APPC, E & M: Unit A HW 1

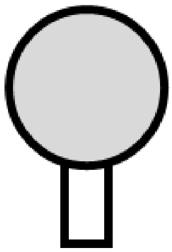
Name: ______________________________

Hr: ___ Due at beg of hr on: __________

UA, HW1, P1

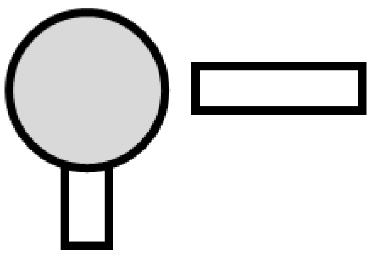
Reference Video: "Polarization and Charging By Induction"
YouTube, lasseviren1, ELECTROSTATICS playlist

Fig. A



1. Shown is an uncharged metal sphere on top of an insulating stand. In Fig. A, label the appropriate places with the words "insulator" and "metal."

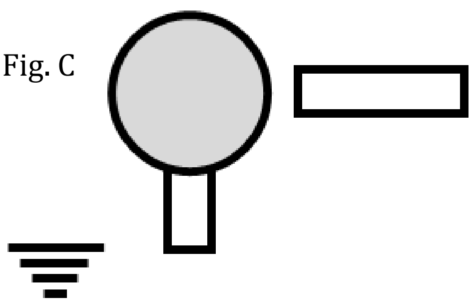
Fig. B



2. A negatively-charged wand is brought near to, but does not touch, the sphere. In Fig. B, draw several negative charges on the wand. Also, draw several charges on the sphere to show what happens to the charges on that object.

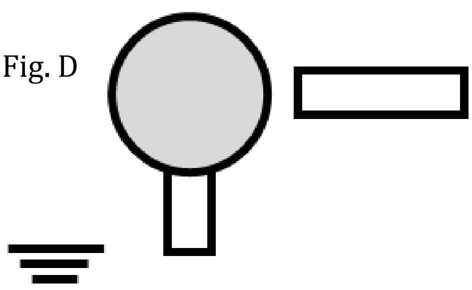
3. There is a now a net force between the wand and the sphere. (Circle your answer.) TRUE FALSE

Fig. C



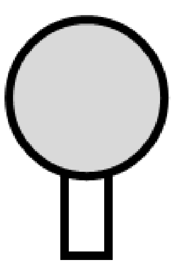
4. The sphere is then connected to ground with a conducting wire. In Fig. C, first, re-draw everything from Fig. B. Then, draw in the grounding wire. Finally, show several symbols next to the grounding wire which indicate the type(s) of charges that are flowing through the wire AND the direction in which they are flowing.

Fig. D



5. After grounding, the wire is disconnected. In Fig. D, first, re-draw the grounding wire, but without any charges shown on it. Then, somehow indicate that the grounding wire is no longer connected. Finally, show the charges on the wand and the sphere, and distributed correctly. (Hint: On the sphere, you will show only one type of charge.)

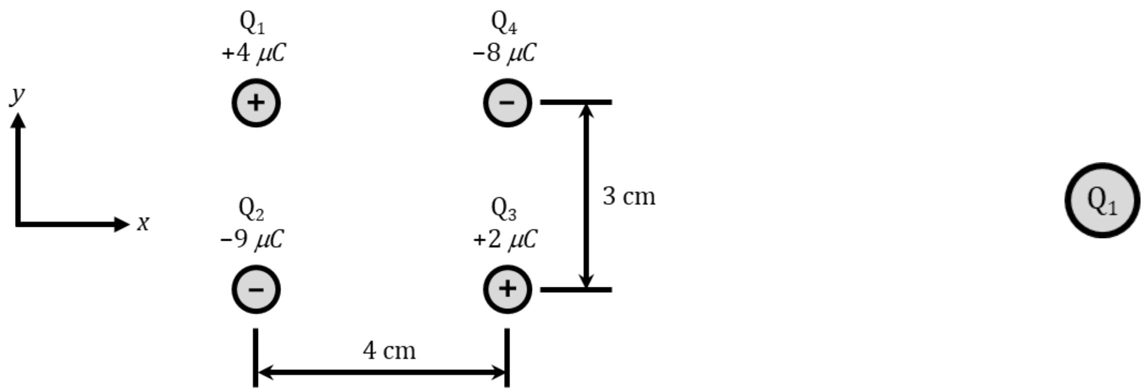
Fig. E



6. The wand is now removed. In Fig. E, indicate the net charge distribution on the sphere, i.e., not only the type of charge(s) on the sphere, but also how those charges are distributed.

7. State what happens with charged particles within the sphere that resulted in the net charge distribution on the sphere changing from what you showed in Fig. D to what you showed in Fig. E.

