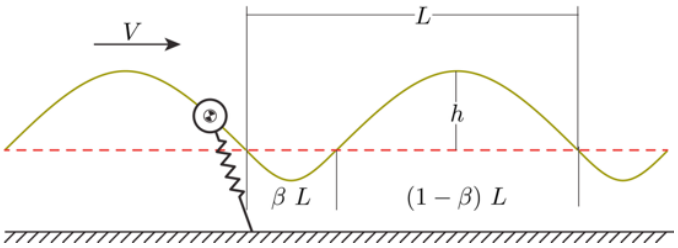
Biology 427 Problem Set 1 Fall 2016

General comments on problems sets.

- All problem sets are due at the beginning of lecture on the Friday one week after they are assigned. Each
- Feel free to work in groups, but be sure the work you turn in is your own.
- Feel free to consult with your instructor and TA. We will have ample office hours for you to invade with your questions.
- We will establish a class
- Please -- always explain your answers and show all your work. By doing so you can often get credit for numerically incorrect answers.
- Imagine you are the TA grading these homework assignments. Problem sets that are clearly written, easy to read, and nicely organized tend to make for happy TAs.

1. (1 pt) Uphill locomotion incurs an extra cost that varies, as expected, with body mass – going uphill you increase your gravitational potential energy by the product of your weight and the height you gain. Say you climb, not an ordinary ladder, but a motorized stepping ladder in which the steps descend at just the speed you climb, so you neither gain nor lose altitude. You find this just as hard as climbing an ordinary ladder! Where does the work of ascent now go? (from Vogel, 2013 "Comparative Biomechanics" 2nd Edition)

2. (4 pts) The jumper model outlined in class (lecture 3) shows the relationship between power and velocity for a given jumpiness.



where *V* is the velocity *L* is the stride length, and β measures the jumpiness. The kinetic energy. The total energy of this jumping animals is *W* as follows:

$$W = PE + KE$$

$$PE = m\ g\ h = (1-\beta)^2 \frac{m\ g^2\ L^2}{8\ V^2}$$

$$KE = \frac{1}{2} m\ V^2$$

where *m* is the mass of the animal and *g* is Earth's gravity.

a) Using the figure above, what is the total air time?
b) Show how *h* in the potential energy equation is equal to

$$(1-\beta)^2 \frac{gL^2}{8V^2}$$

c) What is the equation for the average power per stride?
d) What is the power per stride as velocity tends to zero?

3. (3 pts)

The cost of transport (C) is the ratio of power output (P) to the product of weight ($m\,g$) and velocity (V)

$C = P/(mg\ V)$

a. Show how cost is a dimensionless number

b. What is the equation for the cost of transport per stride for the model in part 2?

c. Compare graphically the the power per stride (part d above) and the cost per stride (hint: explore the limits of 0 velocity and infite V).

4. (2 pts)

Science magazine is among the most prestigious scientific journals in the world. Competition for space in that journal is extremely rigorous. Nearly 80% of all papers submitted to the journal are rejected by the Science board of reviewing editors. The 20% that make it past this step are subject to in depth review by experts in the field. Even then, only a small fraction actually are accepted for publication. That does not mean, however, that all that is published is perfect. There is always room for improvement, additional research and criticism. Read the paper by Burrows and Sutton that appeared in a recent issue of *Science*. As you read the paper, realize that this journal has a strict limit on the length and style of the paper.

The last paragraph of the paper asserts the hypothesis that the cogs insure symmetric coordination, but there are no experiments that clearly support it. Design an experiment to test the hypothesis of synchronization.