Understanding Molecular Machines Handout .[1]

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[1] Read: Chapter 10, Phil Nelson. Biophysics Book

This handout we will think about basic "thermodynamics" of molecular machines.

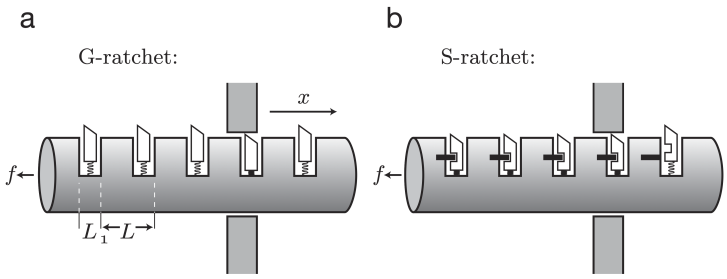

Figure 1: Two "potential" Brownian motors from Phil Nelson's biophysics book. The goal is to move right. One works and one doesn't. (a) The "G-ratchet". A rod (horizontal cylinder) makes a supposedly one-way trip to the right through a hole in a "membrane" (shaded wall), driven by random thermal fluctuations. It's prevented from moving to the left by sliding bolts, similar to those in a door latch. The bolts can move down to allow rightward motion, then pop up as soon as they clear the wall. A possible external "load" is depicted as an applied force f directed to the left. (b) The "S-ratchet." Here the bolts are tied down on the "cell interior" (left side), then released as they emerge on the right.

Phil Nelson, Biophysics Book

Look at the figure above The goal of these machines is to "move" to the right. One of these works and the other doesn't.

1.Which one of these motors is thermodynamically possible?

Individual Answer:

Group Answer:

2. Can you relate this to our discussions about perpetual motion machines and Landauer?

Group Answer:

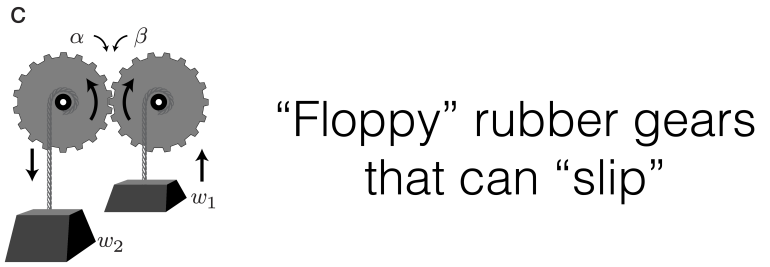

Figure 2: "Floppy" gears from Phil Neson's book.

3. Look at the figure above Can you draw an "energy landscape" as a function of α and β for this gear motor if $w_1 = w_2$? Assume gears are floppy and imperfect so can "slip" by deformation.
Group Answer:

4. Now draw the "energy landscape" as a function of α and β for this gear motor if $w_1 >> w_2$?
Group Answer:

5. . Finally, draw the "energy landscape" as a function of α and β for this gear motor if $w_1 << w_2$?
Group Answer: