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A4_5 Jellyfish Jam

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Abstract

In this paper, we investigate how many jellyfish are required to power Karen's laser from the show *SpongeBob SquarePants* for an hour. We calculate the energy released from an average jellyfish sting as well as the energy required to power a 5 W laser for an hour. Assuming each jellyfish produces one sting, we require 258 jellyfish to power this laser.

Introduction

SpongeBob SquarePants is a very well-known children's TV show, which has been popular since its initial release in 1999 [1]. In this show, one of the main characters is a supercomputer known as Karen Plankton who has been observed to fire lasers in a few of the episodes. With this show being set "under the sea", it is not a surprise that jellyfish are seen throughout the duration of the show. Assuming these are all average jellyfish, how many jellyfish stings are required to fully power Karen's laser?

Energy of a Typical Jellyfish Sting

In this paper, we assume that all of the energy from a jellyfish sting goes into powering Karen's lasers. The pressure exerted by a typical jellyfish sting is more than 7 GPa [2]. To calculate the energy from this pressure, we used Equation 1 [3] below:

$$P = \frac{E}{V} \quad (1)$$

where P is the pressure of the sting, E is the energy produced by the sting, and V is the volume of the venom.

Since 1000 box jellyfish only produce 10 ml of venom [4], we take this to be the amount of venom produced by an average jellyfish. Therefore, one average jellyfish produces 0.01 ml of venom. Converting this to standard units, where $1\,\text{ml} = 1 \times 10^{-6}\,\text{m}^3$, this volume of venom is equivalent to $1 \times 10^{-8}\,\text{m}^3$.

Substituting the values of pressure and volume into Equation 1 and rearranging for energy, we get a value of:

$$E = (7 \times 10^9) \cdot (1 \times 10^{-8}) = 70\,\text{J}$$

Therefore, the sting of an average jellyfish is able to transfer 70 J of energy.

Power Requirements of a Laser

Modern-day laser pointers have a power range between 5 mW and 5 W, with a minimum burning threshold of 100 mW [5]. Since Karen is a supercomputer, we have assumed that her laser pointer has a power output of 5 W.

To calculate the total energy output of a laser, we have used:

$$E = Pt \quad (2)$$

Due to there being a time component in this equation, we will make the assumption that Karen keeps the laser constantly running for an hour, or, equivalently, 3600 s.

Substituting our values of power and time into Equation 2, we get a total energy value of:

$$E = 5 \times 3600 = 18,000\,\mathrm{J}$$

Karen's 5 W laser is therefore able to release 18,000 J of energy in an hour.

In our calculations, we have assumed that the jellyfish are able to transfer the energy from their stings into the laser with 100% efficiency. Taking this assumption into account now, we are able to calculate the minimum number of jellyfish, n, required to power the laser:

$$n = \frac{18,000}{70} = 257.14$$

Since this is not an integer value, we round the number up to 258 to ensure full energy transfer. Therefore, we need 258 jellyfish in total to power Karen's laser for an entire hour.

Discussion

In order for Karen's 5 W laser to be powered for an hour, we would need to use the sting of 258 jellyfish. This number assumes that the efficiency of the energy transfer is 100%. If we take into consideration that, in the real world, no form of energy transfer has a 100% efficiency, it is more than likely that we would need a larger number of jellyfish to power this laser.

With the show being set in the ocean, it is a perfectly reasonable assumption to expect to find this number of jellyfish.

Conclusion

Overall, we have found that, to power Karen's laser for an hour, we would need 258 jellyfish. This is a perfectly reasonable number of jellyfish, especially considering *SpongeBob SquarePants* is set in the ocean.

References

[1] *SpongeBob SquarePants* (2003) IMDb. Available at: `https://www.imdb.com/title/tt0206512/` [Accessed: 21 November 2023]

[2] Haywood, M. (2021) *The science of Jellyfish Stings*, British Sub-Aqua Club. Available at: `https://www.bsac.com/news-and-blog/the-science-of-jellyfish-stings/?&type=rfst&set=true#cookie-widget` [Accessed: 21 November 2023]

[3] Nave, R. (2023) *Pressure*, Hyperphysics. Available at: `http://hyperphysics.phy-astr.gsu.edu/hbase/press.html` [Accessed: 07 December 2023]

[4] Law, Y.-H. (2018) *Jellyfish almost killed this scientist. Now, she wants to save others from their fatal venom*, Science.org. Available at: `https://www.science.org/content/article/jellyfish-almost-killed-scientist-now-she-wants-save-others-their-fatal-venom` [Accessed: 22 November 2023]

[5] *What Qualifies a Laser Pointer as a Burning Laser?* (2019) BigLasers.com. Available at: `https://biglasers.com/blog/2019/10/01/what-qualifies-a-laser-pointer-as-a-burning-laser/#:~:text=Now%2C%20today%20lasers%20can%20go,out%20not%20be%20able%20to.` [Accessed: 22 November 2023]