

Order-of-Magnitude Physics – Problem Set 9

Due at the beginning of class.

Do any 1 of the problems + the last question (make up your own question).

You are free to do more if you like; answers will be graded.

“The ends justify the means.” — Ovid (often misattributed to Machiavelli)

Problem 1. Hummingbirds

Estimate, using order-of-magnitude physics, the mass of the largest bird that can hover. Compare to the mass of the hummingbird.

Problem 2. Cost-Effective Swimming

According to Tucker’s plot of minimum cost of transport vs. body mass (1975, *American Scientist*, v63; page 120 of the Course Reader), the minimum cost of transport $\epsilon \equiv P/(WV)$ for fishes scales with mass as $\epsilon_{\min} \propto m^{-0.3}$. Try to reproduce this scaling by considering two contributions to the power requirement: the basal metabolic rate (BMR) and the power dissipated in drag. Assume that Kleiber’s law holds also for cold-blooded fishes so that $\text{BMR} \propto m^{3/4}$.

Problem 3. Ask Your Own Question

Ask an OOM question of your own. You don’t have to answer it.