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P2 7 Take Back the Moon - A Minecraft Parody of Tidal Forces

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Abstract

In this paper, we investigate the *Minecraft* Moon added in a temporary April Fool's update, and use the parameters in the game alongside a revised force relationship to find the mass of this Moon to be $M_{Moon} \approx 10^{12}$ kg. We find a formula describing the tidal interaction between this moon and a flat semi-infinite plane at the apparent distance in the *Minecraft* 'snapshot'.

Introduction

In our previous paper [1], we performed an investigation into the gravitational constant that defines the world of *Minecraft*. In the 2023 *Minecraft* annual April Fool's update, they temporarily added the ability to visit the Moon [2]. In this paper, we will investigate the parameters of this Moon and find a formula for the tidal force of the Moon.

Mass of the Moon

In the *Minecraft* 'snapshot' that temporarily added the Moon, the player can travel there by flying to a vertical height of 700. They are then 'caught' in the Moon's gravity well and fall down to its surface. The inverse effect occurs similarly at 700 blocks above the Moon [2]. *Minecraft* operates in Cartesian co-ordinates with Y on the vertical and X-Z being the plane of Earth. From our previous paper, we found the acceleration due to gravity of an infinite flat plane [1]. Using Newton's second law, the gravitational force on an object of mass M_{obj} is as follows:

$$F_{Earth} = |g| M_{obj} = 2\pi G \Omega M_{obj} \tag{1}$$

where G is the gravitational constant in *Minecraft* and $\Omega = \rho H$ is the surface mass density, which we approximate using the average volume mass density ρ of a representative material and the average depth from sea level of the *Minecraft* world. We use the value for Ω found in the preceding paper of $\Omega = 340\,200\,\mathrm{kg/m^2}$.

Tidal force is a differential change in gravitational force $\mathrm{d}F$ over a distance $\mathrm{d}R$, so it can be found to be for an infinite flat plane:

$$\frac{\mathrm{d}F_{Earth}}{\mathrm{d}R} = 0 \tag{2}$$

This shows that a flat plane does not cause tidal forces. Instead, we must approximate the moon as a sphere with a gravitational force:

$$F_{Moon} = -\frac{G M_{Moon} M_{obj}}{R_{sep}^2} \tag{3}$$

where M_{Moon} is the mass of the moon, and R_{sep} is the Moon-object separation, in our case 700 m as *Minecraft* blocks are 1 m in height [3]. To find M_{Moon}, we must use the point for our system where the gravitational forces are equal and act-

ing in opposite directions between the two bodies. This gives the following:

$$M_{Moon} = 2\pi\Omega R_{sep}^2 \tag{4}$$

Mass of the Infinite Flat Earth

The mass of a flat plane in cylindrical polar coordinates is:

$$M = \rho V = \pi a^2 \Omega \tag{5}$$

Where a is the polar radius from the origin. An infinite flat plane is a suitable approximation for a plane such that $a >> H$, and so we can surmise that the gravitational constant in our previous paper would hold when not near the edges of the plane. *Minecraft* has a region where the infinite terrain generation breaks down, called the 'far lands'. This occurs at exactly $12,550,821$ blocks away from the origin [4].

Tidal forces on Earth from the Moon

Tidal forces due to a spherical body are as follows:

$$\Delta F_{Moon} = \frac{\mathrm{d}F}{\mathrm{d}R_Y} = \frac{2GM_{Moon}M_{Earth}}{R_Y^3} \tag{6}$$

Where R_Y is the distance from the moon to an arbitrary point. As visualised in Figure 1:

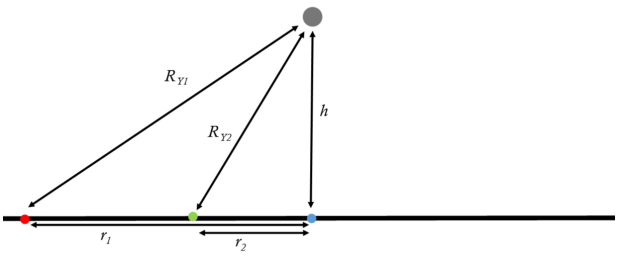

Figure 1: A diagram showing the variation in tidal force from a spherical object across a flat plane. h is the Earth-moon distance, in this case $h = 1338\,\mathrm{m}$ thanks to the two 700 block distances to the point of equal forces, and the *Minecraft* sea level of 62 m.

The effect of the moon's tidal forces will depend upon the location of the measurement taken across the surface of Earth. If we instead define tidal forces in a cylindrical polar environment that depends on the distance r from the origin, we can describe the tidal force at any given point in the *Minecraft* world from the origin, and substitute in the relations for the Masses of the Earth and Moon:

$$\Delta F(r)_{Moon} = \frac{4\pi^2\Omega^2 G R^2 a^2}{(r^2+h^2)^{3/2}} \tag{7}$$
$$r^2 = x^2 + z^2$$

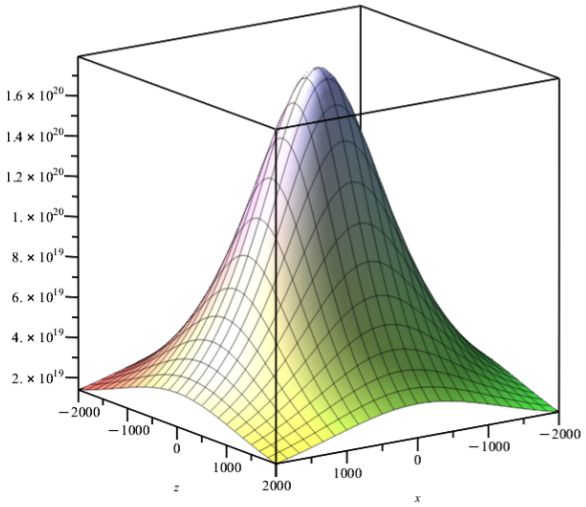

Figure 2: Tidal forces on the *Minecraft* world. x and z are the coordinates in-game, and the y axis shows the magnitude of force in N.

Discussion & Conclusion

The tidal force due to the Moon in this close proximity to Earth, and a significantly higher gravitational constant, even with a small mass of $M_{Moon} = 10^{12}\,\mathrm{kg}$, leads to a significant force magnitude across the entire surface. At the edges of the *Minecraft* world, the force would still be of a magnitude of $\approx 10^8\,\mathrm{N}$. This force would theoretically collapse the Earth into the Moon and would obliterate both objects. Whilst this is an extreme case, this demonstrates how tides on Earth prove that the Earth cannot be flat, as the tides would vary significantly across the disk.

References

[1] N. Sowter, J. Fuller and P. Clevely, *P2 5 Falling Kingdom - A Minecraft Parody of Earth's Gravitational Well*, PST 24, (2025).

[2] `https://minecraft.fandom.com/wiki/The_Moon` [Accessed 11 November 2025]

[3] `https://minecraft.fandom.com/wiki/Block` [Accessed 11 November 2025]

[4] `https://minecraft.fandom.com/wiki/Far_Lands` [Accessed 11 November 2025]