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MK : Fisika Modern

(1) $x_1' = 0$ hingga $x_2' = l_0$

$$L = x_2 - x_1$$

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

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

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

waktu sama ($t_1 = t_2$)

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

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

$$l_0 = x_2' - x_1'$$

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

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

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

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

(2) Dik: $E = 25 \text{ GeV}$

$$d = 3000 \text{ m}$$

$$m_0 = 0.511 \text{ MeV}/c^2$$

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

Dit: a. percepatan elektron yang energinya 25 GeV?

b. Waktu yang diperlukan untuk menempuh jarak 3000 m?

c. Panjang akselerator dalam kerangka acuan elektron?

d. Waktu tempuh elektron dalam kerangka acuan inersia sendiri?

Jwb =

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

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

$$= \frac{25 \times 10^9 \text{ eV}}{0.511 \times 10^6 \text{ eV}}$$

$$= 4.89 \times 10^4$$

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

$$\frac{v^2}{c^2} = 1 - \frac{1}{(4.89 \times 10^4)^2}$$

$$V = c \sqrt{1 - \frac{1}{(4.89 \times 10^4)^2}}$$

$$V \approx c \cdot (1 - 1.05 \times 10^{-10})$$

$$V \approx 2.9999 \times 10^8 \text{ m/s}$$

selisih dengan kecepatan cahaya

$$c - V \approx 0.031 \text{ m/s}$$

Jadi elektron hampir bergerak dengan kecepatan cahaya

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

$$= \frac{3000 \text{ m}}{}$$

$$2.9999 \times 10^8 \text{ m/s}$$

$$= 1.0000000001 \times 10^{-3} \text{ s}$$

$$= 10 \mu\text{s}$$

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

$$\text{Karena } \gamma \approx 4.89 \times 10^4, \text{ maka}$$

$$L' = \frac{3000}{}$$

$$4.89 \times 10^4$$

$$L' = 0.061 \text{ m} = 6.1 \text{ cm}$$

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

$$\gamma$$

$$= 10^{-5}$$

$$4.89 \times 10^4$$

$$= 2.04 \times 10^{-4}$$

$$= 0.204 \text{ ns}$$

$$③ a) \frac{\lambda'}{\lambda_0} = \sqrt{\frac{1 + \frac{v}{c}}{1 - \frac{v}{c}}}$$

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

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

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

$$1 - \frac{v}{c}$$

$$\begin{aligned} \gamma g(1 - \frac{v}{c}) &= 1 + \frac{v}{c} \\ g - g \frac{v}{c} &= 1 + \frac{v}{c} \\ 8 &= 10 \frac{v}{c} \end{aligned}$$

$$\frac{v}{10} = 0.8c$$

$$\begin{aligned} v &= 0.8(3 \times 10^8 \text{ m/s}) \\ &= 2.4 \times 10^8 \text{ m/s} \end{aligned}$$

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

$$\begin{aligned} \lambda'' &= \lambda_0 \times \sqrt{\frac{1 - 0.8}{1 + 0.8}} \\ &= \lambda_0 \times \sqrt{\frac{0.2}{1.8}} \end{aligned}$$

$$= 122 \times 0.3323$$

$$\lambda'' = 40.67 \text{ nm}$$

SiDU

④ Dik = $E \text{ per atom} = 200 \text{ MeV}$

$A = 235$

$1 \text{ MeV} = 1.602 \times 10^{-13} \text{ J}$

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

$m_{\text{atom}} = 235 \text{ g}$

6.022×10^{23}

Jwb = $6 = 200 \text{ MeV} \times 1.602 \times 10^{-13} \text{ J/MeV}$
 $= 3.204 \times 10^{-11} \text{ J}$

Jumlah atom dalam uranium 1 kg

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

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

$= 4.255 \times 10^{21}$

6.022×10^{23}

$= 2.56 \times 10^{24} \text{ atom}$

$E_{\text{total}} = (3.204 \times 10^{-11} \text{ J/atom}) (2.56 \times 10^{24})$
 $= 8.20 \times 10^{13} \text{ J}$

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

$m = (8.20 \times 10^{13} \text{ J}) / (3 \times 10^8 \text{ m/s})^2$
 $\approx 9.11 \times 10^{-4} \text{ kg}$

⑤ Diketahui = $m_p = 1.007276 \text{ u}$

$m_n = 1.008665 \text{ u}$

$m_{\text{helium}} = 4.001506 \text{ u}$

$1 \text{ u} = 1.66054 \times 10^{-27} \text{ kg}$

$1 \text{ u} c^2 = 931.5 \text{ MeV}$

Ditanya = a) energi ikat inti helium ^4_2He

b) beda massa inti helium dengan total massa partikel

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

$= 2(1.007276) + 2(1.008665)$

$= 4.031824$

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

$= 4.031824 - 4.001506$

$= 0.030318 \text{ u}$

$E = \Delta mc^2$

$= (3.044 \times 10^{-29} \text{ kg}) (2.9979 \times 10^8 \text{ m/s})^2$

$= 4.533 \times 10^{-12} \text{ J}$

$= 28.3 \text{ MeV}$

b) $\Delta m_{\text{kg}} = (0.030318 \text{ u}) \times (1.66054 \times 10^{-27} \text{ kg})$
 $= 5.04 \times 10^{-29} \text{ kg}$

⑥ Dik = $V_A = 0.8 \text{ C}$

$V_B = 0.6 \text{ C}$

Jawab =

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

$$= \frac{1,4 c}{1 + 0,48}$$

$$= \frac{1,4}{1,48}$$

$$= 0,946 c$$

7. Dik: $P = 20 \text{ W}$

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

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

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

$$\text{Jawab: } E = \frac{hc}{\lambda} = \frac{(6,626 \times 10^{-34}) (3 \times 10^8)}{589 \times 10^{-9}}$$

$$= \frac{1,9878 \times 10^{-25}}{589 \times 10^{-9}}$$

$$\approx 3,37 \times 10^{-19} \text{ J}$$

$$N = 20$$

$$3,37 \times 10^{-19}$$

$$= 5,94 \times 10^{-19} \text{ foton / detik}$$

8. Dik: $W = 2,2 \text{ eV}$

$$\lambda = 3500 \text{ Å} = 3500 \times 10^{-10} \text{ m}$$

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

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

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

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

$$\text{Jawab: } E = \frac{hc}{\lambda} = \frac{(6,626 \times 10^{-34}) (3 \times 10^8)}{3,5 \times 10^{-7}}$$

$$= \frac{1,9878 \times 10^{-24}}{3,5 \times 10^{-7}}$$

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

$$= 3,53 \text{ eV}$$

$$K = E - W$$

$$= 3,53 - 2,2$$

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