

## Do You Want to Come Fish Blasting with Me?

Jozef Daantos

Natural Sciences (Life and Physical Sciences), School of Biological and Biomedical Sciences, University of Leicester

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### Abstract

This paper investigates the requirements needed for a girl named Klee from Genshin Impact to wipe out an entire lake full of fish. Mathematical modelling was undertaken to calculate the volume of Starfell Lake and the volume of the bomb explosion using in-game figures; this was used to ultimately calculate how many bombs were needed and the energy required per bomb. This paper also dives into the mechanics of slaughtering these fish with bombs and the composition of the bombs.

**Keywords:** Computer Game; Physics; Explosives; Genshin Impact; Klee

### Introduction

The game *Genshin Impact* introduces a young girl named Klee (see Figure 1). In this world, where some individuals are gifted with the power of elemental energy, some use it to fight monsters, and some use it for daily activities. Klee, however, makes bombs. Klee makes so many bombs that her favourite activity is going to a region in Monstadt (a country in the game) called Starfell Lake to blow up fish [1]. This paper will investigate the number of bombs and the energy expenditure required to successfully clear Starfell Lake of fish.



Figure 1 – Image of Klee and her bombs [1].

In this game, Klee possesses a pyro vision, an object in the game that allows her to manipulate the fire element, essentially giving her control over fire and heat, which she uses to trigger her bomb explosions [1].

### Environmental Parameters: Starfell Lake

To determine the volume of Starfell Lake, a standard unit of measurement was established using the sprint velocity of an in-game Genshin character [2]. This speed was calculated by sprinting from point A to B, with an in-game distance of 51 m (see figure 2A). The

sprint between points A and B was found to be 5.62s. For simplicity, acceleration/deceleration time is negligible. Therefore, using the equation:

$$v = d/t = 9.07 \text{ ms}^{-1},$$

where  $d$  is the distance between points A and B,  $v$  is the velocity, and  $t$  is the time taken between both points.



Figure 2 – The Maps used to calculate the distances of Starfell Lake. A) A map with a known distance between points A and B, used to calculate the velocity constant. B) Map used to calculate the diameter of Starfell Lake; time collected were 8.63s and 3.13 sec [1].

	Radius
Lake plus Island	39 m
Island	14 m

Table 1 – Radius calculated using Figure 2B.

Utilising the  $9.07 \text{ ms}^{-1}$  velocity constant calculated, the diameter of both the lake + island and just the

island itself was found (See Table 1). After this, the net volume of the lake was determined by applying the cylindrical volume formula to both the lake and the inner island:

$$V_{starfell} = (\pi R^2 H) - (\pi r^2 H),$$

where  $R$  is the radius of the entire lake and island,  $r$  is the radius of the displaced island, and  $H$  is the assumed constant depth variable (an estimation of 5 m). By substituting the found radius into these variables (see Figure 2A and Table 1),  $V_{starfell}$  was determined to be 20813.1 m<sup>3</sup>.

### The Mechanics of Fish Blasting

As Klee's bombs are thrown into water, the primary cause of fatality is not fire but hydrostatic shock. Because water is nearly incompressible [3], most of the explosive energy is concentrated into a shockwave rather than into the sustained heat of expanding gases [4].

Fish and other aquatic organisms are particularly susceptible to shockwaves because of their internal gas-filled organs (such as swim bladders). Pressures up to 10 psi can cause injury, and up to 21.8 psi is enough to cause mortality in some fish species [5]. The shockwave harms these aquatic organisms by causing the swim bladder to expand and contract violently, leading to immediate rupture, internal haemorrhaging, and total organ failure [6].

### Bomb Energy Requirement

To determine if Klee can effectively blast the fish, we must calculate the energy required to generate a lethal shockwave across a specific radius. In-game, Klee's bomb creates an explosion that's approximately 6m in diameter (from in-game observation). Using the equation [7]:

$$P = \frac{Energy}{\Delta V},$$

where  $P$  is the fatal pressure that harms fish (21.8 psi or  $1.5 \times 10^5$  Pa [5]), and  $\Delta V$  is the volume of the explosion, we can determine the energy required by the bomb. Modelling the bomb explosion as a sphere. The volume of the explosion was calculated using the spherical volume equation:

$$V_{bomb} = (4/3)\pi r^3 = 113.1 m^3.$$

Therefore, the energy required can be calculated using the rearranged formula:

$$Energy = P \times \Delta V \\ E = 1.5 \times 10^5 \times 113.1 = 2121 kJ$$

Therefore 2121 kJ would be required to effectively harm the fish fatally in Starfell Lake.

### Calculating The Quantity Of Bombs Required

As the net volume of the lake ( $V_{starfell}$ ) was calculated to be 20,813.1 m<sup>3</sup> and a single bomb creates an explosion volume of 113.1 m<sup>3</sup>, the total number of bombs required was determined by dividing the lake's volume by the bomb's explosion volume.

$$Total\ bombs = \frac{20813.1 m^3}{113.1 m^3} \approx 184\ bombs$$

$$E_{total} = 184 \times 2121 kJ \approx 390.2 MJ$$

Klee would need 184 bombs, which would expend a total of 390.2 MJ, to potentially clear out all fish at Starfall Lake, assuming that all the fish are evenly distributed throughout the lake.

### Potential Bomb Composition

Klee's bombs are described as being an alchemical-synthetic hybrid explosive [1]. Although typical explosives like TNT or RDX rely on physical detonators [8], Klee's bombs rely on her pyro vision, providing an elemental ignition source to start the reaction.

To address any issues with the explosives operating in water, metallised thermobaric formulations containing metal powders such as aluminium or boron can undergo secondary afterburning within the explosion [9], releasing additional heat that sustains shockwave pressure, thereby extending the positive pressure duration and enhancing damage to underwater targets [10]. Given this information, it is plausible that Klee's alchemical bombs employ similar metal components to maximise their effectiveness in fatally harming the fish.

### Conclusion

Overall, for Klee to successfully wipe out every fish in Starfell Lake, her bombs must exert a hydrostatic shock of 21.8 Psi to fatally wound aquatic species in the lake. For this to happen, the bomb must release 2,121 kJ of energy, and clearing out the entire lake would require approximately 184 bombs. Furthermore, the composition of her bombs likely contains a thermobaric material to enhance underwater performance.

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