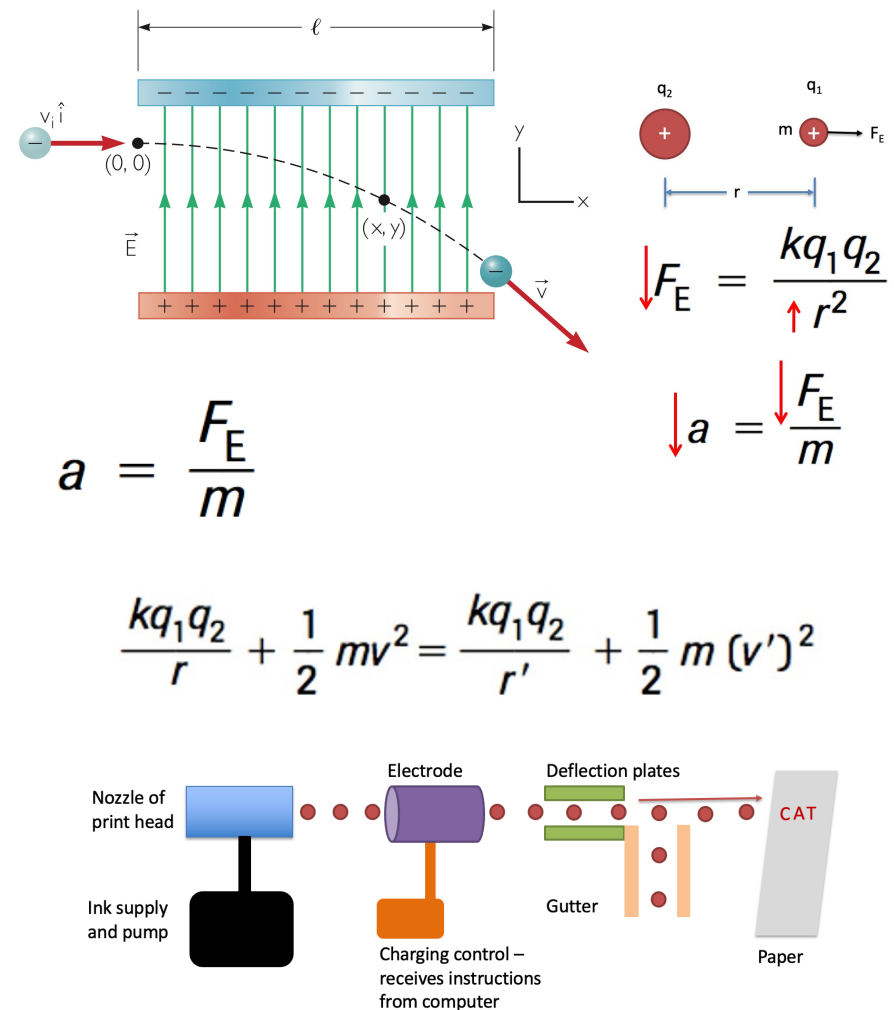


# Particle Motion in Electric Fields

- Electric Force and the Acceleration of a Particle
- Conservation of Energy
- Uniform Electric Fields and Particle Acceleration
- Work Done in Electric Fields
- Application – Inkjet Printers



# Preview File

Please enjoy this preview of your Student Version of the presentation. Please note within this sample file:

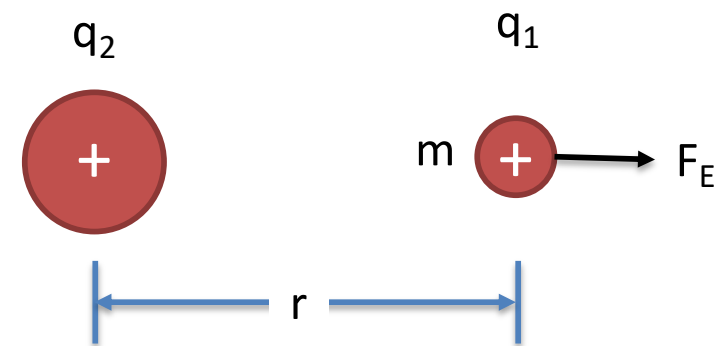
- Some slides appear blank because they have been removed
- Student versions have portions of the text removed which is given in the teacher version and appear as \_\_\_\_\_ which the students are to fill in
- Other slides may have ..... on them, this represents writing that has been removed on this sample

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# Electric Force and the Acceleration of a Particle

- Consider an electric force ( $F_E$ ) which propels  $q_1$  to the right
- What variable will change as the particles separate?
- As this variable changes, what affect will there be on the object's acceleration?



