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Kelas : 23B

Mk : Fisika Modern

① $x'_1 = 0$ hingga $x'_2 = L$

$$L = x_2 - x_1$$

$$x' = \gamma (x - ut)$$

$$t' = \gamma \left(t - \frac{ux}{c^2} \right)$$

$$\gamma = \frac{1}{\sqrt{1 - \frac{u^2}{c^2}}}$$

* waktu sama ($t_1 = t_2$)

$$x'_1 = \gamma (x_1 - ut)$$

$$x'_2 = \gamma (x_2 - ut)$$

$$L_0 = x'_2 - x'_1$$

$$L_0 = \gamma (x_2 - ut) - \gamma (x_1 - ut)$$

* $L_0 = \gamma (x_2 - x_1)$ atau

$$L = \frac{L_0}{\gamma} \rightarrow \gamma = \frac{1}{\sqrt{1 - \frac{u^2}{c^2}}}$$

$$L = L_0 \sqrt{1 - \frac{u^2}{c^2}}$$

② diketahui:

$$E = 25 \text{ GeV}$$

$$d = 300 \text{ m}$$

$$m_0 = 0,511 \text{ meV}/c^2$$

$$c = 3 \times 10^8 \text{ m/s}$$

ditanya:

a. $V \dots ?$

b. $t \dots ?$

c. $L' \dots ?$

d. $t' \dots ?$

Jawab:

$$a.) E = \gamma m_0 c^2$$

$$\gamma = \frac{E}{m_0 c^2}$$

$$\gamma = \frac{25 \times 10^9 \text{ eV}}{0,511 \times 10^6 \text{ eV}}$$

$$\gamma = 4,89 \times 10^4$$

$$1 - \frac{v^2}{c^2} = \frac{1}{\gamma^2}$$

$$\frac{v^2}{c^2} = 1 - \frac{1}{(4,89 \times 10^4)^2}$$

$$v = c \sqrt{1 - \frac{1}{(4,89 \times 10^4)^2}}$$

$$v \approx c (1 - 1,05 \times 10^{-10})$$

$$v \approx 2,9999 \times 10^8 \text{ m/s}$$

Selisih dengan kecepatan cahaya

$$c - v \approx 0,031 \text{ m/s}$$

Jadi elektron hampir bergerak dg kecepatan cahaya

$$c.) L' = L \sqrt{1 - \frac{v^2}{c^2}}$$

karena $\gamma = 4,89 \times 10^4$, maka

$$L' = 3000$$

$$4,89 \times 10^4$$

$$L' = 0,061 \text{ m} \approx 6,1 \text{ cm}$$

$$b.) t = \frac{d}{v}$$

$$t = \frac{3000 \text{ m}}{2,9999 \times 10^8 \text{ m/s}}$$

$$t \approx 1,0000000001 \times 10^{-3} \text{ s}$$

$$= 10 \text{ ns}$$

$$d.) t' = \frac{t}{\gamma}$$

$$t' = 10^{-9}$$

$$4,89 \times 10^4$$

$$t' = 2,04 \times 10^{-9} \text{ s}$$

$$= 0,204 \text{ ns}$$

3. diketahui : ditanya : $v \dots ?$ dan $\lambda'' \dots ?$

$$\lambda_0 = 122 \text{ nm}$$

$$\lambda_1 = 366 \text{ nm}$$

$$c = 3 \times 10^8 \text{ m/s}$$

Jawab:

$$a) \frac{\lambda_1}{\lambda_0} = \sqrt{\frac{1 + \frac{v}{c}}{1 - \frac{v}{c}}}$$

$$\frac{366 \text{ nm}}{122 \text{ nm}} = \sqrt{\frac{1 + \frac{v}{c}}{1 - \frac{v}{c}}}$$

$$3 = \sqrt{\frac{1 + \frac{v}{c}}{1 - \frac{v}{c}}}$$

$$g = \frac{1 + \frac{v}{c}}{1 - \frac{v}{c}}$$

$$g(1 - \frac{v}{c}) = 1 + \frac{v}{c}$$

$$g - g \frac{v}{c} = 1 + \frac{v}{c}$$

$$8 = 10 \frac{v}{c}$$

$$v = \frac{8}{10} c$$

$$v = 0,8 c$$

$$v = 0,8 (3 \times 10^8 \text{ m/s})$$

$$v = 2,4 \times 10^8 \text{ m/s}$$

$$b) \frac{\lambda''}{\lambda_0} = \sqrt{\frac{1 - \frac{v}{c}}{1 + \frac{v}{c}}}$$

