**Define the effectiveness:**

Effectiveness= **A**Lethality+**B**security (**A** and **B** are the weights of lethality and security)

Our goal is finding out the way that can maximized the effectiveness

**Lethality:**

**1.Effect of Weapon Shape**

Air resistance: The flight path and range of the spear are affected by air drag, which can be modeled using Newton's drag equation:

is the drag coefficient, is the air density, *A* is the cross section of the spear, *v* is the velocity of spear.

**2.Modeling Physical Impact**

**Thrown spear**: When humans throw a spear, the impact force depends on the spear’s velocity and mass. You can use the formulas for momentum and kinetic energy:

Where 𝑚 is the mass of the spear, and 𝑣 is the throwing speed.

1. Horizontal Motion:
2. Vertical Motion:

By using these two equations, we could find out the velocity of spear, and then, we could find out the momentum and energy of spear.

**Braced spear**: In the case of an animal charging into a braced spear, the impact is determined by the animal’s velocity and mass

Where 𝑀 is the mass of the animal, and 𝑢 is the speed of the animal.

1. Horizontal Motion:

*f*  is the friction due to the ground.

Then, we can calculate the momentum and energy of spear in the same way.

**Security:**

Until now, I define it as the inverse proportional function. Because when you move away from the mammoth, the security will only slightly increase if you are already far from it. Just like the marginal benefit.