$\boxed{\text{Problem \#1 (P3)}}$: only $\boxed{\text{a) d) and g) are true}}$

$\boxed{\text{Problem \#2 (P6)}}$: $3.0 \times 10^{26}\, W = 3.00 \times 10^{26} \frac{J}{s}$

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

$$\Delta m = \frac{3 \times 10^{26} \frac{J}{s}}{\left(2.998 \times 10^{8} \frac{m}{s}\right)^2} = \boxed{3.34 \times 10^{9} \frac{Kg}{sec}}$$

$\boxed{\text{Problem \#3 (P8)}}$: $\Delta t = 2\mu s = 2 \times 10^{-6} s$, $v = 0.6c$

a) $$\Delta t' = \Delta t \gamma = \frac{\Delta t}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{2 \times 10^{-6} s}{\sqrt{1 - \left(\frac{0.6c}{c}\right)^2}}$$

$$\boxed{\Delta t' = \frac{2 \times 10^{-6} s}{\sqrt{1 - (.6)^2}} = 2.5 \times 10^{-6} sec}$$

b) $$\Delta x = v \Delta t = 0.6 (2.998 \times 10^{8} m/s)(2.5 \times 10^{-6} s) =$$

$$\boxed{\Delta x = 449.7 m = 0.4497 Km}$$

Problem#4(P17) : $L_p = 350$ m $\quad v = 0.63c \quad t' = \text{ship},\ t = \text{tower}$

when is signal sent, according to nose of ship?

a) We may use the classical relation $t = \frac{L}{v} = \frac{350\,m}{.76c} = \boxed{1.54\times10^{-6}s = 1.54\mu s}$

b) When is signal received, according to nose of ship?
we will use the Inverse Lorentz time transformation

$$t' = \gamma\left(t - \frac{vx}{c^2}\right),\quad \gamma = \frac{1}{\sqrt{1 - \frac{.76c^2}{c^2}}} = 1.54$$

$$t' = 1.54\left(t_{received} - \frac{.76\,(2.998\times10^{8}m/s)\,350m}{(2.998\times10^{8}m/s)^2}\right)$$

$t_{received}$ is the proper time according to the nose: t_{sent} + ~~t~~ traverse

$t_{received} = 1.54\times10^{-6}s + \frac{L_p}{c}$

$t_{received} = 1.54\times10^{-6}s + \frac{350m}{2.998\times10^{8}m/s}$

$t_{received} = 1.54\times10^{-6}s + 1.17\times10^{-6}s$

$t_{received} = 2.71\times10^{-6}s = 2.71\mu s$

$$t' = 1.54\left(2.71\times10^{-6}s - .887\times10^{-6}s\right)$$

$$t' = 2.81\times10^{-6}s = 2.81\mu s.$$

c). According to transmitter: $t_{received} = 2.81\,\mu s$ from above

d) $x' = \gamma(x - vt) = 1.54(350\,m - .76c \cdot 2.81\times10^{-6}s)$, $x' = -447$ m.

This problem is very confusing - even when done in the student solution manual - I disagree with several of the answers.

$\boxed{\text{Problem \#5 (P27)}}$: First use Kepler's 3rd Law to determine radius:

$T = 107$ minutes
$= 6.42 \times 10^3$ sec.

$$T^2 = \frac{4\pi^2}{GM_E} r^3 > \frac{4\pi^2}{gR_E^2} r^3 > r = \sqrt[3]{\frac{gR_E^2 T^2}{4\pi^2}}$$

$$r = \sqrt[3]{\frac{(9.81\ m/s^2)(6370 \times 10^3 m)^2 (6.42 \times 10^3 s)^2}{4\pi^2}} = 7.46 \times 10^6 m$$

now determine V from: $V = \frac{2\pi r}{T}$ or $V^2 = \left(\frac{4\pi^2 r^2}{T^2}\right) = \frac{4\pi^2 (7.46 \times 10^6 m)^2}{(6.42 \times 10^3 s)^2} = 5.33 \times 10^7 m^2/s^2$

