2. **An ion accelerated through a potential difference of 115 V experiences an increase in kinetic energy of 7.37 × 10–17 J. Calculate the charge on the ion.**

$$\Delta K = q|\Delta V|$$

$$7.37 \times 10^{-17} = q(115)$$

$$\boxed{q = 6.41 \times 10^{-19}\ \text{C}}$$

3. (a) **Calculate the speed of a proton that is accelerated from rest through a potential difference of 120 V. (b) Calculate the speed of an electron that is accelerated through the same potential difference.**

(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.

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

$$\left(1.60\times10^{-19}\ \text{C}\right)\left(120\ \text{V}\right)\left(\frac{1\ \text{J}}{1\ \text{V}\cdot\text{C}}\right) = \frac{1}{2}\left(1.67\times10^{-27}\ \text{kg}\right)v_p^2$$

$$v_p = \boxed{1.52\times10^{5}\ \text{m/s}}$$

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

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

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

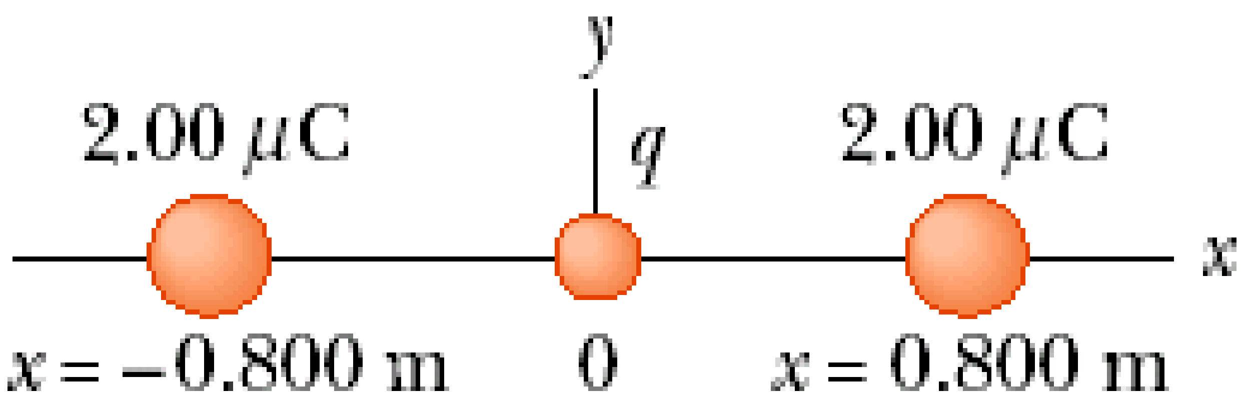
$$0 = \frac{1}{2}\left(9.11 \times 10^{-31}\text{ kg}\right)v_e^2 + \left(-1.60 \times 10^{-19}\text{ C}\right)\left(120\text{ J/C}\right)$$

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

6. The difference in potential between the accelerating plates in the electron gun of a TV picture tube is about 25 000 V. If the distance between these plates is 1.50 cm, what is the magnitude of the uniform electric field in this region?

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

16.Given two 2.00-µC charges, as shown in Figure P25.16, and a positive test charge q = 1.28 × 10–18 C at the origin, (a) what is the net force exerted by the two 2.00-µC charges on the test charge q? (b) What is the electric field at the origin due to the two 2.00-µC charges? (c) What is the electrical potential at the origin due to the two 2.00-µC charges?



(a) Since the charges are equal and placed symmetrically, $\boxed{F = 0}$.

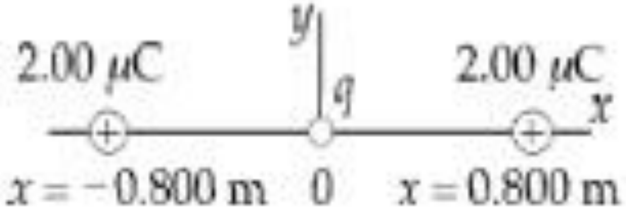


FIG. P25.16

(b) Since $F = qE = 0$, $\boxed{E = 0}$.

(c) $$V = 2k_e \frac{q}{r} = 2\left(8.99 \times 10^9\ \text{N}\cdot\text{m}^2/\text{C}^2\right)\left(\frac{2.00 \times 10^{-6}\ \text{C}}{0.800\ \text{m}}\right)$$

$$V = 4.50 \times 10^4\ \text{V} = \boxed{45.0\ \text{kV}}$$

20. Two point charges, Q1 = +5.00 nC and Q2 = –3.00 nC, are separated by 35.0 cm. (a) What is the potential energy of the pair? What is the significance of the algebraic sign of your answer? (b) What is the electric potential at a point midway between the charges?

(a) $$U = \frac{qQ}{4\pi \epsilon_0 r} = \frac{(5.00\times10^{-9}\ \text{C})(-3.00\times10^{-9}\ \text{C})(8.99\times10^{9}\ \text{V}\cdot\text{m/C})}{(0.350\ \text{m})} = \boxed{-3.86\times10^{-7}\ \text{J}}$$

The minus sign means it takes 3.86×10^{-7} J to pull the two charges apart from 35 cm to a much larger separation.

(b) $$V = \frac{Q_1}{4\pi \epsilon_0 r_1} + \frac{Q_2}{4\pi \epsilon_0 r_2}$$

$$= \frac{(5.00\times10^{-9}\ \text{C})(8.99\times10^{9}\ \text{V}\cdot\text{m/C})}{0.175\ \text{m}} + \frac{(-3.00\times10^{-9}\ \text{C})(8.99\times10^{9}\ \text{V}\cdot\text{m/C})}{0.175\ \text{m}}$$

$$V = \boxed{103\ \text{V}}$$