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P2 6 Falling Kingdom - A Minecraft Parody of Earth's Gravitational Well

N. Sowter, J. Fuller, P. Clevely

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH

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Abstract

The video game *Minecraft* portrays a world that is very different to our own. We perform an experiment to determine the local gravitational field strength of the *Minecraft* world and subsequently determine the *Minecraft* gravitational constant using an infinite slab approximation. The gravitational constant is estimated as $G = (1.220 \pm 0.024) \times 10^{-5}\,\mathrm{N\,m^2\,kg^{-2}}$.

Introduction

In the popular video game *Minecraft*, there are a lot of fan-made mini-games based around jumping and falling. With the geometry of the *Minecraft* world being very different to our own, we perform an experiment to determine how the gravitational constant differs compared to our universe.

Experimental Setup

Assuming that the player, Steve, falls with constant acceleration from a height h with no initial velocity v_0, we can express the fall time as:

$$t^2 = \frac{2}{g}h \tag{1}$$

And so we expect a plot of t^2 against h to follow a linear model with gradient m equal to $\frac{2}{g}$ and an intercept of 0. In *Minecraft*, we constructed several towers of heights varying from $5\,\mathrm{m}$ to $50\,\mathrm{m}$ in steps of 5 as seen in Figure 1 using the fact that a standard *Minecraft* block is a cube occupying a volume of $1\,\mathrm{m}^3$ [1].

We recorded the time it takes for Steve to fall from each height five times, $N = 5$ and took the mean fall time for each tower:

$$\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_i \tag{2}$$

The standard error on each mean, $\sigma_{\bar{t}}$ was computed as:

$$\sigma_{\bar{t}} = \sqrt{\frac{s_t^2}{N}} \tag{3}$$

where s_t^2 is the sample variance [2] on the measured fall times at each height h:

$$s_t^2 = \frac{1}{N-1}\sum_{i=1}^{N}(t_i - \bar{t})^2 \tag{4}$$

Assuming the errors follow a Gaussian distribution, the standard error was then propagated forward using the approximate relation:

$$\sigma_f^2 \approx \sum_{i}^{n}\left(\frac{\partial f}{\partial \theta_i}\right)^2 \sigma_i^2 \tag{5}$$

where σ_f is the error on some function f of n parameters θ where the parameters are assumed to be independent. In all the following work, errors are propagated using Equation 5 except where explicitly stated.

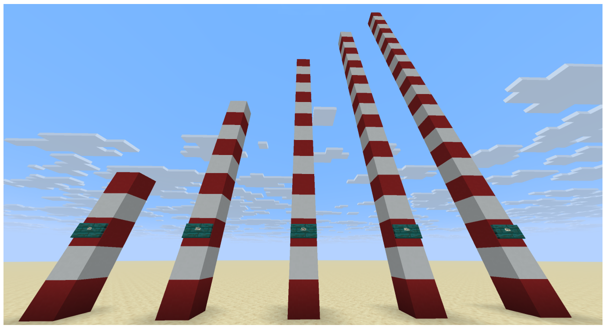

Figure 1: In-game setup of some of the heights the player dropped from. More towers were constructed for increasing heights. Each block is a cubic metre.

Results

In Figure 2, we plotted the relation of t^2 against h in R [3] with error bars as defined by Equations 3 and 5 and fit a linear model using the method of weighted least squares [2]. The linear fit determined the model's gradient and standard error $m = 0.076\,600 \pm 0.001\,493\,\mathrm{s^2\,m^{-1}}$.

From this, we determine the local gravitational field strength as $g = 26.1 \pm 0.5\,\mathrm{m\,s^{-2}}$ or about two and a half times the Earth's surface gravity.

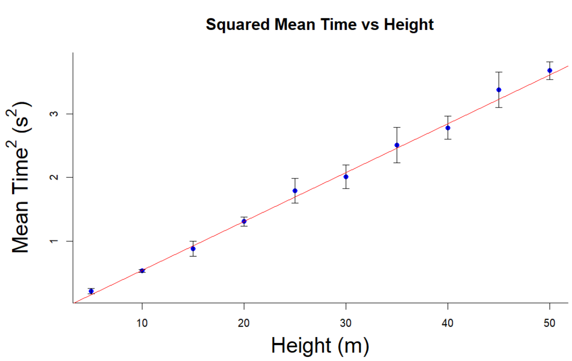

Figure 2: Plot of the relationship between the square of the mean fall time t^2 and vertical height h plotted using R.

The Infinite Slab Approximation

Having determined the gravitational field strength, we now consider what this means for the fundamental constants of the *Minecraft* world. Consider Gauss's law for the gravitational field [4]:

$$\oint_S \vec{g} \cdot d\vec{A} = -4\pi G M \tag{6}$$

where G is the universal gravitational constant and M is the total mass enclosed by the surface S which has area element $d\vec{A}$ pointing normal to the surface.

In *Minecraft*, the world can extend infinitely in the $x - z$ plane but has a defined vertical limit, and so we can approximate it as a flat plane. By constructing a cylindrical Gaussian surface centred on the plane, we can evaluate the gravitational field due to the *Minecraft* world by considering the flux through the caps as [4]:

$$|g| = 2\pi G \Omega \tag{7}$$

where $\Omega = \rho H$ 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.

In *Minecraft*, sea level is defined as being 62 blocks up, and the lowest point you can reach is at -64 blocks, so we estimate $H = 126\,\mathrm{m}$ and we take the density of Rhyolite [5] as a reasonable approximation for volume density $\rho = 2700\,\mathrm{kg\,m^{-3}}$
Rearranging Equation 7 we find that:

$$G = \frac{|g|}{2\pi\rho H} \tag{8}$$

and upon substitution of our defined values, we find that $G = (1.220 \pm 0.024) \times 10^{-5}\,\mathrm{N\,m^2\,kg^{-2}}$

Discussion & Conclusion

Having found a gravitational constant for the *Minecraft* world, we can compare it to Earth's gravitational constant [7] and find that it is approximately 2×10^5 larger, so while gravity is the weakest of the forces in our Universe, it becomes very strong in *Minecraft*.

References

[1] https://minecraft.fandom.com/wiki/Block [Accessed 29 October 2025]

[2] S. Vaughan, *Scientific inference: learning from data.* Cambridge University Press. 3.4 56 (2013).

[3] R, *coding language, used for modelling.* Available at: https://www.r-project.org/ [Accessed 28 October 2025]

[4] A. C. Tort, *An exercise on Gauss's law for gravitation: the flat Earth model.* Phys. Educ. 49 629 (2014)

[5] YouTube, *What is Minecraft stone?* Available at: https://www.youtube.com/watch?v=OgVQK4wXevQ [Accessed 28 October 2025]

[6] Geophysics for Practicing Geoscientists, *Density of Rhyolite.* Available at: https://gpg.geosci.xyz/content/physical_properties/tables/density_igneous_rocks.html [Accessed 28 October 2025]

[7] P. A. Tipler and G. Mosca, *Physics for Scientists and Engineers*, Freeman, New York (2007)