PHYS 272 Key Points

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Contents

1 Disclaimer

These are the highlights that I think are important, but not an exhaustive (or official list) of the topics that might be on the final. These will jog your memory, but you ought to memorize things from your textbook or lecture notes. The topics covered here are only drawn from recitation, lab, and the web assign homework's. If you find a mistake, let me know and I will correct it and resend the document to the class. I cannot guarantee the following is error free.

Also, I will not shy away from some more ”technical” notation. I will also try and explain what they mean though. Hopefully will start to learn them as well. I will try and send this out about every week, it would be beneficial for you to review them each week.

2 Week 0, 8/20 to 8/27

2.1 Lab 0 VPython Review

- Point charges produce electric fields that are completely in the radial direction. They point purely away or purely toward point charge. Electrons produce radially in fields while protons produce radially out fields.
- Know how to do dimensional analysis - check if your equation actually has appropriate units on both sides. This can be very useful when trouble shooting.

2.2 Rec 0

- Know how to add/subtract vectors $\vec{A} \pm \vec{B} = (A_x \pm B_x, A_y \pm B_y, A_z \pm B_z)$. It doesn't matter where a vector "starts" for vector equality, it only matters that every component is equal. $\vec{A} = \vec{B} \leftrightarrow A_i = B_i$ for all $i \in x, y, x$. (Note that $\equiv$ means "is defined as", so we can write $\in \equiv$ in the set, and $\leftrightarrow \equiv$ if and only if.

2.3 WebAssign Problems From this Week

- Know definition, and basic arithmetic for vectors. Addition, subtraction, dot product, multiplication by a scalar, definition of relative position vector, and how to get a unit vector from a regular vector. Note: $|\vec{A} + \vec{B}| \neq |\vec{A}| + |\vec{B}|$.
- Electric dipole: The Electric Field from a dipole is the just the sum of the field from the two particles. If the observation point is much greater than the separation distance for the two charged particles and happens to be on the parallel or perpendicular axis, the formula simplifies nicely:$|\vec{E}|_{\parallel} = \frac{k2qs}{r^3}$ and $|\vec{E}|_{\perp} = \frac{kqs}{r^3}$
- Spherically symmetric charge distributions produce electric fields outside that look just like a point charge at the center of the sphere which has charge equal to the amount in the whole spherical distribution.
- In a conductor, the electric field and drift velocity are related by the mobility: $\vec{V}_{drift} = \mu\vec{E}$ where μ is the mobility (what units must the mobility have?)

3 Week 1, 8/27 to 8/31

3.1 Lab 1 The Electric Field of Charged Particles

- Coloumb's law: $\vec{E}_{pointcharge} = \frac{kq\hat{r}}{|\vec{r}|^2}$. Note that $k \equiv \frac{1}{4\pi\epsilon_0}$.
- Superposition: The electric or magnetic field at a point results from all of the charges or currents around. Simply add their respective contributions.
- Relative position vector. The vector that points from $\vec{r_i}$ to $\vec{r_f}$ is $\vec{r_f} - \vec{r_i}$. This is the vector that is used in coulomb's law with the $\vec{r}\ \equiv$ as the vector that points from the charge to point where the electric field is being calculated.

3.2 Rec 1

- An electric field creates a force on anything with charge. Go between the two with $\vec{F} = q\vec{E}$ where $\vec{F}$ is force, q is charge, and $\vec{E}$ is the electric field. You can also get information about the acceleration $\vec{A}$ as $\vec{F} = m\vec{A}$ where m is mass.
- Principal of Superposition: $\vec{E}_{net} = \sum_{charges} \frac{kq\hat{r}}{|\vec{r}|^2}$. The sum goes over all of the charges present in a given problem that create the electric field of interest.
- Know what the electric field from an electric dipole looks like.

3.3 WebAssign Problems From this Week

- No web assign homework this week...

4 Week 2, 9/1 to 9/8

4.1 Lab 2 -The Electric Field of a Dipole

- Lab explored the electric field of a dipole in three dimensions. No "new physics".

