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Kelas : 2SB

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 ($t_1 = t_2$)

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

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

$l_0 = x'_2 - x'_1$

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

→ $l_0 = \gamma (x_2 - x_1)$ atau

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

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

② Jawab

a) $E = \gamma mc^2$

$\gamma = \frac{E}{mc^2}$

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

$= 4,89 \times 10^4$

$1 - \frac{V^2}{C^2} = \frac{1}{\gamma^2}$

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

→ $V = C \sqrt{1 - \frac{1}{(4,89 \times 10^4)^2}}$

$V \approx C (1 - 1,05 \times 10^{10})$

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

Selisih dengan kecepatan cahaya

$C - V \approx 0,031 \text{ m/s}$

Jadi elektron hampir bergerak dengan kecepatan cahaya.

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

$t = \frac{300\ m}{2,9999 \times 10^8\ m/s}$

$t \approx 1,0000000001 \times 10^{-3}\ s$

$= 10\ \mu s$

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

Karena $\gamma = 4,89 \times 10^4$, maka

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

$l' = 0,061\ m$

$l' = 6,1\ cm$

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

$t' = \frac{10^{-3}}{4,89 \times 10^4}$

$t' \approx 2,04 \times 10^{-4}\ s = 0,204\ ns$

(3) Dik : $\lambda_0 = 122\ nm$

$\lambda' = 366\ nm$

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

Ditanya : a) kecepatan galaksi v jika spektrum bergeser dari λ_0 jadi λ_1 ?

b) Panjang gelombang baru λ jika galaksi mendekati bumi dg kecepatan yg sama

Jawab.

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

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

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

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

$9\left(1 - \frac{v}{c}\right) = 1 + \frac{v}{c}$

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

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

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

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

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

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

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

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

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

$= 122 \times 0,3333$

$\lambda'' \approx 40,67$ nm

(4) Diketahui :

$E_{per\ atom} = 200$ MeV

Muranium :

$A = 235$

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

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

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

Ditanya : Perubahan massa dm akibat reaksi 1 kg uranium ?

Jawab.

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

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

Jumlah atom dalam uranium 1 kg

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

$= \frac{1000g}{\frac{235}{6,022 \times 10^{23}}} = 2,56 \times 10^{24}$ atom

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

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

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

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

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

(5) Diketahui

$m_p = 1,007276\ u$ $\quad 1u = 1,660514 \times 10^{-23}\ kg$

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

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

Ditanya

a) Energi ikat inti helium E_b

b) Beda massa inti helium dg total massa partikel penyusun dalam kg

Jawab.

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

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

$= 4,0318824$

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

$= 4,0318824 - 4,00506$

$= 0,0303764\ u$

$E = \Delta mc$

$= (3,044 \times 10^{-23}\ kg)(2,9979 \times 10^{8}\ m/s)^2$

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

b) $\Delta m_{kg} = (0,030376\ u) \times (1,660514 \times 10^{-27}\ kg)$

$= 3,04 \times 10^{-29}\ kg$

(6) Diketahui:

$V_A = 0{,}8\,c$

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

Ditanya = kecepatan pesawat A menurut pengamat dibulan (V')?

Jawab:

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

(7) Diketahui

$P = 20\ \omega$

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

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

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

Ditanya: Jumlah foton yang dipancarkan?

Jawab:

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

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

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

⑧ Diketahui $w = 2,2$ eV

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

$h = 6,626 \times 10^{-34}\ J/s$

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

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

Ditanya = Energi kinetik maksimum foto elektron (k) dalam eV?

Jawab :

$$E = \frac{hc}{\lambda} = \frac{(6,626 \times 10^{-34})(3 \times 10^{8})}{3,5 \times 10^{-7}} = \frac{1,9178 \times 10^{-25}}{3,5 \times 10^{-7}} \approx 5,68 \cdot \times 10^{-19}\ J$$

$$E = \frac{5,68 \times 10^{-19}}{1,6 \times 10^{-19}} = 3,33\ eV$$

$$K = E - w$$
$$= 3,53 - 2,2$$
$$= 1,35\ eV$$