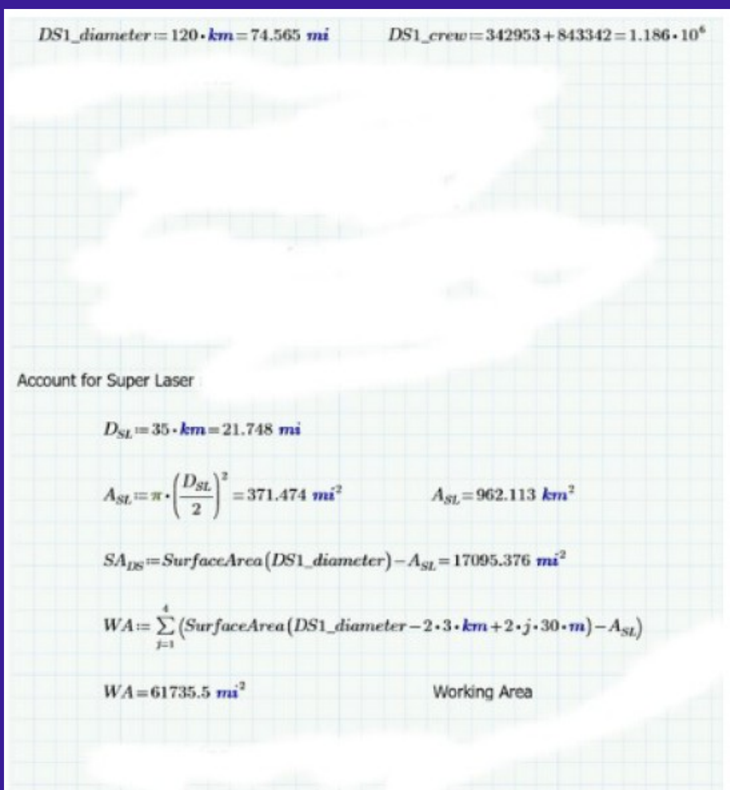
The Death Star: A Case Study in Engineering

"Geometry yields to no one, not even evil empires" (Ben Orlin)

1. Would you say the Death Star is a great design?

2. What (scientific) questions could you ask about it?

3. Look at the scraps from an engineer's calculations. What could he be studying in each case?



$DS1\_diameter := 120 \cdot km = 74.565\ mi$

$DS1\_crew := 342953 + 843342 = 1.186 \cdot 10^6$

Account for Super Laser

$D_{SL} := 35 \cdot km = 21.748\ mi$

$A_{SL} := \pi \cdot \left(\frac{D_{SL}}{2}\right)^2 = 371.474\ mi^2$ $\quad A_{SL} = 962.113\ km^2$

$SA_{DS} := SurfaceArea(DS1\_diameter) - A_{SL} = 17095.376\ mi^2$

$WA := \sum_{j=1}^{4} \left(SurfaceArea(DS1\_diameter - 2 \cdot 3 \cdot km + 2 \cdot j \cdot 30 \cdot m) - A_{SL}\right)$

$WA = 61735.5\ mi^2$ $\quad$ Working Area

$C\ldots e(diameter) := \frac{\pi}{2} \cdot diameter$

$Time(distance, velocity) := \frac{distance}{velocity}$

$V_{TF} := 1200 \cdot \frac{km}{hr} = 745.645 \frac{mi}{hr}$ TIE Fighter

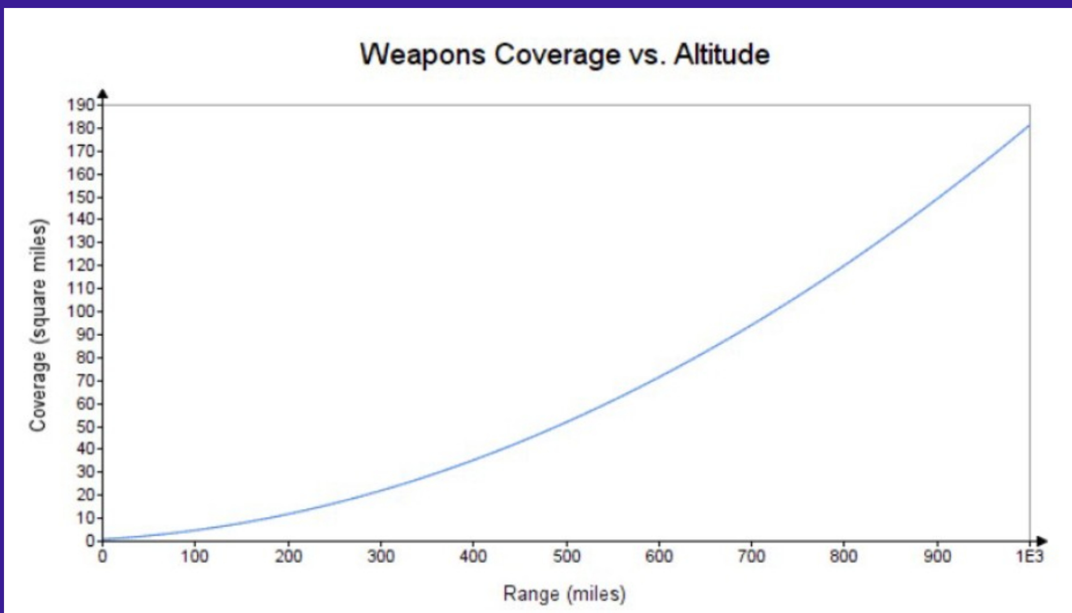
$V_{TCS} := 850 \cdot \frac{km}{hr} = 528.166 \frac{mi}{hr}$ TIE Command Shuttle

