

## Investigating the Properties of Alpha and Beta Particles

As scientists began investigating the properties of atoms, their first discovery was that they could extract negatively charged particles. They called these particles electrons, but they are also known as beta particles in the context of nuclear decay. Robert Millikan used beta particles in his famous Oil Drop Experiment. Another particle ejected during nuclear decay is the alpha particle. An alpha particle is a helium nucleus, or a helium atom without its two electrons. Consequently, an alpha particle is positively charged. Ernest Rutherford used alpha particles in his Gold Foil Experiment.

1. Start *Virtual ChemLab* and select *Alpha and Beta Particles* from the list of assignments. The lab will open in the Quantum laboratory.

2. *What source is used in this experiment?* Drag your cursor over the source to identify it. \_\_\_\_\_

*What type of charge do electrons have?* \_\_\_\_\_

*What detector is used in this experiment?* \_\_\_\_\_

3. Turn on the *Phosphor Screen*. (Click on the green/red buttons.)

*What do you observe?* \_\_\_\_\_

The phosphor screen detects charged particles (such as electrons) and it glows momentarily at the positions where the particles impact the screen.

4. Drag the lab window down and left and the phosphor screen window up and right in order to minimize the overlap. Push the **Grid** button on the phosphor screen, and set the *Magnetic Field* to 30  $\mu\text{T}$ . (Click the button above the tens place three times. If you mistakenly click between digits, it will move the decimal point. Click to place it where it was originally and then click above the tens place.)

*What happens to the spot from the electron gun on the phosphor screen?* \_\_\_\_\_

5. Click once above the tens place on the *Electric Field* meter. Observe the spot. Click a second time above the tens place on the *Electric Field*.

*What happens to the spot from the electron gun on the phosphor screen?* \_\_\_\_\_

6. Zero out the *Magnetic Field* and *Electric Field* meters by clicking on the appropriate digit buttons until the spot on the phosphor screen is centered again.

7. Double-click or click and drag the electron gun to move it to the *Stockroom* counter. Enter the *Stockroom* by clicking inside the *Stockroom*. Double-click the electron gun to move it back to the shelf. Double-click on the alpha source to select it and move it to the *Stockroom* counter. Click on the green *Return to Lab* arrow to return to the lab. Drag the alpha source from the *Stockroom* counter and place it on the table where the electron gun was originally placed (the middle spot light). Click on the front of the alpha source to open the shutter.

*What appears on the phosphor screen?* \_\_\_\_\_

8. Change the unit for the *Magnetic Field* from  $\mu\text{T}$  to  $\text{mT}$  by clicking once above the unit. Click above the hundreds place three times to set the *Magnetic Field* to 300  $\text{mT}$  (millitesla). This magnetic field is one million times stronger than what we used for the electron gun.

*Which direction is the spot deflected when the magnetic field is increased this time?* \_\_\_\_\_

*How does this compare with the direction of movement when the magnetic field was turned on for the electrons?*

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9. Change the unit for the *Electric Field* from  $\text{V}$  to  $\text{kV}$  by clicking once above the unit. Observe the spot as you increase the *Electric Field* strength from 0  $\text{kV}$  to 5  $\text{kV}$ . The movement is slight so pay careful attention.

*Which direction is the spot moved when you increase the Electric Field?* \_\_\_\_\_

*How does this compare with the direction of movement for the electron beam in the Electric Field?*

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*Why does it take significantly stronger magnetic and electric field strengths to move the beam of alpha particles compared with the beam of electrons (beta particles)?*

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10. Return the values on the two meters to zero. Double-click (or click and drag) the alpha source and the phosphor screen to return them to the *Stockroom* counter. Enter the *Stockroom*. Double-click on the alpha source and the phosphor screen to place them on the shelf. Select the laser and the video camera by double-clicking on them, and then click on the green *Return to Lab* arrow to return to the lab. Place the laser in the center spotlight on the left and turn the laser on (click on the red/green light). Place the video camera on the center spotlight on the right and click the video camera to turn it on. Set the laser intensity to 1  $\text{nW}$  and the wavelength to 20  $\text{nm}$ . This wavelength is in the x-ray region of the electromagnetic spectrum. The purple dot is a representation of the x-rays hitting the video camera. Change the *Electric Field* and *Magnetic Field* to determine the effect on the x-rays.

*Did the electric or magnetic fields affect the x-rays? Why or why not?* \_\_\_\_\_

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*Summarize what you have learned about electrons (beta particles), alpha particles, and x-rays.*

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