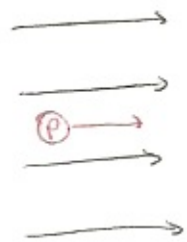
Electric Field: Measuring the Electric Field Using a Test Charge

Example 1:

A) A proton is placed in an electric field as a test charge. The proton is pushed to the right (along a positive x-axis) with a force of 3.20×10^{-15} N. What is the magnitude and direction of this electric field?

B) A force of 8.40 N is exerted on a -8.80 μC charge in a downward direction. What is the magnitude and direction of this electric field?

A.)



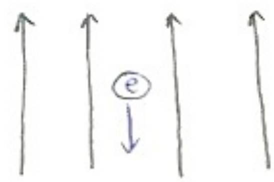
Electric Field must also be to the right. Positive Test charges move with the field.

$$E = \frac{F}{|q|}$$

$$E = \frac{3.20 \times 10^{-15}}{|+1.60 \times 10^{-19}|}$$

$$\boxed{E = 2.0 \times 10^{4}\ N/C}$$

B.)



The electric field must be directed upwards. Negative test charges always move against the field.

$$E = \frac{F}{|q|}$$

$$E = \frac{8.40}{|-8.80 \times 10^{-6}|}$$

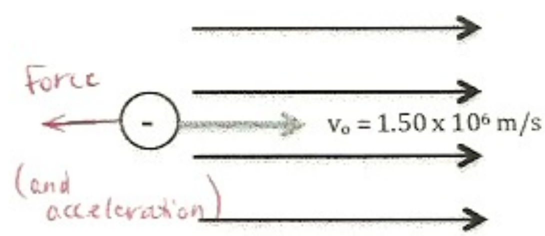
$$\boxed{E = 9.55 \times 10^{5}\ N/C}$$

Example 2:

An electron is traveling with a velocity $v_o = 1.50 \times 10^{6}$ m/s when it runs into an electric field as shown to the right. The electric field has a magnitude of 7.70×10^{3} N/C.

A. How far will the electron travel before coming to a stop?

B. How much time will pass before the electron comes to a stop?



The electron will experience a force and an acceleration in the negative direction. This negative acceleration will cause the electron to lose its positive velocity, slowing it to a stop and eventually accelerating it in a negative direction.

$$E = \frac{F}{|q|}$$

$$F = E \cdot |q|$$

$$F = 7.70 \times 10^{3} |-1.60 \times 10^{-19}|$$

$$F = 1.23 \times 10^{-15}\ N$$

in a negative direction

OR

$$\boxed{F = -1.23 \times 10^{-5}\ N}$$

$$F = ma$$

$$-1.23 \times 10^{-5} = (9.11 \times 10^{-31}) \cdot a$$

$$\boxed{a = -1.35 \times 10^{15}\ m/s^2}$$

A.)

$V_o = 1.50 \times 10^{6}$ m/s

$V_f = 0$ m/s

$a = -1.35 \times 10^{15}$

$x = ?$

$$V_f^2 = V_o^2 + 2ax$$

$$(0)^2 = (1.50 \times 10^{6})^2 + 2(-1.35 \times 10^{15})x$$

$$0 = 2.25 \times 10^{12} - 2.7 \times 10^{15} x$$

$$\boxed{x = 8.33 \times 10^{-4}\ m}$$

B.)

$$v_f = v_o + at$$

$$0 = 1.50 \times 10^{6} + (-1.35 \times 10^{15}) \cdot t$$

$$-1.50 \times 10^{6} = -1.35 \times 10^{15} \cdot t$$

$$\boxed{t = 1.11 \times 10^{-9}\ s}$$