Grade 11 Performance Task

Thermometer Crickets

1. Classroom Activity
2. Student Task
3. Task Specifications
4. Scoring Rubric

Grade 11 Performance Task

Classroom Activity

Note:

Since performance tasks span different parts of the assessment system (summative, interim, and as part of the digital library of resources), here are some suggestions for turning "Thermometer Crickets" into a rich, classroom-based learning task:

- Use available online resources to explore crickets chirping (e.g., counting chirps in sound clips or using apps designed to perform the calculations).
- Ask students to determine how changing to Celsius would affect the interpretations.
- Collect all of the different formulas available for predicting temperature based on the number of cricket chirps.
    - Discuss similarities and differences. For which values of the independent variable are the different formulas more and less discrepant? (assumes the same variables and measurement units)
    - Seek global understanding of why data can lead to different formulas for the same phenomenon.

Setting the Context

Teacher: "Have you ever heard crickets chirping? When do you tend to hear this? What does it sound like? [Let students respond and share information.]

Teacher: "Interestingly, the speed at which crickets chirp has been found to be related to the temperature. In fact, a number of different people have developed formulas over the years to predict the temperature based on how fast crickets are chirping. In this activity, you will learn more about this relationship."

Teacher: "You will be working in small groups to learn some background information about crickets. Each group will be given a 'cricket fun facts' sheet and a slip of paper with one question about crickets. Your group will have approximately 5 minutes to review the cricket fun facts sheet and to answer your question. Please be prepared to share your findings with the rest of the class."

[As an interim task, students should research the answers to the questions themselves. As a summative task, this information would be contained in a 'cricket fun facts' sheet.]

Grade 11 Performance Task

Building Background Knowledge about Crickets

Questions **in bold** for small groups

- **Only male crickets chirp. Why do they chirp?**
  [Answers below]
  - to attract females
  - to act as a warning to other male crickets to stay out of their territory
  - to warn other male crickets to stay away from their females

- **Crickets chirp primarily at night. Why?**
  [Answers below]
  - Crickets are nocturnal insects.
  - They sometimes eat in the daytime.

- **Male crickets rub their wings, not their legs, to chirp. How do crickets make sounds with their wings?**
  [Answers below]
  - The underside of a male cricket's wing is rough and the top side is contoured differently. When rubbed together, they make a chirping sound.

- **Crickets will not chirp if the temperature is below 40 degrees Fahrenheit (°F) or above 100 degrees Fahrenheit (°F). Why?**
  [Answers below]
  - Crickets do not survive in temperatures below 40°F.
  - Crickets cannot live in temperatures above 100°F.

Data Collection

[Teacher: Show "Number of Chirps Data" to students.]

Teacher: "Look at the table of data that represents the chirping of a snowy tree cricket in two different conditions. In the first section of the table, a male cricket was recorded in a room that had a warm temperature. The same cricket was recorded in a much cooler room, as shown in the second section of the table. Each of the cricket recordings shown here lasted 20 seconds."

Number of Chirps Data

Condition of Cricket	Number of Chirps in Recording 1	Number of Chirps in Recording 2	Number of Chirps in Recording 3	Number of Chirps in Recording 4	Average Number of Chirps in 1 minute
Warm	66	62	65	69	
Cool	40	38	42	39	

Teacher: “Using scratch paper, calculate the average number of chirps in one minute for each condition, using the data in the table shown. Remember that each recording lasted 20 seconds.”

Teacher [after 3 minutes, say]: “Okay time is up, here is the correct response.” [Show this table on the overhead projector.]

Number of Chirps Data

Condition of Cricket	Number of Chirps in Recording 1	Number of Chirps in Recording 2	Number of Chirps in Recording 3	Number of Chirps in Recording 4	Average Number of Chirps in 1 minute
Warm	66	62	65	69	196.50
Cool	40	38	42	39	119.25

Teacher: “What do you notice about the consistency of the data across the different recordings?" [Students should notice that under a specific condition, the data are similar but not identical.] "And what do you notice about the chirping rates of the snowy tree cricket in the two different temperature conditions?”

