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## P3_8 No Disintegrations?


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**Abstract**

It is shown within the television show, "The Mandalorian", that a sniper rifle used by the main character can disintegrate a creature with a single shot. A specific example of this is shown within the second episode in which the weapon is used to disintegrate a Jawa, and we calculate the energy required to do this by approximating the energy required to the binding energy of all atoms within the Jawa's body. We find this energy to be a surprisingly low value of $2.009 \times 10^{-4} J$, since some assumptions are made and forces outside of the nuclear force are not considered.


### Introduction

In Disney's popular Star Wars spin-off series, "The Mandalorian", the main character Din Djarin (also known as the Mandalorian) wields a two pronged sniper rifle [1] that appears to disintegrate his enemies. In Season 1, Episode 2, the Mandalorian discovers a group of humanoid creatures called Jawas attempting to break down his ship for parts, and proceeds to shoot them with the rifle. In this paper we aim to calculate the energy required in a single shot to destroy the creatures, as shown in the episode mentioned above.

### Theory

Jawas are 1 meter tall humanoid creatures, with a mass of $30kg$ [2]. They are hypothesised to be either large rodents or devolved humans, so we can assume that they are biologically similar to humans [2] and we can approximate their atomic composition to be the same as humans. The human body consists of just oxygen (24%), carbon (12%), hydrogen (62%), nitrogen (1%), calcium (0.5%) and phosphorus (0.5%), with negligible percentages of other trace elements [3]. We can assume that when the Mandalorian's rifle disintegrates a Jawa, it simply splits each atom within the body into it's constituent sub-atomic particles, and thus we can approximate the energy required to disintegrate a Jawa to the nuclear binding energy of all of the atoms within the body.

### Results

An average human, with a mass of $70kg$ contains approximately $7 \times 10^{27}$ atoms [4]. Therefore, a Jawa contains approximately $3 \times 10^{27}$ atoms.

The energy required to split each atom is equal to the nuclear binding energy, $E$, given by equation 1 [5].

$$E = mc^2 \tag{1}$$

Where $m$ is the mass defect of the atom (the difference in mass between the atomic mass and the sum of the mass of its constituent particles), and $c$ is the speed of light.

The nuclear binding energies of oxygen, carbon, hydrogen, nitrogen, calcium and phosphorus are $1.921 \times 10^{-11} J$, $1.265 \times 10^{-11} J$, 0, $1.568 \times 10^{-11} J$, $3.599 \times 10^{-11} J$ and $4.092 \times 10^{-11} J$ respectively. Note that the binding energy for hydrogen is zero since it's nucleus contains just one proton.

Using the proportions given above for the number of atoms within a Jawa and the atomic composition of a body, the total energy required to disintegrate a Jawa can be calculated.

There are $7.2 \times 10^6$ oxygen atoms within a Jawas body, $3.6 \times 10^6$ carbon atoms, $18.6 \times 10^6$ hydrogen atoms, $3 \times 10^5$ nitrogen atoms, $1.5 \times 10^5$ calcium atoms and $1.5 \times 10^5$ phosphorus atoms. The total energy, $E_{total}$, is therefore given by the sum of all the energies for all the atoms, such that:

$$E_{total} = E_O N_O + E_C N_C + E_H N_H + E_N N_N + E_{Ca} N_{Ca} + E_P N_P \quad (2)$$

Where $E_O$ and $N_O$ are the binding energy and number of atoms for oxygen, and similarly for carbon ($E_C$, $N_C$), hydrogen ($E_H$, $N_H$), nitrogen ($E_N$, $N_N$), calcium ($E_{Ca}$, $N_{Ca}$) and phosphorus ($E_P$, $N_P$).

Using equation 2, $E_{total} = 2.009 \times 10^{-4} J$.

## Discussion and Conclusion

$2.009 \times 10^{-4} J$ seems like an extremely low value considering this is all the energy required to split the atoms within a $30kg$ humanoid creature, however this can be attributed to the fact that no energy is required to split 62% of the atoms since they are hydrogen which contains just a proton. This also relies on the weapon having a 100% efficiency.

Additionally, this calculation does not take into consideration the interatomic and intermolecular forces, which would undoubtedly increase the energy required to disintegrate a Jawa. Because these additional factors have not been considered, it is not possible to state with certainty that this is an accurate representation of the energy required.

## References


[1] https://starwars.fandom.com/wiki/Amban_phase-pulse_blaster [Accessed 25 November 2020]

[2] https://starwars.fandom.com/wiki/Jawa [Accessed 25 November 2020]

[3] https://en.wikipedia.org/wiki/Composition_of_the_human_body [Accessed 25 November 2020]

[4] https://education.jlab.org/qa/mathatom_04.html [Accessed 25 November 2020]

[5] https://en.wikipedia.org/wiki/Nuclear_binding_energy[Accessed 25 November 2020]