Homework 24.1

A particular 12 V car battery can send a total charge of 84 A*h (ampere-hours) through a circuit, from one terminal to the other. (a) How many coulombs of charge does this represent? (*Hint:* See Eq. 21-3) (b) If this entire charge undergoes a change in electrical potential of 12 V, how much energy is involved?

$$i = \frac{dq}{dt}$$

$$dq = i\,dt$$

$$q = I\Delta t = 84\,\frac{\text{coul}}{\text{sec}} * 1\,\text{hr} \times 60\,\frac{\text{min}}{\text{hr}} \times 60\,\frac{\text{sec}}{\text{min}}$$

$$= 84 \times 3600$$

$$q = 3.02 \times 10^5\ \text{coul}$$

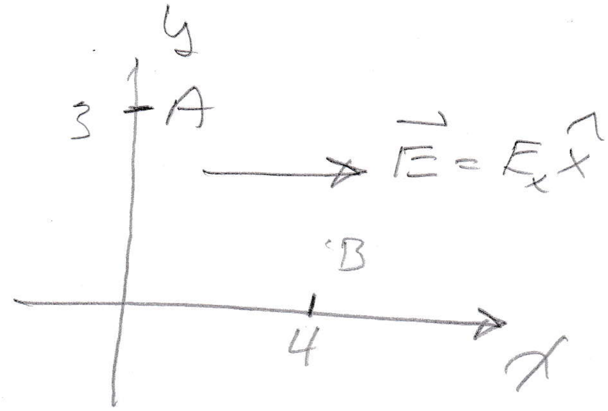
$$U = q\Delta V = 3.02 \times 10^5 * 12$$

$$= 3.6 \times 10^6\ \text{J}$$

Homework 24.7

The electric field in a region of space has components $E_y = E_z = 0$ and $E_x = (4.00\ \text{N/C})x$. Point A is on the y axis at y = 3 m, and point B is on the x axis at x = 4.00 m. What is the potential difference $V_B - V_A$?

$$\Delta V = -\int_A^B \vec{E} \cdot d\vec{s}$$



$$d\vec{s} = \hat{x}\,dx + \hat{y}\,dy$$

$$\vec{E} = E_x \hat{x}$$

$$\vec{E} \cdot d\vec{s} = E_x\,dx$$

$$\Delta V = -\int_A^B E_x\,dx = -\int_0^4 4x\,dx$$

$$= -\left[\frac{4x^2}{2}\right]_0^4 = -2 * 4^2 = -32 \text{ Volts}$$

Homework 24.11

A nonconducting sphere has a radius $R = 2.31\ cm$ and a uniformly distributed charge $q = +3.50\ fC$. Take the electric potential at the sphere's center $V_o = 0$. What is V at radial distance (a) $r = 1.45\ cm$ and (b) $r = R$. (*Hint:* See Module 23-6)

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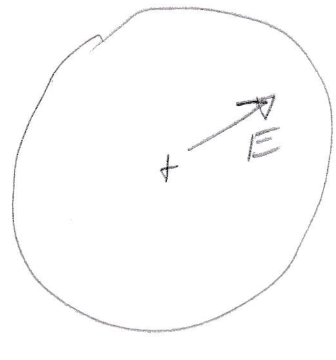

$$E = \frac{1}{4\pi\epsilon_0}\frac{q\,r}{R^3}$$

where q is the total charge

R is the radius of the sphere

r is the point where the E field is to be determined

$$V_2 - V_1 = -\int_{r_1}^{r_2} E \cdot dr$$

$V_1 = 0$

$r_1 = 0$

$$V = V_2 = \int_0^r \frac{1}{4\pi\epsilon_0}\frac{q}{R^3}\, r\,dr = \frac{q}{4\pi\epsilon_0 R^3}\int_0^r r\,dr$$

$$V = \frac{q\; r^2/2}{4\pi\epsilon_0 R^3}$$

If $r = 1.45\ cm$

$$V = \frac{3.5\times10^{-12}\,(.0145)^2}{4\pi\, 8.854\times10^{-12}\,(0.0231)^3 \times 2}$$

$= 268\times10^{-3}$

(a) $V = 268\ mV$

If $r = R$

$$V = \frac{q}{4\pi\epsilon_0 R * 2} = \frac{3.5\times10^{-12}}{8\pi \times 8.854\times10^{-12} \times .0231}$$

(b) $V = 681\ mV$

Homework 24.17

In Fig. 24-38, what is the net electric potential at point P due to the four particles if $V = 0$ at infinity, $q = 5.00\ fC$, and $d = 4.00\ cm$?

