Introduction to Complexity (2020)

10.7 Take Unit 10 Test » Unit 10 Test

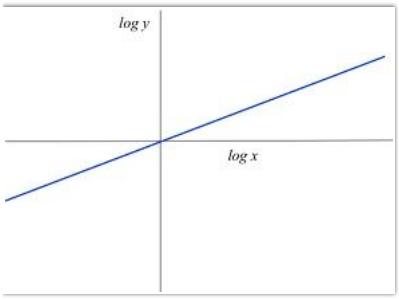
Instructions 1

You may use any course materials, websites, Netlogo models, calculators, etc. for this test. Just don't ask another person for the an share your answers with other people.

Please take ten minutes to complete the post-course survey. Thank you!

Question 2

Suppose you see the following graph (a log-log plot), where the slope of the line is equal to 1/2.



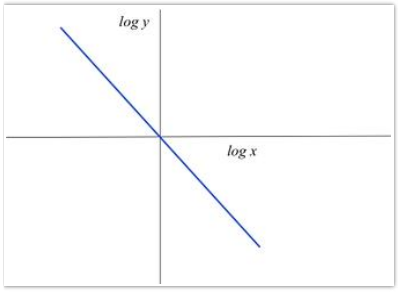
What power law does this correspond to?

- A. $y = x$
- B. $y = x^2$
- C. $y = x^{1/2}$
- D. $y = (1/2)\ x$

Question 3

Suppose you see the following graph, which plots the function

$\log y = -2 \log x$

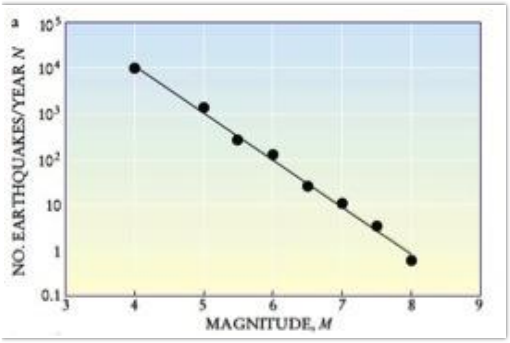


What power law does this correspond to?

- A. $y = -x$
- B. $y = x^{-2}$
- C. $y = -2\ x$
- D. $y = x^{-1/2}$

Question 4

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

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Question 5

The surface hypothesis states that metabolic rate is proportional to body mass raised to the 2/3 power.

Assume that the following equation is true:

$$\textit{metabolic rate} = 4 * (\textit{body mass})^{2/3}$$

where *metabolic rate* is measured in watts and *body mass* is measured in kilograms.

Given this equation, what is the approximate metabolic rate of a 60 kilogram person?

Hint: **See the quiz in Unit 10.2 for instructions on how to use Google as a calculator for problems like this, or use the NetLogo mode PowerLawCalculator.nlogo, which is linked from the Course Materials page under "Unit 10".**

- A. 11 watts
- B. 61 watts
- C. 90 watts
- D. 98 watts

Question 6

Now assume Kleiber's law is true, that is, metabolic rate is proportional to body mass raised to the 3/4 power, and

assume that the following equation is true:

$$\textit{metabolic rate} = 4 * (\textit{body mass})^{3/4}$$

where *metabolic rate* is measured in watts and *body mass* is measured in kilograms.

Given this equation, what is the approximate metabolic rate of a 60 kilogram person?

- A. 44 watts
- B. 57 watts
- C. 86 watts
- D. 105 watts

Question 7

Another observed scaling law mentioned in the lectures is that resting heart rate is proportional to body mass raised to the –1/4 pow question, assume that:

$$\textit{heart rate} = C * (\textit{body mass})^{-1/4},$$

where heart rate is measured in beats per minute, and body mass is measured in kilograms.

Using a calculator or PowerLawCalculator.nlogo (on the Course Materials Page), find the constant C such that a 60 kg human will ha 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 60, alpha to –0.25, a experiment with different values of C.**

- A. C is about 100
- B. C is about 200
- C. C is about 300

Question 8

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

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

- A. About 123
- B. About 155
- C. About 203