Coulomb's Law - Practical

Balloons - Relationship with charge and distance

TEACHER'S GUIDE

Equipment: High voltage power supply (e.g. EHT or Van de Graaff generator), fishing line, balloons, wool cloth, anti-static aerosol spray, insulating handle, scales.

For part 1:

Note, for the electrostatic force's effects to be visible, it is best to tie two balloons to long lengths of fishing line and hang them from the ceiling. You may want to set this part up yourself if you are uncomfortable with students tying string to the ceiling. You will need to know the length of the string to work out angles.

Set-up and information for part 2:

If you are using a Van de Graaff generator to charge some of the balloons, then you will need conducting spheres to transfer the charge to the balloons. To do this, cover a balloon with anti-static spray and attach it to a long insulating handle.

Otherwise, you can use a power supply by grounding the positive terminal and touching the negative terminal to the coated/conductive balloon. You will need to suspend this balloon using an insulating handle.

Tasks for students (outlined in the student worksheet):

1) After charging the two balloons using a cloth and measuring their separation, estimate the repulsive force between them given their masses and separation.
2) Do the same after discharging one of the balloons.
3) If the two balloons had been given the same charge, how would you expect the force to change after discharging one of them? Did this happen? If not, what does that tell you about the charges on the two balloons prior to discharging one of them?
4) When you charge two balloons by rubbing them together, what kind of electrostatic force would this generate? How would you expect the charges of the two balloons to compare?
5) Complete the same analysis for the balloon charged by the power supply.
6) Given the different behaviours exhibited by the balloons throughout this experiment, what can you say about the types of charge that exist? Compare this with what you know about gravity and mass.

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STUDENT INSTRUCTIONS

In this activity, you will investigate the effect of the charge of balloons and the electrostatic force they create. Follow the instructions below and answer the questions to observe and understand how charged particles interact.

Two balloons are connected to the ceiling by long fishing lines.

Part 1: Charged by Friction.

1) Measure how far apart the balloons are from each other hanging from the ceiling.
2) Measure the mass of a spare balloon using the scales and note this down for your calculations later.
3) Charge both balloons on the fishing line by rubbing them with a piece of cloth.
4) Stand back and observe their behaviour. Measure how far apart the balloons are after being charged.
5) Use your measurements to estimate the repulsive force between them.
6) Discharge one of the balloons and observe how their separation changes.
7) Measure this new separation.
8) Use this new separation to estimate the new repulsive force between the balloons.
9) If the two balloons had been given the same charge, how would you expect the force to change after discharging one of them? Did this happen? If not, what does that tell you about the charges on the two balloons prior to discharging one of them?
10) Discharge both balloons, then charge them by rubbing them against each other.
11) Measure their separation.
12) Then discharge one again and measure their new separation.

13) When you charge two balloons by rubbing them together, what kind of electrostatic force would this generate? How would you expect the charges of the two balloons to compare?

Part 2: Charged by voltage source.

1) Coat one balloon with anti-static aerosol spray and charge it using your power supply (consult your teacher if you are unsure how to do this).
2) Charge the other balloon by rubbing it with the cloth.
3) Measure the separation between the two.
4) Estimate the repulsive force between the two. What kind of electrostatic force is this? How would you expect the charges of the two balloons to compare?

Part 3: Extension

Now try charging two free balloons using a piece of cloth and attaching them to a glass window. Why do they stick to the window? Why don't they approach each other?

Summary

Given the different behaviours exhibited by the balloons throughout this experiment, what can you say about the types of charge that exist? Compare this with what you know about gravity and mass.