Moving Mount Fuji

(by Thilo Gross)

How many dump trucks would you need to move mount Fuji[1]?

This is a classic job-interview question and we can find an answer by a so-called a Fermi estimate: We break the answer into little pieces, each easier than the question as a whole.

The volume of a pyramid is a a third of the volume of the box into which the pyramid would fit. Fuji is a mountain, not a pyramid, but we can use this formula to roughly estimate its volume

$$V =$$

So given this volume we can estimate the approximate mass of mount Fuji

$$M =$$

How many trucks would it need to move this mass?

$$N =$$

---

[1]You may asume that the mountain is about 4km tall

Solution

The purpose of this worksheet is to provide a gentle introduction to Fermi estimates. The origins of this question are not completely clear but it became popular after it has been in the standard pool for job interview questions at Microsoft for several years.

We are given that Fuji is 4km high and from the photo it's about twice as wide at the base. Using the "pyramid approximation" we obtain

$$V = \frac{8 \cdot 8 \cdot 4}{3} \text{ km}^3 \approx 85 \text{ km}^3 = 85 \cdot 10^9 \text{ m}^3$$

From somewhere I remember that the density of rock is about 3 kg/l which means 3 tonnes per cubic meter. Hence

$$M \approx 255 \cdot 10^9 \text{ t}$$

As a check I googled for typical mountain masses and various sources say $3 \cdot 10^{14}$ kg, which is in very good agreement with our estimate. A large road-going dump truck can carry approximately 30 tonnes of material. So we need approximately

$$N \approx 10^{10}, \qquad = \text{about 10 billion}$$

trucks. Of course we used wild approximations, but we can be fairly sure that the result is within the right order of magnitude. The Fermi estimate shows that moving a mountain would be huge project. If Japan devoted a fraction of its GDP to this task it may be able to build the road infrastructure and a million trucks, each of which would have to do 10.000 trips to the mountain.

If you want to challenge your students you can ask them to Fermi estimate as well how many large trucks exist in the world. There are many ways in which progress can be made, for example by estimating how many truck drivers exist, or by considering that the world burns about 10 gigatonnes of fossil fuel per year and a least the coal included in this number has been on a truck at some point.