

Order-of-Magnitude Physics – Problem Set 8

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.

“Le mieux est l’ennemi du bien.” — Voltaire

Problem 1. Four Seconds Was the Longest Wait¹

According to practitioners of the sport, cliff diving offers “one of the most intense and thrilling 2 seconds of your life.”

- (a) Estimate the minimum water depth required to cliff dive “safely.”
- (b) Estimate the ratio of stresses experienced by an adult human falling into deep water from a cliff diver’s cliff : the Golden Gate Bridge : an airplane (i.e., if the ratio of stresses is 1:x:y, what are x and y?).²

Problem 2. Ions Can Do It, Too

Usually one thinks of electrons as carrying electrical current because they are so much lighter and more mobile than ions. But this does not have to be the case. If there are too few free electrons, ions can do the job.

Estimate the electrical conductivity σ [expressed either in SI (siemens/m) or cgs (s^{-1}); $\sigma_{\text{SI}} = 10^{-10}\sigma_{\text{cgs}}$] of:

- (a) Pure water. This has a pH=7, which means it has a concentration of about 10^{-7} moles of H^+ and OH^- ions per liter.

Assume that each H_3O^+ ion is enclosed in a cage of water molecules (which because they are polar can stick to the ion). Use your understanding of drag to decide how such an assemblage moves in an applied electric field.

- (b) Sea water. The mass of salt per unit mass of seawater is 0.035.

¹From the song, “Jumpers,” by Sleater-Kinney.

²After I posted this problem on the web, it attracted the attention of a San Francisco businessman and adventurer who had made a bet with his friends that a person jumping off the Golden Gate would not, on the initial plunge into the Bay, descend past a certain depth. I helped him solve the problem; he won the bet; and graciously he awarded me a fraction of the proceeds: a bottle of Napa wine and a CD of Sleater-Kinney’s “The Woods”. Who says physics can’t be profitable?

Problem 3. Hail

Hailstones grow from ice particles that repeatedly fall and rise in the circulating flow of a thundercloud.

A golf-ball-sized (2 cm radius) hailstone drops to your feet. Estimate how many times this hailstone has circulated through the parent thundercloud.

Problem 4. Ask Your Own Question

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