Project Overview:

The temperatures inside a car may reach greater than 40° F above the outside ambient temperature within an hour due to the greenhouse effect within the closed car. Unfortunately, pets are often left to "wait" in the car, without the owners fully understanding how quickly temperatures can rise to life threatening temperatures, especially in a car with the windows rolled up on a hot sunny day.

In this TI-Innovator™ project, students will explore the science behind the greenhouse effect and apply their knowledge to design a product to solve a real world problem of pets dying due to owners leaving them in hot cars. They will have to utilize math skills, computer programming and engineering to design and build a "smart" pet alarm system for a model car. A car equipped with a pet alarm could prevent harm to a pet left inside a hot car by taking action to cool the interior and notify the owner of impending pet harm.

Students will accomplish the following Student Tasks as they design a pet car alarm:

- ✓ Students will write and execute "Hello World" program with the intent of introducing the basic skills and knowledge to write a program on the graphing calculator
- ✓ Students experience identifying and writing down the steps in a repeated pattern, physical actions to turn a light on and off repeatedly. Experience with controlling a digital output, blinking an LED. Introduction to For loop as a way to execute a repeated pattern
- ✓ Students complete the blink an LED program. Prepare for Traffic Light Simulation mini-project by introducing COLOR R G B command and discussing primary and secondary colors.
- ✓ Traffic light simulation mini-project. Apply knowledge from previous sessions: outputs, For loop, design before coding.
- ✓ Students learn about inputs from sensors (temperature) and if-then-else decision logic to control an output (sound or color LED) based on the sensor readings.
- ✓ Students extend the solution from previous tasks to apply to the other devices that will be part of the Pet Car Alarm project: including the Hall Effect magnetic proximity sensor, externally connected LED's and continuous servo motor.
- ✓ Given the design challenge, a graphing calculator, a TI-Innovator™ Hub, sensors and outputs; students will design, build and code a solution to the posed challenge. Overall structure of the control program should be part of the design process.
- ✓ Presentations to sell their products. These can be in the form of a traditional presentation or a gallery-walk style to encourage peer review of designs.

Background Science:

Teachers should refer to the science background information covered in the Teacher Resources_PPT and share these additional resources with students as necessary. Resources include links to information on pet health, videos on the greenhouse effect. Web links on these topics can also be found in the Teacher Resource PPT and the resources section below.

Compatible TI Technologies and Materials:

The Pet Alarm project is compatible with the following technologies:

- TI-Nspire™ CX Handhelds (update to OS 4.5), or
- TI-84 Plus CE calculators,(update to OS 5.3) and
- TI-Innovator Hub (sketch vs.1.3) (1 per group of 3-4 students)
- External Battery for TI-Innovator™ Hub (TI accessory)
- *Optional*- TI-Nspire Teacher Software or TI-Connect CE computer software (to lead and guide students through typing code in to the calculators)

In addition to the above TI technology, the following materials are also required, per group of students building the model:

- Hall Effect (magnetic) Sensor
- Temperature Sensor
- * 2 White LEDs
- * Servo Motor
- Plastic "Fashion Doll" Car (~13.1"L x 7.4"W x 6.4"H)
- ¾" Rare Earth Magnetic disk
- Plastic pet toy (size that is appropriate for size of car)
- Plastic (Saran) wrap
- Tape
- Safety Scissors

***Note: If you have already purchased the TI-Innovator™ I/O Pack**, you can use the White LED (only 1 came in that pack, project requires 2) and Continuous Servo Motor that came with the original pack, These items may also be purchased in sensor packs, where 5 sensors of same kind come in a pack. **For more information on the TI-Innovator accessories and how to purchase, visit https://education.ti.com/en/products/micro-controller/ti-innovator?category=accessories**

Recommended Grade Level and Experience:

- This project is appropriate for students in grades 7-12, although at the earlier grade levels, more time may be required to establish an understanding of the underlying science concepts.
- Some prior coding experience is strongly suggested and familiarity with the graphing calculator is a must.
- *The "DIY Mood Ring" project is considered the entry point for the "STEM Projects using TI-Innovator™ Technology". It is strongly suggested that if your students do not have much familiarity with the coding on the TI calculator, they complete the Mood Ring Project first.*

