Nike Nurapiyani
2311022010 / 2B
Fisika Modern.

1. $x_1' = 0$ hingga $x_2' = L_0$

$L = x_2 - x_1$

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

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

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

* waktu sama ($t_1 = t_2$)

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

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

$L_0 = x_2' - x_1'$

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

$\rightarrow L_0 = \gamma(x_2 - x_1)$ atau

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

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

2. Diketahui: $E = 25$ GeV

$d = 3000$ m

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

$c = 3 \times 10^8$ 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 elektron?

d. waktu tempuh elektron dalam kerangka acuan inersialnya sendiri

Jawab

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

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

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

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

$1 - v^2/c^2 = 1/\gamma^2$

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

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

$v \approx c(1 - 9{,}05 \times 10^{-10})$

$\rightarrow v \approx 2{,}9999 \times 10^8$ m/s

selisih dengan c: $c - v \approx 0{,}03$ m/s

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

$t = \frac{3000 \text{ m}}{2{,}9999 \times 10^8 \text{ m/s}}$

$t \approx 1{,}000000001 \times 10^{-7}$ s

≈ 10 ns

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

karena $\gamma \approx 4{,}89 \times 10^4$, maka $L' = 3000 / 4{,}89 \times 10^4$

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

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

$t' = \frac{10^{-5}}{9{,}89 \times 10^{9}} \Rightarrow t' \simeq 2{,}04 \times 10^{-9}\ s$

3. Diketahui $\lambda_0 = 122\ nm$

$\lambda' = 366\ nm$

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

Ditanya: a). kecepatan galaksi v jika spektrum bergeser dari λ_0 menjadi λ_1

b). panjang gelombang baru jika galaksi mendekati kita dengan kecepatan yang sama v

Jawab

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

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

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

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

$9(1-v/c) = 1+v/c$

$9 - 9v/c = 1+v/c$

$8 = 10\ v/c$

$v = 8/10\ c$

$v = 0{,}8\ c$

$v = 0{,}8\ (3 \times 10^8\ m/s) = 2{,}4 \times 10^8\ m/s$

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

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

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

$= \lambda_0 \times \sqrt{0{,}111}$

$= 122 \times 0{,}3333$

$\lambda'' \simeq 40{,}67\ nm$

4. Diketahui: E per atom = 200 MeV

Muranium = 1 kg = 1000 g

n = 235

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

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

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

Ditanya: Q massa atom akibat reaksi 1 kg muranium?

Jawab:

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

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

Jumlah atom: $N = \frac{1000\ g}{m_{atom}}$

$= 2{,}56 \times 10^{29}\ atom$

$E_{total} = (3{,}204 \times 10^{-11}\ J/atom)(3{,}56 \times 10^{29})$

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

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

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

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

5. Diketahui: $m_p = 1{,}007276\ u$ $\quad 1\ u = 1{,}66054 \times 10^{-27}\ kg$

$m_n = 1{,}008665\ u$ $\quad 1\ uc^2 = 931{,}5\ MeV$

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

Ditanya: a. energi ikat inti helium

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

Jawab:

a. Massa total: $2m_p + 2m_n$

$= 2(1{,}007276\ u) + 2(1{,}008665\ u)$

$= 4{,}031882\ u$

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

$= 4{,}031882 - 4{,}001506 = 0{,}030376\ u$

$E = \Delta mc^2$

$= (5{,}094 \times 10^{-29}\ kg)(2{,}9979 \times 10^8\ m/s)^2$

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

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

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

6. Diketahui: $v_A = 0{,}8c$

$v_B = 0{,}6c$

Ditanya: v pesawat menurut pengamat dibulan (v')?

Jawab:

$$v' = \frac{v_A + v_B}{1 + v_A v_B / c^2} = \frac{0{,}8c + 0{,}6c}{1 + (0{,}8)(0{,}6)/c^2} = \frac{1{,}4c}{1 + 0{,}48} = \frac{1{,}4}{1{,}48} = 0{,}946c.$$

7. Diketahui: $P = 20\ W$

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

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

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

Ditanya: jumlah foton yg dipancarkan / detik (N)

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

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

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

KIKY

8. Diketahui = $W = 2,2\ eV$

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

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

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

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

Ditanya: Ek maks foto elektron (n) dalam eV?

dawab.

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

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

$K = E - W$

$= 3,53 - 2,2 = 1,35\ eV$.