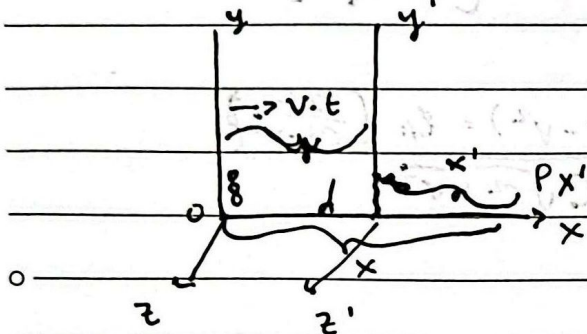


Fisika Modern

Relativitas



$$x' = x - vt$$

$$\frac{dx'}{dt} = \frac{dx}{dt} - v$$

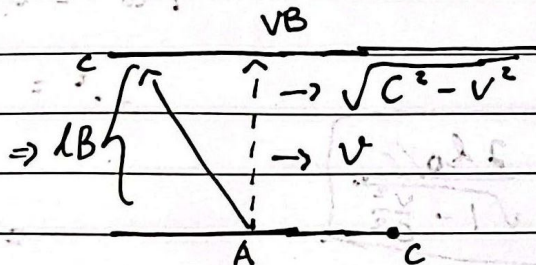
$$V_{x'} = V_x - v$$

$$y = y', \quad z = z'$$

$$\frac{dy}{dt} = \frac{dy'}{dt}, \quad \frac{dz}{dt} = \frac{dz'}{dt}$$

Diketahui: $V_{x'} = 40 \text{ m/s}$

$v = 10 \text{ m/s}$



$$t_B = \frac{l_B}{\sqrt{c^2 - v^2}} + \frac{l_B}{\sqrt{c^2 - v^2}} = \frac{2l_B}{\sqrt{c^2 - v^2}}$$

$$t_A = \frac{l_A}{c + v} + \frac{l_A}{c - v} = l_A \left[\frac{1}{c + v} + \frac{1}{c - v} \right]$$

No.
Date

$$(c+v)(c-v)$$

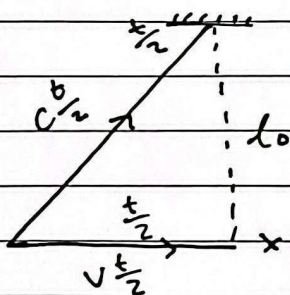
$$c^2 - cv + cv - v^2$$

$$= \frac{c-v + c+v}{c^2 - v^2}$$

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

$$\frac{t_a}{t_b} = \frac{\frac{2L_0}{\sqrt{c^2 - v^2}}}{\frac{2L_0 c}{c^2 - v^2}} = \frac{L_0 (c^2 - v^2)}{L_0 c \sqrt{c^2 - v^2}}$$

Pemuaian
Pelamaan waktu



$$\left(c \frac{t}{2}\right)^2 = L_0^2 + \left(v \frac{t}{2}\right)^2$$

$$\frac{c^2 t^2}{4} = L_0^2 + \frac{v^2 t^2}{4}$$

$$L_0^2 = \frac{t^2}{4} (c^2 - v^2)$$

$$4 L_0^2 = t^2 (c^2 - v^2)$$

$$t^2 = \frac{4 L_0^2}{c^2 - v^2} = \frac{4 L_0^2}{c^2 \left(1 - \frac{v^2}{c^2}\right)}$$

$$t = \frac{2 L_0 / c}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$= \frac{4 L_0^2 / c^2}{1 - \frac{v^2}{c^2}}$$

$$t = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Sebuah partikel μ^0 punya waktu hidup $2,5 \times 10^{-6}$ detik. Jika partikel μ^0 bergerak dengan kecepatan $0,9c$, berapa waktu hidup muon tersebut

diket = $t_0 = 2,5 \times 10^{-6}$

$v = 0,9c$

Dit = t

Jawab =

$$t = \frac{2,5 \times 10^{-6}}{\sqrt{1 - \frac{(0,9c)^2}{c^2}}}$$

$$= \frac{2,5 \times 10^{-6}}{\sqrt{1 - (0,9)^2}}$$

$$= \frac{2,5 \times 10^{-6}}{\sqrt{1 - 0,81}}$$

$$= \frac{2,5 \times 10^{-6}}{\sqrt{0,19}}$$

$$= \frac{2,5 \times 10^{-6}}{0,4359}$$

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Kelas : 23 A

1. Diketahui : • Pemendekan panjang (ΔL) = 2% = 0,02

• Rumus kontraksi panjang:

