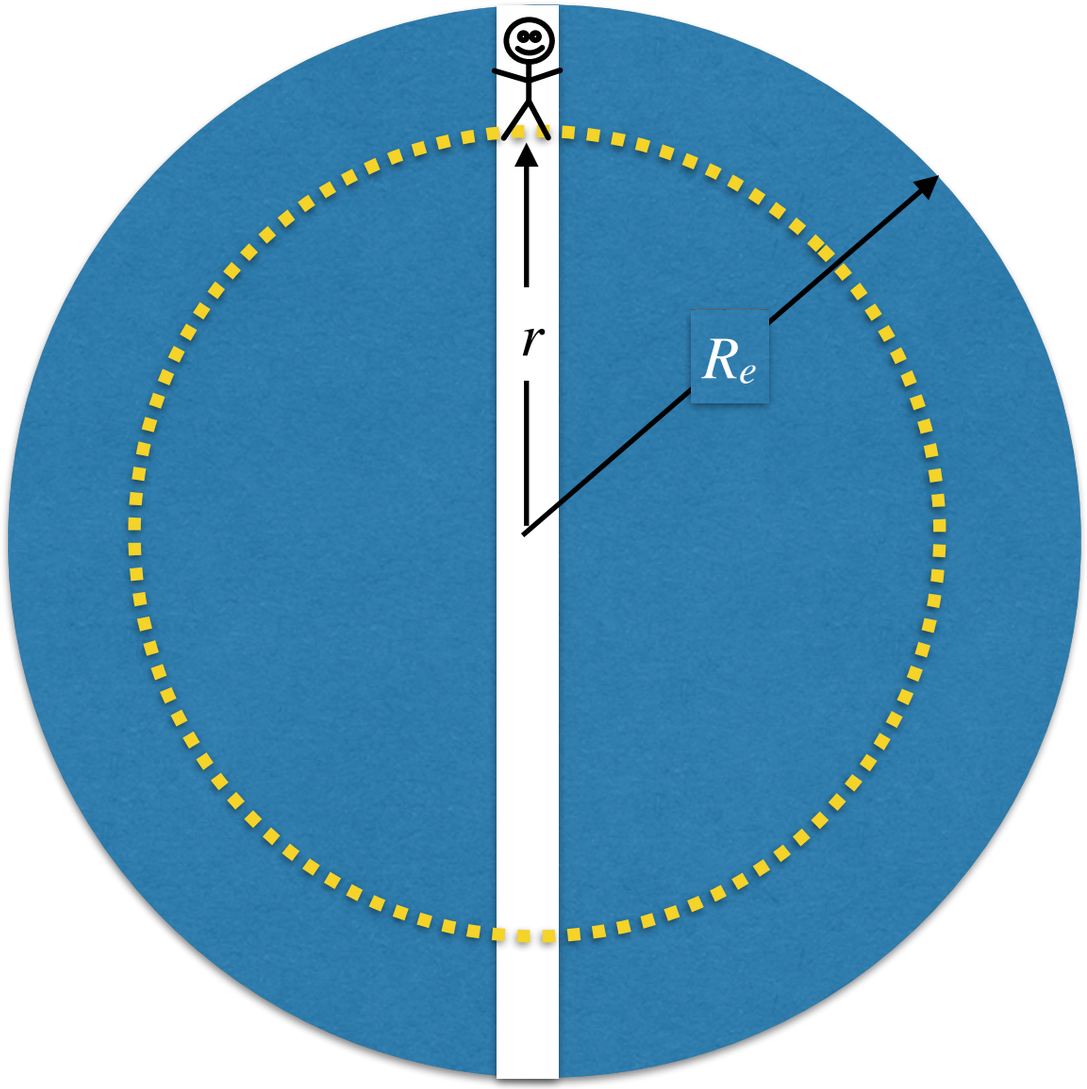
The Hole in the Earth


r
R_e

I want to know why the answer to life is 42!

Drill a hole through the earth and jump in – what happens?

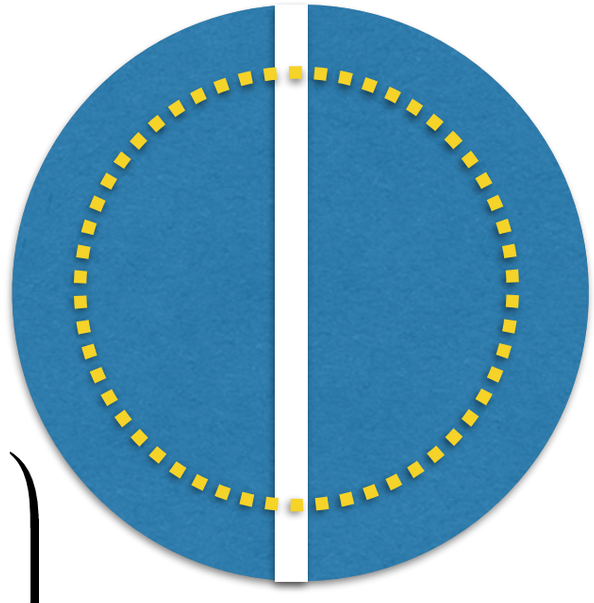
Just for fun – you don’t need to know this.

