Q.1 LA COMPOSANTE y' EST INUTILE.

A. $x_P' = 1\cos\theta + 2\sin\theta$ ET $x_Q' = 3\cos\theta + 4\sin\theta$

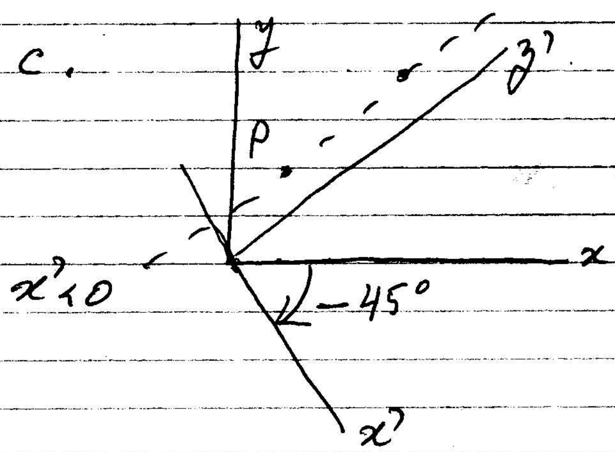
$x_P' = x_Q'$ DONNE, APRÈS SOUSTRACTION, $\cos\theta + \sin\theta = 0$

$\tan\theta = -1$ $\boxed{\theta = -45^\circ}$

B. $x_P' = \cos 45^\circ + 2\sin(-45^\circ) = \frac{1}{\sqrt{2}} - \frac{2}{\sqrt{2}} = \boxed{-\frac{1}{\sqrt{2}} = -0{,}707}$

AUSSI, $x_Q' = 3\cos(-45^\circ) + 4\sin(-45^\circ) = -1/\sqrt{2}$

C.



Q.2

A. $\Delta t = t_2 - t_1 = 4\times10^{-8} - 0\,s$ $\Delta x = x_2 - x_1 = 22 - 2 = 20\,m$

$\Delta t' = \gamma\left(\Delta t - \frac{v\Delta x}{c^2}\right) = 0$ si $v = \frac{\Delta t\, c^2}{\Delta x}$ $\boxed{\text{oui}}$

B. $v = (4\times10^{-8}\,s)(3\times10^{8}\,m/s)^2 / 20\,m = \boxed{1{,}8\times10^{8}\,\frac{m}{s} = 0{,}6c}$

C. $v > 0$ DONC S' SE DÉPLACE $\boxed{\text{VERS } x \text{ POSITIFS}}$

Q.3 2 ÉLÉMENTS = (1) ASTRONAUTE RENCONTRE TERRE ; (2) ASTRONAUTE RENCONTRE ALPHA.
ASTRONAUTE = REPÈRE PROPRE

A. $\Delta t_{TERRE} = \frac{l}{v} = \frac{4{,}37 \text{ années} \times c}{0.95c} = \boxed{4{,}60 \text{ ANNÉES}}$

B. $l_{ASTR} = \frac{l_{TERRE}}{\gamma}$ AVEC $\gamma = \frac{1}{\sqrt{1-\beta^2}} = 3.2$

$l_{ASTR} = \frac{4{,}37 \text{ ANNÉES} \times c}{3{,}2} = \boxed{1{,}37 \text{ ANNÉES-LUMIÈRE}}$

C. $\Delta t_{TERRE} = \gamma \Delta t_{ASTR} \rightarrow \Delta t_{ASTR} = \frac{\overset{4{,}60}{\Delta t_{TERRE}}}{\underset{3{,}2}{\gamma}} = \boxed{1{,}44 \text{ ANNÉES}}$

Q.4 PAR RAPPORT AU SOL : $L_1 = \frac{2m}{\gamma} = (2m)\sqrt{1-0{,}8^2} = 1{,}2m$

$L_2 = L_3 = 2m$ NE CHANGENT PAS

A. AVANT/ARRIÈRE ET DESSUS/DESSOUS : $S = 2 \times 1{,}2 = \boxed{2{,}4m^2}$

GAUCHE/DROITE : $S = 2 \times 2 = \boxed{4m^2}$

B. $V = 2 \times 2 \times 1{,}4 = \boxed{4{,}8m^3}$

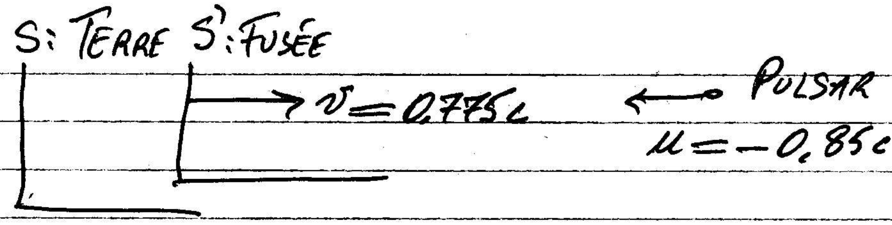
Q.5 $T_{TERRE} = \frac{d}{v} = \frac{2000m}{0.99(3 \times 10^8 \frac{m}{s})} = 6.734\mu s$

