Chapter-2 Homework

$E = m\gamma c^2$ $\beta = v/c$
$E = KE + mc^2$ $\gamma = 1/[1-\beta^2]^{1/2}$
$E = E^2 = p^2c^2 + m^2c^4$ 1 u = 931.MeV
$p = m\gamma\ v = m\gamma\ \beta\ c$

#1(a) $\gamma = 1.0005$ $p = m\gamma v$ =1.673e-27 Kg (1.00005) (3.0e6 m/s)= $\underline{5.02 \times 10^{-21}\ \text{Kg m/s}}$
(b) $\gamma = 1.1550$ $p = m\gamma v$ = 1.673e-27 Kg (1.155) (1.5e6 m/s) = $\underline{2.89\times10^{-19}\ \text{Kg m/s}}$
(c) $\gamma = 2.2942$ $p = m\gamma v$ = 1.673e-27 Kg (2.294) (2.7e6 m/s) = $\underline{1.03\times10^{-18}\ \text{Kg m/s}}$

(d) $p = m\gamma\beta c = (939\ \text{MeV}/c^2)(1.00005)(.01)c =$ $\underline{9.39\ \text{MeV/c}}$
(e) $p = m\gamma\beta c = (939\ \text{MeV}/c^2)(1.155)(.5)c =$ $\underline{540\ \text{MeV/c}}$
(f) $p = m\gamma\beta c = (939\ \text{MeV}/c^2)(2.294)(.9)c =$ $\underline{1930\ \text{MeV/c}}$

#8 $\beta = 0.95$ $\gamma = 3.20$ $E^2 = p^2c^2 + m^2c^4$
(a) Rest Energy $p = 0$ $E = mc^2 = (938.3\ \text{MeV}/c^2)c^2 =$ $\underline{938.3\ \text{MeV}}$
(b) $E = m\gamma c^2 = (938.3\ \text{MeV}/c^2)(3.20)c^2 =$ $\underline{3004\ \text{MeV}}$
(c) $KE = E - mc^2 =$ 3004 MeV - 938.3 MeV = $\underline{2067\ \text{MeV}}$

#9 KE = 5 m = 2555 KeV with $m = 511\ \text{KeV}/c^2$
(a) $E = KE + mc^2 =$ $\underline{3066\ \text{KeV}}$
(β) $\gamma = E/mc^2$ = 3066 KeV / 511 KeV = 6.0
$\beta = [1-(1/\gamma)^2]^{1/2} = 0.986$ or $\underline{v = 0.986\ c}$

#11 KE = 50 GeV $E = KE + mc^2$ = 50 GeV + 0.939GeV =50.939 GeV
(a) $pc = \text{sqrt}(E^2 - m^2c^4)$ = 50.930 GeV or $\underline{p = 50.930\ \text{GeV/c}}$
(b) β/c = p/E = (50.930 GeV/c) / (50.939)GeV = 0.99982 $\underline{v = 0.99982\ c}$

#18 ${}^{55}Cr_{24} \rightarrow {}^{55}Mn_{25} + {}^{0}e_{1}$ A -> B + e MA~MB >> Me
(a) $\Delta M = M_A - M_B$ = 54.928 u– 54.9244 u - = .0035 u = $\underline{3.26\ \text{MeV}/c^2}$

The decay $Q = (M_A - M_B - M_e)c^2 =$ 0,00295 u = 2.75 MeV
(Not exactly what was asked for, BUT!!)

(b) After the decay the Mn nucleus remains virtually stationary (T_{MN}~0) and the net decay energy goes to the electron,

$M_A c^2 = M_B c^2 + T_B(\sim 0) + Me\ c^2 + Te$ *conservation of energy*
$Te \cong \Delta M c^2 - Me\ c^2$ = 3.26 MeV - 0.511MeV = $\underline{2.75\ \text{MeV}}$

OR
$Te = (M_A c^2 - M_B c^2 - Me\ c^2) \cong Q$ = 2.75 MeV