The Cathode Ray Tube (CRT)
This device is a simplified version of a television tube that sends a beam of electrons (a cathode ray) from one end of the tube to another, striking a phosphorescent screen on the other end. In cross-section, the CRT appears as follows:

Parts of the CRT and their functions include the following:

The Electron Gun
At one end, an electron gun produces an electron beam, also called a cathode ray in the following way:
Charged parallel plates have an accelerating electric field between them. The negative plate may be called a cathode, the positive plate, an anode. If the cathode is heated to a high temperature, electrons will “boil” off its surface, creating a cloud of electrons (called a space charge) over the surface of the hot cathode. The electric field between anode and cathode will subsequently accelerate the electrons in the space charge towards the anode. If there is a hole in the anode, the electrons will not stop but pass through, creating an electron beam. All TV’s and cathode ray tubes use this electron gun.
Between anode and cathode, potential energy is converted to kinetic energy so that

\[ q \Delta V = \frac{1}{2} m v^2 \quad \Rightarrow \quad v = \sqrt{\frac{2q \Delta V_a}{m}} \]

Note that \( \Delta V_a \) stands for *accelerating* voltage, the voltage between cathode and anode in the electron gun.

Once through the anode hole, \( v \) remains constant until some other force acts on the beam of electrons. This force is caused by a second *deflecting* voltage \( \Delta V_d \) acting on another set of plates, oriented so that the electrons are deflected up or down as they pass through the plates (similar to what you saw in the last section).

The last two sections explained how to solve relevant problems involving accelerating voltage plates and deflecting voltage plates. Also, a relationship between deflection \( d_y \) and the two voltages involved can be derived, and proven through experimental analysis to be

\[ d_y = k \frac{\Delta V_d}{\Delta V_a} \quad \Rightarrow \quad \text{be sure to memorize this relationship!} \]
Example 16. Given this information:

\( V_a = 100 \text{ V} \) \quad \text{distance between Y-plates} = 0.040 \text{ m} \\
\( V_d = 10.0 \text{ V} \) \quad \text{length of Y-plates} = 0.100 \text{ m} \\

a) use accelerating voltage \( V_a \) to find electron velocity in the \( x \)-direction \( v_x \) after leaving the anode.

b) since \( v_x \) is constant after leaving the anode, calculate the time taken for an electron to pass through the deflecting Y-plates.

c) use deflecting voltage \( V_d \) to find the force \( F_y \) on the electron between the Y-plates.

d) find the acceleration \( a_y \) of the electron between the Y-plates.

e) At this point, you have enough kinematics information to find the \( y \)-deflection \( d_y \) between the Y-plates.

f) If the accelerating voltage is now doubled, while the deflecting voltage is reduced to \( 3/4 \) of its original value, what is the new magnitude for \( d_y \)?

(see Electrostatics Ex 16 for answer)