Nama : Uswatun Hasanah

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MK : Teori relativitas

Jawaban :

1) Diketahui

- Lonceng roket terlambat 1 detik dalam 1 jam relatif terhadap lonceng di bumi
- 1 jam = 3600 detik (di bumi)
- menurut roket $\Delta t_0 = 3600 - 1 = 3599$ detik

$$\Delta t = \gamma \Delta t_0$$

$$3600 = \gamma \times 3599$$

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

$$\frac{1}{\sqrt{1-v^2/c^2}} = \frac{3600}{3599}$$

$$\sqrt{1-v^2/c^2} = \frac{3599}{3600}$$

$$\frac{v^2}{c^2} = 1 - \left(\frac{3599}{3600}\right)^2$$

$$\frac{v^2}{c^2} = \frac{3600^2 - 3599^2}{3600^2}$$

$$\frac{v^2}{c^2} = 7199$$

$$\frac{v}{c} = \frac{\sqrt{7199}}{3600}$$

$$\sqrt{7199} \approx 84.85$$

$$\frac{v}{c} \approx \frac{84.85}{3600} \approx 0,0236\ c$$

Jawaban $v \simeq 7.08 \times 10^6$ m/s atau $0,0236\ c$

2. Diketahui :

- Terbentuk di ketinggian 200 km
- $v = 0,99\ c$ $T_0 = 2.5 \times 10^{-8}$ s
- ketinggian saat meluruh menurut pengamat bumi

Waktu hidup menurut bumi

$T = \gamma T_0$

$$\gamma = \frac{1}{\sqrt{1-0,99^2}} = \frac{1}{\sqrt{0,0199}} \approx \frac{1}{0,141067} \approx 7,0888$$

$$T \approx 7,0888 \times 2,5 \times 10^{-8} \approx 1,7722 \times 10^{-7} \text{ s}$$

Jarak tempuh menurut bumi

$$L = VT \approx 0,99 \times 3 \times 10^8 \times 1,7722 \times 10^{-7}$$

Ketinggian awal 200 km = 200.000 m

$$200.000 - 52,62 \approx 199947,38 \text{ m} \approx 199,95 \text{ km}$$

Jadi ketinggian saat meluruh sekitar 199,95 km diatas permukaan laut

3. Diketahui :

$v = 0,97c$

$f_s = 10^4$ pulsa/s

• Pada laju berapa data itu diterima ?

$$f_T = f_s \sqrt{1-\beta}, \quad \beta = 0,97$$

$$\frac{1-\beta}{1+\beta} = \frac{0,03}{1,97} \approx 0,015228$$

$$\sqrt{0,015228} \approx 0,1234$$

$$f_T \approx 10^4 \times 0,1234 \approx 1234 \text{ pulsa/s}$$

4. Diketahui

• $v = 0,6c$

• $L_P = 45$ m → panjang peron menurut pengamat peron

• $L_K = 45$ m → panjang kereta menurut peron

Jawab :

a) $$t = \frac{45}{0,6 \times 3 \times 10^8} = \frac{45}{1,8 \times 10^8} = 2,5 \times 10^{-7} \text{ s}$$

b) $L_K = L_0 / \gamma$

$$\gamma = \frac{1}{\sqrt{1-0,6^2}} = 1,25$$

$$45 = \frac{L_0}{1,25} \Rightarrow L_0 = 45 \times 1,25 = 56,25 \text{ m}$$

c) $$L'_P = \frac{L_P}{\gamma} = \frac{45}{1,25} = 36 \text{ m}$$

d) • $L_0 = 56,25$ m

• $v = 0,6c$ → kecepatan relatif peron terhadap kereta

(KKY)

$$t' = \frac{L_0}{v} = \frac{56,25}{0,6 \times 3 \times 10^8} \approx \frac{56,25}{1,8 \times 10^8} \approx 3,125 \times 10^{-7}\ s$$

e) $$\Delta t' = \frac{56,25 - 36}{0,6\,c} = \frac{20,25}{1,8 \times 10^8} \approx 1,125 \times 10^{-7}\ s$$

5. Diketahui :

- $v_A = 0,9\,c$ relatif terhadap bumi
- $v'_R = 0,5\,c$ relatif terhadap perawat A (Rusia menyusul Amerika)

jawab :

a) $$v_R = v_A + v'_R = 0,9c + 0,5c = 1.4\,c$$

b) $$v_R = \frac{v_A + v'_R}{1 + \frac{v_A v'_R}{c^2}} = \frac{0,9c + 0,5c}{1 + 0,9 \times 0,5}$$

$$= \frac{1,4c}{1 + 0,45} = \frac{1,4c}{1,45} \approx 0,9655\,c$$

6. Diketahui :

$m_0 = 100$ kg

$m = 101$ kg

$m = \gamma m_0$

$$\gamma = \frac{101}{100} = 1.01$$

$$1,01 = \frac{1}{\sqrt{1 - v^2/c^2}}$$

$$\sqrt{1 - v^2/c^2} = 1/1,01 \approx 0,990099$$

$$1 - v^2/c^2 \approx 0,980296$$

$$v^2/c^2 \approx 0,019704$$

$$v/c \approx 0,14037$$

$$v \approx 0,14\,c \approx 4,21 \times 10^7\ m/s$$

7. $V = 5$ MV, $e = 1,6 \times 10^{-19}$ C, $m_0c^2 = 0,511$ MeV

a) $K = eV = 5$ MeV (karena q elektron = e, dan v = 5MV)

b) $E = K + m_0c^2 = 5 + 0,511 = 5,511$ MeV

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

$m = 5.511$ MeV $/c^2$

KIKY

Dalam kg : $m = \frac{5.511}{0,511} m_0 \approx 10.785 \times 9,11 \times 10^{-31}\ kg \approx 9,83 \times 10^{-30}\ kg$

c) $E = \gamma m_0 c^2 \longrightarrow \gamma = \frac{5.511}{0,511} \approx 10.785$

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

$= c\sqrt{1-1/116,3}$

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

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

$\approx 0,9957\,c$