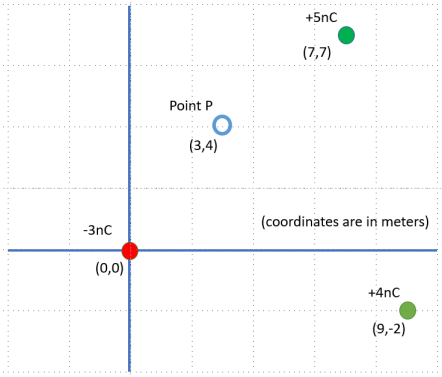
Physics 1320 - Calculus-based Physics II
Summer 2022
Midterm Exam I

Question 1 (20 pts)

Consider the following configuration:



A Draw the electric field lines that result from the three charges.

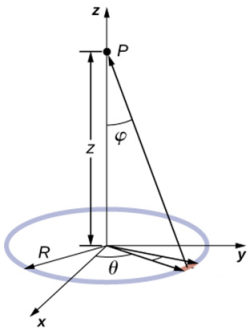
B What is the total Electric Field at point P expressed in vector notation (i.e., $\vec{E} = E_x\hat{i} + E_y\hat{j}$)?

C What is the magnitude (E) and direction (θ) of the Electric Field $\vec{E}$?

D If an electron is placed at point P, what Force ($\vec{F}$) will it experience?

Question 2 (15 pts)

Consider a ring of charge on the xy-plane with a radius $R = 10cm$.



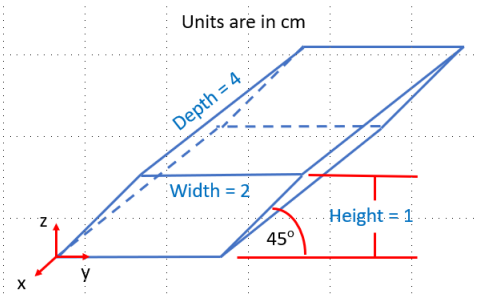
If the total charge on the ring is $-31.5\mu C$.

A What is the charge density on the ring?

B From the charge density, calculate the electric field ($\vec{E}$) at point P where z = 5cm.

Question 3 (15 pts)

Consider the following surface (dimensions are in cm).



Assume that there is a uniform electric field of $\vec{E} = E_x(-\hat{i}) + E_y\hat{j}$, where $E_x = 3\frac{N}{C}$ and $E_y = 8\frac{N}{C}$. Calculate the Flux through:

A Front surface?

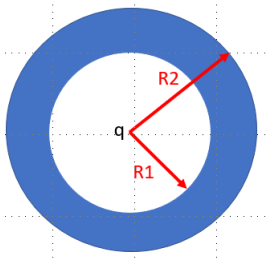
B Top surface?

C Right surface?

D Net flux through all surfaces combined?

Question 4 (15 pts)

Consider the following hallow, spherical, conducting shell.



Assume the total charge on the sphere is $Q_o = 60nC$, and that there is a charge of $Q_{center} = 45nC$ at the center. For the case where $R1 = 0.25m$ and $R2 = 0.42m$. Using Gauss's Law, find:

A The electric field ($\vec{E}$) at a point in the hallow cavity at a distance 0.20m from the center.

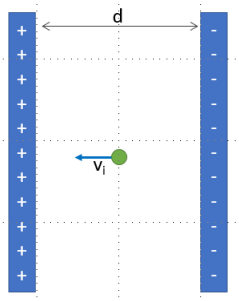
B The electric field inside the shell at a point 0.40m from the center.

C The electric field outside the sphere at a point 0.55m from the center.

D The charge density (σ_i) on the inner surface ($r = R1$) of the sphere.

Question 5 (20 pts)

Consider two equally (but opposite) charged parallel plates as show below.



Assume the distance (d) between the plates is $20cm$ and the charge on each plate has a magnitude of $150\frac{N}{C}$.

A If a proton is at the midpoint between the two plates with initial speed of $10,000\frac{m}{s}$ in the direction shown, then at what location will the proton change direction due to the electric field?

B If the proton is replaced with an electron, how does that change the location where the particle changes direction?

Note: the mass of a proton is $m_p = 1.637 \cdot 10^{-27}kg$ *and the mass of a electron is* $9.11 \cdot 10^{-31}kg$. The charge on an electron is $1.602 \cdot 10^{-19}C$.

Question 6 (15 pts)

Consider a $475\mu F$ parallel plate capacitor filled with air. The magnitude of the charge on the plates is $0.114C$ and the separation between the plates is $0.187mm$.

A What is the Potential difference between the two plates?

B What is the area of the plates?

C What is the magnitude of the Electric Field between the plates?

D What is the charge density on the plates?

Question 7 - Extra Credit (5pts)

A Name one of the two individuals credited with inventing the lightning rod.

B Draw a lightning rod on top of a building (quality of drawing isn't graded).

C Describe how and why a lightning rod works.