UA, HW1, P2
Reference Video: "Coulomb's Law and Electric Fields"
YouTube, lasseviren1, ELECTROSTATICS playlist



1. Above-and-to-the-right, draw a free-body diagram of charge Q_1, showing the electric forces on Q_1 from each of the other three charges. (Gravity is negligible because these charges have very little mass, so don't show a gravitational force.) Draw the forces with the tail of each vector starting on Q_1, and label each force along these lines: $\vec{F}_{12}$ means the force on Charge 1 due to Charge 2, etc.

2. Below, calculate $\vec{F}_{12}$, $\vec{F}_{13}$, and $\vec{F}_{14}$. Show your work. Include units. Write all of your answers as (+), but include an arrow after each answer to show the direction in which that force acts on Charge Q_1.

3. Resolve your forces from Part 2, as needed, into *x*- and *y*-components, taking into account the angle at which each force acts on Q_1. (Notice the coordinate system shown to the left of the figure.) Again, write all answers as (+), but put arrows (this time, in *x*- and *y*-directions only) to show direction.

4. "Add" your *x*-components to get a total *x* force on Charge Q_1, then do the same with the *y*-components. As before, include arrows to show the net direction of each component.

5. Pythagorize and inverse-tangentize your answers to Part 4 to get your final answer for the force on Q_1 due to the other three charges. Report your angle as so-many-degrees above (or below) the +*x*-axis.

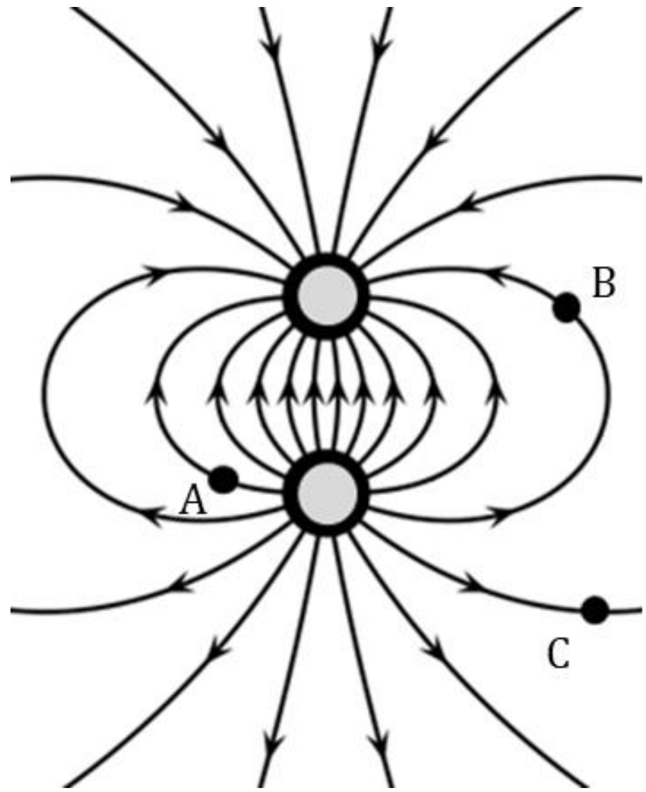
UA, HW1, P3
Reference Video: "Forces and Torques from Electric Forces"
YouTube, lasseviren1, ELECTROSTATICS playlist

1. In the figure is shown an electric dipole and the electric field lines created by the dipole. In the figure, correctly draw a "+" and a "–" symbol, one on each of the charges, to indicate which charge is which.

2. How do the magnitudes of the two charges compare?

3. Now, assume you have a test charge (which is, of course, (+), duh…) at Point A. This test charge will be pushed by the dipole's ___ charge, and pulled by the dipole's ___ charge.

4. At Point A in the figure, draw and label the forces F_{Apush} and F_{Apull}, with the tail of each vector touching Point A. Draw these two forces in the exact right direction, and with magnitudes that correspond to their approximate relative strengths.

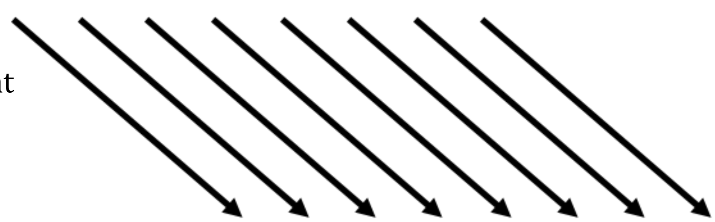


5. Now draw a 2nd F_{Apush} and a 2nd F_{Apull} (no need to label them, this time) so that you make a parallelogram: two sides being F_{Apush} and two sides being F_{Apull}.