PROPRE : $T_{1/2} = 1{,}5\mu s$; TERRE : $T'_{1/2} = \gamma T_{1/2} = \frac{1}{\sqrt{1-0.99^2}} 1{,}5\mu s = 10{,}6\mu s$

NOMBRE DE 1/2-VIES $n = \frac{T_{TERRE}}{T'_{1/2}} = \frac{6.734}{10{,}6} = 0{,}635$

IL RESTE $\frac{N}{2^n} = \frac{650}{2^{0.635}} \simeq \boxed{420 \text{ MUONS}}$

Q.6



$$u' = \frac{u - v}{1 - \frac{uv}{c^2}} = \frac{-0{,}85 - 0{,}775}{1 - (-0{,}85)(0{,}775)}\,c = \boxed{-0{,}980\,c}$$

Q.7

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

A. $K = (\gamma - 1)mc^2$ $\qquad \gamma = \dfrac{\overset{8}{K}}{\underset{0{,}511}{mc^2}} + 1 = 16.655577$

QUI DONNE $\beta = 0.99819598$ $\qquad \boxed{v = 0{,}9982c}$

B. $p = \gamma m u = (16.65\ldots)\left(0.511\,\frac{MeV}{c^2}\right)(0.998\ldots c)$

$$= 8{,}4956459 \simeq \boxed{8{,}496\ MeV/c}$$

C. $E = \underset{8}{\underset{\uparrow}{K}} + \underset{0{,}511}{\underset{\uparrow}{mc^2}} = \boxed{8.511\ MeV}$

(**REMARQUE:** ON PEUT VÉRIFIER QUE $\overset{\text{de C}}{E^2} = \overset{\text{de B}}{(pc)^2} + (mc^2)^2$)

Q.8 $\Lambda \to p + \pi$ (p AU REPOS)

Σp : $\vec{p}_\Lambda = \vec{p}_\pi$ CAR $\vec{p}_p = \vec{0}$ (1)

ΣE : $E_\Lambda = m_p c^2 + E_\pi$ (2)

DE (2) AU CARRÉ : $E_\Lambda^2 = (m_p c^2)^2 + 2 m_p c^2 E_\pi + E_\pi^2$ (3)

DE L'ÉQUATION RELATIVISTE : $E_\Lambda^2 = (p_\Lambda c)^2 + (m_\Lambda c^2)^2$

ET $E_\pi^2 = (p_\pi c)^2 + (m_\pi c^2)^2$

DE CES 2 ÉQUATIONS dans (3), on a CAR $p_\Lambda = p_\pi$, DE (1)

$$\cancel{(p_\Lambda c)^2} + (m_\Lambda c^2)^2 = (m_p c^2)^2 + 2 m_p c^2 E_\pi + \cancel{(p_\pi c)^2} + (m_\pi c^2)^2$$

$$E_\pi = \frac{m_\Lambda^2 - m_p^2 - m_\pi^2}{2 m_p} c^2 = \frac{1116^2 - 938^2 - 140^2}{2 \times 938}$$

$$= \boxed{184 \text{ MeV}}$$

DE (2) : $E_\Lambda = m_p c^2 + E_\pi = 938 + 184 = \boxed{1122 \text{ MeV}}$

Q.9

(a) $W = K_f - K_i = \frac{1}{2}\overset{1.67\times10^{-27}\,kg}{m}\underset{100}{v_f^2} - \frac{1}{2}m\underset{50}{v_i^2} = \boxed{6.26\times10^{-24}\ J}$

(b) $W = (\gamma_f - 1)mc^2 - (\gamma_i - 1)mc^2 = (\gamma_f - \gamma_i)mc^2$

$= \left(\frac{1}{\sqrt{1-\beta_f^2}} - \frac{1}{\sqrt{1-\beta_i^2}}\right)mc^2$ $\qquad \beta_f = \frac{150\,000\,100}{3\times10^8}$

$\qquad \beta_i = \frac{150\,000\,050}{3\times10^8}$

$= \boxed{1.93\times10^{-17}\ J}$

Q.10

A. $E = K + mc^2 = 1.8 + 0.511 = 2.311\ MeV$

$pc = \sqrt{\underset{2.311}{E}^2 - (\underset{0.511}{mc^2})^2} = 2.253797\ MeV$

$p = \frac{2.253797\times10^6\,eV}{3\times10^8\,m/s}\times\frac{1.6\times10^{-19}\,J}{eV} = \boxed{1.202\times10^{-21}\ kg.\frac{m}{s}}$

B. $R = \frac{\overset{de\ A.}{p}}{\underset{1.6\times10^{-19}}{e}\,\underset{0.15}{B}} = \boxed{5.0\ cm}$