

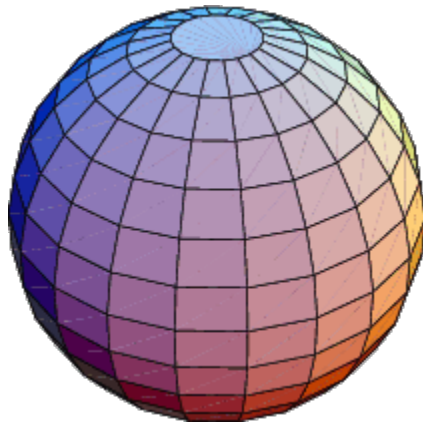
A Sphere that's Not Near: Transition Item #2 of 2

PHYSICS 204
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A fictional planet called '*Iamnot*' is measured to have a mass of M , a radius of R and a density (mass/volume) of ρ . The futuristic tools used to make these measurements are large; variations in both the planet's radius and density are small. In fact, the variations are too small to register on the measuring devices. As far as science is concerned, therefore, *Planet Iamnot* is of essentially ***constant radius*** and ***uniform density***.



You live on a tiny far-flung satellite called '*Luna Staten*'. *Luna Staten* has a mass of m , but in volume is, indeed, tiny. Tiny compared to Earth? Heck, no. Earth who? That allegedly extant piece of dust? Compared to that joke of a shaving from a twig's dropping, *Luna Staten* is a monster-sphere. Compared to *Iamnot*, however, *Luna Staten* is but a ***particle***—located at a ***point***... in space... and time.

That comparative point, *Luna Staten*, is a distance r away from the center of *Iamnot*. No other measurable bit of mass can be detected for parsecs and parsecs and parsecs...

I. The Theme

- a) Expressed as a function of given and fundamental constants, what is the **Gravitational Force** exerted on Luna Staten by Iamnot?
- b) Expressed as a function of given and fundamental constants, what is the **Gravitational Force** exerted by Luna Staten on Iamnot?
- c) Expressed as a function of given and fundamental constants, what is the instantaneous rate at which *Luna Staten* will begin to accelerate toward *Iamnot*?

The first variation: Assume that none of the above facts change EXCEPT:

II. *Iamnot* is now a SPHERICAL SHELL:

It has the same total mass and radius as described before, but now it consists of pure vacuum--other than an infinitesimally thin and perfectly spherical surface. Funny how things change.

- d) Expressed as a function of given and fundamental constants, what is the **Gravitational Force** exerted on Luna Staten by Iamnot?
- e) Expressed as a function of given and fundamental constants, what is the **Gravitational Force** exerted by Luna Staten on Iamnot?
- f) Expressed as a function of given and fundamental constants, what is the instantaneous rate at which *Luna Staten* will begin to accelerate toward *Iamnot*?

The second variation: Assume that none of the above facts change EXCEPT:

III. *Luna Staten* is now somewhere inside that SPHERICAL SHELL:

That is, $r < R$.

- g) Expressed as a function of given and fundamental constants, what is the **Gravitational Force** exerted on Luna Staten by Iamnot?
- h) Expressed as a function of given and fundamental constants, what is the **Gravitational Force** exerted by Luna Staten on Iamnot?
- i) Expressed as a function of given and fundamental constants, what is the instantaneous rate at which *Luna Staten* will begin to accelerate toward *Iamnot*?