HW Ch. 5

5.7	What speed gives m/m_o=1.01 ?

$\gamma = 1.01$

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

$= 0.14\ c$

$= 4.2 \times 10^7\ m/s$

Do the algebra once then keep result
In your head!!!!!!

5.11------What ratio is required for F(parallel)/F(perpendicular) for given various speeds SO THAT in each case (at each speed) a(parallel)=a(perpendicular)?

Note--this would define a force angle for each speed. Speeds of 0.010c, 0.100c, 0.99c

If $a_{\parallel} = a_{\perp}$

then $\frac{F_{\parallel}}{F_{\perp}} = \frac{\gamma^3 m_o \cancel{a_{\parallel}}}{\gamma m_o \cancel{a_{\perp}}}$

$= \gamma^2$

for $0.01c$ $= 1.0001$

$0.1c$ $= 1.01$

$0.99c$ $= 50.25$

5.16

What is the kinetic energy of an electron with mass of ten times the rest mass?

given $\gamma = 10$ $\quad (m = \gamma m_0)$

$$KE = (\gamma - 1)\underbrace{m_0 c^2}$$

$$= 9 * 0.511 \text{ MeV}$$

$$= 4.599 \text{ MeV}$$

$$= 7.358 \times 10^{-13} \text{ J}$$

5-21

a) For what conditions is it true that p=KE/c is true exactly?

$$E^2 = p^2c^2 + E_0^2$$

(~~the new KE = $p^2/2m$~~

If $E_0 = 0 = m_0 c^2$ so $m_0 = 0$

Then

$$E^2 = p^2c^2$$

$$(E-0)^2 = p^2c^2$$

$$KE^2 = p^2c^2 \quad \text{or} \quad p = \frac{KE}{c}$$

Zero rest mass particles do exist!

b) For what conditions is the same relation approximately true.

same equation but now $E_0 \ll E$

This is true for "fast"

$$p^2c^2 = E^2 - E_0^2$$

$$\approx E^2 \rightarrow p \approx E/c$$

$$\approx \frac{E - E_0}{c}$$

$$\approx KE/c$$

5-21 c

When can you say that $p = \sqrt{2E_0\, KE}\,/c$

Since we had --fastest, and very fast, now it is a good guess to look at "slow".

$$p^2c^2 = E^2 - E_0^2 \qquad E = KE + E_0$$

$$= (E - E_0)(E + E_0)$$

$$= KE\,(KE + 2E_0)$$

exact so far

but if KE is small drop

$$p^2c^2 \approx KE\,(2E_0)$$

$$p \approx \sqrt{2\,KE\,E_0}\,/c$$

If (since KE had to be small compared to rest energy) we are moving slow and classical,
Then we can use KE=(1/2)m_0v^2, and see that p simplifies immediately to

$$p = m_0 v$$

For slow cases you should also be able to use KE=(gamma-1)* rest energy and reduce gamma by using expansion (first term in expansion series from calc II).

5-30

Given a spaceship with length 100 m and mass 4.00E9 kg at rest, ….the ship passes you and has length 75 m. What is the momentum?

$L_0 = 100$

$m_0 = 4 \times 10^9$ kg

$L = 75$ m $\longrightarrow$

$\gamma = \frac{4}{3}$

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

$= 0.6614\,c$

$=$

$P = \gamma m_0 V$

$= 1.058 \times 10^{18}$ kg m/s