Now $\Delta t_o = \frac{\Delta t'}{\left(1 - \frac{v^2}{c^2}\right)}$ since $v \ll c$ use Binomial Expansion

$$\Delta t_o = \Delta t' \left(1 - \frac{v^2}{c^2}\right)^{-1/2} = \Delta t' \left(1 + \tfrac{1}{2}(V^2/c^2)\right)$$

now $\Delta t = \Delta t' - \Delta t_o = \Delta t' - \Delta t' \left(1 + \frac{1}{2}\frac{V^2}{c^2}\right) = \Delta t'\left(1 - \left(1 + \frac{1}{2}\frac{V^2}{c^2}\right)\right)$

$$\Delta t = \Delta t' \left(\frac{1}{2}\frac{V^2}{c^2}\right) = \Delta t' \left(\frac{1}{2}\right)\left[\frac{5.37 \times 10^7 m^2/s^2}{(2.998 \times 10^8 m/s)^2}\right] = \Delta t(2.99 \times 10^{-10})$$

$$\Delta t = (2.99 \times 10^{-10})\left(\frac{31.56 \times 10^6 s}{yr}\right) = 9.43 \times 10^{-3} \frac{sec}{yr} = 9.43 \frac{m\,sec}{year}$$

Problem #6 (P34): Particle is frame S has $p = 7\,\frac{MeV}{c}$ and total energy $E = 9\,MeV$.

a). $E^2 = p^2c^2 + E_0^2 \Rightarrow E_0^2 = E^2 - (pc)^2$, $E_0 = m_0c^2$

$$E_0 = \sqrt{E^2 - p^2c^2} = \sqrt{(9\,MeV)^2 - \left(7\,\frac{MeV}{c}\right)^2 c^2} = \sqrt{(81-49)}\,MeV = 5.66\,MeV$$

$$m_0 = \frac{E_0}{c^2} = \frac{5.66\times10^6\,eV \times 1.602\times10^{-19}\,\frac{J}{eV}}{(2.998\times10^8\,m/s)^2} = 1.008\times10^{-29}\,kg$$

b). $E^2 = p^2c^2 + E_0^2$, $E_0 = 5.66\,MeV$

$$E = \sqrt{\left(4\,\frac{MeV}{c}\right)^2 c^2 + (5.66\,MeV)^2} = 6.93\,MeV$$

d) To find relative speeds use Lorentz velocity trans:

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

$u_a \equiv$ Part a velocity

$u_b \equiv$ Part b velocity

Solving for $V = \dfrac{u_a - u_b}{1 - \frac{u_a u_b}{c^2}}$ now need to determine u_a & u_b:

$E = E_0\gamma = \dfrac{E_0}{\sqrt{1 - \frac{u^2}{c^2}}}$ we can solve for $u \Rightarrow c\sqrt{1 - \left(\frac{E_0}{E}\right)^2}$

$$u_a = c\sqrt{1 - \left(\frac{5.66\,MeV}{9\,MeV}\right)^2}$$

$u_a = 2.33\times10^8\,m/s$

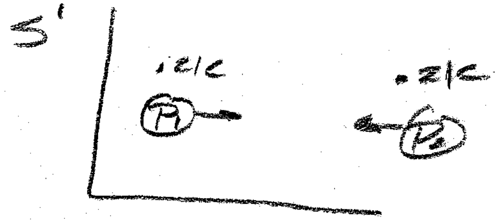
$u_a = .777c$

$$u_b = c\sqrt{1 - \left(\frac{5.66}{6.93}\right)^2}$$

$u_b = 1.73\times10^8\,m/s = .577c$

$$V = \frac{.777c - .577c}{1 - \frac{(.777c)(.577c)}{c^2}} = .363\,c = 1.08\times10^8\,\frac{m}{s}$$

Problem #7 (P37):



For any Proton

$K' = m_0c^2\gamma - m_0c^2 = E_0(\gamma - 1)$

m_0c^2 for a Proton : 938 MeV.

a). For one proton $K' = 938\text{ MeV}\left(\sqrt{\frac{c^2}{c^2-u^2}} - 1\right) = 938\text{ MeV}\sqrt{\frac{c^2}{c^2-(.21c)^2}} - 1$

