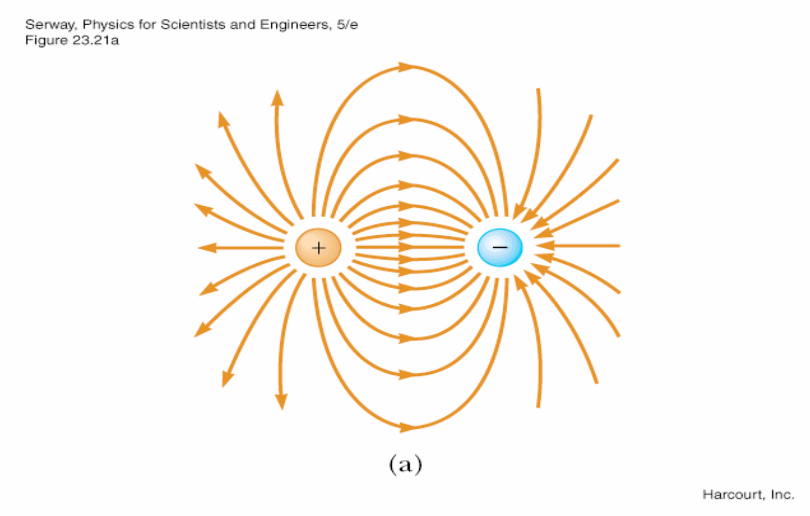
Electric Field Lines



- Same direction as the electric field vector at any point.
- **E** is tangent to the electric field line
- Number of lines perpendicular to the lines is proportional to the field
    - E small: lines further apart
    - E large: Lines closer
- No two lines can cross

Lines begin on a positive charges and end of negative charges

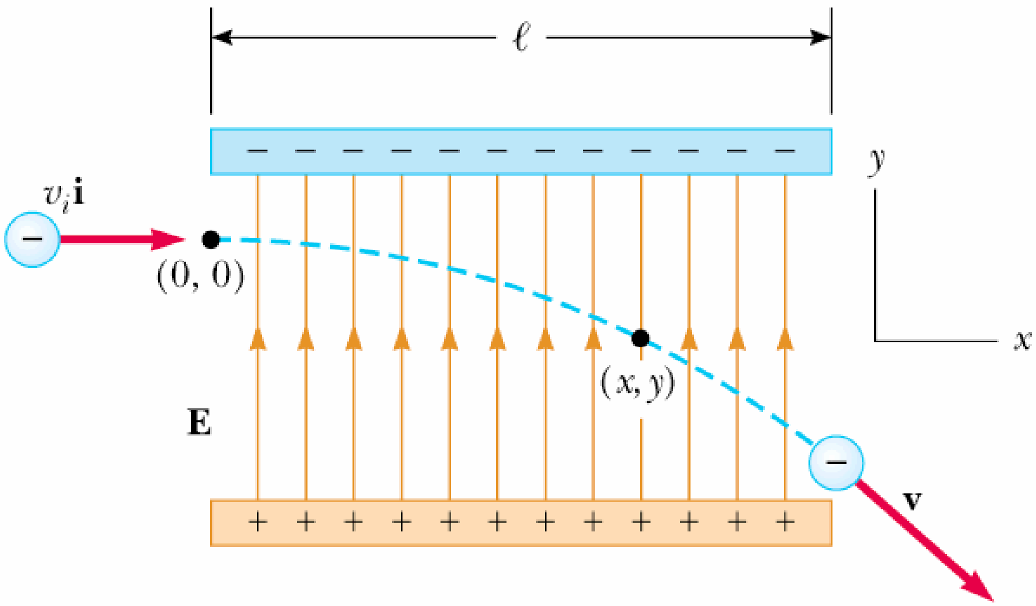
$1/r^2$ behavior from geometry.

