

- P25.1 (a) Energy of the proton-field system is conserved as the proton moves from high to low potential, which can be defined for this problem as moving from 120 V down to 0 V.

$$K_i + U_i + \Delta E_{\text{mech}} = K_f + U_f \quad 0 + qV + 0 = \frac{1}{2}mv_p^2 + 0$$

$$(1.60 \times 10^{-19} \text{ C})(120 \text{ V}) \left(\frac{1 \text{ J}}{1 \text{ V} \cdot \text{C}} \right) = \frac{1}{2} (1.67 \times 10^{-27} \text{ kg}) v_p^2$$

$$v_p = \boxed{1.52 \times 10^5 \text{ m/s}}$$

- (b) The electron will gain speed in moving the other way,

$$\text{from } V_i = 0 \text{ to } V_f = 120 \text{ V: } K_i + U_i + \Delta E_{\text{mech}} = K_f + U_f$$

$$0 + 0 + 0 = \frac{1}{2}mv_e^2 + qV$$

$$0 = \frac{1}{2} (9.11 \times 10^{-31} \text{ kg}) v_e^2 + (-1.60 \times 10^{-19} \text{ C})(120 \text{ V/C})$$

$$v_e = \boxed{6.49 \times 10^6 \text{ m/s}}$$

P25.3 $E = \frac{|\Delta V|}{d} = \frac{25.0 \times 10^3 \text{ J/C}}{1.50 \times 10^{-2} \text{ m}} = 1.67 \times 10^6 \text{ N/C} = \boxed{1.67 \text{ MN/C}}$

P25.12 (a) $E_x = \frac{k_e q_1}{x^2} + \frac{k_e q_2}{(x-2.00)^2} = 0$ becomes $E_x = k_e \left(\frac{+q}{x^2} + \frac{-2q}{(x-2.00)^2} \right) = 0$.

Dividing by k_e , $2qx^2 = q(x-2.00)^2$ $x^2 + 4.00x - 4.00 = 0$.

Therefore $E = 0$ when $x = \frac{-4.00 \pm \sqrt{16.0 + 16.0}}{2} = \boxed{-4.83 \text{ m}}$.

(Note that the positive root does not correspond to a physically valid situation.)

(b) $V = \frac{k_e q_1}{x} + \frac{k_e q_2}{2.00 - x} = 0$ or $V = k_e \left(\frac{+q}{x} - \frac{2q}{2.00 - x} \right) = 0$.

Again solving for x , $2qx = q(2.00 - x)$.

For $0 \leq x \leq 2.00$ $V = 0$ when $x = \boxed{0.667 \text{ m}}$

and $\frac{q}{|x|} = \frac{-2q}{|2-x|}$ For $x < 0$ $x = \boxed{-2.00 \text{ m}}$.

P25.26 (a) $V = \frac{k_e q_1}{r_1} + \frac{k_e q_2}{r_2} = 2 \left(\frac{k_e q}{r} \right)$

$$V = 2 \left(\frac{(8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2)(2.00 \times 10^{-6} \text{ C})}{\sqrt{(1.00 \text{ m})^2 + (0.500 \text{ m})^2}} \right)$$

$$V = 3.22 \times 10^4 \text{ V} = \boxed{32.2 \text{ kV}}$$

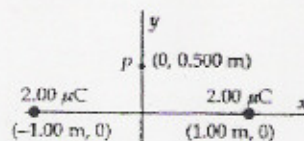


FIG. P25.22

P25.29 $V = a + bx = 10.0 \text{ V} + (-7.00 \text{ V/m})x$

(a) At $x = 0$, $V = \boxed{10.0 \text{ V}}$

At $x = 3.00 \text{ m}$, $V = \boxed{-11.0 \text{ V}}$

At $x = 6.00 \text{ m}$, $V = \boxed{-32.0 \text{ V}}$

(b) $E = -\frac{dV}{dx} = -b = -(-7.00 \text{ V/m}) = \boxed{7.00 \text{ N/C in the } +x \text{ direction}}$

P25.30 (a) For $r < R$ $V = \frac{k_e Q}{R}$

$$E_r = -\frac{dV}{dr} = \boxed{0}$$

(b) For $r \geq R$ $V = \frac{k_e Q}{r}$

$$E_r = -\frac{dV}{dr} = -\left(-\frac{k_e Q}{r^2}\right) = \boxed{\frac{k_e Q}{r^2}}$$

P25.37 $V = \int dV = \frac{1}{4\pi \epsilon_0} \int \frac{dq}{r}$

All bits of charge are at the same distance from O .

So $V = \frac{1}{4\pi \epsilon_0} \left(\frac{Q}{R} \right) = (8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2) \left(\frac{-7.50 \times 10^{-6} \text{ C}}{0.140 \text{ m}/\pi} \right) = \boxed{-1.51 \text{ MV}}$

P25.40 Substituting given values into $V = \frac{k_e q}{r}$

$$7.50 \times 10^3 \text{ V} = \frac{(8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2)q}{0.300 \text{ m}}$$

Substituting $q = 2.50 \times 10^{-7} \text{ C}$,

$$N = \frac{2.50 \times 10^{-7} \text{ C}}{1.60 \times 10^{-19} \text{ C}/e^-} = \boxed{1.56 \times 10^{12} \text{ electrons}}$$