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MK : Fisika Modern

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

$$l = x_2 - x_1$$

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

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

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

• 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 : $E = 25 \text{ GeV}$

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

$$m_0 = 0,5118 \text{ MeV}/c^2$$

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

ditanya : a) Kecepatan elektron yang energinya 25 GeV?

b) Waktu yang diperlukan untuk menempuh jarak 3000 m?

c) Panjang akselerator dalam kerangka atuan elektron?

d) Waktu tempuh elektron dalam kerangka atuan inersianya sendiri?

Jawab.

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

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

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

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

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

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

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

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

$$v \approx 2,99999 \times 10^8 \text{ m/s}$$

Selisih dengan kecepatan cahaya $c - v = 0,051 \text{ m/s}$

Jadi elektron hampir bergerak dengan kecepatan cahaya.

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

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

$$t \approx 1,000000001 \times 10^{-5} \text{ s}$$

$$= 10 \text{ ns}$$

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

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

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

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

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

$$t' = \frac{10^{-5}}{4,89 \times 10^4}$$

$$t' \approx 2,04 \times 10^{-9} \text{ s} = 0,204 \text{ ns}$$

3) diketahui: $\lambda_0 = 122 \text{ nm}$

$$\lambda' = 366 \text{ nm}$$

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

Ditanya: a) Kecepatan gravitasi v jika Spectrum bergeser dari λ_0 menjadi λ'

b) Panjang gelombang baru jika λ' jika dg galaksi mendekati dengan kecepatan yg sama?

Jawab:

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

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

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

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

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

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

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

$$v = \frac{8}{10} c = 0,8 c$$

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

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

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

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

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

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

$$= 122 \times 0,3323$$

$$\lambda'' \approx 40,67 \text{ nm}$$

4) Diketahui : E peratom = 200 meV
uranium

$$A = 235$$

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

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

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

Dit : perubahan massa Δm akibat reaksi 1 kg uranium?

Jawab

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

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

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

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

Jumlah atom dalam uranium 1kg =

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

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

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

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

$$= \frac{1000g}{235} = 2,56 \times 10^{24} \text{ atom}$$

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

5) Dik : $m_p = 1,007276 \text{ u}$

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

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

$$1 \text{ u} \cdot c^2 = 931 \text{ MeV}$$

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

Dit : a) energi luar inti helium E_b

b) beda massa inti helium dengan total massa partikel penyusun dalam kg.

a) massa total = $2m_p + 2m_n$

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

$$= 4,031824$$

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

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

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

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

$$= 0,030318$$

$$E = \Delta mc^2$$

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

$$= 2,733 \times 10^{-12} = 2,73 \text{ MeV}$$

b) Diket : $V_A = 0,8c$

$$V_B = 0,6c$$

Dit : Kecepatan pesawat A menurut pengamat dibulan (V') ?

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

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7) Dik: $p = 20$

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

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

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

Dit: Jumlah atom yang dipancarkan?

Jawab:

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

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

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

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

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

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

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

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

Dit: Energi kinetik maksimum fotoelektron (h) dalam eV

Jawab

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

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

$$K = E - W$$

$$= 3,53 - 2,2 = 1,33 \text{ eV}$$