$$F_E = \frac{kq_1q_2}{r^2}$$

$$a = \frac{F_E}{m}$$

# Electric Force and the Acceleration of a Particle

- As the distance ( $r$ ) between the objects increases, the  $F_E$  decreases

- \_\_\_\_\_

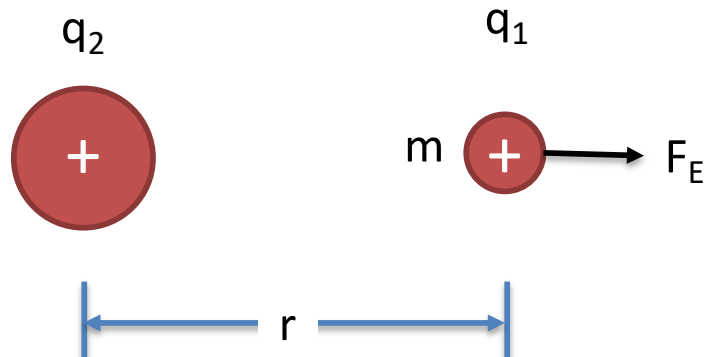


Diagram illustrating the electric force between two positive charges,  $q_1$  and  $q_2$ , separated by a distance  $r$ . Charge  $q_1$  has mass  $m$ . The electric force  $F_E$  is shown acting on  $q_1$  to the right.

$$F_E = \frac{kq_1q_2}{r^2}$$
$$a = \frac{F_E}{m}$$

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# Conservation of Energy

The charged particle,  $q_1$ , moves in the electric field of  $q_2$  in such a way that the electric potential energy it loses ( $-\Delta E_E$ ) is equal to the kinetic energy it gains ( $\Delta E_K$ ).

$$E = E'$$

$$E_E + E_K = E_E' + E_K'$$

$$\frac{kq_1q_2}{r} + \frac{1}{2}mv^2 = \frac{kq_1q_2}{r'} + \frac{1}{2}m(v')^2$$

