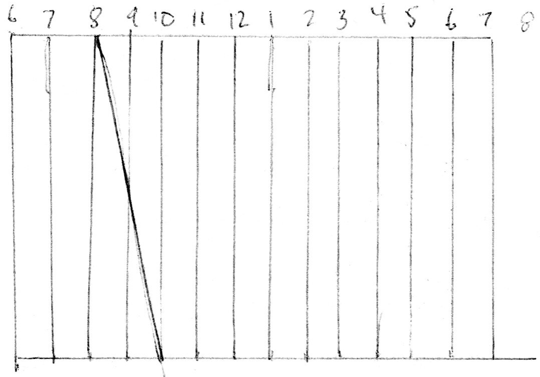
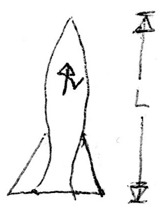
Hartle week 1 Solutions

4.1



$$V = \frac{472\,\text{km}}{\left(2 + \frac{4}{60}\right)\text{hr}} = \boxed{228.4\ \frac{\text{km}}{\text{hr}}}$$

4.2 (a)



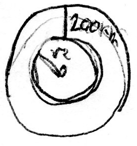
$v = \frac{4}{5}c$, t_0 = when light reaches end of rocket in rocket frame $= \dfrac{L\,\text{m}}{c\,\frac{\text{m}}{\text{s}}} = \boxed{\dfrac{L}{c}\ \text{sec}}$ since light travels at speed c in all reference frames.

(b) In the ground frame the distance from the tail to the nose of the rocket is $L\gamma = L\sqrt{1-\left(\frac{4}{5}\right)^2} = \frac{3}{5}L$

So for light to get to the end it must travel $\frac{3}{5}L + \frac{4}{5}c\Delta t$ where $\frac{4}{5}c\Delta t$ is the distance traveled by the rocket in time Δt

So $c\Delta t = \frac{3}{5}L + \frac{4}{5}c\Delta t \Rightarrow \Delta t = \dfrac{\frac{3}{5}L}{\left(c - \frac{4}{5}c\right)} = \dfrac{\frac{3}{5}L}{\frac{1}{5}c} = \boxed{\dfrac{3L}{c}}$

4.4 we need centrifugal accelration to cancel gravity, so $\frac{V^2}{r} = \frac{GM_e}{r^2} \Rightarrow V = \sqrt{\frac{GM_e}{r}}$



$V_s \approx 7800\,\frac{\text{m}}{\text{s}} \Rightarrow \gamma_s \approx \left(1 + 3.4\times10^{-10}\right)$

So $\Delta t_s = \gamma_s(3600\cdot24) = 86400.00003$

the γ_e for ear the surface is so small $\Delta t_e \approx (3600\cdot24) = 86400$. So the time difference is $\boxed{30\,\mu s}$ not a big difference

$r_s = 6378\,\text{km} + 200\,\text{km} = 6578\,\text{km}$, $r_e = 6378\,\text{km}$