Answer on Question 64278, Physics, Mechanics, Relativity

Question:

A proton moving with a speed of $1.0 \cdot 10^7\ m/s$ passes through a $0.020\ cm$ thick sheet of paper and emerges with a speed of $2.0 \cdot 10^6\ m/s$. Assuming uniform deceleration, find retardation and time taken to pass through the paper?

Solution:

1) We can find the retardation of the proton from the kinematic equation:

$$v_f^2 = v_i^2 + 2as,$$

here, v_i is the initial speed of the proton, v_f is the final speed of the proton (after it passes through the sheet of paper), a is the retardation of the proton, s is the distance that proton passes when moving through the sheet of paper.

Then, we can find the retardation of the proton:

$$a = \frac{v_f^2 - v_i^2}{2s} = \frac{\left(2.0 \cdot 10^6\ \frac{m}{s}\right)^2 - \left(1.0 \cdot 10^7\ \frac{m}{s}\right)^2}{2 \cdot 2 \cdot 10^{-4}\ m} = -2.4 \cdot 10^{17}\,\frac{m}{s^2}.$$

The sign minus indicates that the proton decelerates.

b) We can find the time taken to pass through the paper from another kinematic equation:

$$v_f = v_i + at,$$

$$t = \frac{v_f - v_i}{a} = \frac{2.0 \cdot 10^6\ \frac{m}{s} - 1.0 \cdot 10^7\ \frac{m}{s}}{-2.4 \cdot 10^{17}\ \frac{m}{s^2}} = 3.3 \cdot 10^{-11} s.$$

Answer:

a) $a = -2.4 \cdot 10^{17}\,\frac{m}{s^2}$.

b) $t = 3.3 \cdot 10^{-11} s$.