$Time(C\ldots e(DS1\_diameter), V_{TF}) = 9.425\ min$

$Time(C\ldots de(DS2\_diameter), V_{TF}) = 12.566\ min$

$Time(O\ldots e(DS1\_diameter), V_{TCS}) = 13.306\ min$

$Time(O\ldots e(DS2\_diameter), V_{TCS}) = 17.741\ min$



4. Match the title of the issue being analyzed, the drawing exemplifying it, and the quotation alluding to it.

1. Throwing aerodynamics to the wind

3. West Virginia, floating in space

2. Too big to fail, too small to sphere

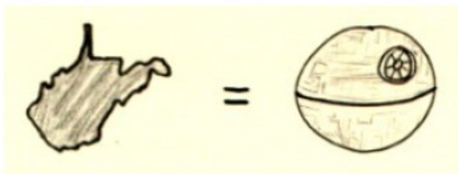
a. The problem that still haunts me is the heating. It's outer space, right? Cold. You want to retain heat, and a sphere is great for that. Minimum surface area means minimum heat loss. But apparently, we did our jobs too well, because early simulations showed that the station would be prone to overheating. […] [S]o [we] put in thermal vents. Nothing big. A few meters wide. Release the heat into space; problem solved. I didn't think… I mean, when I heard that the rebels had destroyed the station by exploiting a thermal vent…

b. Look, I'm no propaganda expert, but the physics is pretty clear. All matter attracts all other matter. More matter, more attraction. […] So, toss a bunch of ingredients together in the mixing bowl of space, and every bit is mutually drawn toward every other bit. They congregate around a kind of 3D balancing point: the center of mass. Over time, the outlying clumps and mire distant protrusions are drawn toward this center, until it reaches the final equilibrium shape: a perfect sphere. But that's only if you've got enough matter. […] The magic size, where you're big enough to go spherical, depends on what you're made of. Ice will go spherical at a diameter of about 400 kilometers, because it's pretty malleable. […] For a material like imperial steel, designed to withstand tectonic-level forces, it'd be even larger. Maybe 700 or 750 kilometers. And the Death Star? It was only 140 kilometers across. A pebble.

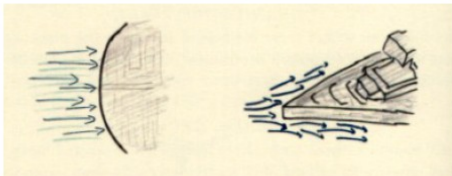
c. Imagine you're flying an airplane. No matter how good a pilot you are, you're going to have A LOT of collisions. I'm referring, of course, to air molecules. Best-case scenario? The air molecules travel parallel to your surface. Then, they won't impact you at all. They're like passing traffic in the neighbouring lane. The worst-case scenario is that the air molecules hit perpendicular to your surface, at 90-degree angles. Then, your vessel bears the full force of the impact. That's why you don't build airplanes with big, flat fronts: it'd be like trying to weasel through a crowd while wearing a giant sandwich board on your torso.

d. There were about 2.1 million people on the Death Star; that's counting droids. Meanwhile, with a radius of 70 kilometers, it had a surface area of almost 62,000 square kilometers. Now, assuming that you bring everybody to the surface level, you'll have a population density of about 30 people per square kilometer. That's five soccer fields per person. […] Want to picture social life on the Death Star?

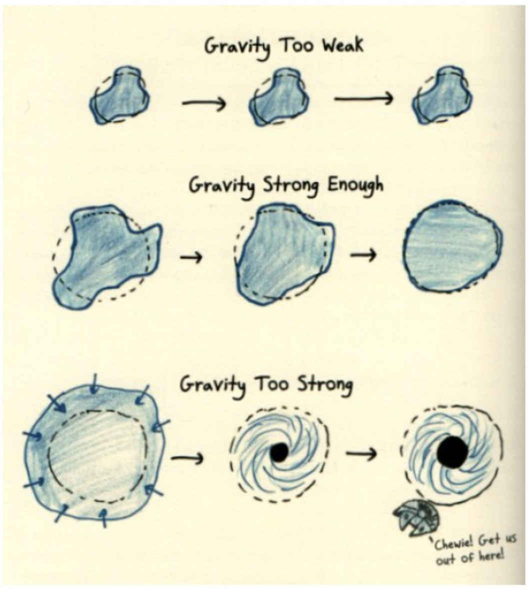
I.



II.



III.



5. Imagine the corresponding title and drawing for the last one.

6. Rephrase the following sentence resorting to the double comparative structure: "Minimum surface area means minimum heat loss."

7. Find in the text the words matching the following definitions.

a division of a road according to speed or direction

a large number of people gathered together

to throw lightly or casually

to be in a steady position; related to an even distribution of weight ensuring stability

a compacted or agglutinated mass

a small stone made smooth and round by the action of water or sand

a straight line from the centre to the circumference of a circle or sphere

likely to suffer from, do, or experience (something unfortunate)

8. Finally, what are your conclusions? Sum them up as an abstract.