Teacher: “These kinds of patterns have encouraged many people to try to develop ways of predicting the temperature by measuring the speed of crickets chirping. Now you will work by yourself on an assessment task that allows you to explore the relationship between cricket chirps and temperature in greater detail.”

Grade 11 Performance Task

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°

Grade 11 Performance Task

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?

Grade 11 Performance Task

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.

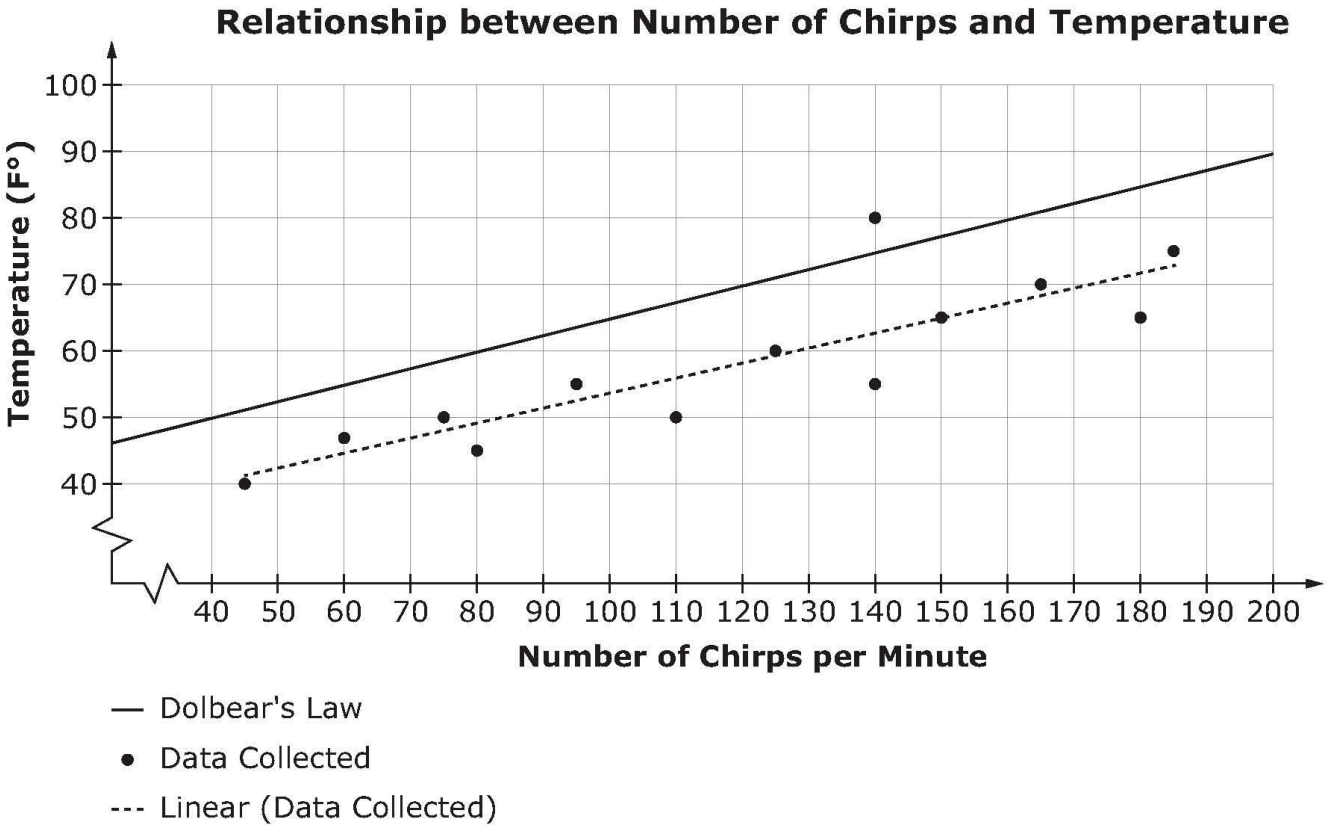
Grade 11 Performance Task

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. 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.	0–4 Points 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.	Contributes 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
Temperature (F°)
100
90
80
70
60
50
40
40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Number of Chirps per Minute
Dolbear's Law
Data Collected
Linear (Data Collected)