Name:_____Date:_____Period:___

Crickets

Linear Functions

Nature's Musical Thermometer

(From the TEKS Clarifying Lessons)

Crickets are one of nature's more interesting insects, partly because of their musical ability. In England, the chirping or singing of a cricket was once considered to be a sign of good luck. In China and Japan, they were kept in fancy cages in the house so the residents could enjoy their singing. Many of us are so used to hearing this sound on a summer evening that we would probably think that something was wrong if it were missing. The male cricket "sings" to attract the female cricket – not just to keep you up at night – and does this by rubbing his two front wings together.

One of the more interesting facts about crickets is that their chirping is dependent upon the temperature. As a result of this, they can be thought of as "natural" thermometers. The rate of a cricket's chirp increases as the temperature increases and depends on the type of cricket. So if you know the right formula and the type of cricket you hear chirping, you can estimate the temperature by counting the chirps. Changes in humidity and different crickets of the same type also produce variations in a cricket's chirping rate. However, the dominant factor is temperature, so formulas relating temperature to the number of chirps are fairly accurate. Below are the rules for finding the temperature, in degrees Fahrenheit, for three different types of crickets.

- The field cricket is the black cricket that is commonly found in the U.S. For a field cricket, you need to count the number of chirps in 15 seconds and add 38 to obtain the temperature in degrees Fahrenheit.
- Tree crickets are the small pale green crickets found on trees. For a tree cricket, the temperature in degrees Fahrenheit can be found by counting the number of chirps in 7 seconds and adding 46.
- The snowy tree cricket is the species whose music is most in tune with that of the temperature since it is believed to be the most accurate. For this cricket, you need to count the number of chirps in 14 seconds and add 42 to obtain the temperature in degrees Fahrenheit.

Notice that each "rule" involves counting the number of chirps in a different predetermined time period, i.e., 15 seconds for the field cricket, 7 seconds for the tree cricket, and 14 seconds for the snowy tree cricket. The inputs for our formula will be **number of chirps per minute.**

1.) a.) If n is the number of chirps per minute, what is the number of chirps in 15 seconds? _____

b.) If n is the number of chirps per minute, what is the number of chirps in 7 seconds? _____

c.) If n is the number of chirps per minute, what is the number of chirps in 14 seconds? _____

d. In general, if n is the number of chirps per minute, what is the number of chirps in s seconds? _____

2.) Now, write an equation for each cricket where the input is n, the number of chirps per minute, and the output is T, the temperature in degrees Fahrenheit.

Field Cricket _____

Tree Cricket _____

Snowy Tree Cricket _____

Input the 3 equations into your graphing calculator and graph them.

3.) If each cricket is chirping 120 times per minute, what does each equation say is the temperature?

Field Cricket _____

Tree Cricket _____

Snowy Tree Cricket _____

4.) If the temperature is 56°F and the cricket chirps 72 times in one minute, to what type of cricket are you listening? How did you decide?

_____

_____

5.) If the temperature is 53°F and the cricket chirps 60 times in one minute, why can't you tell what type of cricket you are hearing?

_____

_____

6.) If the temperature were 90°F, how many times would the snowy tree cricket chirp in 1 minute? _____ Would you be able to identify crickets in 90°F temperature? Why or why not? _____

_____

7.) What happens when the temperature drops below 42°F for each of the crickets?_____

8.) If it is 50°F and you are counting 60 chirps per minute, something is wrong. Why?_____

Part 2.

9.) Explain how you know, just from looking at the equations, that these are linear functions. _____

10.) For each equation, specify a domain and the corresponding range.

Field Cricket _____

Tree Cricket _____

Snowy Tree Cricket _____

10.) Sketch each of the functions on the same set of axis. Be sure to label each line and to label the axes.

11.) Explain the physical meaning of the y-intercepts. _____

_____

12.) Explain the physical meaning of the slope for these functions. _____

_____

Part 3.

Remember that the inverse of a function is the reflection of a function in the line y=x. That reflection switches all the x's and y's. Therefore, to find the equation for the inverse function, we can simply switch the x and y variables and solve for y. Here is an example.

F(x)(or "Y") =2X + 2

To find $F^{-1}(X)$, switch the x and the y

X = 2Y + 2. Then, solve for Y.

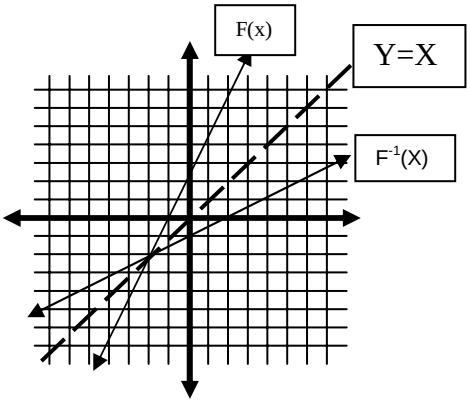
$X - 2 = 2Y$

$\frac{X - 2}{2} = Y$

$\frac{1}{2} X - 1 = Y$

So, $F^{-1}(X)$ (the inverse function)= $\frac{1}{2} X - 4$

Here's a picture of the reflection.



14.) For each of the three equations from Part 1, find the inverse function.

Field Cricket _____

Tree Cricket _____

Snowy Tree Cricket _____

15.) What is the domain and range for each of your inverse functions? How does it compare with the domain and range of the original functions?

Field Cricket _____

Tree Cricket _____

Snowy Tree Cricket _____

_____

_____

16.) What is the slope for each of the inverse functions? How does this compare with the slope for each of the original functions?

Field Cricket _____

Tree Cricket _____

Snowy Tree Cricket _____

_____

_____

17.) Use the inverse functions to determine the number of chirps per minute each cricket would make if it were 70°F.

Field Cricket _____

Tree Cricket _____

Snowy Tree Cricket _____

18.) Graph the three inverses on the same set of axes. Make sure you label each line and the axes.

19.) In Part 1, you saw that data of 53°F and 60 chirps would mean that you couldn't tell between a field cricket and a tree cricket. Are there data points that would leave you unable to decide between a field cricket and a snowy tree cricket?_____

_____

_____

20.) Give a quick way of telling, for any temperature in the range 40°F and 80°F, which cricket chirps at the highest rate. ?_____

_____

_____

21.) The slope of a line tells how "steep" the line is. If you have two lines, is it always true that the line with the largest slope gives the highest output? Explain your answer.

_____

_____

_____

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