Motion of Charged Particles in a Uniform Electric Field

$$\mathbf{F}_e = q\mathbf{E} = m\mathbf{a}$$

$$\Rightarrow \mathbf{a} = \frac{q\mathbf{E}}{m}$$

Serway, Physics for Scientists and Engineers, 5/e
Figure 23.25



47. A proton moved at 4.5×10^5 m/s in the horizontal direction. It enters a uniform vertical electric field of 9.6×10^3 N/C. Find:

- The time it takes the proton to travel 5 cm horizontally.
- Its vertical displacement after it has reached 5 cm horizontally
- The vertical and horizontal components of its velocity at this point.

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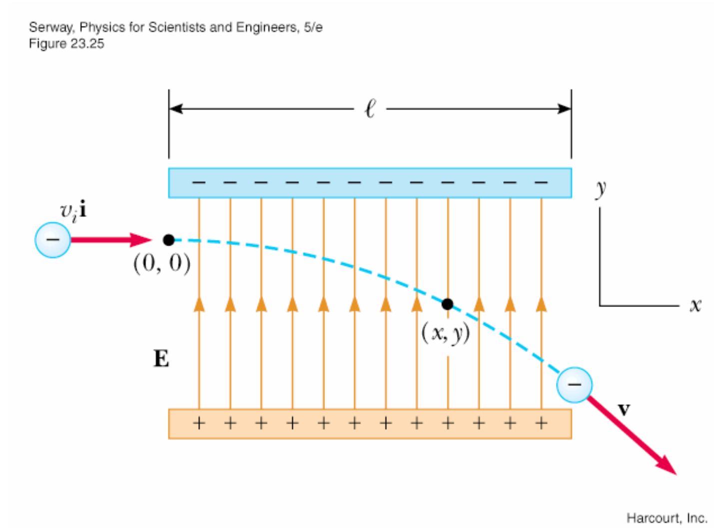


23.47 (a) $t = \frac{x}{v} = \frac{0.0500}{4.50 \times 10^5} = 1.11 \times 10^{-7}\text{ s} = \boxed{111\text{ ns}}$

(b) $a_y = \frac{qE}{m} = \frac{(1.602 \times 10^{-19})(9.60 \times 10^3)}{(1.67 \times 10^{-27})} = 9.21 \times 10^{11}\text{ m/s}^2$

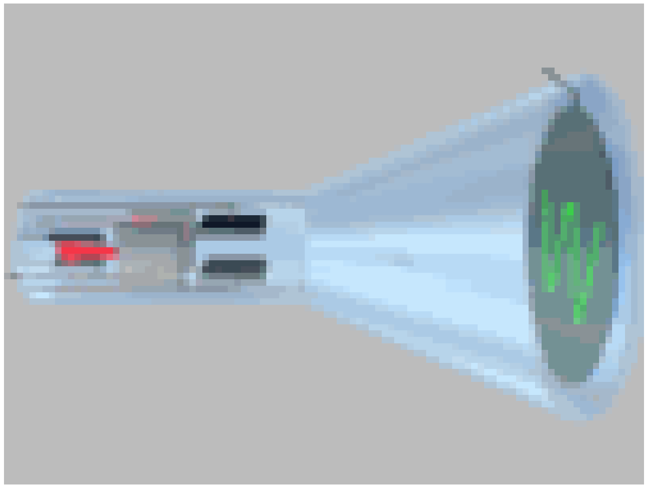
$y - y_i = v_{yi}t + \frac{1}{2}a_y t^2$

$y = \frac{1}{2}(9.21 \times 10^{11})(1.11 \times 10^{-7})^2 = 5.67 \times 10^{-3}\text{ m} = \boxed{5.67\text{ mm}}$

