

Textbook problem 23.55

A charge q released from rest undergoes a displacement \vec{r} in a uniform electric field \vec{E} , while acted on by an unknown force that does an amount of work W_F on the charge. During the displacement the charge experiences a change in kinetic energy ΔK .

$$q = 7.6 \text{ nC}, \quad \vec{r} = 8 \text{ cm } \hat{i}, \quad \vec{E} = -E \hat{i}, \quad W_F = 65 \text{ } \mu\text{J}, \quad \Delta K = 43.5 \text{ } \mu\text{J}$$

Find the work W_E done by the electric field on the charge.

Find the change in potential ΔV .

Find the magnitude E of the electric field.

By the work energy theorem

$$\Delta K = W = W_E + W_F$$

from which

$$W_E = \Delta K - W_F = -21.5 \text{ } \mu\text{J}$$

The change in potential is related to the work done by the field by

$$W_E = -q\Delta V$$

which gives

$$\Delta V = -\frac{W_E}{q} = 2.83 \text{ kV}$$

The work done by the electric field is given by

$$W_E = q\vec{E} \cdot \vec{r} = -qEr$$

from which

$$E = -\frac{W_E}{qr} = 35.4 \frac{\text{kV}}{\text{m}}$$