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Matkul: Fisika Modern

1. Penyelesaian,
Diketahui : Panjang Meteran dalam kerangka diam = l_0
Pengamat O' bergerak relative terhadap O dengan laju u menggunakan transformasi Lorentz
Rumus penyusutan panjang: $L = l_0\sqrt{1-\frac{v^2}{c^2}}$

2. Diketahui : $L = 300\ m$
$E = 25\ GeV = 25 \times 10^9\ eV$
$m_e = 0{,}511\ MeV/c^2$
$c = 3{,}00 \times 10^8\ m/s$

a. Kecepatan elektron
$E = \gamma mc^2$
$\gamma = \frac{E}{mc^2} = \frac{25\times10^9}{0{,}511\times10^6} = 4{,}89 \times 10^4$
$v = c\sqrt{1-\frac{1}{\gamma^2}} = (3{,}00\times10^8)\sqrt{1-\frac{1}{(4{,}89\times10^4)^2}}$
$v = 2{,}999999999999\times10^8$
$\Delta V = c - v = 0{,}000000000006\times10^8 = 60\ m/s$

b. Waktu tempuh Elektron
$t = \frac{L}{v} = \frac{3000}{2{,}999999999999994\times10^8}$
$t \approx 1{,}00\times10^{-5}$ sekon
$t \approx 1\times10^{-5}\ s$

c. Panjang Dalam Kerangka
$l' = L\sqrt{1-\frac{v^2}{c^2}}$
$l' = 3000 \times \sqrt{1-\frac{(2{,}999999999999994\times10^8)^2}{(3\times10^8)^2}}$
$l' = 3000 \times \sqrt{1-\frac{9\times10^{16}}{9\times10^{16}}}$
$l' = 3000 \times \sqrt{1-1}$
$l' = 300 \times 0$
$l' = 0$

d. Waktu tempuh dalam kerangka Elektron
$t' = \frac{t}{\gamma} = \frac{1\times10^{-5}}{4{,}89\times10^4} = 2{,}05\times10^{-10}$

3. Pergeseran Spektrum Hidrogen

Diketahui $= \lambda_0 = 122\ nm$

$\lambda = 366\ nm$

kec. galaksi $= v$

a. Kecepatan galaksi agar spektrum Hidrogen teramati pada 366 nm

$$v = c \times \frac{(\lambda'/\lambda)^2 - 1}{(\lambda'/\lambda)^2 + 1}$$

$$v = (3 \times 10^8) \times \frac{(366/122)^2 - 1}{(366/122)^2 + 1}$$

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

b. Panjang gelombang jika galaksi bergerak mendekati kita

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

$$\lambda' = 122 \sqrt{\frac{1 - 0{,}8}{1 + 0{,}8}}$$

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

4. Perubahan Massa dalam Reaktor Nuklir

Diketahui: $E = 200\ MeV$

$m = 1\ kg$

Penyelesaian:

$$\Delta m = \frac{E}{c^2} = \frac{(200 \times 10^6)(1{,}6 \times 10^{-13})}{(3 \times 10^8)^2}$$

$$\Delta m = 3{,}56 \times 10^{-30}\ kg\ per\ FISI$$

Untuk 1 kg uranium ($6{,}022 \times 10^{24}$ atom/mol)

$$\Delta m = (3{,}36 \times 10^{30})(2{,}5 \times 10^{24})$$

$$\Delta m = 8{,}9 \times 10^{-6}\ kg$$

5. Energi Ikat Inti Helium

Diketahui: $M_{He} = 4{,}001506\ u$

$M_p = 1{,}007276\ u$

$M_n = 1{,}008665\ u$

Energi Ikat

$$\Delta m = 2M_p + 2M_n - M_{He}$$

$$\Delta m = 2(1{,}007276) + 2(1{,}008665) - (4{,}001506)$$

$$\Delta m = 0{,}029244$$

$$E_B = \Delta m c^2 = 0{,}029244 \times 931{,}5$$

$$= 27{,}2\ MeV$$

6. Transformasi Kecepatan Relativistik

Diketahui : $v_A = 0{,}8\,c$

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

Rumus transformasi

$$v = \frac{v_A + v_B}{1 - \frac{v_A v_B}{2}}$$

$$v = \frac{0{,}8\,c + 0{,}6c}{1 + (0{,}8 \times 0{,}6)} = \frac{1{,}4c}{1{,}48} = 0{,}94\,c$$

7. Jumlah foton oleh lampu Natrium

$P = 20\,W$

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

Penyelesaian:

$$E_P = \frac{hc}{\lambda} = \frac{(6{,}63 \times 10^{-34})(3 \times 10^{8})}{589 \times 10^{-9}}$$

$$E_P = 3{,}37 \times 10^{-19}\,J$$

$$n = \frac{P}{E_P} = \frac{20}{3{,}37 \times 10^{-19}} = 5{,}93 \times 10^{19}\ foton/s$$

8. Energi kinetik fotoelektron

Diketahui : $\lambda = 3300\,\text{Å}$

$w = 2{,}2\,eV$

Penyelesaian:

$$E_P = \frac{hc}{\lambda} = \frac{1.240}{330} = 3{,}34\,eV$$

$$k = E_P - w = 3{,}34 - 2{,}2 = 1{,}34\,eV$$