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① Sebuah roket melaju dengan kecepatan v, loncengnya berbunyi 1 detik terlambat dalam 1 jam relatif terhadap lonceng dibumi. Berapa kecepatan roket tersebut?

Diketahui : Jam diroket terlambat 1 detik tiap 1 jam bumi
t dibumi $= 3600$ s
t diroket $= 3599$ s

Ditanya : v .... ?
Jawab : $t = \gamma t'$ dengan $\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$

* tentukan faktor lorentz γ

$$\gamma = \frac{t}{t'} = \frac{3600}{3599}$$

$$\gamma = \frac{3600}{3599}$$
$$= 1.000277$$

* Hubungkan γ dengan v

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

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

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

$$\frac{1}{\gamma^2} = \frac{1}{(1.000277)^2}$$
$$= \frac{1}{1,000556} = 0,999\,4443$$

$$\frac{v^2}{c^2} = 1 - 0,999\,4443 = 0,000\,5557$$

$$\frac{v}{c} = \sqrt{0,000\,5557} = 0,0236$$

$$v = 0,0236.c$$
$$= 0,0236 \times 3,0 \times 10^8 \text{ m/s}$$
$$= 7,1 \times 10^6 \text{ m/s}$$

② Diketahui : $v = 0{,}99\ c$ Ketinggian awal = 200 km

$t_0 = 2{,}5 \times 10^{-8}\ s$

Ditanya : Pada ketinggian berapa meson masih dapat diamati dari bumi sebelum meluncur ?

Jawab : $T = \dfrac{T_0}{\sqrt{1 - \frac{v^2}{c^2}}}$

* Hitung faktor lorentz

$$\sqrt{1 - \frac{v^2}{c^2}} = \sqrt{1 - (0{,}99)^2}$$
$$= \sqrt{1 - 0{,}9801}$$
$$= \sqrt{0{,}0199} = 0{,}141$$

$$T = \frac{T_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$
$$= \frac{2{,}5 \times 10^{-8}\ s}{0{,}141}$$
$$= 1{,}773 \times 10^{-7}\ s$$

* Hitung Jarak yang ditempuh meson.

$D = v \cdot t$

$= 0{,}99\ c \cdot T$

- Subtitusi nilai c

$D = 0{,}99c \cdot (3 \times 10^8\ m/s) \cdot (1{,}773 \times 10^{-7}\ s)$

$= 0{,}99c \cdot (5{,}319 \times 10^{1}\ m)$

$= 5{,}26\ m$

* Hitung ketinggian akhir

$K_A = 200\ km - 0{,}00526\ km$

$= 199{,}995\ km$. diatas permukaan laut .

③ Dik : $v = 0{,}97\ c$

$f_0 = 10^4$ Pulsa/s

Dit : f .. ?

Jawab : $f = f_0 \sqrt{\dfrac{1-\beta}{1+\beta}}$, $\beta = \dfrac{v}{c}$

$= \sqrt{\dfrac{1 - 0{,}97}{1 + 0{,}97}}$

$= \sqrt{\dfrac{591}{197}} = 0{,}123$

Jadi $f = 10^4 \times 0{,}123$

$= 1{,}23 \times 10^3$ pulsa/s

(4) Dik : $v = 0{,}6c$

$c = 3{,}0 \times 10^8$ m/s

$L_{peron} = 45$ m

$L = 45$ m

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

$$\gamma = \sqrt{\frac{1}{1-(0{,}6)^2}} = \frac{1}{\sqrt{1-0{,}36}}$$

$$= \frac{1}{\sqrt{0{,}64}} = 1{,}25$$

a. Waktu kereta melewati ~~titik~~ satu titik di peron

$$t = \frac{L}{v.c} = \frac{45}{0{,}6 \times (3{,}0 \times 10^8)}$$

$$= 2{,}5 \times 10^{-7} \text{ s}.$$

b. Panjang sebenarnya kereta

$$L = \frac{L_0}{\gamma} \Rightarrow L_0 = \gamma . L$$

$$= 1{,}25 \cdot 45$$

$$= 56{,}25 \text{ m}$$

c. Panjang peron menurut pengamat dikereta.

$$L'_{peron} = \frac{L}{\gamma}$$

$$= \frac{45}{1{,}25} = 36 \text{ m}$$

d. Waktu titik peron melewati kereta menurut pengamat dikereta.

$$t' = \frac{L_0}{v.c}$$

$$= \frac{56{,}25}{0{,}6 \times (3{,}0 \times 10^8)} = 3{,}13 \times 10^{-7} \text{ s}$$

e. Selang waktu antara dua kejadian simultan di peron menurut pengamat dikereta.

Pada kerangka peron. $\Delta t = 0$ $\Delta x = 45$ m

$$\frac{v \Delta x}{c^2} = \frac{0{,}6 \times 45}{c^2}$$

$$= \frac{27}{c} = \frac{27}{3{,}0 \times 10^8}$$

$$= 9{,}0 \times 10^{-8} \text{ s}$$

$\Delta t' = 1{,}25 \times (9{,}0 \times 10^{-8})$

$= 1{,}13 \times 10^{-7}$ s

⑤ Dik : $u = 0.9c$

$v_{rel} = 0,5c$

a. kecepatan pesawat rusia terhadap bumi menurut mekanika klasik (Penjumlahan biasa)

$v_{kelas} = u + v_{rel}$

$= 0,9 + 0,5$

$= 1,4\ c$

$= 419.709.441,2\ m/s$

b. kecepatan pesawat rusia terhadap bumi menurut relativitas khusus

$$v = \frac{u+u}{1+uv}$$

$$= \frac{0.9c + 0.5c}{1 + 0.9 \times 0.5}$$

$$= \frac{1,4\ c}{1,45}$$

$$= \frac{28}{29}\ c$$

$$= 0,965\ c = 2,8945 \times 10^8\ m/s$$

⑥ Dik : $m_0 = 100\ kg$

$m = 101\ kg$

Dit = $v \ldots ?$

Jawb = $\gamma = \frac{m}{m_0} = \frac{101}{100} = 1,01$

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

$\gamma^2 = 1,01^2 = 1,0201$

$\frac{1}{\gamma^2} = 0,9802$

$1 = \frac{1}{\gamma^2} = 0,0197$

$\sqrt{0,0197} = 0,14037\ c$

$v = 4,2082 \times 10^7\ m/s$

No.

Date:

7 Dik : V = 5 mv

$e = 1,6 \times 10^{-19}$ C

$m_{oc} = 0,511$ mev

Jawab :

a. k : ev = 5 mev (karena yelektron = e

v = 5 mv)

b. $E = k + m_o c^2$

$= 5 + 0,511$

$= 5,511$ mev

$m = E/c^2$ dalam urut energi c^2

$m = 5,511$ mev/c^2

$kg = m = \frac{5,511\ m_o}{0,511}$

$= 10,785 \times 9,11 \times 10^{-31}$ kg

$= 9,83 \times 10^{-30}$ kg

c. $E = \gamma m_{oc}^2$ → $\gamma = \frac{5,511}{0,511} = 10,785$

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

$= c\sqrt{\frac{1-1}{11,6}}$

$= c\sqrt{1-0,0086}$

$v = c\sqrt{0,9914}$

$= 0,9957\ c$