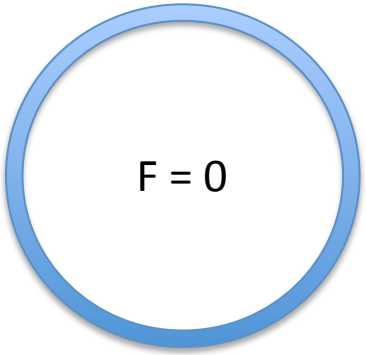
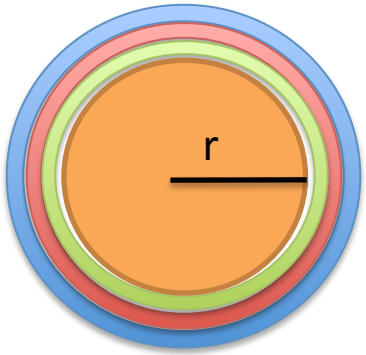
Inside a Sphere

Force of Gravity Inside a Sphere

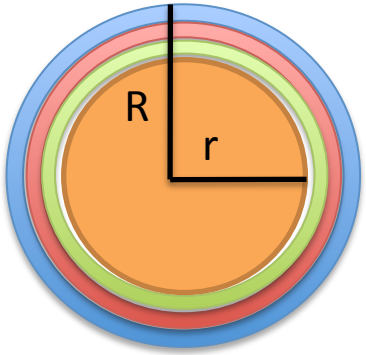
1. If the sphere is hollow (picture a ping pong ball), the force of gravity is zero everywhere inside.



2. If the sphere is solid, the force is not zero inside. Think of a solid sphere as many concentric shells. The outside shells don't matter – only mass the pulls is that enclosed in the shaded area.



How much mass is enclosed?



- If the density of the sphere is uniform, then the density of the big sphere = the ρ of the little sphere.

$$\rho_{big} = \rho_{little}$$

$$\frac{M}{V} = \frac{m}{v}$$

$$\frac{M}{\frac{4}{3}\pi R^3} = \frac{m}{\frac{4}{3}\pi r^3}$$

$$m = \frac{r^3}{R^3} M$$

- So force of attraction is given by:

$$F = \frac{Gmm}{r^2} = \frac{Gm(r^3 M)}{r^2 R^3}$$

$$F = \frac{GmM}{R^3} r$$

R = radius of sphere

r = distance object is from center

3. If you are on the surface or beyond the radius of either type of sphere, treat all the mass of the sphere as if it is located at the center.

Ex: A solid sphere of mass 2000 kg and radius 5 m is inside and concentric with a spherical shell of mass 1000 kg and radius 8 m. Find the gravitational force exerted by the spheres on a 50 kg object located:

A) 10 m from the center

B) 7 m from the center

C) 4 m from the center

D) At the center