The Dangers of Dogs in Hot Cars: Teaching Guide

Introduction

Do you know how quickly your car can reach deadly temperatures for dogs when it's parked in the sun with the windows cracked on a warm day? Your students will know all about this topic after completing this activity. Students will enjoy applying concepts in physics, biology and mathematics to a real-life problem that occurs in virtually every community.

This teaching guide is geared toward fifth grade and is designed to be completed in two class periods. Adaptations for younger and older students are included.

The teaching guide is inspired by the My Dog Is Cool campaign, which aims to reduce needless animal suffering by educating communities about the dangers of leaving dogs in hot cars. Learn more at MyDogIsCool.com.

Contents

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www.RedRover.org/Readers

Objectives and overview

Objectives

Students will understand the following:

- How cars heat up from sunlight
- Why dogs are unable to withstand heat as well as humans can

Overview

This activity is designed to be completed in two to three class periods. During the first class period, students receive an overview of the issue, and then collect and graph data about the rise of temperatures within a car. During the second class period, the students learn why cars heat up the way they do, why dogs cannot withstand heat, and apply what they learned to create a public education message. Creating the public education message can be a separate class period.

Materials

Part 1:

- Means to play an online video with sound
- Access to a car parked in a safe place in sunlight; with ambient outdoor temperatures of at least 65 degrees. The car should begin the experiment with the interior temperature the same as the ambient temperatures. The windows can either be rolled up or cracked a few inches.
  OR
  Model and sunlight: For example, an enclosed glass tank or large jar with black fabric or paper on the bottom side. Do an internet search for "solar ovens" for ideas.
  OR
  Sample data (provided)

- Two thermometers, such as an outdoor thermometer, infrared thermometer or other thermometer available from science dept. Thermometer should measure a range that includes 70 degrees to 120+ degrees, and one thermometer should be able to fit inside car or model.
- Stopwatch, watch or clock that clearly shows minutes
- Handouts: Graph template and colored pens, pencils for each student
  OR

White board or large paper; colored pens to make a graph as a class

Part 2:

- Handouts: biology diagram, instructions (optional)
- Means to show PowerPoint slides (optional)
- Paper, pens, crayons, pencils, etc. to create a poster

Procedures

Part 1 (60 to 90 minutes, including 30 minutes of active instruction time)

Preparation
Before the activity begins, if using a car or model, ensure that the interior of the car/model is approximately the same as the ambient temperatures.

Introduction and video (5 minutes)
Discuss: Have you ever left anything in a hot car that melted or was ruined because of heat, such as a chocolate candy bar? What was it?
Watch video: https://www.youtube.com/watch?v=lu9Og8y4-fI (1:18 minutes)
Discussion questions:

- Explain what you saw in the video. What stood out to you?
- Why do you think this is important?

Experiment (15 minutes of instruction; 40 to 70 minutes of activity)
Instructions (3 to 5 minutes)

- The video showed how quickly cars can heat up when they're parked in the sun.
- Today, we are going to replicate the experiment shown in the video and explore the relationship between heat and time.
- Create hypothesis. Write it together as a class, or have each student write his/her own. Discussion questions:
  - What is our hypothesis of what will happen to the temperatures within the car?
  - What is the temperature outside now?
  - How hot will it get in the car within one hour?
- Create a graph with the following attributes *(see template/example provided)*:
  - Y axis: temperatures, suggest range of 60 to 160 degrees. For example: 60 degrees, 70 degrees, 80 degrees, 90 degrees...
  - X axis: time, suggest range of every 5 to 10 minutes for 60 minutes. For example: 0 minutes, 5 minutes, 10 minutes, 15 minutes...
- Create a table to take notes with the following attributes *(see template/example provided)*:
  - Time, outside temperature, temperature inside car/model
  - Note the conditions of the car, such as whether it is in shade or partial shade, what color it is, and whether the windows are cracked or not.
- Over the course of 60 minutes (or more), divide students into pairs or singles and have teams note the time, inside temperature and outside temperature at even intervals. We suggest intervals of 5 to 10 minutes. Since most heating happens in the first 15 to 30 minutes, shorter intervals will be better. **Note:** Other activities should be planned to take place during data collection.