$K' = 21.4\text{ MeV}$

For both Protons $K'_{TOTAL} = 42.8\text{ MeV}$.

b). Let one proton be moving in frame S, $K' = (\gamma - 1)E_0$

S is moving at same speed as Proton. Find velocity of proton in frame S: $u = \frac{u_x' + v}{1 + \frac{v u_x'}{c^2}} = \frac{.21c + .21c}{1 + \frac{(.21c)(.21c)}{c^2}} = .402c$

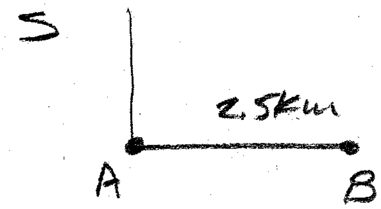
γ in moving frame is: $\frac{1}{\sqrt{1 - \frac{uv}{c^2}}} = \frac{1}{\sqrt{1 - \frac{(.402)(.402)c^2}{c^2}}} = 1.09$

$K = (1.09 - 1)\,42.8\text{ MeV} = 3.94\text{ MeV}$

$\boxed{\text{Problem\# 8 (P2)}}$: Due to gravitational time dilation > Stronger $g \Rightarrow$ slower time

Thus, twin working in basement will age slower.

$\boxed{\text{Problem\# 9 (P18)}}$:



$\Delta t_{BA} = 2\times10^{-6}s$.

using Lorentz time transform:

a) $\Delta t' = t_B' - t_A' = \gamma\left[(t_B - t_A) - \frac{v}{c^2}(x_B - x_A)\right]$

$\Delta t' = \gamma\left(\Delta t - \frac{v}{c^2}\Delta x\right)$ we wish to find v such that $\Delta t' = 0$

$\gamma\left(\Delta t - \frac{v}{c^2}\Delta x\right) = 0 > \gamma\Delta t - \frac{\gamma v}{c^2}\Delta x = 0$

$\gamma\Delta t = \frac{\gamma v}{c^2}\Delta x > \gamma v = \frac{\gamma\Delta t c^2}{\Delta x} > v = \frac{\Delta t c^2}{\Delta x}$

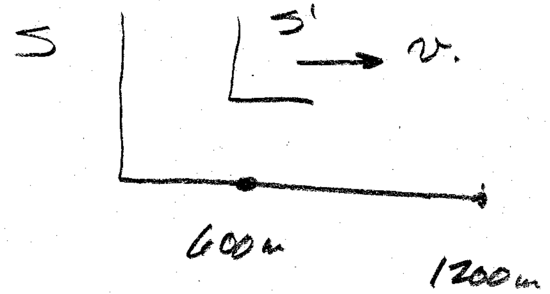
$v = \left(\frac{(2\times10^{-6}s)}{2.5\times10^{3}m}c\right)c = .24c$

b) for B to occur before A, $\Delta t < 0$

$\Delta t' = \gamma\left(\Delta t - \frac{v\Delta x}{c^2}\right) < 0 > \Delta t < \frac{v\Delta x}{c^2}$; $v > \frac{\Delta t c^2}{\Delta x} >$

Thus if $v > .24c$, event B will seen before event A for the observer moving $> 0.24c$.

Problem#10(P19):



$\Delta t = 6\mu s$

for S' $\Delta x' = 0$

Determine $\Delta t'$

first determine v from $\Delta x' = \gamma(\Delta x - v\Delta t)$, $\Delta x' = 0$

$$\Delta x = v\Delta t \Rightarrow v = \frac{\Delta x}{\Delta t} = \frac{600m}{6\times10^{-6}s} = 100\times10^{6} m/s$$

$$= 1\times10^{8} m/s = .334c.$$

now $\Delta t' = \gamma\left(\Delta t - \frac{v\Delta x}{c^2}\right)$; $\gamma' = \frac{1}{\sqrt{1-.334^2}} = 1.06$

$$\Delta t' = 1.06\left[6\times10^{-6}s - \frac{600m\,(.334c)}{c^2}\right] = 5.65\times10^{-6}s = 5.65\mu s.$$