

## Homework 5

### Problem 1

(a) No, he would experience an effective gravitational field since he is in a non-inertial reference frame.

(b)

$$g_{effective} = a = \frac{\Delta v}{\Delta t} = 1 \text{ m/s}^2$$

(c) Starting with

$$s = \frac{1}{2}at^2$$

and rearranging we get

$$t = \sqrt{\frac{2s}{a}} = \sqrt{2}s = 1.4s.$$

(d) He would float freely and appear weightless.

### Problem 2

(a)

$$\Delta t = \frac{\Delta x}{v} = \frac{1.04}{c} \text{s} = 3.5 \cdot 10^{-9} \text{s}$$

$$d_{\text{test}} = \frac{1}{2}at^2 = 6.0 \cdot 10^{-17} \text{m}$$

To get a feel for how this compares to the diameter of a atomic nucleus we calculate

$$\frac{d_{\text{test}}}{d_{\text{nucleous}}} = .06.$$

(b) From problem (1c) we have the relation

$$t_{\text{test}} = \sqrt{\frac{2s_{\text{test}}}{a}} = 1.4 \cdot 10^{-4} \text{s}.$$

$$d_{\text{fast}} = v_{\text{fast}}t_{\text{fast}} = 4.0 \cdot 10^4 \text{m}$$

So a chamber with any width  $< 4.0 \cdot 10^4 \text{m}$  can be considering a freely falling frame.

**Problem 3** From class we have that tidal effects are proportional to (initial separation)·(strength of gravity) or

$$\Delta d = \alpha g d_o$$

for a constant  $\alpha$ . Also from class we have for  $g = g_{\text{earth}}$  and  $d_o = 200\text{m}$  that  $\Delta d = 1\text{mm}$  thus we can solve for  $\alpha$

$$\alpha = \frac{.001\text{m}}{9.8\text{m/s}^2 20\text{m}} = 5 \cdot 10^{-6} \text{s}^2/\text{m}$$

Thus we have

$$\Delta d_{\text{earth}} = \alpha g_{\text{earth}} d_{o,\text{earth}} = 10\text{mm}.$$

**Problem 4** Similarly we have

$$\Delta d_{\text{moon}} = \alpha \frac{g_{\text{earth}}}{6} d_{o,\text{moon}} = .2\text{mm}.$$

**Problem 5** And again

$$\Delta d_{\text{neutron star}} = \alpha 10^4 g_{\text{neutron star}} d_{o,\text{neutron star}} = 10\text{m}.$$