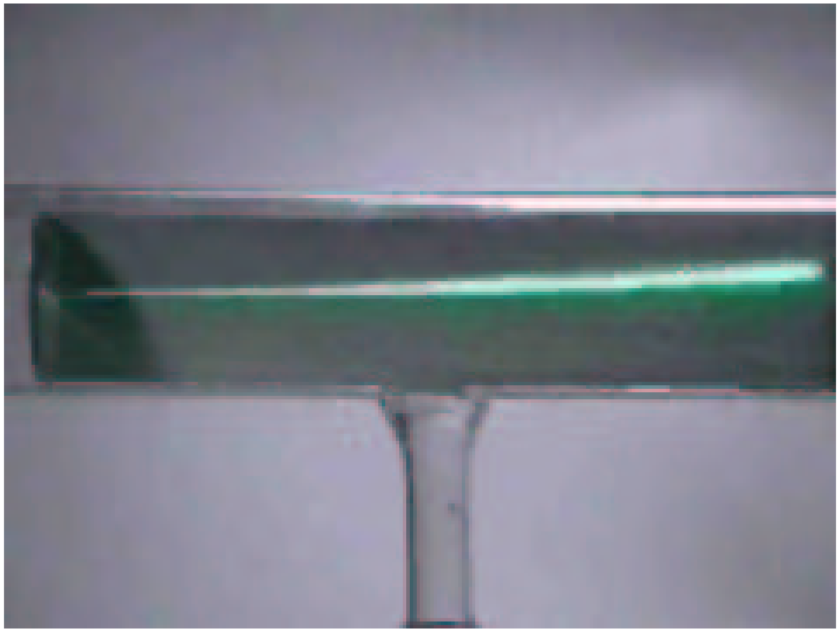
(c) $v_x = \boxed{4.50 \times 10^5\text{ m/s}}$

$v_y = v_{yi} + a_y = (9.21 \times 10^{11})(1.11 \times 10^{-7}) = \boxed{1.02 \times 10^5\text{ m/s}}$

Cathode Ray Tube



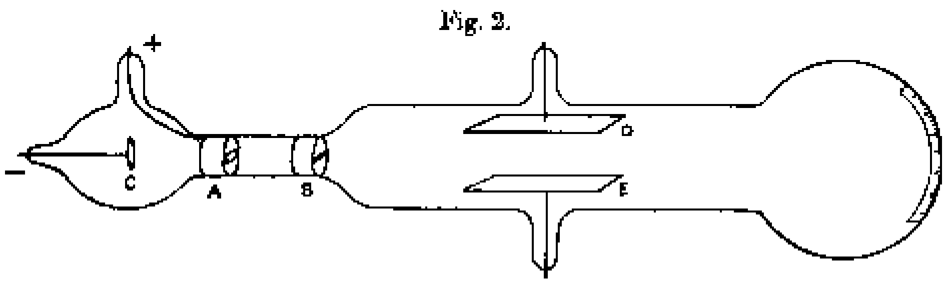
Changing E field applied on the deflection plate (electrodes) moves the electron beam.

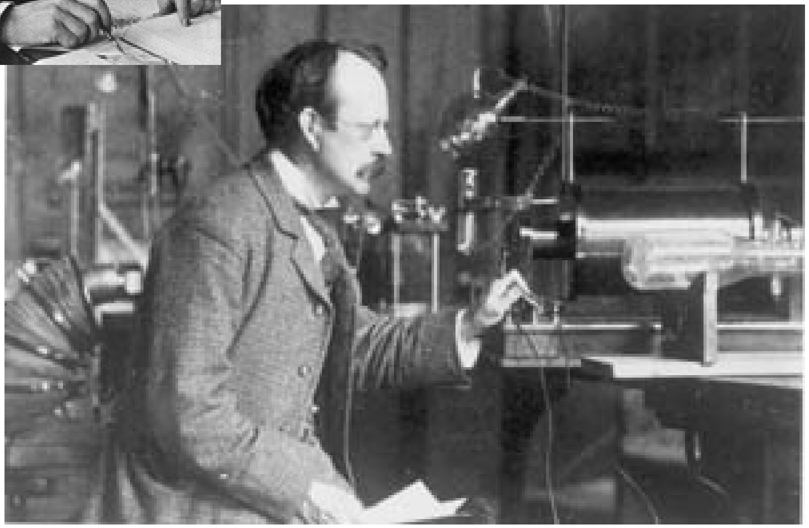


Cathode Ray Tube (CRT)