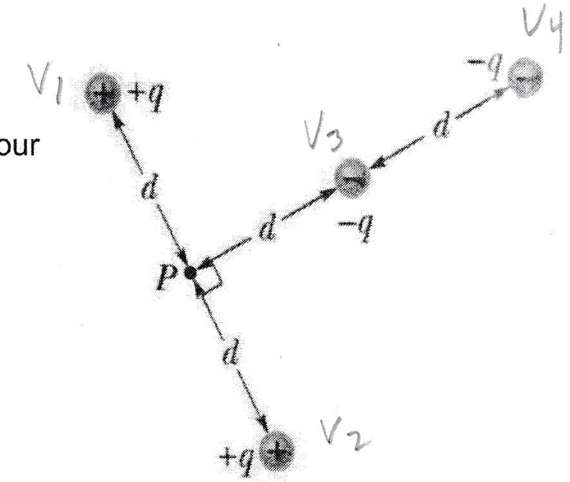

Figure 24-38

$$V_1 = \frac{q}{4\pi\epsilon_0 d}$$

$$V_2 = \frac{q}{4\pi\epsilon_0 d}$$

$$V_3 = \frac{-q}{4\pi\epsilon_0 d}$$

$$V_4 = \frac{-q}{4\pi\epsilon_0 2d}$$

$$V = V_1 + V_2 + V_3 + V_4$$

$$V = \frac{q}{4\pi\epsilon_0 d}\left[1 + 1 - 1 - \frac{1}{2}\right]$$

$$V = \frac{q}{4\pi\epsilon_0 2d} = \frac{5 \times 10^{-12}}{4\pi\, 8.854 \times 10^{-12} \cdot 2 \times 0.04}$$

$$V = \frac{5}{4\pi\, 8.854 * 0.08} = 0.5617$$

V = 562 mV

Homework 24.59

In Fig. 24-60, a charged particle (either an electron or a proton) is moving rightward between two parallel charged plates separated by a distance d = *2.00 mm*. The plate potentials are V_1 = *-70.0 V* and V_2 = -50.0 V. The particle is slowing from an initial speed of *90.0 km/s* at the left plate. (a) Is the particle an electron or a proton? (b) What is its speed just as it reached plate 2?

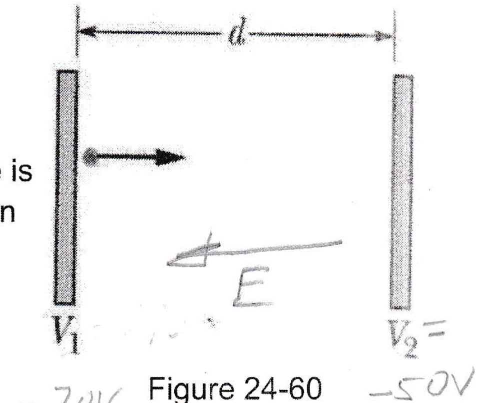

Figure 24-60

$E = \frac{\Delta V}{d} = \frac{(-70+50)}{2} \times 10^3$

$= -100$ N/C

The voltage is higher on the RIGHT

The electric field points away from higher voltages

Since the particle is slowing, the force on it is to the left ∴ it is a

(a) positron

Change in potential energy = change in kinetic energy

$q\Delta V = \frac{1}{2}mv_1^2 - \frac{1}{2}mv_2^2$ $v_1 = (90 \times 10^3)^2$

$v_2^2 = v_1^2 - \frac{qV}{m} \times 2$

$= [90 \times 10^3]^2 - \frac{1.6 \times 10^{-19} \times 20 \times 2}{1.67 \times 10^{-27}}$

$= [81 - 38.32] \times 10^8$ $v_2 = 65.3$ km/s