- Create a line graph with the data: one color for outside temperature and one color for inside temperature. This can be done as a class as the data is collected, as individuals, or as homework.

⇨ *Alternate plan:* If a car or model isn't available, or if the weather isn't cooperating, watch the video then use the sample data provided to create a graph.

Part 2:

Preparation

We suggest doing an Internet search to see if there have been any media reports about recent cases of dogs left in hot cars in your state/area. If so, that may be a useful case study to substitute.

Introduction - Case Study (5 minutes)

Students may read the following aloud for the class:

In April 2013, two cases of dogs left in cars made headlines. In Virginia, a woman parked her car in a shaded area and cracked the windows, and left her seven-year-old cocker spaniel and five-year-old cocker spaniel-poodle mix in the car while she shopped. The outside high temperature that day was 91 degrees, sunny with some clouds. She came back an hour later and saw police officers standing near her car. Unfortunately, both her dogs had died. She was arrested and charged with two counts of animal cruelty.

In Massachusetts, a student at Cape Cod Community College left his golden retriever in the car while he went to class. The police were called to rescue the dog because the dog was heavily panting. Even though it was only around 70 degrees that day and overcast, the temperature inside the car was 106 degrees. The dog was rescued and will be OK. The student was arrested on animal cruelty charges.

Discussion:

- What is your reaction to these stories? What surprised you about these stories?
- What do you know so far about why it's dangerous for dogs to be left in a hot car?

Physics behind heat in cars (5 minutes)

Observation (discussion):

- What do you notice happens when you leave a car in the sun and come back to it?
- What are some variables that could change what happens to the temperature inside a car?
    - Outside temperature: e.g. 95 degrees vs. 75 degrees vs. 30 degrees
    - Shade
    - Windows
    - What else? e.g. color of car

Explanation (refer to Figure 1 or PowerPoint presentation)

- The sun's energy passes through the windshield and is absorbed by the interior of the car, such as the seats and dashboard.
- Light energy turns into heat energy.
- The heat energy is re-radiated from the car's interior, but it cannot pass back through the glass and the car warms up!

Discussion:

- Can you think of anything that uses this physics concept in order to work?
  (Possible answers: greenhouse, solar oven, camping water heater, solar panel)
- Thinking about a car heating up, what are some reasons to explain why cracking the windows does not cool the car very much?

Check in with data (5 minutes)

- Revisit the graph created in Part 1.

Discussion questions:

- What do you notice about the data?
- Does it match the hypothesis that was created? Why or why not?
- How is the data that we collected similar/different from the data collected in the sample study?

Biology (10 minutes)

Discussion:

- Imagine it's hot outside. What happens to your body when it is hot? (sweating)
- What can you do to help your body cool itself when you're too hot?
  (drink water, mist water onto body)
- How do these things work to cool a person's body? (evaporative cooling)
- Evaporative cooling is…
  when water heats up and evaporates into the surrounding air. When water molecules leave a person's skin, they take heat with them.
- Thermoregulation is…
  The physiological process controlling the balance between heat production and heat loss in the body so as to maintain body temperature. This is controlled by part of the brain called the hypothalamus.
- Hyperthermia and hypothermia are…
  Hyperthermia is getting too hot; hypothermia is getting too cold. Both conditions can cause the body to shut down and can even cause death.

Distribute dog biology handout. Fill in the blanks and discuss as desired.

Dogs and humans both have cooling systems. Let's take a look at how they are similar and different.

- What does a dog's body do to cool itself down?
  Panting; sweat glands in feet and ear canals; mechanical process that involves muscles.
- In what ways are dogs and humans similar? In what ways are they different?
- What is surface area?
- How does surface area for cooling compare in dogs and humans?

A dog panting is similar to the way humans sweat, except less efficient. Humans sweat all over their entire body, dogs only "sweat" with their tongues, ear canal and feet.

- How does a hot car feel to a dog?
- How might you know by observing the dog that he is too hot?
- A dog's normal body temperature is about 100.5 degrees. Thinking about the graph that was made and the sample data, how do you know when it is too warm for a dog to be left in a car?

See supplemental teacher information for further information about these concepts.

Discussion (5 minutes)
Engage class in perspective-taking discussion as preparation for the application exercise.

