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Physics 203

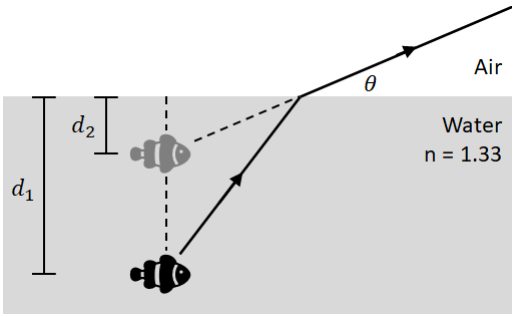
Final Exam | Part 1 (35 minutes) | Corvallis

6/8/2021

Collaboration is not allowed. You will have 35 minutes to download, solve, take pictures, AND upload this exam to Gradescope.

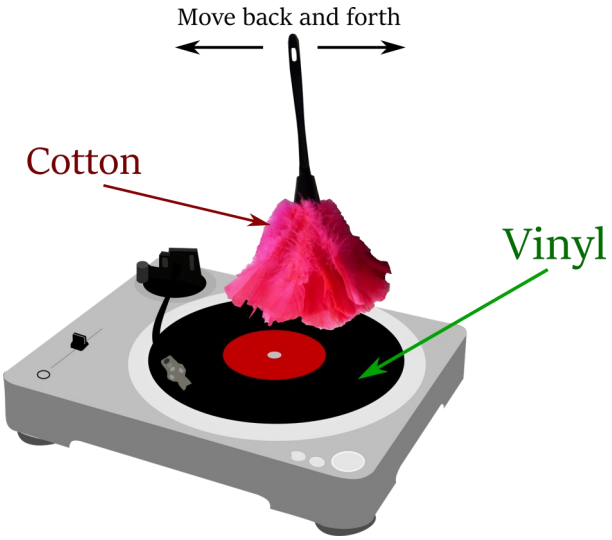
1. (8 points) A fish, underneath the water, appears to be at a depth, $\mathbf{d_2 = 0.6}$ **meters** beneath the surface of the water. It is actually at an unknown depth of $\mathbf{d_1}$. One way to calculate the actual depth, $\mathbf{d_1}$, of the fish is to assume an angle of incidence. The rays in the diagram drawn here make an angle of $\boldsymbol{\theta = 30}$ **degrees** with the horizontal as they exit the water into the air.

   Using the chosen rays in the diagram, find the actual depth of the fish, $\mathbf{d_1}$. (hint: finding the width between the light rays at the water's surface might help)



Question 2 on next page

2. (6 points) Consider a room that has a net neutral cotton duster, a net neutral vinyl record, and net neutral dust particles floating around in the air. It is observed that after cleaning the vinyl record with the cotton duster, the record player attracts the small dust particles that are floating around in the air nearby. Use physics concepts to explain why these dust particles are attracted to the freshly cleaned vinyl record. Ignore gravitational effects.



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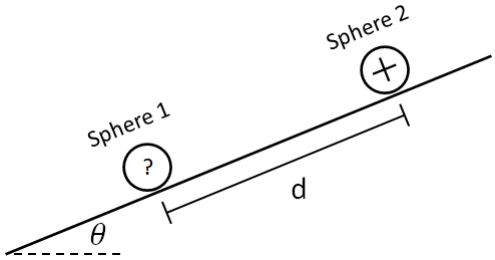
Physics 203

Final Exam | Part 2 (35 minutes) | Corvallis

6/8/2021

Collaboration is not allowed. You will have 35 minutes to download, solve, take pictures, AND upload this exam to Gradescope.

1. (6 points) Two small charged spheres of identical charge magnitude and mass m = 1.0 kg are placed on an inclined frictionless surface which makes an angle of 30 degrees with the horizontal. They are placed a distance d = 10 cm apart. Sphere 2 is positively charged, the charge of sphere 1 is unknown. When they are simultaneously released from rest, the initial acceleration of sphere 1 is 0 m/s^2.



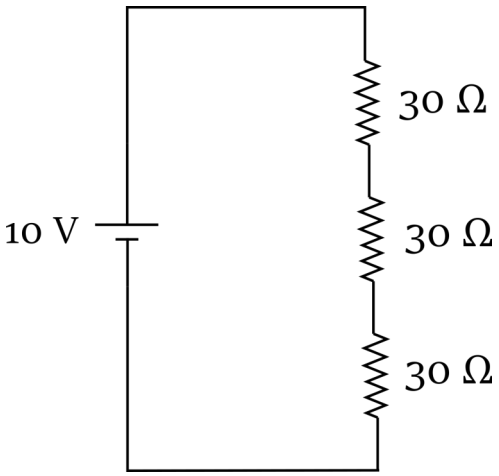
(a) What is the sign of the charge on sphere 1? Is it possible to know this? Explain.

(b) What is the magnitude of the charge on the spheres? Explain.

