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Physics 1314 Exam 1

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Please PRINT your name so that we can READ it.

Name: ____________________________________

Useful Formulae and Physical Data

$E = kq/r^2$	$k = 9 \times 10^9\,\mathrm{N/C}$
$F = IlB$	$F = qvB$
$\vec{F} = q\vec{E}$	$V = P.E./q$
$F_c = mv^2/r$	$F = mg$
$1\,\mu\mathrm{C} = 1 \times 10^{-6}\mathrm{C}$	charge of electron $= -1.6 \times 10^{-19}\,\mathrm{C}$
$g = 9.8\,\mathrm{m/s^2}$	

OPEN BOOK. OPEN NOTES

5. pts I place four identical charges $q = 0.2\,C$ at the corners of a square. The length of each side of the square is 2.0 m. What is the magnitude of the electric field E at the exact center of the square?

- $E = 10.0\,\mathrm{N/C}$;
- $E = 0\,\mathrm{N/C}$;
- $E = 500.0\,\mathrm{N/C}$.

5. pts An electron travels with a speed $v = 2 \times 10^5\,\mathrm{m/s}$ through a region where the magnitude of the magnetic field $B = 100\,\mathrm{T}$. You can assume that $\vec{v} \perp \vec{B}$. After the electron emerges through this region, what is its new speed?

- $v = 3 \times 10^7\,\mathrm{m/s}$;
- $v = 8 \times 10^5\,\mathrm{m/s}$;
- $v = 2 \times 10^5\,\mathrm{m/s}$.

5. pts Suppose you are 10 m away from a proton. You measure the magnitude of the electric field E_1 at your location. You now double your distance from the proton and remeasure the magnitude of the electric field E_2 at your new location. What can you say about the ratio E_1/E_2?

- $E_1/E_2 = 4$;
- $E_1/E_2 = 2$;
- $E_1/E_2 = 8$.

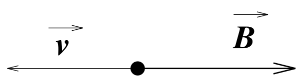
5. pts Suppose you have 2 protons separated by a distance $r = 2.0\,\mathrm{m}$. You calculate their potential energy U_1 at this separation. You release the protons and let them move. You remeasure their potential energy U_2. What can you say about the ratio U_1/U_2?

- $U_1/U_2 = 1$;
- $U_1/U_2 < 1$;
- $U_1/U_2 > 1$.

5. pts Suppose you have 2 metal spheres. Sphere 1 has a radius $r_1 = 0.1\,\text{m}$. Sphere 2 has a radius $r_2 = 0.2\,\text{m}$. You place the *same* charge on each sphere. You now measure the magnitude of the electric field E just outside the surface of each sphere. Let this magnitude be E_1 for sphere 1 and E_2 for sphere 2. What can you say about the ratio E_1/E_2?

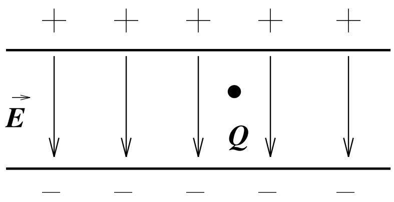
- $E_1/E_2 = 1$;
- $E_1/E_2 < 1$;
- $E_1/E_2 > 1$.

5. pts Suppose an electron has the velocity $\vec{v} = 100\,\text{m/s}$ with a direction as shown below and is travelling near a magnet. Further suppose that the magnetic field $\vec{B} = 100\,\text{T}$, with the direction shown below. What is the magnetic force $\vec{F}_B$ on the electron?

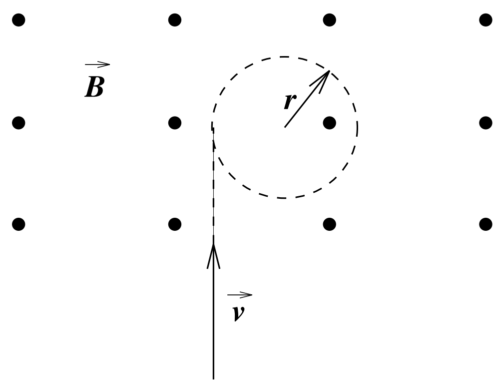


- $\vec{F}_B = 0$;
- $\vec{F}_B = 1.6 \times 10^{-15}\,\text{N}$ directed toward the top of the page;
- $\vec{F}_B = 1.6 \times 10^{-15}\,\text{N}$ directed toward the bottom of the page;

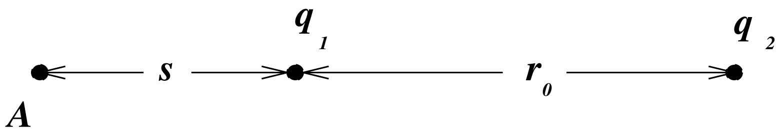
1. **15 pts.** A biological cell of mass $m = 10^{-8}$ kg carries some net electric charge Q and floats between two charged parallel plates. If the electric field $\vec{E}$ between the plates has a magnitude of $E = 10^4$ N/C and points downward, what is the charge Q on the biological cell? Don't forget about the effects of gravity. Refer to the figure below.



2. **20 pts.** A proton with speed $v = 1.6 \times 10^7\,\mathrm{m/s}$ enters a magnetic field as shown in the diagram. The charge is moving perpindicular to the direction of $\vec{B}$ and due to the Lorentz force on it travels in a a circle of radius $r = 1 \times 10^{-3}\,\mathrm{m}$. What must be the magnitude of the B-field B for this to happen? Refer to the front sheet for the relevant physical data.



3. 20 pts. Suppose you have 2 charges that lie on a line as shown in the figure below. Charge $q_1 = +4\,\mathrm{C}$ and charge $q_2 = -9\,\mathrm{C}$. The charges are separated by a distance $r_0 = 1.0\,\mathrm{m}$. There is a point A somewhere to the *left* of q_1 where the net electric field $\vec{E} = 0$. What is the distance s between q_1 and A?



4. **15 pts.** Suppose you connect a wire to your car battery and run this wire through a region with a magnetic field. Refer to the figure below. The magnitude of the B-field is $B = 0.1$ Tesla and the portion of the wire in the B-field has a mass $m = 0.1$ kg and some unknown length l. You turn a switch and a current $I = 10$ A flows through the wire. If the length of wire l "floats", what is this wire length l? Don't forget about gravity.