(13.2) Assume a linear accelerator is built in three sections, each with 30 stages of 100 kV. Between which sections should a thin carbon stripper foil be placed in order to achieve the highest final energy, when accelerating ^{84}Kr ions from an ion source emitting low energy $^{84}Kr^{4+}$ ions? Consider only the nearest integer charge after stripping.

Basic definitions:

$$MeV := 1.602177 \cdot 10^{-13} \cdot joule \qquad amu := 1.660540 \cdot 10^{-27} \cdot kg$$

Assume that the velocities are small compared to the speed of light. Hence we can use $E_{kin} = (1/2)m_0 v^2$

$$z := 4 \qquad E_{acc} := 0.1 \cdot MeV \qquad n_{stages} := 30 \qquad Z := 36$$

$$E_1 := n_{stages} \cdot z \cdot E_{acc} \qquad \text{Eqn. (13.1)}$$

$$E_1 = 12 \cdot MeV \qquad v_1 := \sqrt{\frac{2 \cdot E_1}{(84 - 4 \cdot 0.0055) \cdot amu}} \qquad$$ Remember that we must subtract the missing e⁻ mass (4+ ions)

$$v_1 = 5.251 \cdot 10^6 \cdot m \cdot sec^{-1}$$

1. assume stripper after first section and use eqn. (13.2) to compute average charge after stripper foil:

$$z_2 := Z \cdot \left[1 + \left[\frac{v_1}{3.6 \cdot 10^6 \cdot \frac{m}{(sec)} \cdot Z^{0.45}} \right]^{-1.67} \right]^{-0.6}$$

$$z_2 = 9.72 \qquad \text{Nearest integer charge is 10.}$$

$$z_2 := 10$$

$$E_{123} := 2 \cdot \left(n_{stages} \cdot z_2 \cdot E_{acc} \right) + E_1 \qquad\qquad E_{123} = 72 \cdot MeV \qquad \text{Final energy}$$

2. assume stripper after second section:

$$E_2 := \left(n_{stages} \cdot z \cdot E_{acc} \right) \cdot 2 \qquad E_2 = 24 \cdot MeV$$

$$v_2 := \sqrt{\frac{2 \cdot E_2}{(84 - 4 \cdot 0.0055) \cdot amu}} \qquad v_2 = 7.426 \cdot 10^6 \cdot m \cdot sec^{-1}$$

$$z_3 := Z \cdot \left[1 + \left(\frac{v_2}{3.6 \cdot 10^6 \cdot \frac{m}{sec} \cdot Z^{0.45}} \right)^{-1.67} \right]^{-0.6}$$

$$z_3 = 13.074 \qquad \text{Nearest integer charge is 13.}$$

$$z_3 := 13$$

$$E_{123} := \left(n_{stages} \cdot z_3 \cdot E_{acc} \right) + E_2 \qquad\qquad E_{123} = 63 \cdot MeV \qquad \text{Final energy}$$

Answer: Because the first final energy is greater than the last final energy, the foil should be between first and second section.