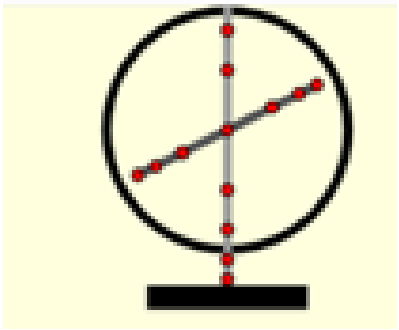
Use File > Make a copy to make your own copy of this worksheet, so that you can edit it.

Electroscope

<u>Part 1:</u> Worksheet on the sImulation An electroscope



This is really a set of three static scenarios. Using the buttons, you can choose between

- *an uncharged electroscope, almost vertical position, has plenty of electrons, but the net charge is zero - there are as many protons as electrons*
- *a positively charged electroscope has a deficit of electrons*
- *a negatively charged electroscope has an excess number of electrons*

Note that positive charges are shown in red, and negative charges are shown in blue. Usually you can't tell the sign of the charge an electroscope has. Unlike in this simulation, you can't see the charges!

<u>Briefly propose an experimental setup that could create these 3 outcomes.</u>

1. How do the components of the system interact?

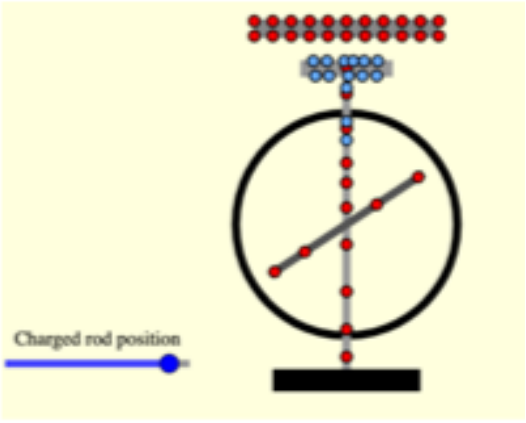
2. When is the system stable and under what conditions does it change?

3. How could you measure the changes?

4. How does the structure of the electroscope relate to its function?

An electroscope and a charged rod

Link to the simulation:
https://physics.bu.edu/~duffy/HTML5/electroscope_charged_rod.html



A charged rod near an electroscope

Note that the electroscope here is always neutral, even at the beginning.

*If you bring the insulating **charged rod** closer to the electroscope, you'll be able to see that the electrons (in blue) and the positive charges (red) on the electroscope cancel one another out.When you bring the rod closer to the electroscope, the electroscope acts like it is charged even though it isn't. The electroscope becomes polarized. Moving the rod away reverses the movement of the electrons, so the needle deflects less.*

- *If the rod has a positive charge, electrons in the electroscope are attracted toward the rod and therefore the electrons move toward the top plate of the electroscope, leaving a net positive charge on and near the needle, which deflects.*
- *If, instead, the rod has a negative charge, electrons in the top plate of the electroscope are repelled by the electrons on the rod. The electrons on the electroscope move toward the needle, which then deflects.*

<u>Briefly describe the simulation.</u>

1. What is the independent variable?

2. What is the dependent variable?

3. How can the rod be charged with friction? How does the rod acquire a positive charge?

4. Draw a free-body diagram showing all the forces acting on the rotating bar when the bar is maximally displaced at angle theta.

5. When an electroscope is charged, the bar rises to a certain angle and remains at that angle. Why doesn't it rise farther?

6. One charged electroscope has an angle of 15 degrees. Another charged electroscope has an angle of 30 degrees.
What factors would explain the difference? Consider both potential process factors and structure function factors.

7. Compare charging by conduction and induction using examples from this simulation. How would the humidity affect the outcome?

8. Explain how to charge an electroscope positively using

   a. positive rod

   b. negative rod

9. What two properties explain why a neutral object is attracted to both positively and negatively charged objects

Part 3: Homework

Build an electroscope at home with tinsel and a large unfolded metal paperclip. Charge the paperclip at a distance by an alligator clip on a wire.

This worksheet was created by Katherine Prammer at the Creating Curricular Materials AAPT workshop on July 9, 2022.