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P1_7 Solar-Powered Superhero: What's Superman's Power Consumption?

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Abstract

In this paper, we assess the viability of Superman being powered by solar energy. We do this by calculating the energy that he would be able to absorb in a day - 3×10^7J - and comparing it to the energy that he requires to carry out certain superhuman activities. We find that he could leap the Empire State Building 75 times using the energy he acquires in a day, but he requires 3 days worth of energy to match the energy output of a train for one second.

Introduction

Superman is famously powered by sunlight, allowing him to carry out superhuman feats. Two things he is best known for is his ability to "leap tall buildings in a single bound" and be "more powerful than a locomotive"; we will assess the energy required to do this and see if he would be able to gain that energy from the Sun. We will also consider that he has been storing energy for some time before he became Superman.

Method

First we make the assumption that Superman lives in New York (as Metropolis is based on it), which - on average over a year - has 7 sunlight hours a day[1]. An adult male has an average surface area of 18000cm^2[2] (1.8m^2) - as only one face will be facing the sun, we halve this to 0.9m^2 to find his illuminated surface area. We will also need the intensity of sunlight at the surface of Earth, which is 1360W/m^2[3]. We multiply these numbers to find the power that Superman absorbs from the sun, which we can then use to find the energy that he absorbs in a day with 7 sunlight hours.

Comparatively, we can work out the amount of energy (neglecting air resistance) it would require for Superman to leap a tall building in a single bound. As it is New York, we will take the Empire State Building[4], rounding the height up to 400m, to allow for clearance in his jump. Using equation (1),

$$v^2 = u^2 + 2gs, \tag{1}$$

(where v is the velocity at peak height, u is the initial velocity, g is the acceleration due to gravity and s is the height traveled) we calculate the speed which Superman would have to leave the floor at. Then, using equation (2),

$$E_k = \frac{1}{2} m {v_s}^2, \tag{2}$$

with the mass of Superman (107kg[5]) we can then calculate the energy required for his jump.

Superman is also said to be "more powerful than a locomotive". Assuming a 50 tonne train (taking a middle value from [6]) moving at 130mph[7] (58m/s), we can work out (using equation (2)) the energy output of the train every second (ignoring air resistance acting on the train), which we can also compare to Superman's energy intake.

Results and Discussion

Using the method discussed in the previous section, we calculated the power Superman absorbs to be 1200W and subsequently, the energy he absorbs in a day to be 3×10^7J. Using equation (1), we found the speed at which Superman leaves the floor to be 89m/s, which we used in equation (2) to find the energy he exhausts in a single leap to be 4×10^5J.

From comparison of these values, we find that he could leap the Empire State Building 75 times before exhausting his daily solar energy allowance.

Calculating the energy output of the train per second, we find it to be 8×10^7J, which is about 3 times larger than the amount of energy Superman absorbs per day. Though, if we consider that he has energy stored from before he started operating as Superman (if we assume that he started absorbing sunlight at 15 and started operating at 25), we can calculate the amount he has stored in that time - which comes out to be 1×10^{11}J. However, this would only allow him to exert the same amount of energy as a moving train for 1200 seconds (about 20 minutes), severely limiting his ability to be "more powerful than a locomotive".

In this assessment, we have assumed that Superman absorbs all of the sunlight incident on him (through his clothes as well) and likely ignored various parts of Superman lore.

Conclusion

Through calculating the energy required for some of Superman's feats and comparing them to the energy he absorbs, we have found that, though he has sufficient energy to leap the empire state building 75 times a day, he does not have enough energy to match a train for very long - even if we consider the latent energy he has stored from before he became Superman.

References

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