1-41. Orbit circumference $\approx 4.0 \times 10^7\,m$.

Satellite speed $v = 4.0 \times 10^7\,m/(90\,\text{min} \times 60\,s/\text{min}) = 7.41 \times 10^3\,m/s$

$$\Delta t - \Delta t_0 = t_{diff}$$

$$\Delta t - \Delta t/\gamma = t_{diff} = \Delta t(1 - 1/\gamma) \approx \Delta t\left(\frac{1}{2}\beta^2\right) \quad \text{(Problem 1-20)}$$

$$t_{diff} = (3.16 \times 10^7\,m/s)(1/2)(7.41 \times 10^3/3.0 \times 10^8)^2$$

$$= 0.0096\,s = 9.6\,ms$$

1-46. (a) $L = L_p/\gamma = L_p\sqrt{1 - u^2/c^2} = 100\,m\sqrt{1 - (0.85)^2} = 52.7\,m$

(b) $u' = \dfrac{u + u}{1 + uu/c^2} = \dfrac{0.85\,c + 0.85\,c}{1 + (0.85)^2} = \dfrac{1.70\,c}{1.72} = 0.987\,c$

(c) $L' = L_p/\gamma' = L_p\sqrt{1 - u'^2/c^2} = 100\,m\sqrt{1 - (1.70/1.72)^2} = 16.1\,m$

(d) As viewed from Earth, the ships pass in the time required for one ship to move its own contracted length. $\Delta t = \dfrac{L}{u} = \dfrac{52.7\,m}{0.85 \times 3.00 \times 10^8\,m/s} = 2.1 \times 10^{-7}\,s$

(e)