I. Weightlifter

A weightlifter grabs a 100 kg dumbbell that's sitting on the floor and lifts it 2.0 meters to a point over her head. Then she holds the dumbbell over her head, motionless, for several seconds.

A. How much work did she do on the dumbbell while lifting it? Show your reasoning.

B. How much work did she do on the dumbbell while holding it over her head? Explain.

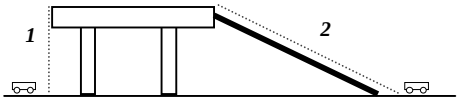
C. The weightlifter says,

> Don't even *try* to tell me I'm not doing work while holding the dumbbell over my head. I'm working hard—look at me sweat, and look how tired I get!

Reconcile your part b answer with the weightlifter's feeling that she's doing work on the dumbbell while holding it motionless. In other words, explain how it's the case that the weightlifter gets tired even though she's not doing work on the dumbbell.

II. Ramp vs. straight up

A lazy professor wants to lift a cart from the floor onto a table. He can either lift it straight up along path 1, or he can push it up the ramp along path 2 (see the dashed lines in the diagram). If he chooses path 2, the cart rolls with negligible friction. Whichever path he chooses, the cart starts at rest on the floor and ends at rest on the table. Here's the issue: Along which path will the professor do less work on the cart?



A. Why might a smart student say the professor does less work lifting the cart along path 1?

B. Why might a smart student say the professor does less work pushing the cart along path 2?

C. Along which path, if either, does the professor do less work? Hint: Think about the connection between work and potential energy (in cases where the object gains no kinetic energy).

D. Reconcile your part C answer with the arguments given in parts A and/or B. In other words, show how elements of the "incorrect" ideas from parts A and/or B can be used to *correctly* explain why your part C answer makes intuitive sense. Continue on back if needed.

