Physics 1C Chapter 37 HW

37.1) a) at the same time, before

b) **bolt A**

37.8) $\gamma = 100$

$\Delta t' = 1s$

$\begin{bmatrix} c\Delta t \\ \Delta x \end{bmatrix} = \gamma \begin{bmatrix} 1 & \beta \\ \beta & 1 \end{bmatrix} \begin{bmatrix} c\Delta t' \\ \Delta x' \end{bmatrix}$

$\Delta t = \gamma \Delta t'$

$\boxed{\Delta t = 100s}$

$v \approx c$

$\Delta x = c\Delta t$

$\boxed{\Delta x = 3 \times 10^{10} m}$

37.11) $\Delta t' = 2.24s$

a) $v \approx c$

$\Delta x' = c\Delta t'$

$\boxed{\Delta x' = 660m}$

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

$\beta = \frac{u}{c} = 0.999$

$\gamma = 22.37$

$\Delta t = \gamma \Delta t'$

$\boxed{\Delta t = 4.9 \times 10^{-5} s}$

c) $\Delta x = 0.999c(\Delta t)$

$\boxed{\Delta x = 14.7 km}$

d) **Yes, 14.7 > 14**

e) $L = \frac{L'}{\gamma}$

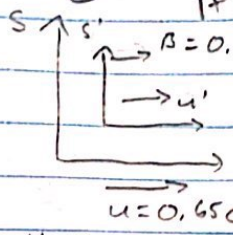
$\gamma = 22.37$

$L' = 141cm$

$\boxed{L = 0.63km}$

f) **Yes, 0.66km > 0.63km**

37.17) a) $\frac{u_{11}}{c} = \frac{\beta + u'_{11}/c}{1 + \beta u'_{11}/c}$



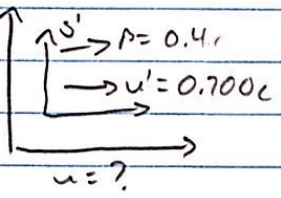
$\frac{u_{11}}{c}(1 + \beta u'_{11}/c) = \beta + u'_{11}/c$

$\frac{u_{11}}{c} + \beta \frac{u_{11}u'_{11}}{c^2} = \beta + u'_{11}/c$

$\boxed{u'_{11} = -1.26 \times 10^8 m/s}$

b) **Toward**

37.18)



a) $\frac{u_{11}}{c} = \frac{\beta + u'_{11}/c}{1 + \beta u'_{11}/c}$

$\frac{u_{11}}{c} = 0.86$

$\boxed{u_{11} = 0.86c}$

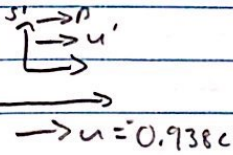
b) $u_{11} = 0.86c$

$\Delta x = u_{11} \Delta t$

$\Delta x = 8 \times 10^6 km = 8 \times 10^7 m$

$\boxed{\Delta t = 31s}$

37.20)



