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$$1) \begin{aligned} K'_2 &= \gamma(v_2 - u_1) \\ K'_1 &= \gamma(v_1 - u_2) \end{aligned}$$

$$\begin{aligned} L_0 &= K'_2 - K'_1 \\ &= \gamma(v_2 - v_1) \\ &= \gamma L \end{aligned}$$

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

$$2) \begin{aligned} P, Z: E &= 25 \text{ GeV} = 25 \times 10^9 \text{ eV} \\ m_e &= 0.511 \text{ MeV}/c^2 = 0.511 \times 10^6 \text{ eV}/c^2 \\ L_0 &= 3000 \text{ m} \end{aligned}$$

a. Kecepatan elektron (v) dan seimbang dengan c

$$\begin{aligned} E &= \gamma m_e c^2 \\ \gamma &= \frac{E}{m_e c^2} = \frac{25 \times 10^9}{0.511 \times 10^6} = 48923,7 \end{aligned}$$

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

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

$$c - v = \frac{c}{2\gamma^2} = \frac{3 \times 10^8}{2 \times (48923,7)^2} \approx 0,0626 \text{ m/s}$$

b. Waktu tempuh dalam kerangka lab (t)

$$t = \frac{L_0}{v} = \frac{3000}{3 \times 10^8} = 10^{-5} \text{ s} = 10 \text{ } \mu\text{s}$$

c. Panjang akselerator dalam kerangka elektron (L')

$$L' = \frac{L_0}{\gamma} = \frac{3000}{48923,7} = 0,0613 \text{ m} = 6,13 \text{ cm}$$

d. Waktu tempuh (t')

$$t' = \frac{L'}{v} = \frac{0,0613}{3 \times 10^8} = 2,04 \times 10^{-10} \text{ s} = 0,204 \text{ ns}$$

$$3. \lambda_{ik} = \lambda_0 = 122 \text{ nm}$$

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

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

$$\frac{366}{122} = 3 = \frac{\sqrt{1+\beta}}{1-\beta}$$

$$9 - 9\beta = 1 + \beta$$

$$8 = 10\beta$$

$$\beta = 0.8$$

$$v = 0.8c$$

b. Panjang gelombang jika galaksi mendekat =

$$\frac{\lambda'}{\lambda_0} = \sqrt{\frac{1-\beta}{1+\beta}} = \sqrt{\frac{1-0.8}{1+0.8}} = \sqrt{\frac{0.2}{0.1}} = \sqrt{\frac{1}{0.5}} = \frac{1}{\sqrt{0.5}}$$

$$\lambda' = \frac{122}{\sqrt{0.5}} = 172.2 \text{ nm}$$

4. dik : Energi Per fisi = 200 MeV = $200 \times 10^6 \text{ eV}$

massa Uranium = 1 kg

massa molar Uranium = 235 g/mol (U-235)

dik : Perubahan massa (Δm) untuk 1 kg Uranium

$$N = \frac{1000 \text{ g}}{235 \text{ g/mol}} \times 6.022 \times 10^{23} \text{ atom/mol}$$

$$= 2.56 \times 10^{24} \text{ atom}$$

$$E = 2.56 \times 10^{24} \times 200 \text{ MeV} = 5.12 \times 10^{26} \text{ MeV}$$

$$= 5.12 \times 10^{26} \times 1.602 \times 10^{-13} \text{ J} = 8.20 \times 10^{13} \text{ J}$$

$$\Delta m = \frac{E}{c^2} = \frac{8.20 \times 10^{13}}{(3 \times 10^8)^2} = 0.00091 \text{ kg} = 0.91 \text{ g}$$

5. dik : massa inti helium = 4.001506 u

massa Proton : 1.007276 u

massa neutron : 1.008665 u

$$1 \text{ u} = 931.5 \text{ MeV}/c^2$$

a. energi ikat

$$\text{Defek massa} = \Delta m = 4,031882 - 4,001506 = 0,030376 \text{ u}$$

$$\text{Energi ikat} = E_b = 0,030376 \times 931,5 = 28,30 \text{ MeV}$$

b. beda massa dalam kg :

$$\Delta m = 0,030376 \text{ u} \times 1,66 \times 10^{-27} \text{ kg/u} = 5,0 \times 10^{-29} \text{ kg}$$

$$6. \text{dik} = V_A/B = 0,8 c$$

$$V_B/B_{\text{bulan}} = 0,6 c$$

$$\text{dik} = V_A/B_{\text{bulan}}$$

$$V_A/B_{\text{bulan}} = \frac{V_A/B + V_B/B_{\text{bulan}}}{1 + \frac{V_A/B \cdot V_B/B_{\text{bulan}}}{c^2}} = \frac{0,8 c + 0,6 c}{1 + 0,8 \times 0,6} = \frac{1,4 c}{1,48} = 0,946 c$$

$$7. P = 20 \text{ W}$$

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

$$\text{dik} = N \text{ foton}$$

$$P = \frac{hc}{\lambda} = \frac{6,626 \times 10^{-34} \times 3 \times 10^8}{589 \times 10^{-9}} = 3,37 \times 10^{-19} \text{ J}$$

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

$$8. \lambda = 3500 \text{ \AA} = 350 \text{ nm} = 350 \times 10^{-9} \text{ m}$$

$$\phi = 2,2 \text{ eV}$$

$$\text{diket} = K$$

$$E = \frac{hc}{\lambda} = \frac{6,626 \times 10^{-34} \times 3 \times 10^8}{350 \times 10^{-9}} = 5,68 \times 10^{-19} \text{ J}$$

$$F = \frac{5,68 \times 10^{-19}}{1,602 \times 10^{-19}} = 3,54 \text{ eV}$$

$$K = E - \phi = 3,54 - 2,2 = 1,34 \text{ eV}$$