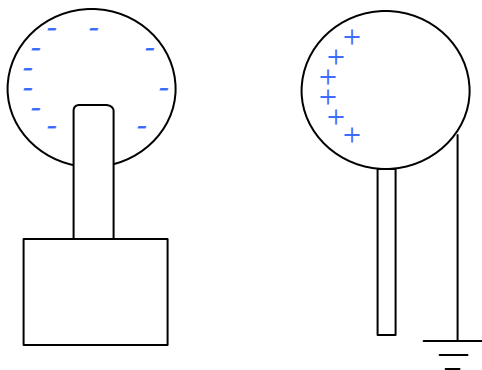


- 1) Suppose you have a Van de Graaf generator near a metal discharge sphere connected by a wire to the ground.
- (a) Draw on the diagram below to show what excess charge there is on the discharge sphere while the Van de Graaf is running. Explain why there would or wouldn't be charge on the discharge sphere.
  - (b) Explain what is different, if anything, a few seconds after the generator is turned off.
  - [(c) If you have extra time, think of this one. Would there be more or less force on the discharge sphere if it were not connected to ground?]



- a) If there were no wire to ground, some of the negative charges on the discharge sphere would go to the right (because they are repelled by the generator's negative charge) and collect on the far side of the sphere, leaving an excess positive charge on the left side, but no excess total on the discharge sphere. No charge would flow between the spheres because air is a bad conductor (It HAS to be or the generator would never build up a charge, right? The charge would just immediately flow off through the air!) With the wire to ground, the negatives that are pushed away by the generator's charges can flow out into the ground. Basically they're doing the same thing as without a wire, separating from the positives, but the ground wire (a conductor connected to another, huge conductor) gives them an opportunity to separate more, to get farther away. Now there's an excess positive charge both on the left side and on the sphere as a whole since the negatives have left the sphere.

[This part of the problem was graded for consistency with the model of charge we've developed in class and your consistency with common sense. Our model doesn't explicitly say, for example, what is a good or bad conductor, so I wouldn't mark you off for forgetting what air was, perhaps, EXCEPT that you can use the model to figure that out. If air conducts, it allows charges to move to ground always, not just to the discharge sphere! So this would mean the generator could never charge up! I probably should have taken more than 2/6 points off for this. Think about what makes sense!!! Try to make your assumptions explicit! What are you working with from the model and what are other ideas that you are using. If it's not explicitly in the model, you need

to say why you think it's true, preferably from the model, but also from common sense and experience.]

- b) When the generator is turned off, no more charges are added to it, but *nothing else changes*. The air is still a bad conductor and can't conduct the charge away, and the plastic tube the generator sphere sits on still can't conduct charge away (or else it would be doing that all the time and no charge could build up.) So nothing much changes. Over a longer period of time the generator's charge would leak off slowly into the air, and positive charge on the discharge sphere would pull negatives up from the ground until it neutralized again when the generator does. [NOTE: I graded this part fully for consistency with a). You must be consistent with yourself first and foremost!]
- c) With the ground wire there is an excess positive charge that attracts the generator. So there is a force on the discharge sphere to the left. Without the ground wire, the charges would separate on the sphere, and the positives would still pull left, but the negatives would be pushed away. The pushing of the negatives is weaker than the pulling of the positives because the negatives are farther from the generator, which leaves a net force to the left, but weaker if there was a ground wire.