Inverse Square Law

Since we know that the force of gravity is inversely proportional to the square of the distance we can simplify many questions.

$$F_g \propto \frac{a}{r^2}$$

The gravitational field $(\vec{g})$ on Jupiter is roughly 25 N/kg.

What is the gravitational field $(\vec{g})$ at four times Jupiter's radius? $r_{Jupiter}$=70Mm.

$$(\vec{g}) = \frac{Gm}{r^2}$$

Find $(\vec{g})$ at a height of $3.0x10^6$m above Earth's surface.

$$(\vec{g}) = \frac{Gm}{(r+h)^2}$$

$$= \frac{6.67x10^{-11}\left(5.98x10^{24}\right)}{(6.38x10^6 + 3.0x10^6)^2}$$

$$= 4.53\ \frac{N}{kg}$$

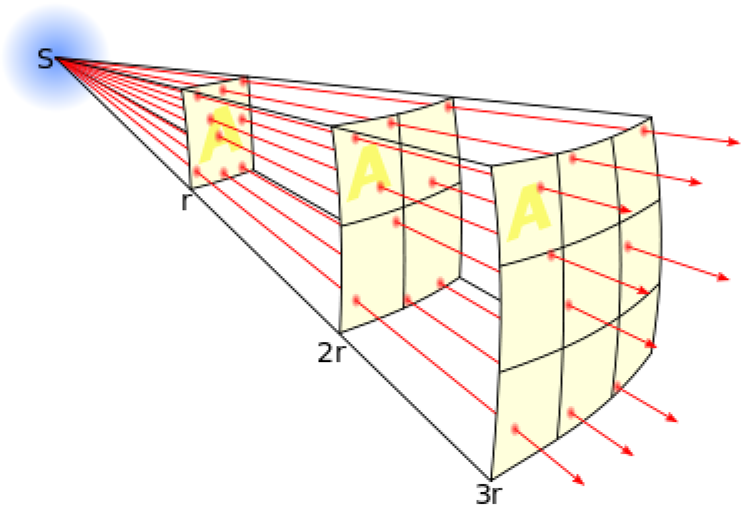
Determine the orbital velocity at that height.

$$F_c = F_g$$

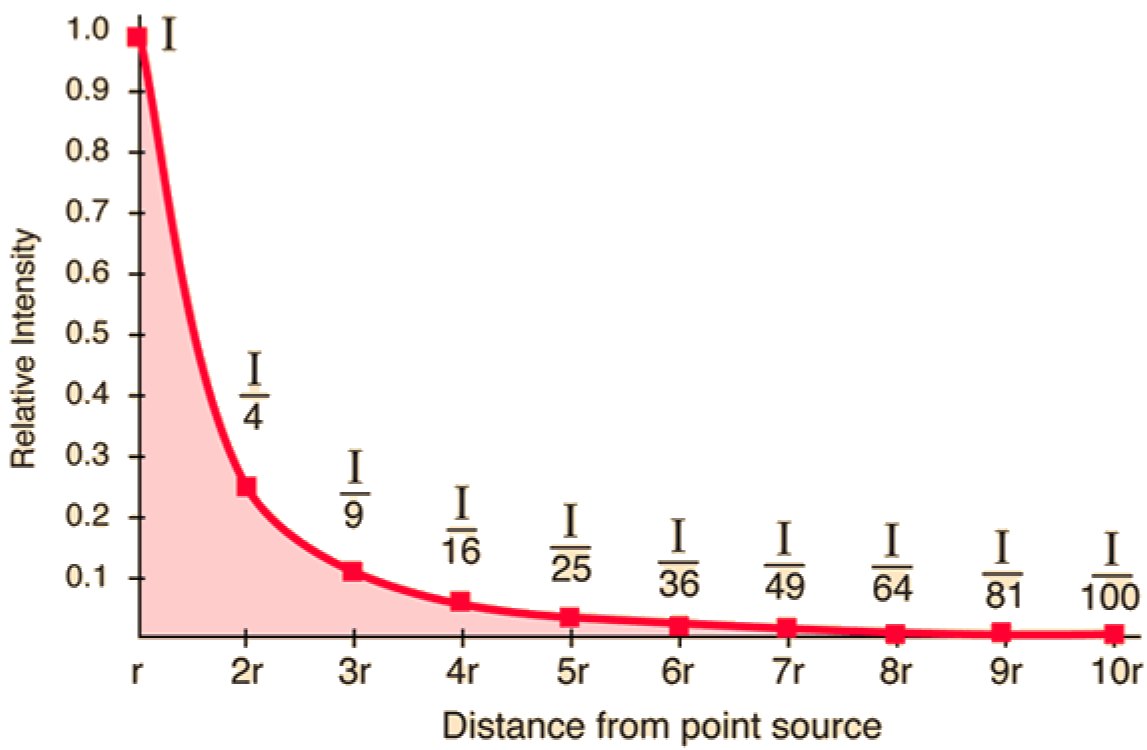
A test question might look something like this:

“An exoplanet has gravitational field strength of 36N/kg at its surface. What is $\vec{g}$ at a height of 5 radii?”

Here is a graphical representation of the Inverse Square Law:



And, a nice trick to use it:



Let us assume we had a pug on the surface of the Earth. F_g of the pug is 50N. We then moved that pug to twice the distance from the center of the Earth. What is the new F_g?

$$\frac{F_{g1}}{F_{g2}} = \frac{(2r_1)^2}{r_1^2}$$

Hint: 12.5N

The original F_g was 50N. The new one is 12.5N. This is 50/4 ie: $\frac{50}{2^2}$. This is how the inverse square law can help to solve problems faster.

2 Questions for you to practice on:

1) An exoplanet has a gravitational field of 15 N/kg at its surface. What will be its gravitational field strength at 3 radii from the center?

Hint: 1.67 N/kg

2) A star has a planet orbiting it, and experiences a force of gravity of 5.0×10^{40}N between the two. If the separation magically doubled how many times greater is F_{g1} compared to F_{g2} and what is it's value?

Hint: $F_{g2} = 1.25 \times 10^{40}$N