STEM works THINKit

CIRCUITS & HARDWARE

Community Need

Our community needs

Tech Tool Ideas:

Career Connections:

01 DEFINE THE PROBLEM

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

02 GATHER PERTINENT INFO

Gather Pertinent Info

1.

2.

3.

4.

03 GENERATE IDEAS! 04 REFLECT & SELECT! 05 DESIGN SOLUTION! 06 TEST & OPTIMIZE! 07 SHARE & REFLECT!

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CIRCUITS & HARDWARE

CODING

Community Need

Pets can easily get lost and some have even been hit by cars! Some pets overheat or are not warm enough. Pet owners would like a way to see or protect their pet outside so they can be healthy, safe, or easily found.

Tech Tool Ideas:

Conductive Connections
Snap Circuits
Micro:bit
Arduino

Career Connections:

Programmer
Electrician
Electrical Engineer
Machinist

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. Is the invention stationary or wearable?
2. How might your device fit on a pet or be secured to a wall, post, or the ground?
3. Will the device use sound, light, or another kind of energy? If so, what is needed to make a circuit or what is needed for thermal energy transfer?
4. If it is raining, or if a pet needs a bath, does the device need to be waterproof?
5. Can the pet owner easily detach the device?
6. How is your design safe for a pet?
7. How will you market your device to your community?

Unit Extension Ideas

Connect to the NGSS Standards!

Decide on some physical criteria for success and collect data on the physical properties of each design. Students might rate performance by durability, strength, flexibility, hardness, texture, absorbency, etc. Analyze the data to decide on designs best suited for your solution.

2nd

- ❑ **PE:** Matter and Its Interactions: 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
- ❑ **SEP:** Analyzing and Interpreting Data
- ❑ **DCI:** PS1.A: Structure and Properties of Matter
- ❑ **CCC:** Cause and Effect

Challenge students to create a solution that uses heat, light, or sound energy.

4th

- ❑ **PE:** Energy: 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS3.B Conservation of Energy and Energy Transfer, PS3.D Energy in chemical Processes and Everyday Life, **EDP**: ETS1.A: Defining Engineering Problems
- ❑ **CCC:** Energy and Matter

Challenge students to create a solution that uses thermal energy transfer to either heat or cool a pet. Have students think about the pet shipping industry, keeping pets warm in cold areas and cool in warm areas.

6-8

- ❑ **PE:** Energy: MS-PS3-3: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS3.A: Definitions of Energy, PS3.B Conservation of Energy and Energy Transfer, **EDP**: ETS1.A: Defining Engineering Problems, ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Energy and Matter

Challenge students to design a solution for an individual's specific pet, using input from the owner for criteria and constraints. The solution must keep the pet safe and incorporate energy transfer. Students should measure success using quantitative and qualitative evaluation.

9-12

- ❑ **PE:** Energy: HS-PS3-3: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS3.A: Definitions of Energy, PS3.D Energy in Chemical Processes, **EDP**: ETS1.A: Defining and Delimitating an Engineering Problem
- ❑ **CCC:** Energy and Matter

STEM works THINKit

CODING

CIRCUITS & HARDWARE

Community Need

The county fair is coming up and your school is designing and building a parade float. Any animatronics that light up, move or make sounds are especially fun!

Tech Tool Ideas:

Ozobot, Sphero, littleBits, Micro:bit, Makey Makey, Snap Circuits, Arduino

Career Connections:

Machinist
Programmer
Set Designer
Electrical Engineer
Electrician

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. How can you use the tech tools to design movement, sounds, or lights?
2. What materials will make the movement of your animatronics seem more lifelike?
3. Will your animatronics be autonomous or will it be controlled by people riding on the float?
4. How can you use code to control movement?
5. Does your float have a theme or message that you want your community to understand?

Unit Extension Ideas

Connect to the NGSS Standards!

Students design a float with access to the same materials. Discuss the variance in final designs. Encourage students to disassemble their work and recycle their materials to improve/build an alternative solution.

2nd

- ❑ **PE:** Matter and its Interactions: 2-PS1-3: Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS1.A: Structures and Properties of Matter
- ❑ **CCC:** Energy and Matter

Discuss the path of each float design. Can their motion be predicted? Have students explain how they use observation and measurement (distance, direction, or time) to predict the future motion/path of their float. Explain how technology was used to make it predictable or explain why the motion may not be predictable.

