

## Capacitors

PH 112

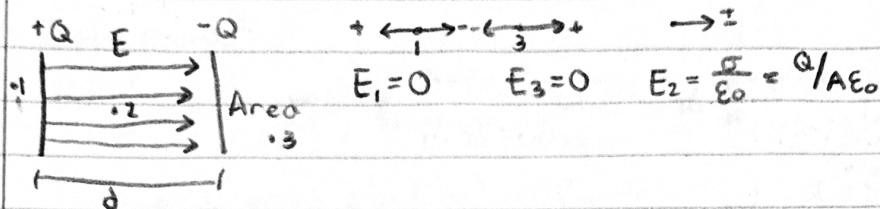


Diagram showing a particle with charge  $q$  and mass  $m$  moving in an electric field  $E$ . The force  $F = qE = ma$  and the acceleration  $a = \frac{q}{m}E$ .

### Example #1

$\phi = 6 \text{ cm} = .06 \text{ m}$   
 $d = 5 \text{ mm} \times 10^{-3} \text{ m}$   
 $N_e = 10^{11} \text{ e}$   
 $t = ?$   $v = ?$

$$F = \frac{eQ}{\pi \epsilon_0 r^2}$$

$$Q = eN_e = 1.6 \times 10^{-19} (10^{11}) = 1.6 \times 10^{-8} \text{ C}$$

$$\epsilon_0 = \frac{1}{4\pi \times 9 \times 10^9} \quad r = \frac{\phi}{2} = 0.03 \text{ m}$$

$$a = \frac{F}{m_e} \quad m_e = 9.1 \times 10^{-31} \text{ kg} \quad a = 1.12 \times 10^{17} \text{ m/s}^2$$

$$t = \sqrt{2d/a} \quad v = at \quad t = 0.3 \text{ s} \quad v = 3.3 \times 10^7 \text{ m/s}$$

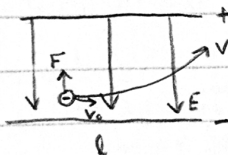
### Example #2

$v_{ox} = 3.34 \times 10^7 \text{ m/s}$

$\lambda = 2 \text{ cm} = .02 \text{ m}$

$E = 5 \times 10^4 \text{ N/C}$

$\theta = ?$



$\tan \theta = \frac{v_y}{v_x} \quad F_e = ma \quad eE = m_e a$   
 $v_y = at \quad v_x = v_{ox} \quad a_y = \frac{e}{m_e} E = \frac{1.6 \times 10^{-19}}{9.1 \times 10^{-31}} (5 \times 10^4)$   
 $l = v_{ox} t \quad t = \frac{l}{v_{ox}} = \frac{0.02}{3.34 \times 10^7} = 8.79 \times 10^{-10} \text{ s}$   
 $= 0.6 \text{ ns} \quad v_y = 8.79 \times 10^{15} (8.79 \times 10^{-10}) = 5.3 \times 10^6 \text{ m/s}$   
 $\theta = \tan^{-1} \left( \frac{5.3 \times 10^6}{3.34 \times 10^7} \right) = 8.95^\circ$