Journal of Physics Special Topics
An undergraduate physics journal

A1_4 One Punch Man - Strength Test

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November 24, 2016

Abstract

The "hero for fun", Saitama, of 'One Punch Man' shows an amazing display of strength to save his city from a falling meteor by punching it. We calculated that Saitama can pack a punch of 2.3x10^{19}N and whilst he destroys the meteor, it shatters, and the size of the shattered particles are 2080cm.

Introduction

In chapters 23 to 26 of the One Punch Man manga, a meteor is heading towards Earth, threatening the destruction of City Z [1]. Saitama uses his incredible stength and tries to save his city by punching the meteor. Whilst this meteor is destroyed, smaller meteors still collide with City Z, causing widespread chaos. From this scene, we can quantify the upper value of the force of one of his punches and provide a comparison, and determine the size of the particles of the shattered meteor.

Theory

To find the kinetic energy of the meteor as it heads for a collision with City Z. To calculate this, we must estimate the meteor's mass and velocity. A meteor's velocity can vary between 11kms^{-1} and 72kms^{-1} as it enters the Earth's atmosphere [2]. This variation in speed is due to the Earth's movement around the Sun. Meteors colliding head-on with Earth will be travelling faster relative to meteors trailing Earth.

To find the mass of the meteor, we compared the height of the meteor to Saitama's height in the manga and found the meteor to be 80m in length. Although the meteor appears to be an oblate spheroid, we will assume it is a sphere for ease of calculations. 95.6% of meteorites found on Earth are stony, with Ordinary Chondrites making up 67.5% of that. The maximum average density of one of these meteorites is 3.4gcm^{-3} [3]. We will assume that the meteor heading for City Z is an Ordinary Chondrite within this range. Using this information, we will calculate the volume and mass of the meteor.

Hence, to work out the maximum display of strength in this instance, we will take the upper limit for the meteor velocity and density.

To find the kinetic energy of the meteor, E_K, we use the equation

$$E_K = \frac{1}{2}mv^2, \tag{1}$$

where m = mass of the meteor, and v = velocity of the meteor.

To find Saitama's force, we will assume that all kinetic energy from the meteor is imparted during one punch in the distance, d of one fist's length, assumed to be 0.1m. To find the force, F, of the punch, we will use the equation

$$F = \frac{E_K}{d}. \tag{2}$$

In the anime and manga, Saitama's velocity is not affected by the collision, and instead passes straight through. Due to this unrealistic situation, we will assume that during the short duration of the punch, Saitama is stationary.

We can compare this to the thrust force of the Saturn V rocket, the most powerful machine created by humans [4]. The energy can be expressed as an equivalent of megatons of TNT, where 1 megaton of TNT is equivalent to 4.184 petajoules [5]. This energy can be compared to the energy of Saitama's Moon-Earth jump A1_2 One Punch Man - Speed Test [6].

The force of Saitamas punch shatters the meteor. To work out the average size of the shattered particles of meteor $x_m$cm, we will use the Kuz-Ram model [7]. This model predicts rock shattering by blasting using an explosive, and we can use this to give a good idea of how the meteor might shatter.

$$x_m = AK^{-0.8}Q^{\frac{1}{6}}\left(\frac{1.15}{RWS}\right)^{\frac{19}{21}} \quad (3)$$

where A = rock factor, K = powder factor, Q = mass of explosive required and RWS = relative weight strength, a percentage used to calculate the effectiveness of explosive material. If we consider Saitama as an explosive, his energy density would be much greater, also changing the previously stated values. However, in this case, we will use values for the explosive "Blastex" to provide a simple model [8].

Results

The meteor heading for the city is 80m in length with a maximum average density of 3.43gcm^{-3}, giving us a mass of 8.85x10^{8}kg. If the meteor has a maximum velocity of 72kms^{-1}, we can use equation (1) to find the kinetic energy of the meteor to be 2.3x10^{18}J. This is equivalent to 475 megatons of TNT, almost 140 times the energy of Saitama's Moon-Earth jump.

To find the force of one of Saitama's punches, we can use equation (2) to give F as 2.3x10^{19}N. This is comparable to the total thrust of 7x10^{11} Saturn V rockets taking off.

Using equation (3) to find the size of the particles, x_m, we use values for ironstone [9], a rock of similar hardness to iron rich chondrites, where A is 13, K is 0.7kgm^{3}, Q is the energy of the meteor divided by the energy in 1kg of Blastex [8], and RWS is 0.84. This gives x_m to be 2080cm.

Discussion

We made a number of assumptions in these calculations, including no effects of air resistance, and the impossible scenario that Saitama loses no kinetic energy through the collision.

Despite these assumptions, these calculations show that one of Saitama's punches has an incredibly deadly force, and that even with his best efforts to destroy the meteor, particles this size falling on a city would still cause large scale damage, however the particle size would be much larger than shown in the manga.

References

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[6] H. B. Thiemann et al., *A1_2 One Punch Man - Speed Test*, PST Vol. 15, (2016)

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