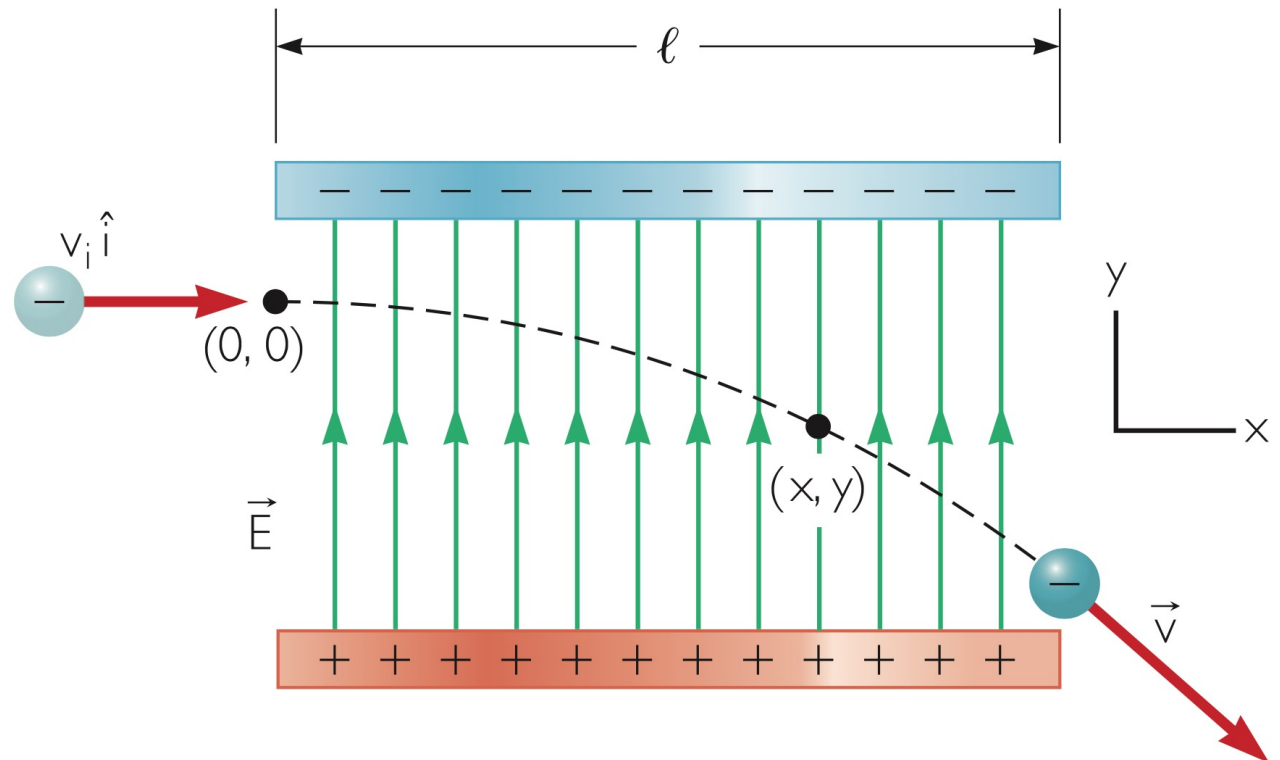
# Check Your Understanding

Two pucks are placed on separate insulating spheres. One puck is anchored to the surface, while the other is allowed to move freely on an air table. The mass of the sphere and puck together is 0.15 kg, and the charge on each sphere is  $+3.0 \times 10^{-6} \text{ C}$  and  $+5.0 \times 10^{-9} \text{ C}$ . The two spheres are initially 0.25 m apart. How fast will the sphere be moving when they are 0.65 m apart?

$$\frac{kq_1q_2}{r} + \frac{1}{2}mv^2 = \frac{kq_1q_2}{r'} + \frac{1}{2}m(v')^2$$

# Uniform Electric fields

In a uniform electric field, the force is constant and therefore, understanding the motion of the particle becomes much simpler as acceleration is also constant.



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# Work Done

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$$\vec{F}_E = q\vec{\mathcal{E}}$$

$$W = \vec{F}_E \cdot \vec{r}$$
$$= \mathcal{E}qr$$

$$\vec{\mathcal{E}} = \frac{\Delta V}{r}$$

$$= \frac{\Delta V}{d} qr$$

$$W = \Delta Vq$$

Since 'r' and 'd' both represent the distance, they cancel out.

# Check Your Understanding

The potential difference between two parallel plates is  $1.5 \times 10^2$  V. You would have to do 0.24 J of work if you were to move a small charge, in opposition to the electric force, from one plate to the other. Calculate the magnitude of the charge.

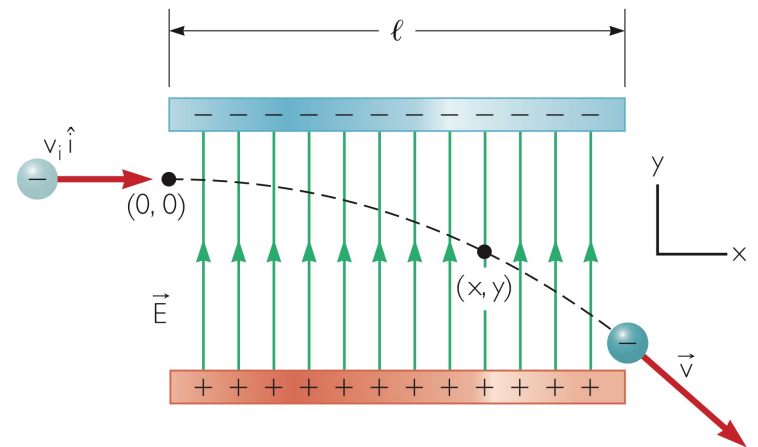
$$W = \Delta Vq$$

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# Check Your Understanding

An electron is fired horizontally at  $2.5 \times 10^6$  m/s between two horizontal parallel plates 7.5 cm long. The magnitude of the electric field is 130 N/C. The plate separation is great enough to allow the electron to escape (ignore gravity as its negligible). Find the velocity of the electron as it escapes from between the plates.