•J. J. Thomson Used a CRT to discover the electron in 1897

•Physics Nobel Prize in 1906





Used in many applications:

- **•TV**
- **•Oscilloscope**
- **•(old fashioned) computer monitors !**

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Friday, 27 July, 2001, 15:42 GMT 16:42 UK

R.I.P. Cathode ray tube monitor

CATHODE RAY TUBE MONITOR, slipped away quietly after a lifetime dedicated to public service, Hitachi has announced.

Closing its £333.8m-a-year cathode ray tube (CRT) operation the electronics company said: "There are no prospects for growth of the monitor CRT market."

Confusion surrounds the birth of the tube monitor, with some putting its age at 106 (though a German birth certificate has been found dated 1855).

AP
CRT: Always there with a friendly word

It appears unlikely the centenarian ever knew the true identity of its father - with X-ray pioneer William Roentgen, electron experimenter JJ Thompson and Nobel prize-winning physicist Karl Ferdinand Braun all in the frame.

In its youth, CRT devoted its considerable energies to the pursuit

See also:

- 11 Jul 01 | UK
  R.I.P. Millbank Tower
- 11 May 01 | UK
  R.I.P. British Airways' funky tailfins
- 13 Apr 01 | UK
  R.I.P Industry Standard Europe

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- Police shoot man on the M6
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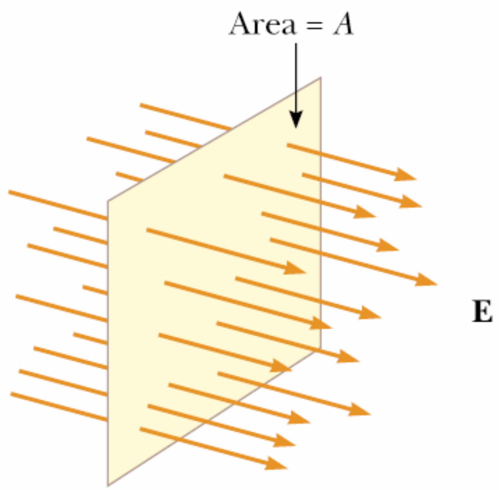
- Judge urges life sentence shake-up

Links to more UK stories are at the foot of the page.

Electric Flux

Proportional to the number of electric field lines penetrating a surface.

