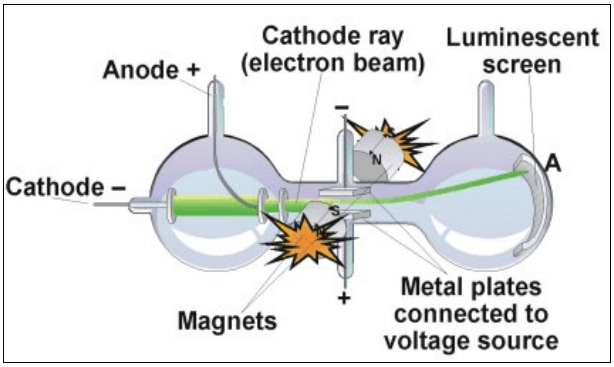
The Discovery of Electrons

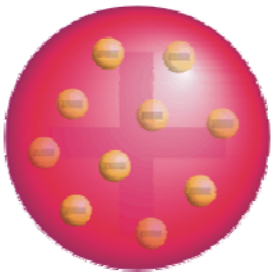
When Dalton first showed the existence of atoms, atoms were simple. Dalton's model postulated an atom that was indivisible–no parts! The only distinguishing characteristic of the Dalton atom was its mass. But the Dalton model didn't explain the electrical nature of matter. For example, a comb doesn't normally attract bits of paper. But if you rub it, it acquires an electrical charge and attracts the paper. How does neutral matter do that?

J. J. Thomson did some experiments that provided the answer. Thomson did experiments with cathode rays, a beam of light that traveled from the negative electrode to the positive electrode of a cathode ray tube. Using a modified cathode ray tube, Thomson showed several things about cathode rays: [1] They respond to a magnetic field by bending. [2] They respond to electricity by bending away from the negative electrode. [3] The size of the response shows they are negative particles many times smaller than an atom. [4] The particles are identical regardless of what metal is used for the cathode. Thomson concluded that all atoms contained these tiny, negative particles. He called them electrons.



A cathode ray is deflected by a magnetic field. Changing motion in response to forces is typical behavior for matter.

Now that Thomson postulated the existence of electrons, he had to explain why atoms weren't negatively charged. The obvious answer is that they have as much positive charge as they have negative charge, so they are neutral. But how are the charges distributed? Since the electrons come off atoms easily when you rub them or when you turn on electricity, Thomson concluded that they are spread evenly through a cloudlike positive charge. If the negative were not spread evenly through the positive, there would be unbalanced forces of attraction that would cause the charged particles to move. If the positive part were solid instead of cloudlike, the electrons would be stuck in place. Thomson's model is often called the "plum pudding" model.



Thomson's model

Answer the questions below about the Thomson model of the atom.

1. What behaviors of cathode rays convinced Thomson that they were negatively charged particles that came from atoms? _____

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2. Why did Thomson think part of the atom had to be positively charged? _____

3. Why did Thomson think the positive part of the atom had to be cloudlike? _____

4. Why did Thomson think the positive and negative charges had to be distributed evenly? _____

5. If Thomson's model of the atom were correct, and the atom were cloudlike, how would things made out of atoms ever be solid? (*HINT:* What effect do like charges have on each other?) _____

6. How does the Thomson model contradict the Dalton model of the atom? _____