$\frac{u_{11}}{c} = \frac{\beta + u'_{11}/c}{1 + \beta u'_{11}/c}$

$-0.938 - 0.88 \frac{u'_{11}}{c} = 0.938 + \frac{u'_{11}}{c}$

$-1.876 = 1.88\left(\frac{u'_{11}}{c}\right)$

$\boxed{u'_{11} = 0.998c}$

37.28) $L=120m$, $\partial=25m$

$m=4\times10^3 kg$

$L=50m$

a) $\partial=\partial'=25m$

b) $p=\gamma m\vec{v}=\gamma\vec{p}'$

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

$50\gamma=120$

$\gamma=2.4$

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

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

$v=2.73\times10^8\frac{m}{s}$

$\boxed{p=2.62\times10^{12}Ns}$

37.35) $m=6.64\times10^{-27}kg$

$p=2.03\times10^{-18}kg\frac{m}{s}$

a) $E=\gamma mc^2$

$p=\gamma mv$

$E^2=(mc)^2+(pc)^2$

$E^2=3.57\times10^{-17}J+3.7\times10^{-17}J$

$\boxed{E=8.52\times10^{-10}J}$

b) $K=E-mc^2$

$\boxed{K=2.56\times10^{-10}J}$

c) $\frac{K}{mc^2}$

$\boxed{0.43}$

37.38) $M=1.67\times10^{-27}kg$

$m=9.75\times10^{-28}kg$

$E_i=\gamma Mc^2+\gamma Mc^2$

$E_i=E_f$

$E_f=2Mc^2+mc^2$

$2\gamma Mc^2=2Mc^2+mc^2$

$\gamma=1.29$

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

$\boxed{v_i=0.633c}$

b) $K=(\gamma-1)mc^2$

$K=4.36\times10^{-11}J$

$\boxed{K=272.07MeV}$

c) $E_0=mc^2$

$E_0=8.78\times10^{-11}J$

$\boxed{E_0=547.74MeV}$

37.42) $L'=a$, $V'=a^3$

$v=u$

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

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

$L=a\sqrt{1-u^2/c^2}$

$\boxed{V=a^3\sqrt{1-u^2/c^2}}$

37.47) $C=27km$

a) $K=6TeV=9.61\times10^{-7}J$

$v=(1-\Delta)c$

$K=\frac{mc^2}{\sqrt{1-v^2/c^2}}-mc^2$

$K=\frac{mc^2}{\sqrt{1-(1-\Delta)^2}}-mc^2$

$9.61\times10^{-7}J=\frac{mc^2}{\sqrt{1-(1-\Delta)^2}}$

$1-(1-\Delta)^2=2.45\times10^{-8}$

$\boxed{\Delta=1.22\times10^{-8}}$

b) $m_{rel}=\gamma m_{rest}$

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

$\gamma=6401.84$

$\boxed{m_{rel}=6401.84\,m_{rest}}$

37.51) $n=1.52$

$n=\frac{c}{v}$

$v=1.97\times10^8\frac{m}{s}$

$K=\frac{mc^2}{\sqrt{1-u^2/c^2}}-mc^2$

$K=2.68\times10^{-14}J$

$\boxed{K=0.17MeV}$

37.53) $m_0 = 17\,kg$

$\Delta m_0 = 17 \times 10^{-4}\,kg$

a) $E = mc^2$

$\Delta E = \Delta m_0 c^2$

$\boxed{\Delta E = 1.53 \times 10^{14}\,J}$

b) $\Delta t = 4.5\,ms$

$P_{avg} = \frac{\Delta E}{\Delta t}$

$\boxed{P_{avg} = 3.4 \times 10^{17}\,W}$

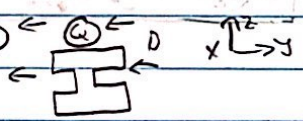
c) $U = mgh$

$\Delta E = mgh$

$m = \frac{\Delta E}{gh}$

$\boxed{m = 1.56 \times 10^{10}\,kg}$

37.56)



a) at rest

$\boxed{\Sigma F = 0N}$

b) $\vec{v} = v\hat{i}$ $\vec{B}' = \vec{B}\gamma$

$\boxed{\vec{B}' = -B\gamma\hat{j}}$

c) $\vec{F}_B = q\vec{v} \times \vec{B}$

$\vec{F} = Q(-v\hat{i}) \times (-B\gamma\hat{j})$

$\boxed{\vec{F} = -QvB\gamma\hat{k}}$

d) $|\vec{F}_d| = |\vec{F}_E|$

$QvB\gamma = QE$

$E = vB\gamma$

$\boxed{\vec{E} = vB\gamma\hat{E}}$

e) $\boxed{\vec{E}_\perp = \gamma\vec{v} \times \vec{B}}$

37.58) $\Delta t = 1.7\,s$, $\Delta t' = 2\,s$

$$\begin{bmatrix} c\Delta t \\ \Delta x \end{bmatrix} = \gamma \begin{bmatrix} 1 & \beta \\ \beta & 1 \end{bmatrix} \begin{bmatrix} c\Delta t' \\ \Delta x' \end{bmatrix}$$

$\Delta x^2 + (c\Delta t)^2$

$0 + (c\Delta t)^2 = \Delta x^2 \pm (c\Delta t)^2$

$\boxed{\Delta x = 3.16 \times 10^8\,m}$

37.60) $L = 20\,m$, $m = 0.058\,kg$

a) $v = 81\,\frac{m}{s}$

$K = \frac{1}{2}mv^2$

$\boxed{K = 190.27\,J}$

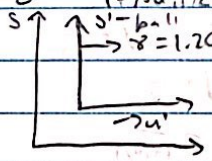
b) $K = \frac{mc^2}{\sqrt{1 - v^2/c^2}} - mc^2$

