Student Task

THERMOMETER CRICKETS PERFORMANCE TASK

In this task, you will organize and analyze data to model the relationship between temperature and the chirping rates of snowy tree crickets. You will develop an equation to describe the relationship, and you will compare your mathematical model to another formula.

Data Set

This table shows data about snowy tree crickets. Each data point in the table represents the average number of chirps per minute at a specific temperature.

Average Number of Chirps (per min)	Temperature (°F)
45	40°
60	47°
75	50°
80	45°
95	55°
110	50°
125	60°
140	55°
140	80°
150	65°
165	70°
180	65°
185	75°

Developing and Analyzing a Model

1. A. Using the data table, create a scatter plot of the temperature and number of chirps per minute for snowy tree crickets. [Note: The online delivery and response format for these types of questions is still being evaluated.]
    B. Explain the patterns you observe on the graph.

2. A. Estimate the line of best fit for the data points on the graph, and graph this line.
    B. Write an equation to represent the line.
    C. Write an interpretation of the slope of your equation (mathematical model) in terms of the context of chirping rates and temperature.

3. Describe how well your mathematical model fits the given observation data on cricket chirps and temperature, using correlation coefficient, R^2, and/or plots of residuals.

Comparing a Model

Amos Dolbear developed an equation in 1897 called Dolbear's law. He arrived at the relationship between number of chirps per minute of a snowy tree cricket and temperature. You can use this law to approximate the temperature, in degrees Fahrenheit, based on the number of chirps heard in one minute.

Dolbear's law:
$$T = 50 + \frac{N - 40}{4}$$

where T = temperature (°Fahrenheit)

N = number of chirps per minute

4. A. Plot the line that represents Dolbear's Law on the same graph as your line of best fit.
    B. What are the differences between this model and the one you developed earlier? (Include a discussion of their slopes and y-intercepts in your answer.) Interpret what these differences mean in the context of chirping rates and temperature.

5. Explain the differences between the results of Dolbear's formula and what you see in the observation data for determining the temperature depending on the number of times a cricket chirps. Support your conclusion using four data points. Why do you think these differences could occur?

Task Specifications

Sample Item Id:	MAT.HS.CRICKETS.PT
Title:	Thermometer Crickets
Content Domain(s):	Modeling; Algebra; Functions; Statistics and Probability
Assessment Target(S):	Claim 2, Target A: Apply mathematics to solve problems arising in everyday life, society, and the workplace. Claim 2, Target C: Interpret results in the context of a situation. Claim 2, Target D: Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flowcharts, or formulas). Claim 3, Target C: State logical assumptions being used. Claim 3, Target F: Base arguments on concrete referents such as objects, drawings, diagrams, and actions. Claim 4, Target D: Interpret results in the context of a situation. Claim 4, Target E: Analyze the adequacy of and make improvements to an existing model or develop a mathematical model of a real phenomenon.
Score Points:	See Scoring Rubric
Task Purpose:	The purpose of this task is to assess students' ability to use new data to challenge the assumptions of an existing mathematical formula.

Scoring Rubric

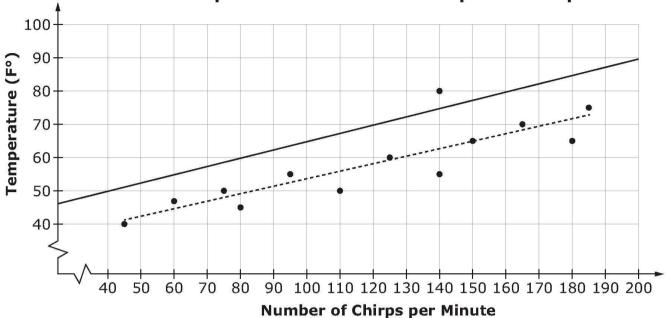Scoring Criteria for Thermometer Crickets Task

Scorable Parts	Points	Claims
1. A. Using the data table, create a scatter plot of the temperature and number of chirps per minute for snowy tree crickets. B. Explain the patterns you observe on the graph.	0–2 Points Full credit for correctly plotting data points. Students might note a possible linear relationship between the two variables. Accept other valid responses.	Contributes evidence to Claim 2, Problem-solving
2. A. Estimate the line of best fit for the data points on the graph, and graph this line. B. Write an equation to represent the line. C. Write an interpretation of the slope of your equation (mathematical model) in terms of the context of chirping rates and temperature.	0–3 Points Full credit for providing a line of best of fit approximating $y = 0.23x + 31$, depending on tools used. Possible interpretation of slope would be that "for every one unit increase in the rate of chirping, there is an average increase of 0.23 degrees in temperature (°F)." Accept other valid responses. See sample graph on last page of this document.	Contributes evidence to Claim 4, Modeling
3. Describe how well your mathematical model fits the given observation data on cricket chirps and temperature, using correlation coefficient, R^2, and/or plots of residuals.	0–3 Points Full credit for reporting on Pearson correlation coefficient, approximately $r = 0.85$, indicating a strong positive association. Informal residual analysis supports the appropriateness of linear model. Accept other valid responses.	Contributes evidence to Claim 4, Modeling

4.	0–4 Points	Contributes
A. Plot the line that represents Dolbear's Law on the same graph as your line of best fit. B. What are the differences between this model and the one you developed earlier? (Include a discussion of their slopes and *y*-intercepts in your answer.) Interpret what these differences mean in the context of chirping rates and temperature.	Full credit for noting that the both Dolbear's formula and the constructed model have positive slopes, but differ slightly (0.25 and 0.23). One interpretation of this could be that compared to Dolbear's formula predictions, the observed crickets in the data table seemed to have a slightly slower rate of temperature change for every unit change in number of chirps. Responses also note that *y*-intercepts for the two models also differ, 40 and 31. Accept other valid responses.	evidence to Claim 4, Modeling, and to Claim 3, Communicating Reasoning
5. Explain the differences between the results of Dolbear's formula and what you see in the observation data for determining the temperature depending on the number of times a cricket chirps. Support your conclusion using four data points. Why do you think these differences could occur?	0–2 Points Full credit is given for noting that in all but one case, Dolbear's formula overestimated the temperature of the observed crickets in the data table. Responses should include the calculating of four data points using Dolbear's formula to support explanation. *(Students may speculate about the discrepancy in Dolbear's formula and the data collected in terms of measurement error, possible different species of crickets, other environmental variables [e.g., humidity], proximity to mating season, other valid response.)*	Contributes evidence to Claim 3, Communicating Reasoning

Relationship between Number of Chirps and Temperature

— Dolbear's Law

• Data Collected

--- Linear (Data Collected)