Journal of Physics Special Topics
An undergraduate physics journal

A6_6 "Where We Dropping, Boys?" - Investigating the Fortnite Meteor

M. Favaro-Bedford, C. Wallis, R. Lindon, E. Day, J. Mayes

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

December 12, 2018

Abstract

Fortnite: Battle Royale is a computer game which has become popular online in the last year. In one of the updates, the game introduced a large crater created by a meteor. Information regarding this meteor before impact is largely unknown, however. In this paper, we derive a simple equation which relates the dimensions and velocity of the meteor to it's corresponding crater size. We determine the dimensions of the in-game crater using footage found online, before plotting a series of solution curves which represent radius-velocity pairs the meteor could have had given the measured dimensions of the crater.

Introduction

In the popular game 'Fortnite: Battle Royale', a meteor hit a location that would become known as 'Dusty Divot', although there is no information on the meteor itself. By using basic physics and what information is available, we aim to predict the possible properties of the meteor before impact.
[1]

Method

We will assume that the energy of the meteor is fully converted into the work done to remove the material on the ground, and that the impact will occur at 90 °. The energy required to remove mass a of material from the ground is given by

$$W = Fd, \qquad (1)$$

where F is the force applied and d is the distance over which that force is applied. However, (1) does not identify the size of the of the crater, nor the material it is made from. Therefore, by considering the force applied as the displaced weight, we must introduce the displaced mass - a function of volume and density. Of course, the volume term requires the crater dimensions. As craters are not often perfect hemispheres, we have defined the volume of the crater as half the volume of an ovoid allowing for more accurate calculations. Using the updated information, (1) can be written as

$$W = \frac{2}{3}\pi abc^2\rho_E g, \qquad (2)$$

where a and b are the perpendicular radii and c is the depth. The density of the impact material is ρ_E. It should also be noted that the distance over which the force is applied, d, is considered equal to the crater depth.

Assuming negligible air resistance, the kinetic energy of the meteor at impact is simply

[1] The authors would like to state that they do not play Fortnite.

$$E = \frac{1}{2} m_m v_m^2, \quad (3)$$

where m_m and v_m are the mass and impact velocity of the meteor respectively. Again, (3) does not directly account for the composition of the meteor or indeed its dimensions. Therefore, by making the same substitutions for mass as before, it can be shown that

$$E = \frac{2}{3} \pi R_m^3 \rho_m v^2. \quad (4)$$

In this case, the radius of the meteor is R_m and its density is ρ_m. It should be noted a spherical meteor was assumed here, although for an ovoid meteor ${R_m}^3$ may be substituted for abc. The two energies (equations (2) and (4)) can be equated to give the final result

$$R_m = \sqrt[3]{\frac{abc^2 \rho_E g}{\rho_m v^2}}, \quad (5)$$

which gives R_m as a function of v_m and the observed crater dimensions.

The radii of the Fortnite crater were obtained using an interactive map [1], however, the depth was calculated from footage of a free fall through the crater [2](Earth-like gravity was assumed for this calculation). The dimensions were found to be $a = 150$ m, $b = 112$ m and $c = 78.48$ m.

The required meteor radius was plotted across a sensible range of impact velocities (i.e. not unfeasibly fast) for three different densities using (5) and the dimensions found above. Points on each curve represent a valid 'solution' to the Fortnite meteor prior to impact (given the densities are correct). In other words, any point on the curves represents a velocity-radius pair the meteor may have had before impact using the densities of the three most common meteorite compositions. The plot is shown in Figure 1.

Conclusion

The solution curves presented in Figure 1 seem physically feasible providing no obvious reason to dispute the model, even given it's simplicity. The model could, in theory, be applied to any real world meteor where only the crater dimensions are known. Without knowledge of either it's velocity or radius, it is still impossible to determine the exact properties of the meteor prior to impact, however, results in this paper should provide interested readers and players with a better understanding than was previously available. To improve the model, considerations of impact angle or ejector could be made. To further check the reliability of the model, experiments could be conducted.

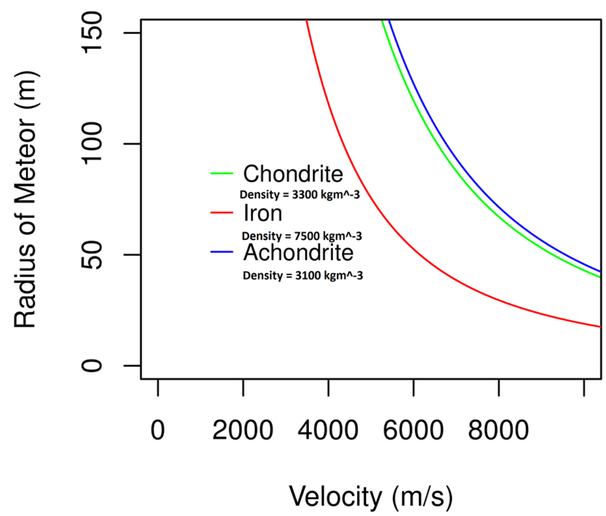

Figure 1: Solutions to the Fortnite meteor using (5) and considering the densities of the three most common meteor rock types [3]. It should be noted that the compositions used here are not directly relevant. Their use is to highlight the effect of density in (5).

References

[1] http://maps.livfor.it/?fbclid=IwAR3h_jbkCVxgyG22FlupkZ_vKlzMl1JIqErqd0L7kLSmoEl2hG3fiaPOg1o [Accessed 5/11/18]

[2] JonJon, *Jumping Dusty Divot With A Shopping Cart!! In Fortnite Battle Royale!*, https://www.youtube.com/watch?v=oxJB943b_Go [Accessed 5/11/18]

[3] http://meteorites.wustl.edu/id/density.htm [Accessed 5/11/18]