- Based on what we learned today, why is leaving dogs in cars dangerous for the dog?
- With this in mind and thinking about the real-life cases we discussed earlier, why do people still leave their dogs in the car?
- Before this class, did you know how dangerous it is to leave dogs in a car?
- What can people do when they see a dog suffering in a hot car?
- What would you say to someone who is about to leave a dog in a car on a hot day?
- What can this class do to spread the word about this issue?

Exercise (30 minutes)
Instructions: In small groups, students will have the opportunity to choose to create a skit or a poster.

Skit: Create a short (two-minute) skit illustrating a situation that applies the concept of why it is dangerous to leave a dog in a hot car. Idea starters:
A friend is about to leave their dog in the car and you encounter them. What do you say?
A dog owner leaves the dog in a car, thinking that going into the store will only take five minutes. But first they run into an old friend, then the item they came for is out of stock, then the line to purchase the item takes too long…
Be sure to portray the dog's perspective!

Poster: Create a poster advising people not to leave dogs in cars, including why it's important as well as information learned in class to support your point.
If you were looking at posters, what would get your attention?
If you were going to create a poster to put on a store and tell customers not to leave their dogs, what would it say?

Share: After 15 minutes of practice time, ask the class to share their skits and posters with the full group (25 minutes).

⇨ *Alternate options:*

- Have the class choose to either do skits or posters
- Do the skit in class, but assign the poster as homework.
- The exercise portion can also be separated out as its own class period.

Conclusion/Reflection (5 minutes)
- What did you learn about dogs in hot cars?
- Who can you share this with? And why is it important to share?

- If a skit was created, students could share it at a school-wide event.
- If posters were drawn then they could be placed throughout the campus.

Handouts and resources

Visit www.RedRover.org/MDIClesson to download:

- Printable MS Excel sample data sheet and sample graph; blank data sheet and blank graph
- MS PowerPoint presentation

Sample data:

Data point	Time (in minutes since start)	Outside temperature	Inside temperature
1	0	75	75
2	5	75	81
3	10	75	90
4	15	75	94
5	20	76	98
6	25	77	103
7	30	77	105
8	35	77	107
9	40	78	109
10	45	78	110
11	50	78	113
12	55	78	115
13	60	78	117

Time started: 4:30 a.m.

Weather description: sunny, few clouds, blue skies

Car description: Windows down 3 inches, red car

parked without any shade on car

Sample graph:

