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MK : Fisika Modern

1) $x'_1 = 0$ hingga $x'_2 = l_0$

$$l = x_2 - x_1$$

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

$$t'_1 = \gamma \left(t - \frac{vx_1}{c^2} \right)$$

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

• waktu sama ($t_1 = t_2$)

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

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

$$l_0 = x'_2 - x'_1$$

$$l_0 = \gamma (x_2 - vt) - \gamma (x_1 - vt)$$

$$l_0 = \gamma (x_2 - x_1) \text{ atau } l = \frac{l_0}{\gamma} \rightarrow \gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$l = l_0 \sqrt{1 - \frac{v^2}{c^2}}$$

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 dg cahaya $0,031 \text{ m/s}$, jadi elektron hampir bergerak dg kecepatan cahaya



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

karena $v = 4,89 \times 10^8$, maka

$$l' = \frac{3000}{4,89 \times 10^8}$$

$$l' = 0,0061 \text{ m} \Rightarrow 6,1 \text{ cm}$$

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

$$t = \frac{3000 \text{ m}}{2,99999 \times 10^8 \text{ m/s}}$$

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

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

$$t' = \frac{10^{-3}}{4,89 \times 10^8}$$

$$t' = 2,04 \times 10^{-4} \text{ s} \\ = 0,204 \mu\text{s}$$

3) diketahui

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

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

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

ditanya = $v \dots ?$ dan $\lambda'' \dots ?$

Jawab:

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

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

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

$$9 = \frac{1 + \frac{v}{c}}{1 - \frac{v}{c}}$$

~~sketch~~

$$9(1 - \frac{v}{c}) = 1 + \frac{v}{c}$$

$$9 - 9 \frac{v}{c} = 1 + \frac{v}{c}$$

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

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

$$v = 0,8 c$$

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

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

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

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

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

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

$$= 122 \times 0,3323$$

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

4) diketahui:

$$E/\text{atom} = 200 \text{ MeV}$$

$$A = 235$$

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

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

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

ditanya: m ?

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:

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

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

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

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

$$= 8,26 \times 10^{13} \text{ J}$$

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

$$m = (8,26 \times 10^{13} \text{ J}) / (3 \times 10^8 \text{ m/s})^2$$

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

5) diketahui:

$$m_p = 1,007276 \text{ u}$$

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

$$m_{\text{Helium}} = 4,001506 \text{ u}$$

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

$$1 \text{ u}^2 = 931,5 \text{ MeV}$$

ditanya:

$$a. E \dots ?$$

$$b. \Delta m \text{ kg} ?$$

Jawab:

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

$$= 2(1,007276) + 2(1,008665)$$

$$= 4,03188 \text{ u}$$

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

$$= 4,0318824 - 4,001506$$

$$= 0,030376 \text{ u}$$

$$E = \Delta m^2$$

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

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

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

$$b) \Delta m \text{ kg} = (0,030376 \text{ u}) (1,66054 \times 10^{-27})$$

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



6) diketahui :

$$V_A = 0,8 \text{ C}$$

$$V_B = 0,6 \text{ C}$$

ditanya:

$$V' ?$$

Jawab:

$$V' = \frac{V_A + V_B}{1 + \frac{V_A V_B}{c^2}} = \frac{0,8 + 0,6}{1 + \frac{(0,8)(0,6)}{c^2}} = \frac{1,4}{1 + 0,48} = \frac{1,4}{1,48} = 0,946 \text{ C}$$

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:

$$E = \frac{hc}{\lambda} = \frac{(6,626 \times 10^{-34})(3 \times 10^8)}{589 \times 10^{-9}} = \frac{1,9878 \times 10^{-25}}{5,89 \times 10^{-9}} = 3,37 \times 10^{-9} \text{ J}$$

$$N = \frac{20}{3,37 \times 10^{-9}} = 5,94 \times 10^{19} \text{ foton/s}$$

8) Diketahui : $\omega = 2,2 \text{ eV}$

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

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

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

$$h\nu = 1,6 \times 10^{-19} \text{ J}$$

Ditanya : Energi kinetik maksimum fotoelektron (h) dalam eV?

Jawab:

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

$$E = \frac{5,68 \times 10^{-19}}{1,6 \times 10^{-19}} = 3,53 \text{ eV}$$

$$K = E - \omega = 3,53 - 2,2 = 1,33 \text{ eV.}$$