Journal of Interdisciplinary Science Topics

Thiago on the Moon

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30/03/2026

Abstract

In the world of football, there is a retired footballer called Thiago Alcântara. A feat that many football fans around the world would remember him by is his goal against Porto in the second leg of a Champions League quarter-final match in 2021 [1]. This paper investigates the metrics of this shot on Earth and then proceeds to investigate whether the shot would have entered the goal if it were taken on the Moon by presenting it as a simplified projectile model. The calculations show that on the Moon the shot would have travelled approximately 3.76 m above the crossbar.

Keywords: *Sports; Physics; Mechanics; Gravity; Football; Thiago Alcantara*

Introduction

Thiago Alcântara is a retired Spanish footballer who is currently the assistant manager of Barcelona [1]. He had a prolific career playing for many prestigious clubs such as Barcelona, Bayern Munich and Liverpool [1]. Thiago had a creative playstyle, with a mastery in playmaking and ball control, allowing him to primarily play most of his career as a central midfielder [1]. A special moment that captured the hearts of many football fans around the world is when Thiago scored a spectacular shot against Porto in the second leg of a Champions League quarter-final match in 2021 [1]. This paper will explore the metrics of this shot on Earth and calculate whether it would have gone in had it been taken on the Moon.

Figure 1 – Shows Thiago striking the ball for his goal against Porto in the Champions League [2].

Earth's Model

We can present this shot as a simplified projectile model. For this scenario, Thiago was 22.86 metres away from the goal [3]. Using the real-time video replay, we can approximate the time of flight of the ball to be 1.2 seconds and the height at which it reached the goal to be 0.3 metres [4]. As this model is based on Earth, we will use the gravitational acceleration of 9.81 ms^{-2} [5]. As the height of the ball was very low when struck, for the simplicity of the model, we will assume the ball was struck from ground height and that there is no air resistance. The horizontal velocity can be given by the equation [6]:

$$v_x = \frac{x}{t} \qquad (Eq^n 1)$$

$$v_x = \frac{22.86}{1.2} \approx 19.05\ \mathrm{ms^{-1}}$$

The vertical velocity can be given by the equation [7]:

$$y = v_y t - \frac{1}{2} g t^2 \qquad (Eq^n\ 2)$$

Which can be rearranged to find the vertical velocity:

$$v_y = \frac{y + \frac{1}{2}gt^2}{t}$$

$$v_y = \frac{0.3 + \frac{1}{2}(9.81)(1.2)^2}{1.2} \approx 6.14\, ms^{-1}$$

The total initial velocity can be given by the equation [7]:

$$v = \sqrt{v_x^2 + v_y^2} \quad (Eq^n\ 3)$$

$$v = \sqrt{(19.05)^2 + (6.14)^2} \approx 20.02\, ms^{-1}$$

Using the horizontal velocity and the vertical velocity, we can calculate the launch angle using the equation [8]:

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right) \quad (Eq^n\ 4)$$

$$\theta = \tan^{-1}\left(\frac{6.14}{19.05}\right) \approx 17.9°$$

The launch angle shows the direction in which Thiago struck the ball on Earth. By keeping this angle consistent, we can directly compare how the change in gravitational acceleration affects the trajectory of the shot.

Moon's Model

To investigate whether Thiago's shot would go in under lunar conditions, we will use the Moon's gravitational acceleration of 1.62 ms^{-2} compared to Earth's 9.81 ms^{-2} [9]. As horizontal velocity is unaffected by gravity, we can still use the same time taken of 1.2 seconds.

We can use Eq. 2 again to find the vertical height of the ball [7]:

$$y = v_y t - \frac{1}{2}gt^2$$

$$y = (6.14)(1.2) - \frac{1}{2}(1.62)(1.2)^2 \approx 6.20\, m$$

The standard height of a professional football goal is 2.44 metres [10]. As the newly calculated height of 6.20 metres is greater than 2.44 metres, it means that if Thiago took his shot on the Moon, the ball would travel a significant distance above the crossbar (3.76 metres). This is a result of the weaker gravitational pull on the Moon compared to Earth, allowing the ball to gain more height when travelling towards the goal. Due to this gain in height, Thiago's goal would no longer count as the shot would travel over the crossbar.