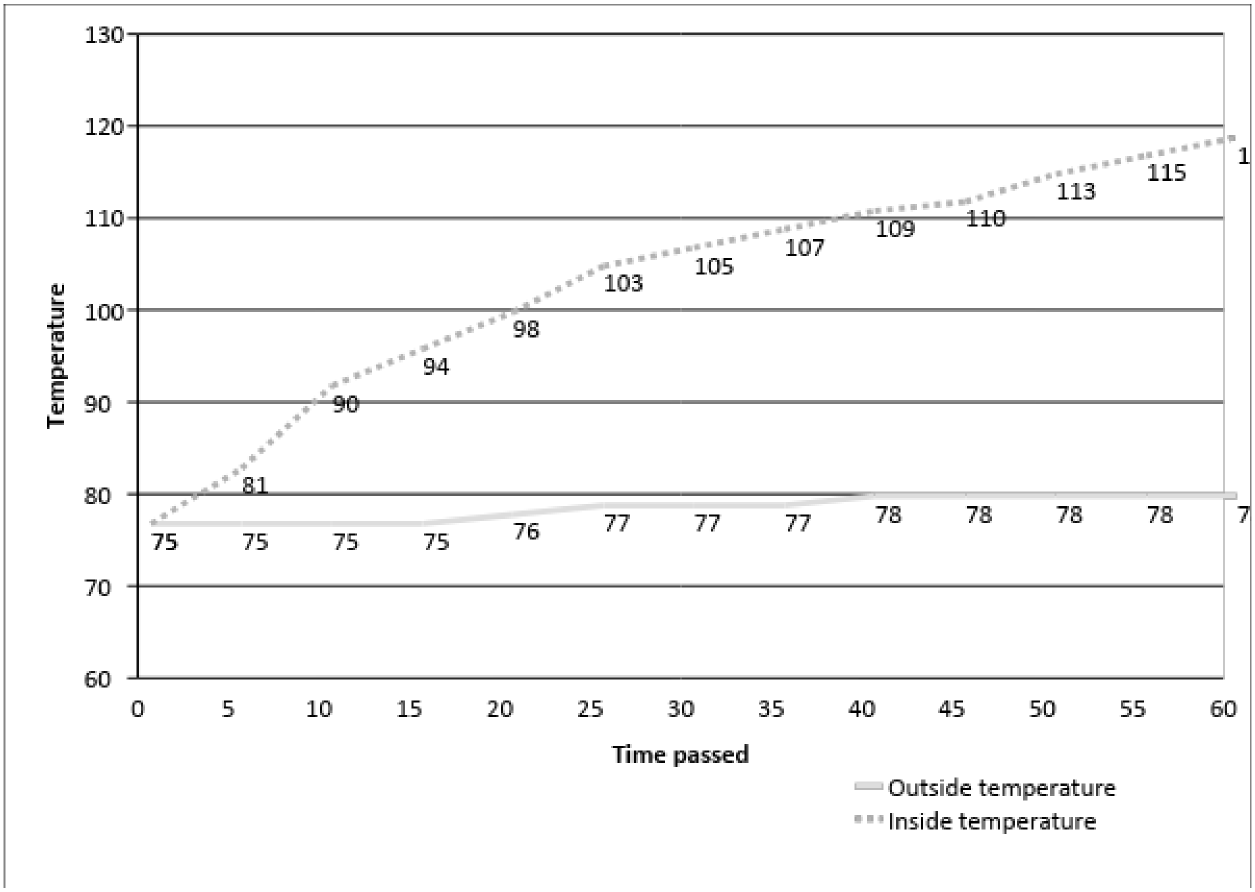


FIGURE 1: ***Cars heat up:***

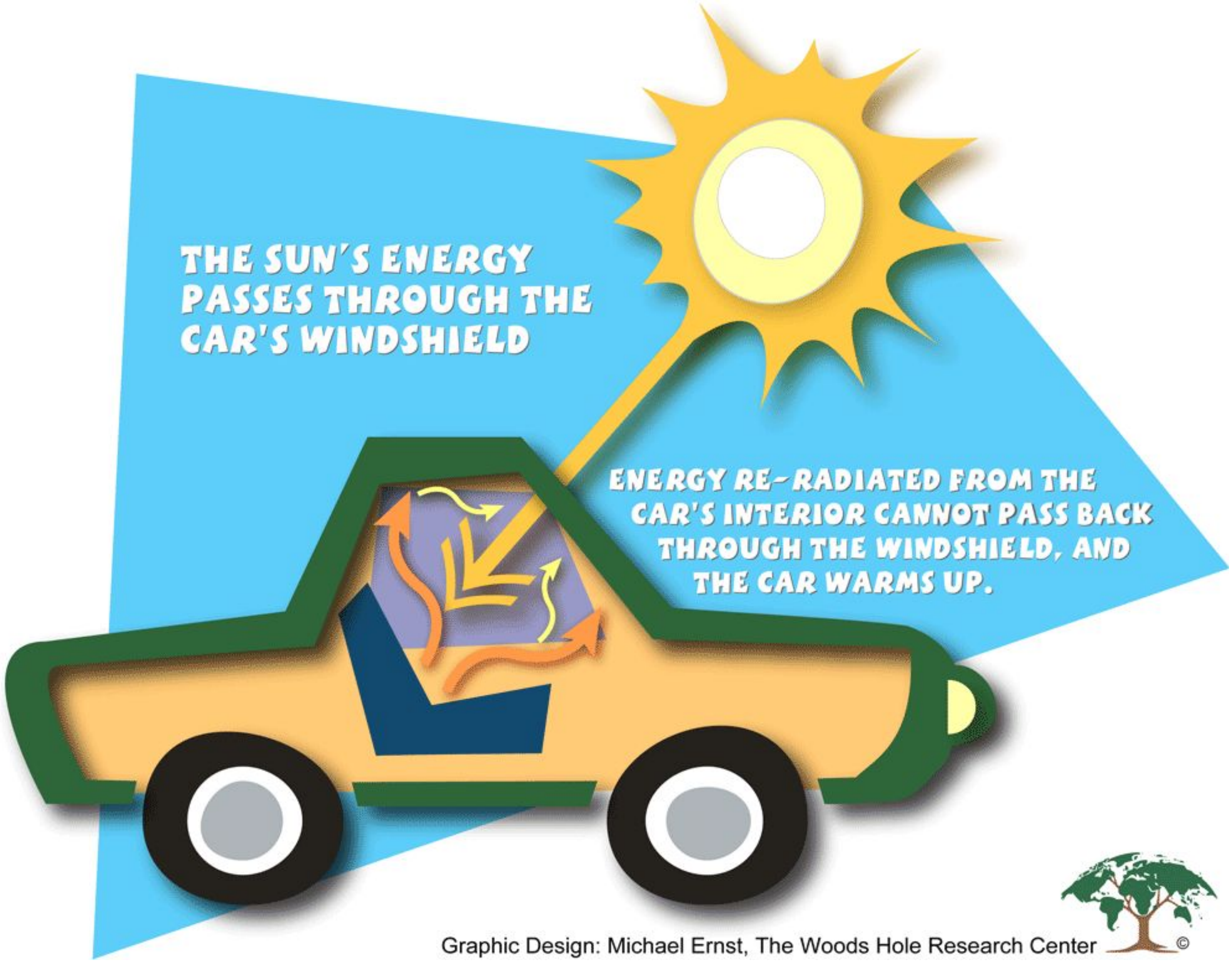
