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Fisika Modern

1. $x'_1 = 0$ hingga $x'_2 = L_0$

$$L = x_2 - x_1$$

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

$$t' = \gamma \left(1 - \frac{u^2}{c^2}\right)$$

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

• waktu sama ($t_1 = t_2$)

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

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

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

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

$$L_0 = \gamma (x_2 - x_1) \text{ atau}$$

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

2. Diket = $E = 25 \text{ GeV}$

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

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

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

Jawab =

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

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

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

$$= 4.89 \times 10^4$$

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

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

$$\begin{aligned} v &= c \sqrt{1 - \frac{1}{(4.89 \times 10^4)^2}} \\ v &\approx c, c(1 - 1.05 \times 10^{-10}) \\ v &\approx 2.999 \times 10^8 \text{ m/s} \end{aligned}$$

Selisih dg kecepatan

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

Jadi, elektron hampir bergerak dg kecepatan cahaya



$$b). t = \frac{d}{v} = \frac{3000 \text{ m}}{2.999 \times 10^8 \text{ m/s}}$$

$$= 1.000000001 \times 10^{-3} \text{ s}$$

$$t = 1.000000001 \times 10^{-3} \text{ s}$$

$$= 10^{-4}$$

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

karana $\gamma = 4.89 \times 10^4$, maka

$$L' = \frac{3000}{4.89 \times 10^4}$$

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

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

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

$$t' = \frac{10^{-4}}{4.89 \times 10^4}$$

$$t' = 2.04 \times 10^{-9} \text{ s} = 0.204 \text{ ns}$$

$$3. \text{ Diket } \lambda_0 = 122 \text{ nm}$$

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

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

Jawab =

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

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

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

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

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

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

$$0 = 10 \frac{v}{c}$$

$$v = \frac{8}{10} c = 0.8c$$

$$v = 0.8 (3 \times 10^8 \text{ m/s})$$

$$= 2.4 \times 10^8 \text{ m/s}$$

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

$$\lambda'' = 122 \text{ nm} \sqrt{\frac{1 - 0.8}{1 + 0.8}}$$

$$= 122 \times \sqrt{\frac{0.2}{1.8}}$$

$$= 122 \times 0.3323$$

$$= 40.67 \text{ nm}$$

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



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

$m \text{ uranium} = 235 \text{ g}$

$A = 235$

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

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

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

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

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

$N = 1000 \text{ g}$

$m \text{ atom}$

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

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

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

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

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

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

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

$\approx 9,11 \times 10^{-4} \text{ kg}$

5. Diket = $M_p = 1,007276 \text{ u}$ $M_n = 1,66054 \times 10^{-27} \text{ kg}$

$M_{\text{He}} = 4,001506 \text{ u}$ $E_{\text{He}} = 931,5 \text{ MeV}$

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

Jawab =

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

$= 2(1,007276) + 2(1,66054)$

$= 4,031824$

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

$= 4,031824 - 4,001506$

$= 0,030318 \text{ u}$



☐ $E = \Delta mc^2$

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

☐ $= 4,533 \times 10^{-12} \text{ J} = 28,3 \text{ MeV}$

☐ b. $\Delta m_{\text{kg}} = (0,00376 \text{ u}) \times (1,66054 \times 10^{-27} \text{ kg})$

☐ $= 3,04 \times 10^{-29} \text{ kg}$

☐ 6. Diket = $V_A = 0,8 \text{ C}$

☐ $V_B = 0,6 \text{ C}$

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

☐ 7. Diket = $P = 20 \text{ W}$

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

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

☐ $c = 3 \times 10^8 \text{ m/s}$

☐ Jawab =

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

☐ $= \frac{1,9878 \times 10^{-25}}{589 \times 10^{-9}} = 3,37 \times 10^{-19} \text{ J}$

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

☐ 8. $W = \phi = 2,2 \text{ eV}$

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

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

☐ $v = 3 \times 10^8 \text{ m/s}$

☐ $W = 1,6 \times 10^{-19} \text{ J}$

☐ Jawab =

☐
$$E = \frac{hc}{\lambda} = \frac{(6,626 \times 10^{-34}) (3 \times 10^8)}{3,5 \times 10^{-7}} = \frac{1,9178 \times 10^{-23}}{3,5 \times 10^{-7}} = 5,68 \times 10^{-19} \text{ J}$$

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

☐ $K = E - W$

☐ $= 3,53 - 2,2 = 1,33 \text{ eV}$