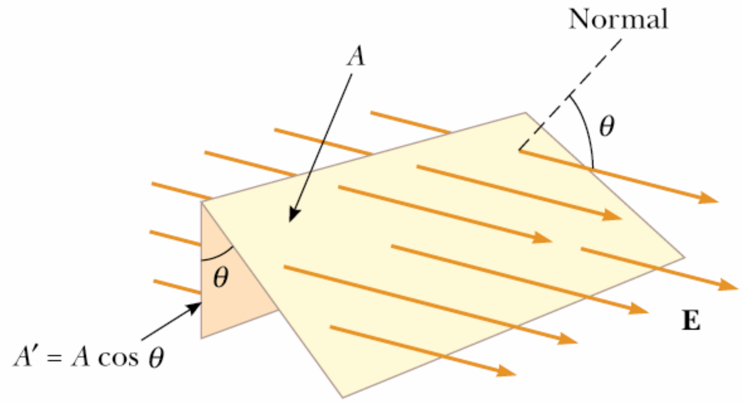


$$\Phi_E = EA$$

Harcou Serway, Physics for Scientists and Engineers, 5/e
Figure 24.2

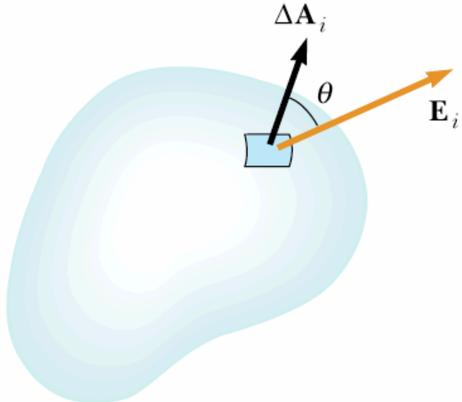
$$\Phi_E = EA\cos\theta$$

$$\Phi_E = \mathbf{E} \cdot \mathbf{A}$$



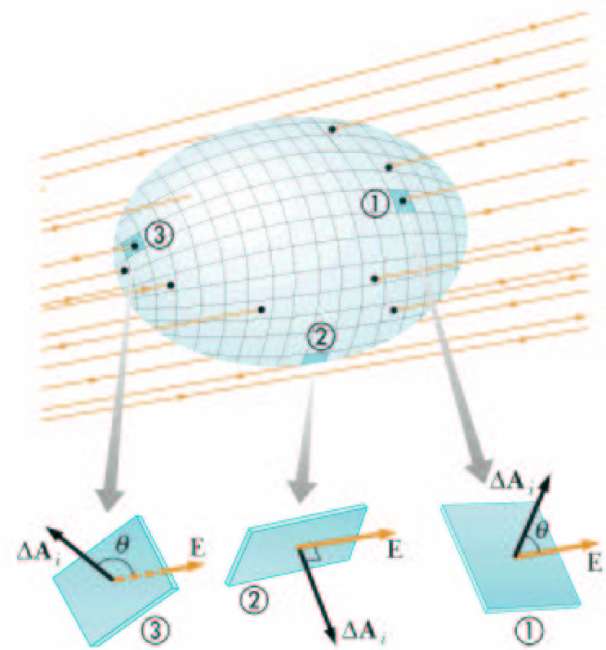
Harcourt, Inc.

Serway, Physics for Scientists and Engineers, 5/e
Figure 24.3

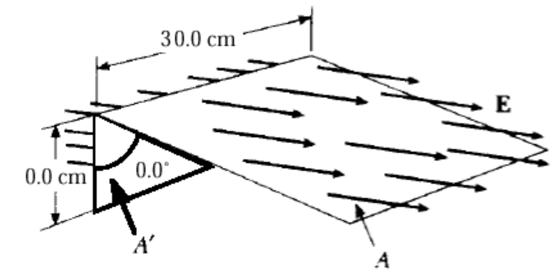


$$\Phi_E = \int \mathbf{E} \cdot d\mathbf{A}$$

Serway, Physics for Scientists and Engineers, 5/e
Figure 24.4



24.5 (a) $A' = (10.0\text{ cm})(30.0\text{ cm})$



$A' = 300\text{ cm}^2 = 0.0300\text{ m}^2$

$\Phi_{E,\,A'} = EA'\cos\theta$

$\Phi_{E,\,A'} = \left(7.80\times10^4\right)(0.0300)\cos 180°$

$\Phi_{E,\,A'} = \boxed{-2.34\ \text{kN}\cdot\text{m}^2/\text{C}}$

(b) $\Phi_{E,\,A} = EA\cos\theta = \left(7.80\times10^4\right)(A)\cos 60.0°$

$A = (30.0\text{ cm})(w) = (30.0\text{ cm})\left(\dfrac{10.0\text{ cm}}{\cos 60.0°}\right) = 600\text{ cm}^2 = 0.0600\text{ m}^2$

$\Phi_{E,\,A} = \left(7.80\times10^4\right)(0.0600)\cos 60° = \boxed{+2.34\ \text{kN}\cdot\text{m}^2/\text{C}}$

(c) The bottom and the two triangular sides all lie *parallel* to **E**, so $\Phi_E = 0$ for each of these. Thus,

$$\Phi_{E,\,\text{total}} = -2.34\ \text{kN}\cdot\text{m}^2/\text{C} + 2.34\ \text{kN}\cdot\text{m}^2/\text{C} + 0 + 0 + 0 = \boxed{0}$$