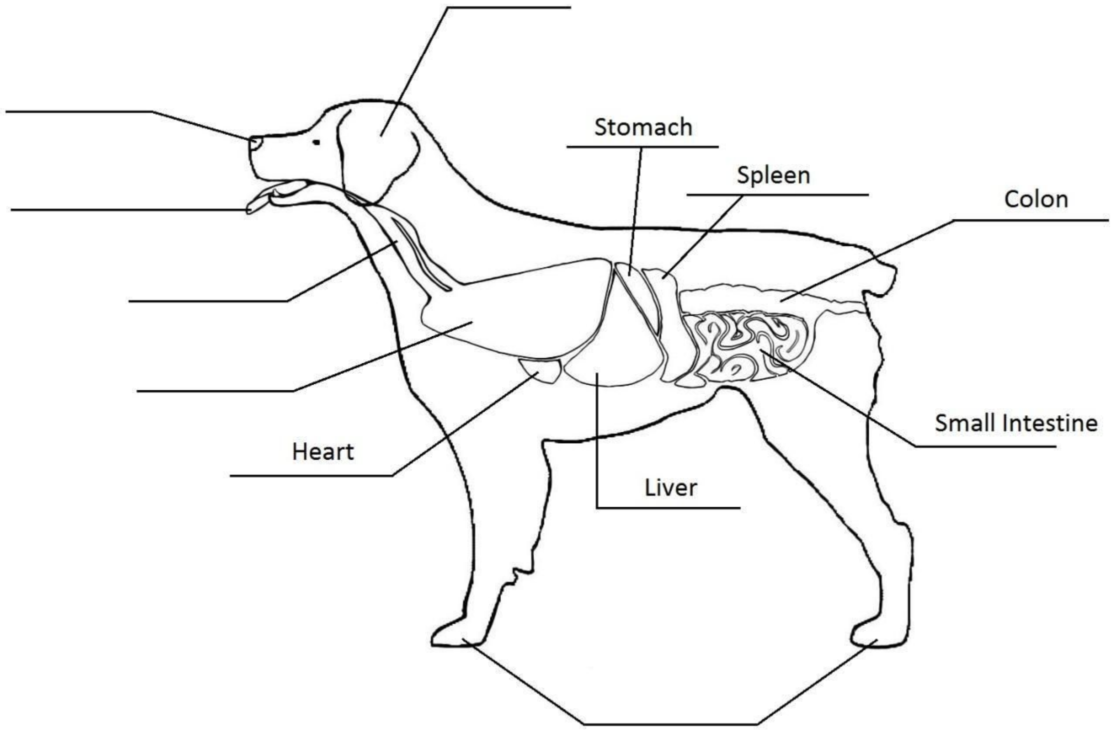
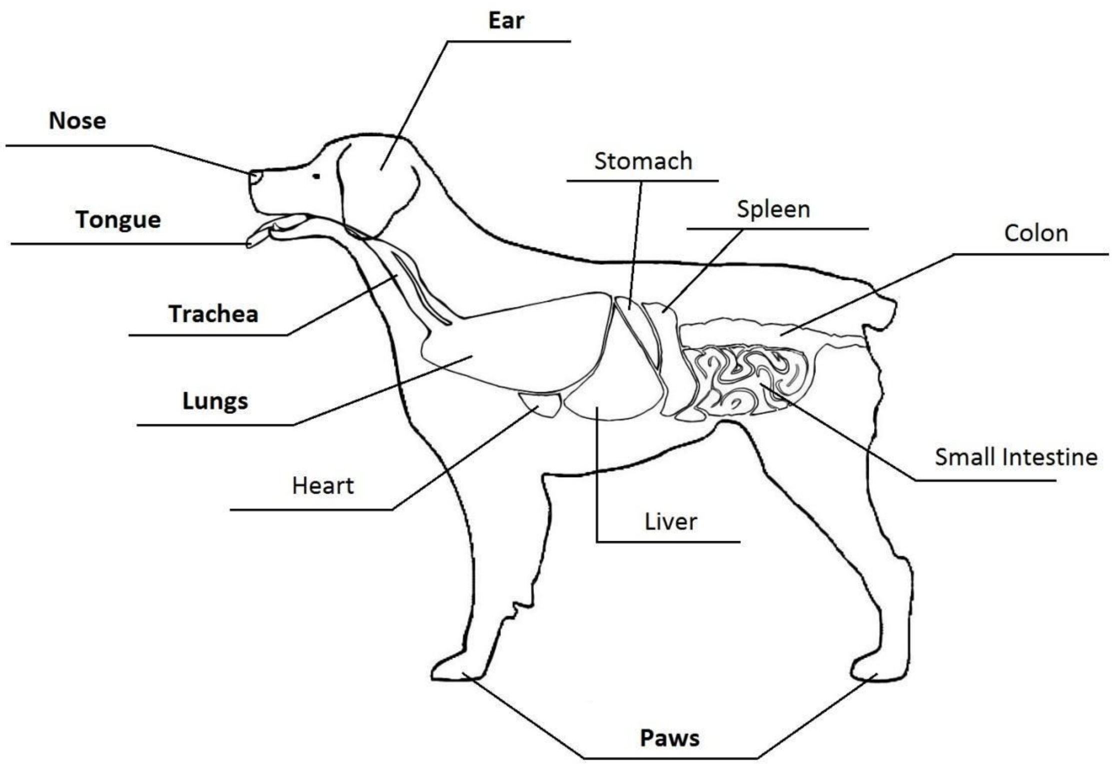