$v = 1.82 \times 10^8\,\frac{m}{s}$

$\gamma = 1.26$

$\boxed{K = 1.35 \times 10^{17}\,J}$

c) $\frac{u_{11}}{c} = \frac{\beta + u'_{11}/c}{1 + \beta u'_{11}/c}$



$u = 2.25 \times 16^8\,\frac{m}{s}$

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

$\beta = 0.607$

$0.75 = \frac{\beta + u'_{11}/c}{1 + \beta u'_{11}/c}$

$0.75 + 0.455\left(\frac{u'_{11}}{c}\right) = 0.607 + \frac{u'_{11}}{c}$

$0.143 = 0.545\left(\frac{u'_{11}}{c}\right)$

$\boxed{u'_{11} = 7.87 \times 10^7\,\frac{m}{s}}$

d) $v = 2.25 \times 10^8\,\frac{m}{s}$

$\gamma = 1.51$

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

$L' = 20\,m$

$\boxed{L = 13.2\,m}$

e) $x = vt$

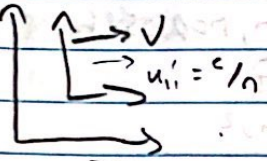
$\boxed{t = 8.87 \times 10^{-8}\,s}$

f) $x = vt$

$x = 13.2\,m$

$\boxed{t = 5.89 \times 10^{-8}\,s}$

37.64) S



$u_{11} = ?$

$\frac{u_{11}}{c} = \frac{\beta_{rel} + \beta_{rel}/c}{1 + \beta_{rel}/c}$

$\frac{u_{11}}{c} = \frac{\beta + 1/n}{1 + \beta/n}$

$\frac{u_{11}}{c}(1 + \beta/n) = \beta + \frac{1}{n}$

$\beta = \frac{v}{c}$

$\frac{u_{11}}{c}(1 + v/cn) = \frac{v}{c} + \frac{1}{n}$

$u_{11}(1 + v/cn) = v + \frac{c}{n}$

$u_{11} = \frac{1}{1 + v/cn} v + \frac{c}{n}$

$k = \frac{1}{1 + v/cn} = \frac{1}{1 + \beta n}$

$\boxed{k = 0.4372}$

37.65) $p + p \rightarrow p + p + K^- + K^+$

a) $E_{0k} = 493.7\,MeV$

$E_{0p} = 938.3\,MeV$

$P_{1i} + P_{2i} = P_{1f} + P_{2f} + P_{3f} + P_{4f}$

$P_{1i}^2 + P_{2i}^2 + 2P_{1i}P_{2i} = P_{1f}'^2 + P_{2f}'^2 + P_{3f}'^2 + P_{4f}'^2 + 2P_{1f}'P_{2f}' + 2P_{1f}'P_{3f}' + 2P_{1f}'P_{4f}' + 2P_{2f}'P_{3f}' + 2P_{2f}'P_{4f}' + 2P_{3f}'P_{4f}'$

$2\left(\frac{E_1}{c}\frac{m_2c^2}{c}\right) = m_3^2c^2 + m_4^2c^2 + 2(m_1m_3c^2 + m_1m_4c^2 + m_2m_3c^2 + m_2m_4c^2 + m_3m_4c^2)$

$2\left(\frac{E_1}{c}\frac{E_{0p}}{c}\right) = 2m_3^2c^2 + 2\left(\frac{E_{0p}^2}{c^2} + 4\frac{E_{0k}E_{0p}}{c^2} + \frac{E_{0k}^2}{c^2}\right)$

$E_1 = \frac{c^2}{E_{0p}}m_3^2c^2 + E_{0p} + 4E_{0k} + \frac{E_{0k}^2}{E_{0p}}$

$E_1 = E_{0p} + 4E_{0k} + \frac{2E_{0k}^2}{E_{0p}}$

$E_1 = K + E_{0p}$

$K = 4E_{0k} + \frac{2E_{0k}^2}{E_{0p}}$

$\boxed{K = 2494\,MeV}$

b) $\frac{K}{2E_{0k}}$

$E_{0k} = 493.7\,MeV$

$\boxed{\frac{K}{2E_{0k}} = 2.53}$

c) $2\left(\frac{E_1}{c}\frac{E_2}{c}\right) = 2m_3^2c^2 + \frac{2}{c^2}\left(E_{0p} + 4E_{0k} + \frac{E_{0k}^2}{E_{0p}}\right)$

$E_1 = E_2 =$

$\boxed{\text{To lazy}} \rightarrow \boxed{987.4\,MeV}$

d) $\boxed{\frac{K}{2E_{0k}} = 1}$

37.70) a) $\left(1 - \frac{v^2}{c^2}\right)\frac{\partial^2 E(x',t')}{\partial x'^2} + \frac{2v}{c^2}\frac{\partial^2 E(x',t')}{\partial x' \partial t'} - \frac{1}{c^2}\frac{\partial^2 E(x',t')}{\partial t'^2} = 0$

b) Physics laws stay the same

$\boxed{\frac{\partial^2 E(x',t')}{\partial x'^2} - \frac{1}{c^2}\frac{\partial^2 E(x',t')}{\partial t'^2} = 0}$