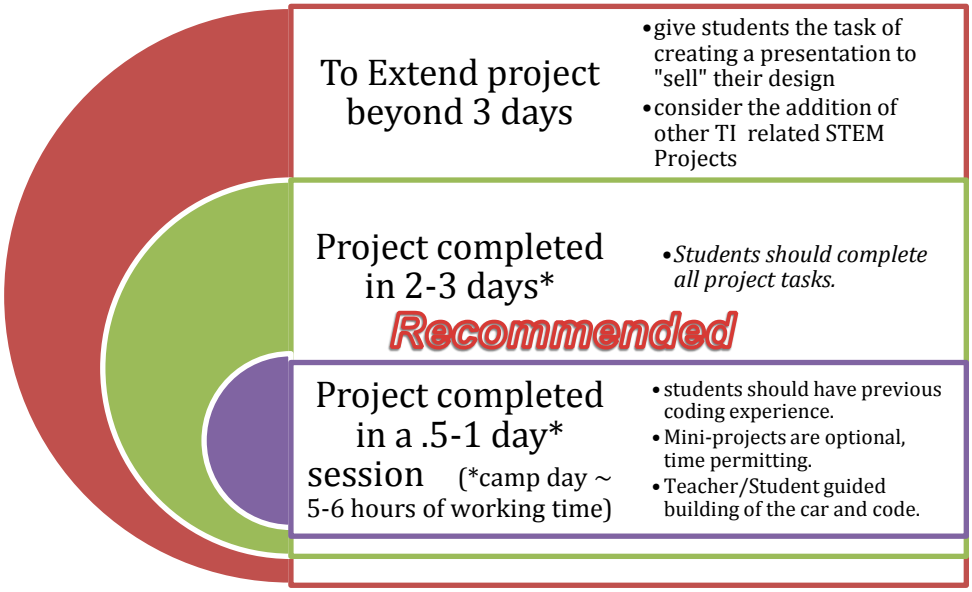
Standards:

NGSS 3-D Standards:

- MS-PS1-4 Matter and its Interactions
  - 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.
- MS-PS3-3 Energy
  - Apply scientific principles to design, construct and test a device that either minimizes or maximizes thermal energy transfer.
- Science and Engineering Practice:
  - Develop a model to predict and/or describe a phenomenon.
- Crosscutting Concepts:
  - Within a natural system, the transfer of energy drives the motion of matter.

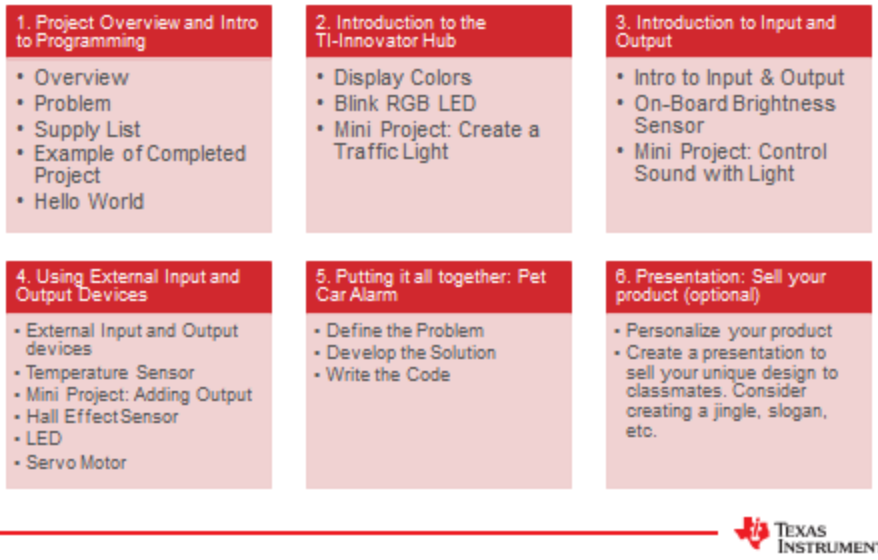
Pacing Guide:

- The project can be adapted for a variety of time lengths and environments including, but not limited to, after school clubs, project-based STEM camps, in-class special projects, etc. If time is an issue, and students do not have much previous experience with coding, you may choose to give them parts of the program(s) to modify and then walk them through the construction.
- *Note: The "DIY Mood Ring" project is considered the entry point for the "STEM Projects using TI-Innovator™ Technology". It is strongly suggested that if your students do not have much familiarity with the coding on the TI calculator, they start with the Mood Ring project first to build coding skills and confidence, and then progress to more complex projects like the Pet Car Alarm, or Smart Water project.*



Project Outline, Description of Student Tasks, and Classroom Presentation:

The following slides have been taken from the **Pet Alarm_Classroom Presentation PPT**. The Classroom Presentation PPT is designed to be used in the classroom/camp to guide students through the tasks they will complete. Although it is strongly recommended that students begin with the introductory project "DIY: Mood Ring", references to the 10 Minutes of Codes lessons that support the coding skills utilized in this project, can be found in the slide notes and below in the outline. *Note that if students have already completed the related STEM projects: DIY: Mood Ring project, and/or the Smart Water project, some of the initial tasks will be familiar to students, but will provide a good opportunity for review of skills.*



1. ***Project Overview and Introduction to Programming***

   Summary: Students are acquainted with the Pet Car Alarm project and a review of the calculator platform and basic coding as students are tasked to create and execute a program to display "Hello World". If students struggle with the initial task, and have not yet completed 10 Minutes of Code lessons previously, it is recommended that they do so before moving forward with this project.