FIGURE 2: ***Dog anatomy handout:***



_____________________ is a term that refers to the body's temperature control system. Dogs have sweat glands located in their _____________________, but these do not help cool the dog very much in very hot temperatures, since these body parts are small compared to the rest of the dog. The main way that dogs cool themselves off is through _____________________. A dog's _____________________ is moist and wide, making it possible for water to _____________________ from its surface, and take heat away with it. When a dog pants, it switches from normal breathing to fast, shallow breathing. This shallow breathing means that the dog is using its muscles to work its _____________________ harder. This increase in muscle use causes the dog's _____________________ to work harder to pump blood to his muscles. Panting, like _____________________ in humans, is a form of _____________________.

FIGURE 2: Dog anatomy – teacher version:



(Thermoregulation) is a term that refers to the body's temperature control system. Dogs have sweat glands located in their (paws and ear canals), but these do not help cool the dog very much in very hot temperatures, since these body parts are small compared to the rest of the dog. The main way that dogs cool themselves off is through (panting). A dog's (tongue) is moist and wide, making it possible for water to (evaporate) from its surface, , and take heat away with it. When a dog pants, it switches from normal breathing to fast, shallow breathing. This shallow breathing means that the dog is using its muscles to work its (lungs) harder. This increase in muscle use causes the dog's (heart) to work harder to pump blood to his muscles. Panting, like (sweating) in humans, is a form of (evaporative cooling).

