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Kelas : 23-B

MK : Fisika Modern

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

$$l = x_2 - x_1$$

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

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

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

• waktu sama ($t_1 = t_2$)

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

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

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

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

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

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

2. Diketahui : $E = 25 \text{ GeV}$

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

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

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

Ditanya ? a) kecepatan elektron yang energinya 25 GeV ?

b) Waktu yang diperlukan untuk menempuh jarak 3000 m ?

c) panjang akselerator dalam kerangka acuan masing-masing sendiri ?

Jawab :

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

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

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

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

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

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

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

$$v \approx c (1 - 1,05 \times 10^{-10}) \rightarrow v = 2,99999 \times 10^8 \text{ m/s}$$

jadi elektron hampir bergerak dgn

kecepatan cahaya. Selisih dgn kecepatan

cahaya $c - v = 0,03 \text{ m/s}$

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

$$t = \frac{3000 \text{ m}}{2.99999 \times 10^8 \text{ m/s}}$$

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

$$= 10 \text{ ms}$$

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

karena $v = 4.89 \times 10^4 \text{ m/s}$ maka

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

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

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

$$t' = \frac{10^{-5}}{4.89 \times 10^4}$$

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

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 spektrum bergeser dari λ_0 menjadi λ_i

b) panjang gelombang baru jika λ' jika digalaksi mendekati dgn kecepatan yang sama.

Jawab :

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

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

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

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

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

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

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

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

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

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

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

$$\lambda'' = \lambda_0 \times \sqrt{\frac{1 - 0.8}{1 + 0.8}}$$

$$= \lambda_0 \times \sqrt{\frac{0.2}{1.8}}$$

$$= 122 \times \sqrt{0.1111}$$

$$= 122 \times 0.3323$$

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

4. Diketahui : $E_{\text{perorom}} = 200 \text{ MeV}$
 Uranium

$$A = 235$$

$$1 \text{ MeV} = 1,602 \times 10^{-12} \text{ J}$$

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

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

Ditanya? perubahan massa dm akibat reaksi 1 kg uranium?

Jawab :

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

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

Jumlah atom dalam uranium 1 kg =

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

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

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

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

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

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

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

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

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

5. Diketahui : $m_p = 1,007276 \text{ u}$

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

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

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

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

Ditanya? a.) Energi luar inti helium E_b

b.) Beda masa inti helium dgn total massa partikel pengusun dalam kg

Jawab :

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

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

$$= 4,031882 \text{ u}$$

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

$$= 4,031882 \text{ u} - 4,001506 \text{ u}$$

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

$$E = \Delta mc^2$$

$$= (0,030376 \text{ u}) (1,66054 \times 10^{-27} \text{ kg}) (3 \times 10^8 \text{ m/s})^2$$

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

b.) $\Delta m \text{ kg} = (0,030376 \text{ u}) \times$

$$(1,66054 \times 10^{-27} \text{ kg})$$

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

6. Diketahui : $V_A = 0,8 \text{ c}$

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

Ditanya? kecepatan pesawat A menurut pengamat di bulan (v^*)?

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

7. Diketahui : $p = 20$

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

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

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

Ditanya? Jumlah atom yang dipancarkan?

Jawab:

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

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

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

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

$$\lambda = 3,500 \text{ \AA} = 3,500 \times 10^{-10} \text{ m} = \omega = 3,5 \times 10^{-7} \text{ m}$$

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

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

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

Ditanya? Energi kinetik maksimum fotoelektron (h) dalam eV

Jawab:

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

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

$$K = E - \omega$$

$$= 3,53 - 2,2 = 1,35 \text{ eV}$$