6. Originating at Point A, draw a heavy resultant force vector representing the combination of F_{Apush} and F_{Apull}. This resultant will bisect the parallelogram from Part 5 and should be tangent to the electric field line at Point A.

7. Repeat Parts 4-6, this time imagining that you have a test charge at Point B and then at Point C.

Now, suppose the above dipole is subjected to an external electric field (i.e., one generated by some source that we can't see in the figure). Suppose also that the field is uniform, and that its field lines are oriented as shown at right. Circle the correct choices below.



8. What would be the net force on the dipole?

A. There would be a nonzero net force on the dipole, and its direction would be down-and-to-the-right.

B. There would be a nonzero net force on the dipole, and its direction would be up-and-to-the-left.

C. There would be zero net force on the dipole.

9. What would be the net torque on the dipole?

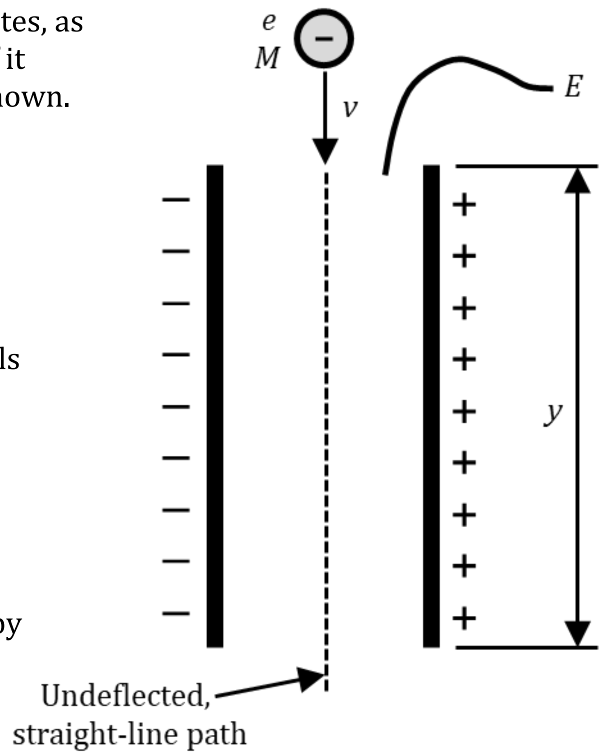
A. There would be a nonzero net torque on the dipole, and its direction would be counterclockwise.

B. There would be a nonzero net torque on the dipole, and its direction would be clockwise.

C. There would be zero net torque on the dipole.

UA, HW1, P4
Reference Video: "The Motion of Charged Particles in Uniform Electric Fields"
YouTube, lasseviren1, ELECTROSTATICS playlist

An electron approaches the midline between two charged plates, as shown. For reference, the path that the electron would take if it were not affected by the electric field between the plates is shown.



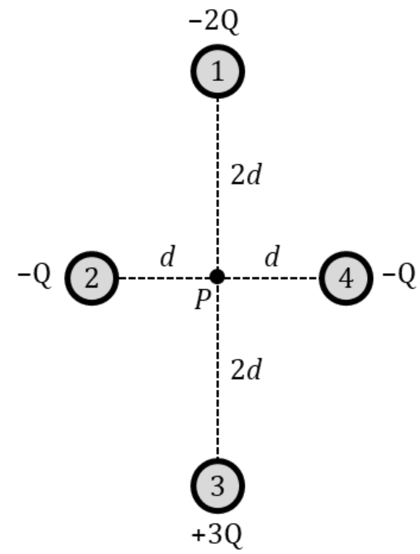
1. Draw E field lines between the plates. Ignore any fringing that may occur at the edges of the plates.

2. Draw the trajectory that the electron would take as it travels between plates. Assume that the electron does not collide with either plate, and emerges at the bottom.

3. In terms of the electron's charge e, its mass M, the electric field E, the vertical distance y, and the electron's initial speed v, derive an expression for Δx, which is the amount by which the electron has deviated from its straight-line path after it has traveled a distance y. Gravity is not a factor.

UA, HW1, P5
Reference Video: "The Electric Field Due to Two or More Charges"
YouTube, lasseviren1, ELECTROSTATICS playlist

1. On the point at right (which represents Point *P* in the figure), draw electric field vectors due to each of the Charges 1-4…at Point *P*. (This means you'll need to draw four *E* field vectors.) Label each vector in this fashion: $\vec{E}_{P1}$ means the *E* field vector at *P* due to Charge 1, etc. Show the vectors in the correct direction and with the approximate correct magnitude, based on what is shown in the figure at the far right.



2. Using the equation for the *E* field due to a point charge, derive an expression for the magnitude of the *E* field at *P*.