4.2 Rec 2

- As a rule you can hold to, conductors cancel electric fields on the inside of themselves. When placed in an external electric field, the charges in the conductor redistribute on the surface and cancel the electric field on the inside. So conductors can make an electric field, but the only do so to cancel the field that is already on the inside and make the net field zero.
- Know what the electric field from an electric dipole looks like, and how to calculate the magnitude and assign the direction when you are far from the dipole on either the parallel or perpendicular axis.
- Sometimes electric fields are dynamic. One electric field redistributes charge on something else, and then this redistribution creates another electric field that redistributes charge elsewhere and so on. Recall the two conducting spheres affecting each other in the recitation problem.
- Non-conductors will polarize in the presence of an electric field. The charges do now flow like in a metal, but shift in their location. This is why you can stick a ballon to a wall after charging it by rubbing it on something. The ballon polarizes the wall and then experiences an attraction force towards the induced dipoles.

4.3 WebAssign Problems From this Week

- Polarization Vector $\vec{P} \propto \vec{E}$. If you don't have an electric field vector, then you have no polarization.
- Shell Theorem: uniform spherical charge distributions create electric field's exactly like point charges (with charge equal to the total charge on the spherical distribution) when outside the sphere and create zero electric field on the inside of the sphere.

5 Week of 9/9 to 9/16

5.1 Lab 3 -Charge on Tape

- Lab explored the charge on the tape and gave practical experience dealing with assumptions.

- The electric field of an infinite plane carrying a uniform charge surface density, $\sigma \equiv \frac{charge}{area}$ is $\vec{E} = \frac{\sigma}{2\epsilon_0}\hat{a}$ where $\hat{a}$ is a unit vector that points perpendicularly in (out) for negative (positive) charge densities.

5.2 Rec 4

- The charges on a conductor rearrange in response to an electric field in order to cancel any electric field on their inside. Conductors have no electric field inside their bulk.
- For a rod of length L, and carrying charge q, $|\vec{E}| = \frac{q}{4\pi\epsilon_0\sqrt{r^2+(L/2)^2}}$. This formula strictly valid only on the perpendicular axis at the mid point of the wire. It is approximately valid when close to this. Know how to assign the direction of this.

5.3 Webassign Problems From this Week

- The Electric field on the axis of a uniform disk of charge is $2\pi k\sigma[1 - \frac{r}{\sqrt{r^2+r_0^2}}]\hat{r}$, σ is the charge density, q/area, r_0 is the radius, and $\hat{r}$.

6 Week of 9/17 to 9/24

6.1 Lab 4 - Electric Field of a Uniformly Charged Rod

- If you need to find the electric field of some random charge distribution, this usually means coding. Split the distribution into point charges and simply sum the $\vec{E}$ contributions using coulomb's law to get $\vec{E}_{net}$.

6.2 Rec 5

- See shell theorem already discussed above.
- You used the fact that in a steady state, $\vec{E} = \vec{0}$ on the inside of a conductor to get a relationship between the charge on the inside and outside of a capacitor made of two parallel thin disks.

6.3 WebAssign Problems From this Week

- Kinetic energy is $\frac{1}{2}m\vec{v}^2$, where m is the mass and $\vec{v}$ is the velocity vector, and the speed is simply the magnitude of $vecv$.
- Know how to get potential from an electric field path integral: $\Delta V = V_f - V_i = -\int_{\vec{r}_i}^{\vec{r}_f} \vec{E} \cdot \vec{dl}$. This is typically three integrals (x,y,z), and $\vec{dl}$ runs along any path from $\vec{r}_i\ \ to\ \vec{r_f}$. Know how to do path integrals, this is important. Ask me if you don't! This integral simplifies if $\vec{E}$ is constant over some portion of the total path. Along these segments, the contribution to the change in potential is $-\vec{E} \cdot \vec{L}$ where $\vec{L}$ is the total displacement only along the part of the path where the electric field is constant.
- Positive charges go to regions of lower electric potential, while negative charges go to regions of higher electric potential. Both go to regions of lower potential energy.
- Electric potential change and potential energy change are related as $Volts = \frac{Joules}{Coulomb}$. $E = q \cdot V$ where E is the energy, V is the voltage, and q is the charge.