   ✓ Student Task: Write a program that displays "Hello World" on the calculator using the Disp command. *Note that if the student has done the related Mood Ring project, this task will likely be review, and will test their recall of basic coding skills.*

   ✓ If students struggle with the above task, refer students to the following 10 Minutes of Code lessons for review, or to get an introduction to coding before moving forward.
   - **For TI-84 technology: https://education.ti.com/en/activities/ti-codes/84/10-minutes**
     - Unit 1: Program Basics and Displaying on the Screen
       - SB 1: Using Program Editor and Syntax
       - SB 2: Editing the Programs Clearing the Screen
       - SB 3: Output to the Home Screen ***(optional)***
       - Application: Create a Title Screen ***(optional)***

- Unit 3: Conditional Statements (If…)
  - SB 1: Conditions and the If Statements
  - SB 2: If…then…end and compound conditions
  - SB 3: If…then…else statements ***(optional)***
- Unit 4: Repetition
  - SB 1: For…Next…statements

➢ **For TI-Nspire CX technology: https://education.ti.com/en/activities/ti-codes/nspire/10-minutes**

- Unit 1: Program Basics
  - SB 1: Introducing the Program Editor
  - SB 2: Arguments and Expressions
- Unit 3: Conditional Statements
  - SB 1: Request and If
  - SB 2: If… Then… Statements
  - SB 3: If…Then…Else…Statements
- Unit 4: Repetition
  - For…Next…Statements

2. ***Introduction to the TI-Innovator Hub***

Summary: Students are acquainted with the TI-Innovator Hub. Students will create and execute a program using COLOR command to display different colors using the Red-Green-Blue LED, and also write a program to blink the LED.

✓ Student Task: Write a program that explores the different colors produced on the Hub RGB LED by setting the red, green and blue components with the COLOR command.
- Extension: Using a For loop, blink the RGB LED10 times.

✓ Student Task: Mini-Project: Create a Traffic Light.
Write a program to control the COLOR LED to simulate a traffic light using a single bulb by creating a sequence of statements with proper timing controls.
- Extension – add displays to show Walk/Don't Walk, add audible signal for blind.

✓ If students struggle with the above task(s), refer students to the following 10 Minutes of Code lessons for additional review or instruction, before moving forward.

➢ **For TI-84 Plus CE technology**: https://education.ti.com/en/activities/ti-codes/84/10-minutes-innovator

➢ **For TI-Nspire CX technology:** https://education.ti.com/en/activities/ti-codes/nspire/10-minutes-innovator

- Unit 1: Getting Started with TI-Innovator Hub
  - SB 1: Your first program!
  - SB 2: Input and Color
  - SB 3: Request/Input and Sound (optional)
  - Application: Traffic Light (Mini-Project)
- Unit 2: For Loops with TI-Innovator Hub
  - SB 1: Blink the Light
  - SB 2: Loop Through Colors
  - SB 3: Loop through the musical notes (optional**)**

3. ***Introduction to Input and Output***

Summary: Students are acquainted with using the internal Brightness sensor on the Hub as well as using it to trigger the output of sound and/or light.

- ✓ Student Task: Mini-Project: Using what you learned from the example program using the Brightness Sensor, write a program that will use the brightness of the sensor as input to trigger different sounds as output.
  - Extension - Create a function to determine the frequency of the sound that is triggered
- ✓ If students struggle with the above task(s), refer students to the following 10 Minutes of Code lessons for additional review or instruction.
  - ➢ **For TI-84 Plus CE technology**: https://education.ti.com/en/activities/ti-codes/84/10-minutes-innovator
  - ➢ **For TI-Nspire CX technology:** https://education.ti.com/en/activities/ti-codes/nspire/10-minutes-innovator
    - Unit 3: BRIGHTNESS, IF and WHILE with TI-Innovator Hub
      - SB 1: Brightness measurements
      - SB 2: Brightness & Light with IF, WHILE (optional)
      - SB 3: Brightness and Color (optional)
      - Application: Lite Music
        - Note that the Application in this unit is almost identical to the task in the PowerPoint, and can be used alternative for a more step-by-step experience.

