StarWars Visions Ep 5: The Ninth Jedi

This episode shows rocket powered trebuchets! They are not used as war siege machines but for mining asteroids… rocks? Moonlets that are in the ring of the planet the episode is set on.

Moonlet -> Suffix “let” is old French for adding a double-diminutive quality to a noun. Omelet….

Another interesting word is “mascon” or mass concentration

How these trebuchets work is they used a counterweight to heave a rocket powered claw grabber into orbit.

The grabber’s rockets fire and then it ascends like a JATO rocket into the upper atmosphere to snag a moonlet.

Once it grabs its target it is just a matter of time before the line goes tight and the rock falls at great speed to the ground. Taking roughly 6 seconds to smash into the ground.

We are going to explore what kind of forces are involved here and what would happen if this object really fell that quickly?

Our assumptions

- Earth like planet
- Object is in lowest “stable” orbit given our atmosphere makeup and gravity
    - The absolute closest rings could get is **somewhere above the atmospheric layer known as the thermosphere**, which reaches up as high as 620 miles (1,000 km), according to the University Corporation for Atmospheric Research.
    - So 620 miles or 1000km up! It's clearly closer in the episode.
    - Our object is traveling at…
        - velocity = √ gravitational constant * total mass / orbit radius
        - Grav constant for earth = 3.986004418*10^14 m^3/s^2
        - ~19,964 m/s
- Looking at the size of the grabber and the impacts the objects have the objects can’t be much larger than a beachball
    - Beachball size of what material?
    - Episode is about building lightsabers so maybe Varium

        - Varium is one of the most conductive materials known, whether it be heat or electricity.
    - With that property of Varium let's use Silver as our analog
    - Silver sized beach ball would weigh
        - V=4/3πr^3
        - 0.5m diameter beachball
        - 0.06545 m ^3 volume
        - Silvers density is 10,497 kg/m^3
        - So our beachball of silver is 687.02865 kg! Which is a tad over 1500lbs.
- Material Science be damned

How much force is applied to the cable?

Momentum of the silver beachball

p = mv -> 13053 kg·m/s

So lets say it's gotta change direction to “suck” the object back to the base. Means momentum needs to cross zero.

F = Impulse / T

It is hard to tell but it looks like it takes ~3 seconds for the object to start moving towards the trebuchet

-13053kg m/s / 3seconds = 4571756 Newtons of Force -> 1,027,771 lb force

Lb force of a Rocketdyne F1 engine is 1,746,000 so not totally unthinkable!

(Wire Tensile Strength × π × (Wire Diameter)^2) / 4 = Breaking force of a cable

350 MPa used for plain steel cable

If we just used a plain steel cable rope we are looking at a ~5” diameter (130mm) cable to handle the force. This leaves no safety factor or any regard to the weight of this enormous cable either.

Ok we captured our object. Lets reel it back in at 3 seconds over 1000km! We are traveling over 333km/s

Most asteroids/meteoroids enter the earth's atmosphere at 20km/s. We are going 16 times faster than that! Maybe this Varium is more heat resistant than silver.

Perdue has an interesting impact crater estimator.

https://www.eaps.purdue.edu/impactcrater/crater_c.html

Our estimated crater size is ~50 meters

Image from the episode looks like ~10m

Ok maybe the object is not as dense or it's smaller or the dirt is softer than “sand”

Another interesting thought is the kinetic energy of this object

38,090,371,500,000 J = 9100 Tons of TNT

Why a trebuchet?

1. Arm allows some flex spring action to slow down the impulses? Assume a non stretchy cable?
2. Launches the rocket away from the workers/housing to a safer distance?
3. It just looks cool.