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Can anyone survive Weedy's liquid nitrogen cannon?

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Abstract
This paper aims to investigate the possibility of a human surviving a cannon of compressed liquid nitrogen, based on the signature skill of the operator Weedy from the videogame Arknights. The skill deals damage with the nitrogen itself, as well as by pushing the target with force, therefore chemical and physical perspectives will be considered.

Keywords: *Computer Game; Chemistry; Physics; Kinetic energy; Liquid nitrogen; Arknights; Weedy*

Introduction
Weedy is a character from the videogame Arknights, her signature skill is called "Liquid Nitrogen Cannon" and it works as follows: "Immediately fires a compressed liquid nitrogen cannon, dealing 350% *Arts damage* in an area and pushing enemies away greatly; For 8 seconds, enemies hit by this ability take *True Damage* proportional to distance travelled." The enemy takes 1200 damage per grid moved [1]. In Arknights, *Arts damage* can be reduced by factors such as the enemy's *Resistance*, while *True Damage* ignores the enemy's *Defence* and *Resistance*.

The interesting part of this skill is that not only does it involve a shot of liquid nitrogen, but it also involves the target taking damage by being pushed across a distance. This paper aims to discuss a scenario where a human would get targeted by this skill and explore ways, if any, for the human to survive it.

The properties of Liquid Nitrogen
Liquid Nitrogen is a cryogenic fluid with a boiling point of -195.8 °C, the boiling point is very low due to the weak Van der Waals interactions between the 2 N_2 molecules [2].

In real life, liquid nitrogen has many hazards associated with it, such as cryoburns, which are similar to frostbite and can be severe enough to lead to amputation of the affected digits, as well as the need of plastic surgery to repair the damaged tissue. Another hazard is the possibility of oxygen depletion which is caused by the evaporation of liquid nitrogen, leading to a lack of oxygen which can cause mental impairment, as well as coma [3].

In our scenario, the cryoburns would be the issue as it would be the instant effect of Weedy's skill, we can assume that the "350% *Arts damage* in an area" refers to this specifically, which would lead to the demise of any human, just like it does in game for basic enemies such as the crossbowman in figure 1, where it can be observed that 2324 damage is being dealt to the target. The crossbowman has 1400 HP, which means instant death. If we were to give an arbitrary HP value to the average human, 1000 HP seems suitable, slightly lower than the crossbowman who is "equipped with illegally obtained weapons and armour" [4].

Figure 1 – Weedy's Liquid Nitrogen Cannon in action against a crossbowman in Arknights [5].

If we were to look at Weedy's performance against a stronger enemy with higher health, we can see in figure 2 against a Heavy Defender who is able to survive the shot itself. This suggests that by wearing strong armour, which is most likely not comparable

to anything in the real world if you consider the kind of materials present in Arknights, it's possible to survive the impact with the liquid nitrogen. Compared to the crossbowman's health, the Heavy Defender has 6000 HP, more than 4 times higher [6], we can assume that this is due to the armour, which greatly amplifies the target's survivability. In real life it's suggested to wear loose fitting thermal insulated gloves, long sleeve shirts, trousers without cuffs, and safety shoes when coming into contact with liquid nitrogen [7].

We could assume that a human could wear the aforementioned protective equipment to reach 2500 HP and increase their *Resistance* to survive the *Arts damage*. However, that doesn't take into account the fact that Weedy's skill is also meant to push the target, with this specific part of the skill dealing *True Damage* that is caused depending on the distance travelled, on top of the *Arts damage* that we have already discussed.

Figure 2 – Weedy's Liquid Nitrogen Cannon in action against a Heavy Defender in Arknights [5].

Damage proportional to distance

The second part of Weedy's skill states that "For 8 seconds, enemies hit by this ability take *True Damage* proportional to distance travelled". *True Damage* in Arknights is damage that ignores *Defence* and *Resistance* and is not affected by damage mitigation effects, meaning that it is not affected by *Resistance* the same way *Arts damage* is [8].

This means that even with the suitable protective equipment, the target will still take damage because of the kinetic energy caused by Weedy's skill. To analyse this, we can use Newton's second law of motion which relates force, mass, and acceleration [9]. This law can be expressed by the following equation:

$$F = ma,$$

where F is the force, m is mass and a is acceleration.

In our scenario Weedy's force is the same against all types of targets, meaning that the target's mass is inversely proportional to the acceleration. This is also equal to the change in kinetic energy of the target, which can be described by the following equation:

$$KE = \frac{1}{2}mv^2,$$

where KE is the kinetic energy, m is mass and v is velocity.

A higher acceleration would lead to more distance being travelled, therefore leading to more damage. We can express this with the following equation:

$$TD = kd$$

where TD is the *True damage* dealt, k is damage per metre and d is distance.

The damage per metre is 1200, as the skill "deals 1200 damage per grid moved", for a real life scenario we assume that a grid's length is 1 metre. Looking at figure 2, we can observe that the Heavy Defender has been pushed across 3 grids. Therefore, according to the TD equation, the Heavy Defender takes 3600 *True Damage*, which is added to the 2324 *Arts damage* from the liquid nitrogen itself. With 6000 HP, the Heavy Defender takes 5924 overall damage, surviving with 76 HP. This suggests that the use of armour would be helpful but only if it is heavy as well, as it would increase the target's mass, reducing the distance travelled, and therefore reducing the overall damage taken by the target.

We must still consider that the armour from the world of Arknights may not be possible to be recreated in the real world and a human would also need to be strong enough to wear such heavy armour.

Conclusion

In conclusion, would a human be able to survive against Weedy's Liquid Nitrogen Cannon? Definitely not. There are mainly two factors in play that lead to this, one of them being that liquid nitrogen itself is very hazardous even with slight contact, therefore Weedy's ability would cause extensive damage. The other factor is the kinetic energy caused by this move, there is no scenario in which a human can realistically survive against Weedy's skill.

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