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

$$\text{Dimana } L = (1 - 0,02) L_0 = 0,98 L_0$$

Penyelesaian :

$$0,98 \sqrt{1 - \frac{v^2}{c^2}}$$

kuadratkan kedua sisi:

$$(0,98)^2 = 1 - \frac{v^2}{c^2}$$

$$0,9604 = 1 - \frac{v^2}{c^2}$$

$$\frac{v^2}{c^2} = 1 - 0,9604 = 0,0396$$

$$v = c \sqrt{0,0396}$$

$$v = c \times 0,199$$

Jadi, kecepatan roket tersebut adalah 0,199 c atau sekitar 19,9% kecepatan cahaya

$$2. \text{ Jawab : } \gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\text{Dimana : } v = 3 \times 10^4 \text{ m/s (orbit bumi)}$$

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

$$\Rightarrow \frac{v^2}{c^2} = \frac{(3 \times 10^4)^2}{(3 \times 10^8)^2} = 10^{-8}$$

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

$$\frac{1}{\sqrt{1-x}} \approx 1 + \frac{1}{2}x$$

$$\gamma \approx 1 + \frac{1}{2} \times 10^{-8}$$

$$\gamma \approx 1 + 5 \times 10^{-9}$$

$$L_0 - L = L - \frac{L_0}{\gamma}$$

$$L_0 - L = L_0 \left(1 - \frac{1}{\gamma} \right)$$

$$\frac{1}{\gamma} \approx 1 - \frac{1}{2} \times 10^{-8}$$

3. Diketahui : $L_0 = 1 \text{ m}$

$$v = 0,8c$$

$$\theta = 60^\circ$$

$$\text{Dimana } x \rightarrow L_x = L_0 \cos \theta = 1 \times \cos 60^\circ = 0,5 \text{ m}$$

$$y \rightarrow L_y = L_0 \sin \theta = 1 \times \sin 60^\circ = 0,866 \text{ m}$$

$$\begin{aligned} L_x' &= L_x \sqrt{1 - \frac{v^2}{c^2}} \\ &= 0,5 \sqrt{1 - (0,8)^2} \\ &= 0,5 \sqrt{1 - 0,64} \\ &= 0,5 \sqrt{0,36} = 0,5 \times 0,6 = 0,3 \text{ m} \end{aligned}$$

$$\begin{aligned} L' &= \sqrt{(L_x')^2 + (L_y')^2} \\ &= \sqrt{(0,3)^2 + (0,866)^2} \\ &= \sqrt{0,09 + 0,75} \\ &= \sqrt{0,84} = 0,916 \text{ m} \end{aligned}$$

$$\tan \theta' = \frac{L_y'}{L_x'} = \frac{0,866}{0,3} = 2,887$$

$$\theta' = \tan^{-1} (2,887) = 70,9^\circ$$

Jadi, panjang batang = $0,916 \text{ m}$, sudut batang terhadap sumbu x berubah dari 60° menjadi $70,9^\circ$.

4. Diketahui : $V_{bus} = 15 \text{ m/s}$

$$V_{penumpang} = 2 \text{ m/s}$$

Jawab :

$$\begin{aligned} \text{a) } V_{tot} &= V_{bus} + V_{penumpang} \\ &= 15 \text{ m/s} + 2 \text{ m/s} = 17 \text{ m/s} \end{aligned}$$

$$\text{b) } v = \frac{v_1 + v_2}{1 + \frac{v_1 v_2}{c^2}} = \frac{15 + 2}{1 + \frac{15 \cdot 2}{(3 \times 10^8)^2}} = 17 \text{ m/s}$$

5. Diket : $v_A = 0,8c$

$$v_B = 0,6c$$

Ditanya : a) A dan B menurut pengamat di bumi?

b) kec. A menurut B?

c) kec. B menurut A)

*)

Jawab : a) kec. A menurut pengamat di bumi = $0,8c$

*) kec. B menurut pengamat di bumi = $0,6c$



6). kec. pesawat A menurut B

$$v' = \frac{v_A - v_B}{1 - \frac{v_A v_B}{c^2}}$$

$$= \frac{0,8c - (-0,6c)}{1 - \frac{(0,8)(-0,6)}{c^2}}$$

$$= \frac{0,8c + 0,6c}{1 + 0,48}$$

$$= \frac{1,4c}{1,48} = 0,946c$$