Limitations

It is important to address the limitations of this simplified model and how they can be improved in future work. Firstly, parameters such as the flight time of the ball and the goal entry height were estimated from video footage. This introduces uncertainty due to factors such as frame rate and perspective distortion which could be resolved by using motion-tracking software to be more precise. Secondly, this model assumes an ideal projectile motion, which ignores factors such as air resistance and the Magnus effect caused by the spin of the ball which could affect the trajectory of Thiago's shot. Future studies could analyse the drag coefficient and the spin-induced forces on the ball to enhance the precision of this model. Finally, this model assumes a uniform gravitational field and does not consider the lack of atmosphere on the Moon. A more advanced analysis could include variable gravitational fields as well as a vacuum environment to further increase the precision of this research. Despite these limitations, the model acts as an adequate initial approximation of the projectile motion of Thiago's shot, allowing comparisons between Earth's and the Moon's gravitational conditions.

Conclusion

Ultimately, although Thiago's famous goal may be described as magical by football fans on Earth, the same would not be true on the Moon. On the Moon, the ball would travel approximately 3.76 metres above the crossbar, resulting in a shot that Thiago himself may aim to forget.

References

[1] Wikipedia (2026) *Thiago Alcântara*. [Online] Available at: https://en.wikipedia.org/wiki/Thiago_Alc%C3%A2ntara [Accessed: 14 March 2026].

[2] Durkan, J. (2021) *Watch Thiago's stunning half-volley goal vs. Porto again!*. This Is Anfield. [Online] Available at: https://www.thisisanfield.com/2021/11/watch-thiagos-stunning-half-volley-goal-vs-porto-again/ [Accessed: 14 March 2026].

[3] TNT Sports (2021) *Liverpool v Porto – follow live coverage*. TNT Sports. [Online] Available at: https://www.tntsports.co.uk/football/champions-league/2021-2022/liverpool-v-porto-follow-live-coverage_sto8637952/story.shtml [Accessed: 14 March 2026].

[4] Greats Goals (2021). *Thiago Alcántara – Ridiculous goal vs. Porto – Champions League – 24.11.2021*. YouTube Video. [Online]. Available at: https://www.youtube.com/watch?v=kWf93ngb4Xw [Accessed: 14 March 2026].

[5] NASA Glenn Research Center (1999) *Weight and Mass*. NASA. [Online] Available at: https://www.grc.nasa.gov/WWW/K-12/Enginesim/weight_and_mass.htm [Accessed: 14 March 2026].

[6] LibreTexts (2024) *2.3: Time, Velocity, and Speed* [Online] Available at: https://phys.libretexts.org/Bookshelves/College_Physics/College_Physics_1e_(OpenStax)/02%3A_Kinematics/2.03%3A_Time_Velocity_and_Speed [Accessed: 14 March 2026]

[7] LibreTexts (2020) *3.3: Projectile Motion* [Online] Available at: https://phys.libretexts.org/Bookshelves/University_Physics/Physics_(Boundless)/3%3A_Two-Dimensional_Kinematics/3.3%3A_Projectile_Motion [Accessed: 14 March 2026]

[8] Science Ready (2026) *Full-flight Projectile Motion: Initial Velocity and Launch Angle*. Science Ready. [Online] Available at: https://scienceready.com.au/pages/full-flight-projectile-motion-initial-velocity-and-launch-angle [Accessed: 14 March 2026].

[9] NASA Glenn Research Center (2025) *Moon*. NASA. [Online] Available at: https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/moon/ [Accessed: 14 March 2026].

[10] Ramsay Ladders (n.d.) *Football goal size guide*. Ramsay Ladders. [Online] Available at: https://www.ramsayladders.co.uk/football-goal-size-guide.html [Accessed: 14 March 2026].