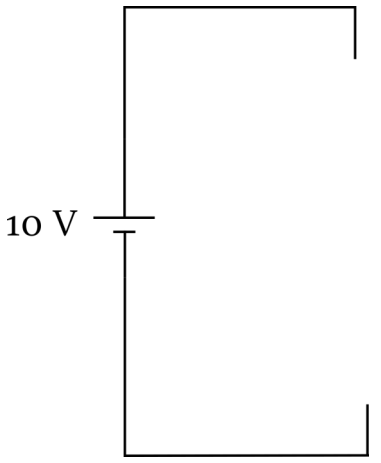
Question 2 on next page

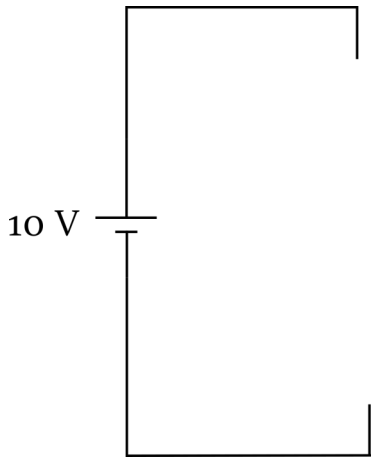
2. (10 points) Consider three identical resistors with resistance of 30 ohms, and a single constant voltage source of 10 volts.

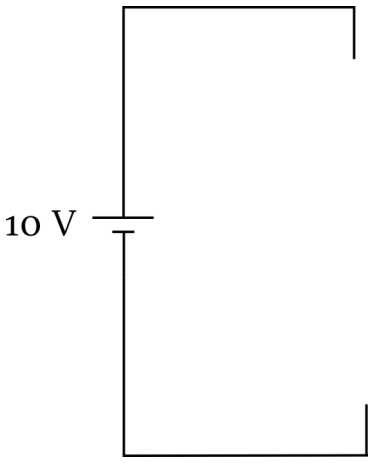
(a) What is the equivalent resistance of the circuit shown? Show your work.



(b) You wish to determine all of the possible equivalent resistances you can achieve using these three resistors in some combination of series and parallel arrangements. One of the four possible arrangements is already shown in part (a). Use the partially drawn circuits to clearly construct the three other possible arrangements that would result in a unique equivalent resistance. You must use all three resistors in each circuit. For each circuit, find the equivalent resistance showing your work.







(c) Which circuit would the constant voltage battery run out of energy first? Explain.

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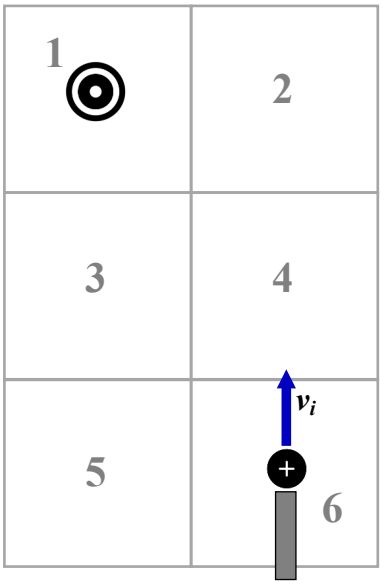
Physics 203

Final Exam | Part 3 (30 minutes) | Corvallis

6/8/2021

Collaboration is not allowed. You will have 30 minutes to download, solve, take pictures, AND upload this exam to Gradescope.

1. (6 points) In a strange dream you find yourself in a carnival ran by physicists playing a game called ***The Beam Bender***. There is a positron cannon that fires positive charges vertically upward from the middle of square 6, as show in the figure. There is a target in the middle of square 1 and the goal is to get the positrons to hit the target.

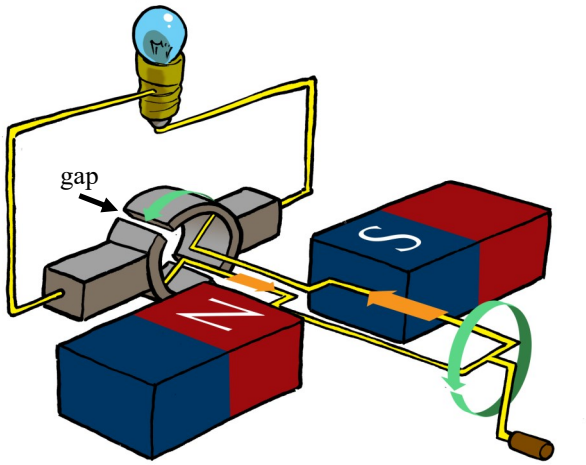


(a) You are able to turn on a constant magnetic field in only ***one*** of the 6 squares. The magnetic field can be in any direction and of any strength. Which square do you turn the magnetic field on and in which direction should the field point? Explain your reasoning with a clear sketch of the field and the particle's trajectory (solid line). Assume the effects of gravity are negligible.

(b) Answer the same question as part (a) but instead of a magnetic field, assume it is an electric field you can turn on in one of the squares. Label a second E-field trajectory (dotted line) and note any differences the two methods may produce.

Question 2 on next page

2. (6 points) The figure shows a simple electrical generator. By rotating the handle on the right, the loop of wire rotates between two stationary magnets with opposite facing poles. The other end of the wires rotate around, touching the inside of a circular piece of metal that has a small gap. The circular piece has wires on opposite sides that are then connected to the positive and negative terminals of a light-bulb. When the handle is rotated, the light bulb lights up.



(a) Explain the energy transfers occurring in the operation of this device.

(b) What is the purpose of the magnets?

(c) Explain how the electric current is generated through the lightbulb. Be sure to include the role of magnetic flux in your explanation.

Question 3 on next page

3. (4 points) Consider the arrangement of 4 current carrying wires in the figure. There are three long straight wires with their current directions indicated. The wires form an equilateral triangle but do not touch. The fourth wire is shaped into a circle (that also doesn't touch the other wires). Point **P** is at the center of both the circle and the triangle. What direction (cw or ccw) must the current in the circular wire be in order for the net magnetic field to be zero at the point P. Explain your reasoning.