$$\lambda'' = \lambda_0 \times \sqrt{\frac{1 - 0,8}{1 + 0,8}}$$

$$= \lambda_0 \times \sqrt{\frac{0,2}{1,8}}$$

$$= 122 \times \sqrt{0,1111}$$

$$= 122 \times 0,3333$$

$$\lambda'' = 40,64 \text{ nm}$$

4. diketahui : ditanya : $m \dots ?$

$$E_{\text{atom}} = 200 \text{ MeV}$$

$$A = 235$$

$$1 \text{ MeV} = 1,602 \times 10^{-13} \text{ J}$$

$$c = 3 \times 10^8 \text{ m/s}$$

$$m_{\text{atom}} = \frac{235g}{6,022 \times 10^{23}}$$

Jawab:

$$E = 200 \text{ MeV} \times 1,602 \times 10^{-13} \text{ J/MeV}$$

$$= 3,204 \times 10^{-11} \text{ J}$$

Jumlah atom dalam uranium 1 kg:

$$N = \frac{1000g}{m_{\text{atom}}}$$

$$= \frac{1000g}{\frac{235g}{6,022 \times 10^{23}}}$$

$$= \frac{1000g}{235g}$$

$$= 6,022 \times 10^{23}$$

$$= 2,56 \times 10^{24} \text{ atom}$$

$$E_{\text{total}} = (3,204 \times 10^{-11} \text{ J/atom}) (2,56 \times 10^{24})$$

$$= 8,20 \times 10^{13} \text{ J}$$

$$E = mc^2 \rightarrow m = E/c^2$$

$$m = (8,20 \times 10^{13} \text{ J}) / (3 \times 10^8 \text{ m/s})^2$$

$$= 9,11 \times 10^{-14} \text{ kg}$$

5) diketahui:

$$m_p = 1,087276 \text{ u}$$

$$m_n = 1,008665 \text{ u}$$

$$M_{\text{helium}} = 4,001506 \text{ u}$$

$$m_u = 1,66054 \times 10^{-27} \text{ kg}$$

$$1 \text{ u} = 931,5 \text{ MeV}$$

Jawab:

$$a.) \text{ massa total} = 2m_p + 2m_n$$

$$= 2(1,087276) + 2(1,008665)$$

$$= 4,031824$$

$$\Delta m = m_{\text{total}} - m_{\text{helium}}$$

$$= 4,031824 - 4,001506$$

$$= 0,030318 \text{ u}$$

$$E = \Delta m^2$$

$$= (3,044 \times 10^{-29} \text{ kg})(2,9979 \times 10^8 \text{ m/s})^2$$

$$= 4,533 \times 10^{-12}$$

$$= 28,3 \text{ MeV}$$

=

$$b.) \Delta m_{\text{kg}} = (0,030318)(1,66054 \times 10^{-27} \text{ kg})$$

$$= 5,04 \times 10^{-29} \text{ kg}$$

6) diketahui:

$$v_A = 0,8c$$

$$v_B = 0,6c$$

ditanya:

$$v' \dots ?$$

Jawab:

$$v' = \frac{v_A + v_B}{1 + \frac{v_A v_B}{c^2}} = \frac{0,8 + 0,6}{1 + \frac{(0,8)(0,6)}{c^2}} = \frac{1,4c}{1 + 0,48} = \frac{1,4}{1,48} = 0,946c$$

7) diketahui:

$$P = 20 \text{ W}$$

$$\lambda = 589 \text{ nm} = 589 \times 10^{-9} \text{ m}$$

$$h = 6,626 \times 10^{-34} \text{ Js}$$

$$c = 3 \times 10^8 \text{ m/s}$$

ditanya: N ... ?

Jawab:

$$E = \frac{hc}{\lambda} = \frac{(6,626 \times 10^{-34})(3 \times 10^8)}{589 \times 10^{-9}} = \frac{1,9878 \times 10^{-25}}{589 \times 10^{-9}} = 3,37 \times 10^{-9} \text{ J}$$

$$N = \frac{20}{3,37 \times 10^{-9}} = 5,94 \times 10^9 \text{ foton/s}$$

8) diketahui:

$$W = 2,2 \text{ eV}$$

$$\lambda = 3500 \text{ \AA} = 3500 \times 10^{-10} \text{ m} = 3,5 \times 10^{-7} \text{ m}$$

$$h = 6,626 \times 10^{-34} \text{ Js}$$

$$c = 3 \times 10^8 \text{ m/s}$$

$$m = 1,6 \times 10^{-19} \text{ kg}$$

ditanya:

$$K \dots ?$$

Jawab:

$$E = \frac{hc}{\lambda} = \frac{(6,626 \times 10^{-34})(3 \times 10^8)}{3,5 \times 10^{-7}} = \frac{1,9878 \times 10^{-25}}{3,5 \times 10^{-7}} = 5,68 \times 10^{-19} \text{ J}$$

$$E = \frac{5,68 \times 10^{-19}}{1,6 \times 10^{-19}} = 3,55 \text{ eV}$$

$$K = E - W$$

$$= 3,55 - 2,2$$

$$= 1,35 \text{ eV}$$

(KKY)