Adaptations and extensions

- Create a display for the school, showcasing the posters created.
- Create a display in the school's pick-up area using an actual car and stuffed animal dog so that parents picking up students can see the message. Set up a display at a different location off-site, such as a strip mall.
- Invite an animal control officer to visit the classroom to talk about their procedures and the legal aspects of leaving a dog in a hot car.
- Invite a veterinarian to visit the classroom to discuss the physiological aspects of hyperthermia in more detail.
- Expand the data collection experimentation to include different variables, such as windows cracked, closed and fully open; car color; parked in shade versus direct sun; different days with variable weather.
- Write a letter to the editor of a local newspaper about the issue. Find out if your state explicitly makes leaving a dog in a hot car illegal If not, write to your state representatives and ask them to create or amend a law.

Standards

This teaching guide may be used to address the academic standards listed here. These standards are drawn from the Next Generation Science Standards (NGSS) and the Next Generation Science Standards for California Public Schools.

Kindergarten:

From Molecules to Organisms: Structures and Processes

K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.

Earth and Human Activity

K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

First grade:

Earth's Place in the Universe

1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year.

Second grade:

Matter and its Interactions

2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

Third grade:

Heredity: Inheritance and Variation of Traits

3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.

Biological Evolution: Unity and Diversity

3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

Fourth grade:

Energy

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

From Molecules to Organisms: Structures and Processes

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Fifth grade:

Earth's Systems

5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Middle School:

Matter and Its Interactions

MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Waves and Their Applications in Technologies for Information Transfer

MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials

From Molecules to Organisms: Structures and Processes

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Supplementary teacher information

Physics

When a car is parked, the sunlight enters the car through the windshield and most of this heat is absorbed by the seats, floor, and other interior items of the car. Some of this heat then reradiates back into the car, but gets trapped (like in a greenhouse) and heats the air within the car. This causes the car to heat up to 80 percent of its final temperature within the first 10 to 30 minutes of being parked. The other 20 percent comes from temperature fluctuations through the day.

Biology

The thermoregulatory system of dogs is different from that of humans in that dogs can only release heat by panting and by sweat glands in the pads of their feet. Panting is similar to sweating for humans, except that it is a mechanical process for the dog – the dog has to use each breath to expel water vapor, whereas humans just passively release water through our skin. Dogs do not have as efficient of a "sweating" mechanism as humans do; the trachea, lungs, tongue, and nose are very small in proportion to the rest of the dog. Therefore the dog will experience the effects of hyperthermia rapidly.

Dogs left in cars

Two things that people might typically do when they do decide to leave their dog in the car for a quick run into the store are leaving a dish of water out and leaving the window cracked. However, neither of these do anything to help the dog. Because the seats and interior are the main source of heating in the car, cracking the window will be ineffective in allowing heat to release from the car.

A bowl of water will absorb heat similarly to the way that the seats and the rest of the interior will heat up, so the idea that the dog's internal body temperature will cool down by drinking cool water is not realistic. While even warm water can help humans cope with heat because of our profuse ability to sweat, dogs' lack of ability to cool themselves via sweating

Additionally, dogs tend to get agitated as they overheat, and begin to bounce around or struggle for a way out. This further leads to overheating and exhaustion. Their heavy panting will raise the humidity within the car itself, making panting even less efficient as a cooling mechanism.

References

For more in-depth discussion of these topics, please refer to the links below:

Greenhouse effect: How Stuff Works
Evaporative cooling: Prezi.com
Thermoregulation in dogs: Animal cruelty investigation and prosecution; (see Investigation Resources section) New England Animal Control
Thermoregulation in dogs and hyperthermia: Google Answers

Reporting and feedback

Report about your experience with the teaching guide! We want to know how you're using this teaching guide in your classroom. Submit your survey report here: www.surveymonkey.com/s/CDZZQBX

Credits

Jeriel Fountain, Emily Gorrie and Gina Sardo; students at Sacramento State University; Honors 103: Civic Engagement, Service Learning: Pursuing the Public Good

DeAnn Edwards, Fifth Grade Teacher, Barbara Morse Elementary School, Sacramento, California.

Karen Brown, Karly Noel, Susan Robert; RedRover staff

Vehicle heat study: Golden Gate Weather Services
www.ggweather.com/heat/