The gravitational form of Gauss' Law

$$\Phi_G = 4\pi G M_{\text{encl}}$$

$$g(4\pi r^2) = 4\pi G M_{\text{encl}}$$

$$g(4\pi r^2) = 4\pi G M_{\text{earth}} \left(\frac{r^3}{R_{\text{earth}}^3} \right)$$

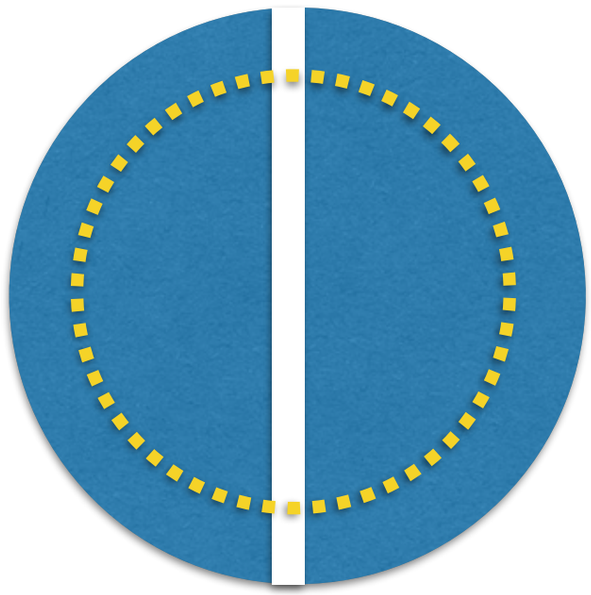


$$g = \frac{G M_{\text{earth}}}{R_{\text{earth}}^2} \left(\frac{r}{R_{\text{earth}}} \right)$$

$$g = \frac{g_{\text{outside}}}{R_{\text{earth}}} r$$

$$F_g = mg = \frac{m g_{\text{outside}}}{R_{\text{earth}}} r$$

$$F_g = mg = \frac{mg_{\text{outside}}}{R_{\text{earth}}} r$$



This looks like Hooke's law for springs.
Spring constant is

$$k = \frac{mg_{\text{outside}}}{R_{\text{earth}}}$$

Period of oscillation

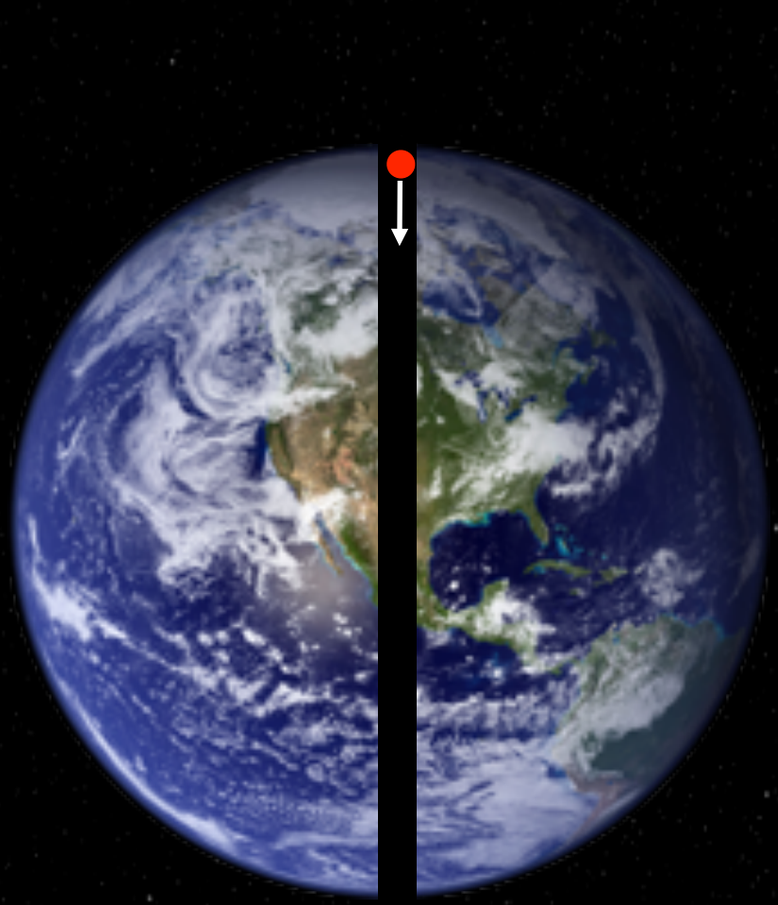
$$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{R_e}{g_{\text{outside}}}} = 2\pi\sqrt{\frac{6466\text{ km}}{9.8\text{ m/s}^2}} =$$

5064 s = 84 minutes
round trip

Drill a hole through the earth and jump in – what happens?

You will oscillate like a mass on a spring with a period of 84 minutes.

It takes 42 minutes to come out the other side!



$k = mg/R_E$