Magnitude  $q_e = 1.6 \times 10^{-19}$  C    $m_e = 9.1 \times 10^{-31}$  kg



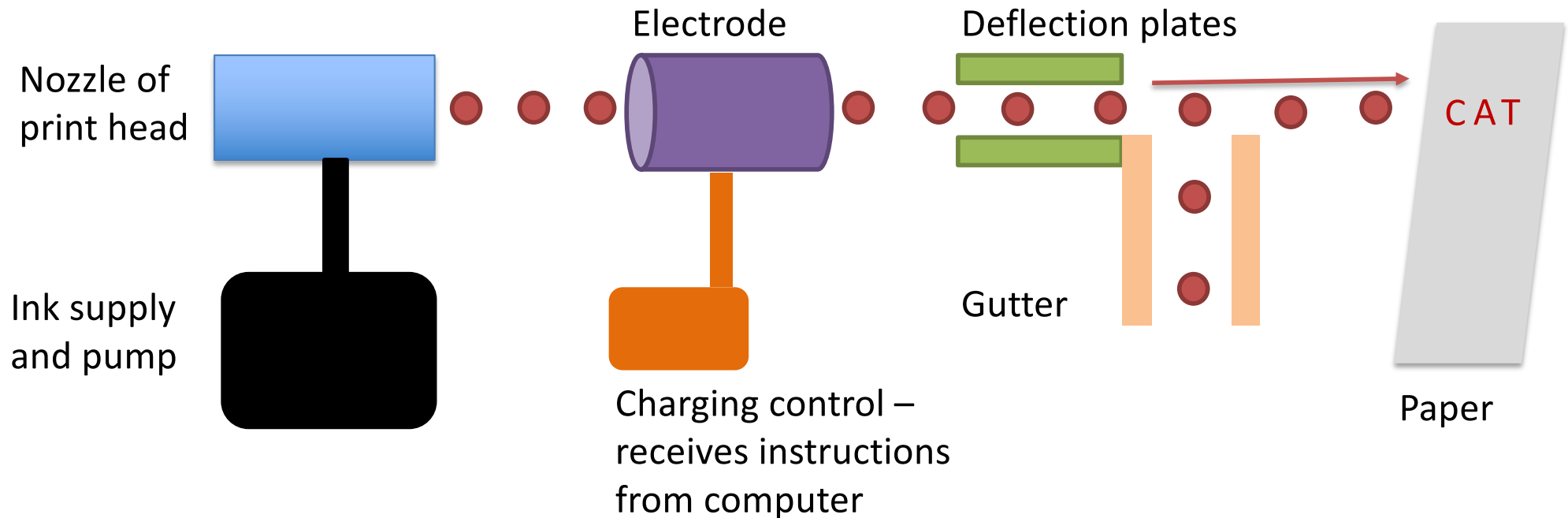
**The Kinematic Equations:**

$$d = v_i t + \frac{1}{2} a t^2 \qquad v_f^2 = v_i^2 + 2 a d$$

$$d = \frac{(v_i + v_f)}{2} t \qquad v_f = v_i + a t$$

# Application – Inkjet Printers

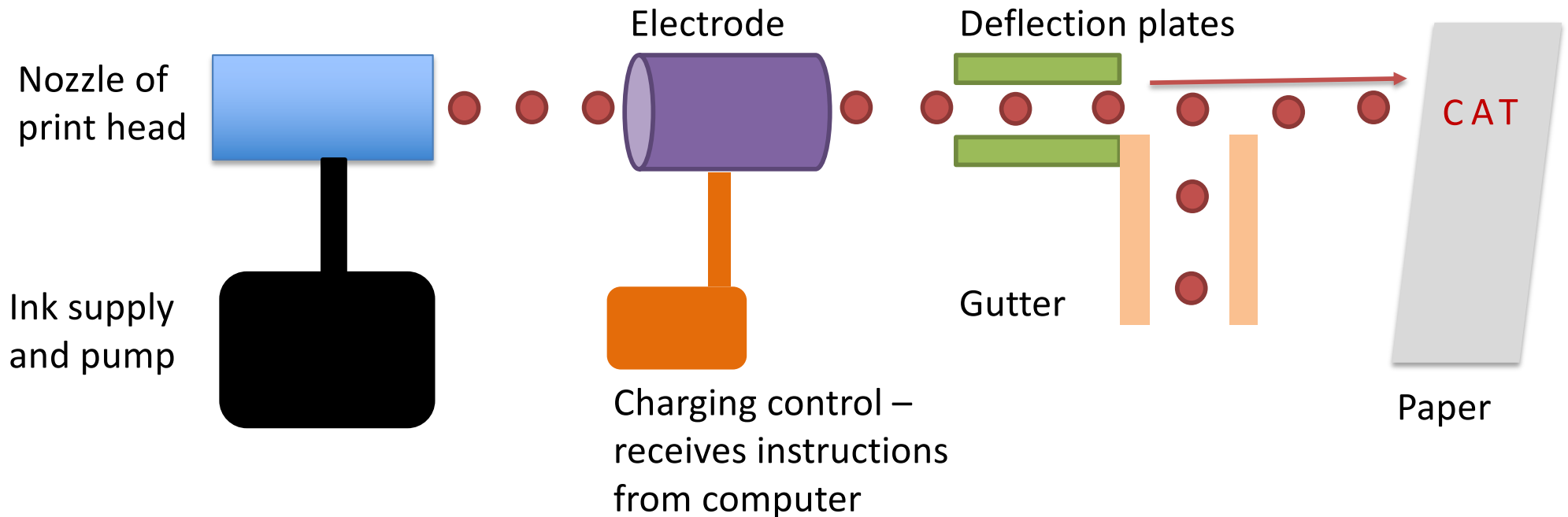
- \_\_\_\_\_
- When the print head passes over an area where ink is to be placed, the uncharged ink droplets pass through the deflection plates in a straight line, landing on the paper



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# Application – Inkjet Printers

- \_\_\_\_\_
- This creates an electric field between the print head and the electrode giving the ink droplets a charge



# Application – Inkjet Printers

- \_\_\_\_\_
- This is similar to the question that was just covered in this lesson

