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P3_8 Which Earth material is most similar to Doonium?

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Abstract

We aim to explore which of the primary metallic candidates (carbon steel, titanium, and aluminium) would most closely resemble Doonium, a heavy metal found in the Star Wars universe for constructing starships [1]. Here, we compare the time taken to cut vertically through a $2m$ tall door with a lightsaber from Season 1 Episode 5 of Star Wars Rebels [2], as the Ghost crew flees from the Grand Inquisitor to the time taken to cut through the three identical doors made from Earth materials mentioned above. We find that the time taken to cut through two doors made from carbon steel, titanium and aluminium are 31.6s, 25.7s and 15.7s respectively.

Introduction

Lightsabers are extremely useful in the Star Wars universe, used by Jedi and Sith Lords alike, and come in several different colours. Here we will explore the Grand Inquisitor's red lightsaber, used in the Stygeon Prime arc of Star Wars Rebels [2]. The power of this lightsaber is 5.47 MW [3] and it has a total length of 1m [4], which we will use to determine which Earth material most closely resembles Doonium.

Method and Results

We first find the volume of material melted by the lightsaber. In this episode, the Grand Inquisitor makes a vertical cut through the blast door which means that we can model the cut as a cuboid. We know that only the tip is exposed as he cuts through the door and that the total length of his lightsaber is 1m[4]. If one half of this lightsaber goes through the door, then the thickness of the door is 0.5m. The width of the lightsaber is 0.04m [5] and the height of the door is equal to the height of the Grand Inquisitor ($\sim$ 2m) [8]. Hence, the volume of the material melted is 0.040 m^3. We need to find the mass of the melted material by using the following equation:

$$m = \rho V, \tag{1}$$

where m is the mass, ρ is the density, and V is the volume. Here we consider titanium and aluminium as 'good' metals [3]. However, for high blast resistance, one might use steel [6] so we also analyse this material. The densities of carbon steel, titanium and aluminium are 7840 kgm^{-3} [7], 4506 kgm^{-3} [9], and 2710 kgm^{-3} [10]. Plugging these values and the volume of melted material into Eq. 1 gives masses of 313.6 kg, 180.2 kg, and 108.4 kg.

Now we can calculate the energy required to melt the amount of each material, using the latent heat of fusion equation shown below:

$$E = mL_f, \tag{2}$$

where E is the energy needed, m is the mass,

and L_f is the latent heat of fusion. We can combine this with the power equation and find an equation in terms of t. Here P is the power of the red lightsaber, 5.47 MW [3].

$$P = \frac{E}{t} = \frac{mL_f}{t} \implies t = \frac{mL_f}{P}, \qquad (3)$$

Putting in the L_f values for each material (2.76×10^5 Jkg^{-1} for carbon steel [11], 3.90×10^5 Jkg^{-1} for titanium [12], and 3.96×10^5 Jkg^{-1} for aluminium [12]) gives a time for each material. We multiply this by two as he cuts through two doors, so the times for carbon steel, titanium and aluminium are 31.6s, 25.7s and 15.7s.

Discussion and Conclusion

While this seems to be a good approximation for the time taken to cut through two doors, the time taken in the episode was 92s, implying that none of these Earth materials closely resembles Doonium. Our values might not be accurate due to the emphasis placed on Kanan and Ezra opening a larger blast door [2], and the true time elapsed is much shorter. Qui-Gon Jinn took 11s to melt through a blast door in the Phantom Menace [5], in line with our results for titanium. Another reason for these inaccuracies is that the method used for calculating the energy is simplified. We could have also considered the energy needed to take it from the melting point to the final temperature, and also the energy needed from room temperature to the melting point, potentially making the results more accurate.

In conclusion, the results obtained for this scene are not close to the time taken in the episode, implying that none of the Earth materials are similar to Doonium. This could be due to an inaccurate portrayal of time as we obtain similar values for titanium when comparing to Qui-Gon Jinn's scene [5]. An improvement would be to consider a variety of scenes with different shapes and lightsaber colours to determine which Earth material most closely resembles Doonium.

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