Physics 120 Homework SL
May 8, 2014

6.X.39 The speed is determined from the relativistic energy equation. We have

$$E_{total,e} = \gamma_{f,e} m_e c^2 = E_{rest,p} = m_p c^2 \rightarrow \gamma_{f,e} = \frac{m_p}{m_e} = \frac{1.67\times10^{-27} kg}{9.11\times10^{-31} kg} = 1833$$

$$\gamma_{f,e} = 1833 = \frac{1}{\sqrt{1-\frac{v_{f,e}^2}{c^2}}} \rightarrow v_{f,e} = \sqrt{\frac{\gamma_{f,e}^2 - 1}{\gamma_{f,e}^2}} c = \sqrt{\frac{(1833)^2 - 1}{(1833)^2}} c = 0.99999985c$$

The kinetic energy of the electron is given by

$$E_{total} = E_{rest} + KE \rightarrow KE = E_{total} - E_{rest} = (\gamma_{f,e} - 1) m_e c^2$$

$$KE = (\gamma_{f,e} - 1) m_e c^2 = (1832)\times 9.11\times10^{-31} kg \times \left(3\times10^8 \tfrac{m}{s}\right)^2 = 1.5\times10^{-10} J$$

6.X.47 The work done by you is given as

$$W = F_{net} \cdot dr = \int \langle F\cos\theta, F_N - F\sin\theta - F_W, 0\rangle \cdot \langle dx, 0, 0\rangle$$

$$W = F\cos\theta \Delta x = 40N \times 3m \times \cos 40 = 91.9J$$

6.X.49 Work

a. Holding the book does no work since there is no motion.

b. The string does no work on the pendulum mass since it is in uniform circular motion.

c. For a half-cycle and full cycle of an oscillating mass on a spring the net work done is zero because there is no change in the KE of the block and there is also no change in the spring potential energy.

6.X.51 Work done by gravity

a. The work done by gravity is given by
$W = \vec{F} \cdot d\vec{r} = \int \langle 0, -mg, 0\rangle \cdot \langle 0, -dy, 0\rangle = mg\Delta y = 0.7kg \times 9.8 \tfrac{m}{s^2} \times 4.5m = 30.9J.$

b. Since the work done is positive, the KE of the ball increases.

c. The work done by gravity is given by
$W = \vec{F} \cdot d\vec{r} = \int \langle 0, -mg, 0\rangle \cdot \langle 0, dy, 0\rangle = -mg\Delta y = -0.7kg \times 9.8 \tfrac{m}{s^2} \times 4.5m = -30.9J.$

d. Since the work done is negative, the KE of the ball decreases.