a dE as shown from the left half circle. You may assume that both charge densities are positive.



Consider just the left half circle with radius a first.

a) What direction will the field point after integrating?

b) Write dq for a little arc length of charge? Write the arc length in terms of the radius a and an angle $d\theta$?

c) Write the magnitude of dE that is produced by dq?

d) Write the component of dE that will survive in terms of $\cos\theta$

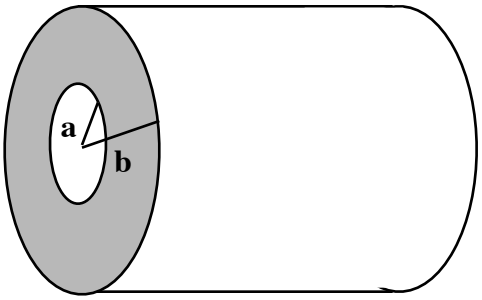
e) Integrate θ from $-\pi/2$ to $+\pi/2$ to find the field. Remember that

$$\int_{-\pi/2}^{\pi/2} \cos d\theta = \sin\theta\Big|_{-\pi/2}^{\pi/2} = \sin\frac{\pi}{2} - \sin\left(-\frac{\pi}{2}\right) = 2$$

f) Now knowing the field due to the left half circle, what is the field due to both half circles. Hint: You can just write the field due to the right half circle down with appropriate substitution and then add the fields together as appropriate.

Bonus) What is the relationship between λ_a and λ_b such that the field is zero?

3. Consider the **nonconducting** infinite cylindrical shell shown below . It has inner radius a and outer radius b. You may assume uniform charge density ρ .



a) What is the field for radii less than a and why?

Choose a Gaussian surface for a < r < b.

b) What is the charge enclosed by this surface? (Hint: The volume of a cylinder is at the end of the exam. Don't forget to subtract the hole).

c) Use Gauss' Law to find the electric field for **a < r < b**.

Choose a Gaussian surface for r > b.

d) What is the charge enclosed in this surface? (Hint: The volume of a cylinder is at the end of the exam. Don't forget to subtract the hole).

e) Use Gauss' Law to find the field for **r > b.**.

Some useful formulae

Charge on the proton: $+1.6\times10^{-19}C$

Charge on the electron $-1.6\times10^{-19}C$

$$\varepsilon_0 = 8.85\times10^{-12}\ \frac{\mathrm{C}^2}{\mathrm{N\ m}^2}$$

Surface area of a sphere: $A = 4\pi r^2$

Surface area of cylinder: $A = 2\pi a L + 2\pi a^2$

Volume of a sphere: $V = \frac{4}{3}\pi r^3$

Volume of a cylinder: $V = \pi a^2 L$