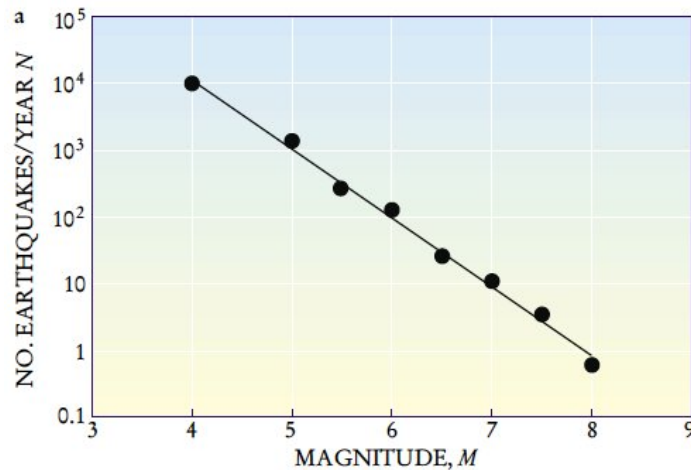Unit 9 Homework

Graded Part

1. Consider the following log-log plot of earthquake magnitudes recorded worldwide.

(from http://www.physics.buffalo.edu/phy410505/2011/topic1/app2/index.html).

Which of the following is true, given the data in the plot?

A. There are about 2 times as many magnitude 4 earthquakes as magnitude 5 earthquakes

B. There are about 10 times as many magnitude 4 earthquakes as magnitude 5 earthquakes.

C. There are about 100 times as many magnitude 4 earthquakes as magnitude 5 earthquakes.

2. Zipf's law predicts that in a given text (in any natural language), that the frequency of a word in the text is proportional to the inverse of the word's rank (where the most frequent word has rank 1, the second most frequent word has rank 2, etc.):

Frequency of word $\propto$ 1 / rank.

Thus, Zipf's law predicts the following:

A. The most frequent word will appear 10 times more often than the second most frequent word.

B. The most frequent word will appear twice as often as the second most frequent word.

C. The most frequent word will appear five times as often as the second most frequent word.

3. The surface hypothesis states that that metabolic rate is proportional to mass$^{2/3}$ (.e., mass to the 2/3 power).

For this question, assume that

metabolic rate (in calories per day) = 90 * mass$^{2/3}$ (in kilograms).

Using a calculator or PowerLawCalculator.nlogo (from the Course Materials page), use this formula to find the predicted metabolic rate of a 70 kg human. (Hint: In the PowerLawCalculator, set C to 90, X to 70, and alpha to 0.667)

A. About 1531 calories per day

B. About 2040 calories per day

C. About 900 calories per day

4. Kleiber's law states that metabolic rate is proportional to mass$^{3/4}$. For this question, assume that

metabolic rate (in calories per day) = 90 * mass$^{3/4}$ (in kilograms).

Using a calculator or PowerLawCalculator.nlogo (from the Course Materials page), use this formula to find the predicted metabolic rate of a 70 kg human. (Hint: In the PowerLawCalculator, set C to 90, X to 70, and alpha to 0.75)

A. About 2178 calories per day

B. About 3025 calories per day

C. About 1974 calories per day

5. Which of the following is implied if Keliber's law is true?

A. A mouse and a human will have the same metabolic rate.

B. A 70 kg human has a higher metabolic rate than the surface hypothesis would predict.

C. None of the above.

6. Another observed scaling law mentioned in the lectures is that heart rate is proportional to mass raised to the −1/4 power. For this question, assume that

heart rate (beats per minute) = C * mass$^{-1/4}$ (in kilograms).

where C is a constant.

Using a calculator or PowerLawCalculator.nlogo, find the constant C such that a 70 kg human will have heart rate approximately 70 beats per minute.

[Hint: You can do this either via trial and error, or by solving an equation. In PowerLawCalculator.nlogo, set X to 70, alpha to −0.25, and experiment with different values of C)

Which of these is correct?

A. C is about 100

B. C is about 200

C. C is about 300

7. Using the same value of C that you found for question 6, find the predicted heart rate in beats per minute of a 7 kg dog.

A. About 123

B. About 155

C. About 203

If you have a dog at home, measure the dog's heart rate to see if it is close to what the equation predicts!

No ungraded part on this homework.