4. ***Using External Input and Output Devices***

*Summary: Students are acquainted with using **external** input devices including the temperature sensor and Hall Effect sensor, and output devices including the White LED and Motor.*

- ✓ Student Task: Students learn about inputs from sensors (temperature) and if-then-else decision logic to control an output (sound or color LED) based on the sensor readings.
- ✓ Student Task: Mini Project: Adding Output
  Write a program that controls an output (Sound, Color and/or Disp) when the temperature (input) gets too high
- ✓ Student Task: Write a program to connect and read the values of these additional sensors:
  - Connect and use the Hall Effect sensor.
  - Connect an LED and blink it.
  - Connect a Servo motor and make it spin Counter Clockwise

  *Note that there are currently no 10 Minute of Codes lessons currently on these sensors.

5. ***Putting it all together: The Pet Car Alarm***

Summary: Students are now tasked with assimilating the code snippets and skills, and what they learned in the mini projects, to design a Pet Car Alarm.

- ✓ Student Task: Students use the programming skills they have learned previously, to design and build a Pet Car Alarm using the following multiple sensors and a toy car:
  - Magnetic Proximity Sensor
  - External digital outputs, LED's.
  - External analog outputs, (sweep) servo motor, with External battery
  - Temperature Sensor
    - Extension – Add a sound component. Write a version using a While loop that runs until an alarm is triggered. Add another temperature sensor to represent "outside" of the car temperature

7. ***Presentation: Sell your product! (optional)***

Summary: If time allows, encourage students to get creative, allowing them to customize their products, as well as creating a presentation to "sell it" to their peers. They can consider creating a commercial, jingle, etc. It is always good practice for students to speak in front of their peers, and make a persuasive presentation.

- ✓ Student Task: Have students present their alarms for sale to their classmates, emphasizing the identified problem including the science behind it, and the functionality of how it works.
  - What makes your product unique?
  - How does your product work?
  - Why is it better than the next "safety device" for sale?
  - Consider a unique name for your product, customization, etc.
  - Create a slogan, jingle and/or commercial for your product.

Description of Additional Teaching Resources & Lesson Materials:

Title	File Format	Intended Audience	Description
Pet Alarm Classroom Presentation_Nspire Pet Alarm Classroom Presentation_84CE	PPT	Student	Used by teacher to lead students through the flow of the entire project, and tasks. Designed for classroom presentation.
Pet Alarm_Nspire_Student Pet Alarm_84CE_Student	DOC/ PDF	Student	Student handouts are technology specific and will include sample code snippets for students.
Teacher Notes (you are reading these now!)	PDF	Teacher	Essential guide for teaching the activity.
Pet Alarm Teacher Resources	PPT	Teacher	Additional resources to assist the teacher in preparation to teach the project including sample programs, background content).
Sample Programs	TNS/.8xv	Teacher	Completed programs (“answers” for teacher’s reference

References and Additional Resources

- Read about this problem and watch the animation in the publication from American Veterinary Medical Association cited and linked below.https://www.avma.org/public/PetCare/Pages/pets-in-vehicles.aspx
- US National Weather Service, Heat Safety site: http://www.nws.noaa.gov/om/heat/index.shtml
- Explanation of the Greenhouse effect in relation to cars from the HyperPhysics site at Georgia State University
- http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/grnhse.html
- Explanation of the Greenhouse effect in relation to cars from HOWSTUFFWORKS site.
- http://science.howstuffworks.com/environmental/green-science/global-warming2.htm
- Here is another explanation from a graduate student on the Quora site.
- https://www.quora.com/What-happens-inside-the-when-a-car-is-parked-in-the-hot-sun
- Study reported on by the Arizona Republic Newspaper
- http://www.azcentral.com/story/news/local/arizona-weather/2016/06/16/does-shaded-parking-keep-cars-cooler/85561580/
- NBC News Report from 2011 on automakers and the hot car problem
- http://www.nbcnews.com/storyline/hot-cars-and-kids/death-hot-cars-why-cant-automakers-prevent-danger-n152911
- Heat Strokes in Dogs http://www.petmd.com/dog/conditions/cardiovascular/c_dg_heat_stroke
- Heat Exposure in Children http://www.seattlechildrens.org/medical-conditions/symptom-index/heat-exposure-reactions/

If you are interested in other STEM projects using TI-Innovator, check out these related projects on education.ti.com: