GENERATIONGENIUS
ALWAYS QUESTION. ALWAYS WONDER.

LESSON PLAN

INTRODUCTION TO CLIMATE CHANGE
GRADES 6-8

SUMMARY

Students will develop and revise a model using data from student-designed investigations that describe unobservable mechanisms that account for the rise in Earth's mean surface temperature.

NEXT GENERATION SCIENCE STANDARDS CORRELATION

MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Science & Engineering Practices	Connections to Classroom Activity
Develop and use a model	• Students will develop an initial model and revise it based on evidence to explain why the air inside of a car gets hotter than the outside air.
Plan and carry out investigations	• Students will collaboratively plan an investigation, identify IV, DV, and controls, determine measurements to make, and how many data are needed to support a claim to answer the focus question, why does air inside of a car get so much hotter than the air outside the car when the car is parked in direct sunlight?
Engage in argument from evidence	• Students will present a written argument supported by empirical evidence from their investigation and scientific reasoning to support a model-based explanation for the greenhouse effect.

Disciplinary Core Ideas	Connections to Classroom Activity
ESS3.D: Global Climate Change Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.	• Students will use the model-based explanation they develop from their investigations to understand how greenhouse gases affect Earth's mean surface temperature.

Cross Cutting Concepts	Connections to Classroom Activity
Systems and system models	• Students will represent the sun-car system and their interactions (inputs – sunlight, processes – energy transfer, transformation, and conservation, and outputs – increased air temperature inside the car) to explain the effect of greenhouse gases on Earth's mean surface temperature.

DURATION

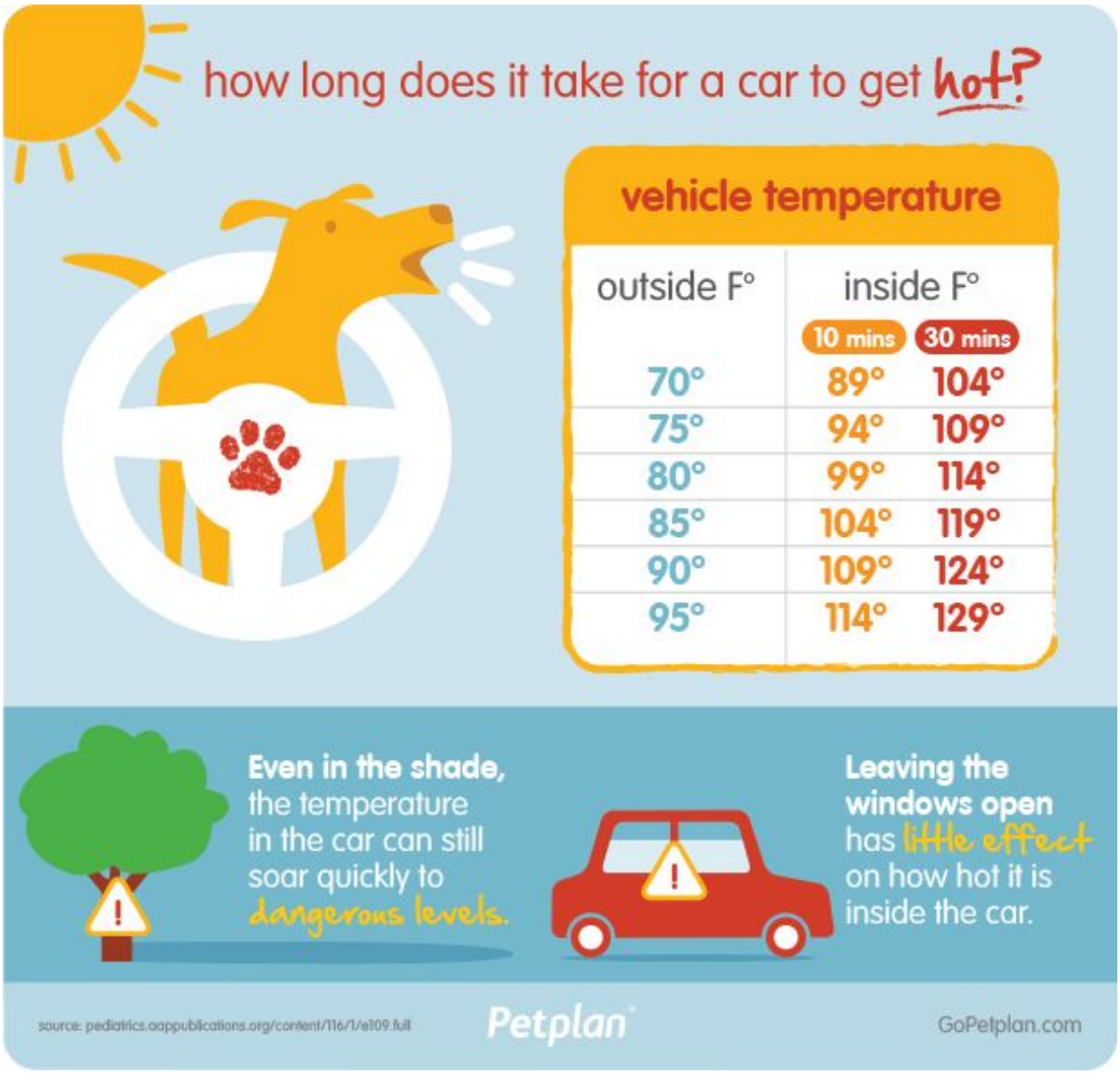
90 minutes

ENGAGE

Show the infographic from Petplan, which has data about rapid increase of the inside temperature in a car left in the sun. Ask students if they have ever experienced how hot a car gets when left in the sun, especially on summer days? Have students develop an initial model to explain this phenomenon. (*See Teacher Tips for support in facilitating model development by students.*) As you circulate, note where students are in their understanding of energy transfer, transformation, and conservation; their ideas about causal agents; and their understanding of scientific models. Lead a quick whole-class discussion of the components of the car–sunlight system (inputs: sunlight; outputs: increased air temperature inside the car; processes: energy transfer, transformation, and conservation) based on their initial models. Post for the class to reference along with the focus question: why does air inside of a car get so much hotter than the air outside the car when the car is parked in direct sunlight?

MATERIALS

- Range of containers (glass jars or food storage tubs with clear lids, plastic food storage tubs with clear lids clear plastic soda bottle with top cut off, clear plastic wrap); enough for each group to have at least four of a kind
- Swatches of fabrics to fit on the bottom of containers (leather, plastic/vinyl, cloth)
- Natural gas (which is mostly methane) from lab stations and plastic tubing
- Thermometers or temperature probes
- Antacid tablets (like Alka-Seltzer)
- Small paper cups
- Water
- Droppers
- Rubber bands
- Clip-on light with 100-watt incandescent bulb (optional, if not sunny)
- Chart paper or white boards
- Sticky notes



EXPLORE

Have students work in small groups of 3–4 to plan an investigation to determine what affects the change in temperature inside the car compared with outside the car when in direct sunlight. Compile a class list of variables that might affect the temperature (e.g., type of light, type of barrier (glass, plastic, tinted), material inside the car (cloth, leather, plastic), components of air inside the car, material car is parked on). Have each small group select one of the variables to test, so that all the variables are tested in an efficient manner. (*See Teacher Tips for support in facilitating investigation planning by students.*)

Have each group photograph or draw their set-up to share with their findings. Have students carry out their investigations and record their data. Note: if it is not sunny on the day of the investigation, then a clip-on light with a 100-watt incandescent bulb can be used as a substitute for the sun.

End of Day 1

Ask a student to state the focus question the class is trying to answer. Refer to the chart of the class's initial ideas and tie to the investigations they have conducted. Provide time for each group to draft their argument to the focus question based on their findings and revisions to their initial model as necessary. Prompt students to include indicators of energy transfers, transformations, and conservation in their model, including those at the microscopic level. Have each group post a chart of their draft argument including their revised model. Students may find using the Engaging in Argument from Evidence organizer helpful for drafting their argument.

Engaging in Argument from Evidence

1 Identify the **Research Question**

2 Provide **Evidence**

3 Make a **Claim**

4 Link claim and evidence with **Reasoning**

5 Identify additional **Research Questions**

Adapted from: Dr. Kate McNeill and Dr. Joe Krajcik and https://argumentdriveninquiry.com/

Conduct a Gallery Walk, so that each group can review the findings and models of all the other groups. Have students use sticky notes to provide feedback, ask questions, and make comments to other groups. Students may find these prompts useful:

- What did the group do to make sure the data collected are reliable? What did they do to decrease measurement error?
- How did the group analyze the data?
- Are there other ways to interpret the data? Is the interpretation of the analysis appropriate?

- How did the group use their findings to revise their model? Are there other considerations that are warranted for their model based on their results? Have they indicated what is occurring at the molecular level?
- What could the group do to increase their confidence in their data and analysis?
- How do this group's findings support your argument?
- What additional questions do you have about the phenomenon?

After the Gallery Walk, lead a class discussion to determine the variables that seemed to affect the rise in temperature inside a car, revisions to a class consensus model, and questions students still have.

WATCH THE GENERATION GENIUS INTRO TO CLIMATE CHANGE VIDEO AS A GROUP

Ask students how investigating the factors that affect the temperature inside a car parked in the sun could help them understand weather and climate on Earth? Utilize the Before Discussion Questions to elicit student understanding of relevant ideas and to prime them for the GG video. Challenge students to gather additional evidence and scientific principles from the GG video that might help them construct a model-based explanation for the phenomenon they are trying to figure out.

After the GG video, use the After Discussion questions to reinforce and clarify ideas about climate change. Provide time for each group to revise their explanation and model using information gleaned from the video. Call on a group to share their explanation and model that answers the lesson's focus question, allowing for other groups to add ideas and clarifications.

ELABORATE

Have students create an Analogy Map comparing their model of the greenhouse effect to the real thing. Discuss the usefulness and limitations of scientific models and how they support our sense-making of phenomena.

EVALUATE

There are multiple ways to assess your students' understanding of this topic. The exit ticket is an opportunity for students to use the science ideas they built in the lesson in a new context. Alternatively, you can use the Kahoot! quiz (which provides downloadable scores at the end of the game) and/or the paper quiz. All these resources are located right below the video in the assessment section.

EXTENSION

Students who demonstrate a more advanced understanding of the greenhouse effect can use The greenhouse effect PHeT simulation to test varying amounts of greenhouse gases in the atmosphere and cloud cover to generate additional evidence to explain the phenomenon of the increased temperature inside the car and relate that to climate change.