3rd

- ❑ **PE:** Motion and Stability: Forces and Interactions: 3-PS2-2: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** PS2.A: Forces and Motion
- ❑ **CCC:** Patterns

Research and discuss electromagnetic trains. Have students use magnets to either make a vehicle move or make an animatronic device that simulates movement using magnets, electrically charged objects, and/or gravity.

6-8

- ❑ **PE:** Motion and Stability: Forces and Interactions: MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** PS2.B: Types of Interactions
- ❑ **CCC:** Cause & Effect

Parade floats travel at a slow speed but people often ride them. If an accident were to occur, design a solution to minimize the risk (impact) during a collision. (This idea may also be extended to solutions that minimize the collision risk of animals riding in truck beds). Be sure to include a method that could be used to systematically collect data that would measure the devices ability to protect against damage!

9-12

- ❑ **PE:** Motion and Stability: Forces and Interactions: HS-PS2-3: Apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
- ❑ **SEP:** Constructing Explanations and Designing Solutions.
- ❑ **DCI:** PS2.A: Forces and Motion, **EDP:** ETS1.A: Defining and Delimitating an Engineering Problem, ETS1.C: Optimizing the Design Solution
- ❑ **CCC:** Cause and Effect

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CIRCUITS & HARDWARE

PROTOTYPE

Community Need

Many buildings do not have air conditioning, but it is also important to save energy. Our homes and stores may need to use alternative energy, increase shade, turn lights off while keeping a fan running, or have improved designs for natural air flow. This helps save energy for our homes and businesses

Tech Tool Ideas:

Snap Circuits
K'NEX Solar Energy
Legos

Career Connections:

Electrician
Electrical Engineer
Landscaper
Solar Installer

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. How can you limit energy use and/or cooling costs?
2. Are there non-electronic ways to save energy and/or keep spaces cooler?
3. What is needed for a circuit?
4. Why do the switches in your house not turn everything off?
5. What is a parallel or series circuit?
6. How will you share your design with the community?

Unit Extension Ideas

Connect to the NGSS Standards!

Observe the effects of the sun on the temperature of objects, including buildings and the air inside rooms. Design a solution to keep buildings or rooms cooler during hot days.

K

- ❑ **PE:** Energy: K-PS3-1: Make observations to determine the effect of sunlight on Earth's surface.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** PS3.B: Conservation of Energy and Energy Transfer
- ❑ **CCC:** Cause and Effect

Did you know that some hotels have lights that shut off when you leave the room? Design, test, and improve a solution that will keep a space cooler by producing motion, sound, or light.

4th

- ❑ **PE:** Energy: 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS3.B: Conservation of Energy and Energy Transfer, PS3.D: Energy in Chemical Processes and Everyday Life,
  EDP: ETS1.A: Defining Engineering Problems
- ❑ **CCC:** Energy and Matter

Energy moves from hotter regions to colder ones. Design a space that would encourage natural air flow, which could also be accelerated by fans, to cool or warm a room.

6-8

- ❑ **PE:** Energy: MS-PS3-3: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS3. A Definitions of Energy, PS3.B Conservation of Energy and Energy Transfer,
  EDP: ETS1.A Defining and Delimitating an Engineering Problem
- ❑ **CCC:** Energy and Matter

Explore small scale local solutions that could be widespread, if effective, for cooling homes and/or saving daily energy use. Evaluate current solutions, then choose one solution to further refine. Explain how it can reduce the impact of human activities on Earth.

9-12

- ❑ **PE:** Earth and Human Activity: HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- ❑ **SEP:** Constructing Explanations and Designing Solutions.
- ❑ **DCI:** ESS3.C: Human Impacts on Earth Systems,
  EDP: ETS1.B Developing Possible Solutions
- ❑ **CCC:** Stability and Change

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CIRCUITS & HARDWARE

PROTOTYPE

Community Need

Many streets are not well lit, but evening is the coolest time of day for exercising. People might walk alone, with pets, or even push strollers. Our community of walkers, bikers, and runners need wearable technology that alerts drivers to their location for safety.

Tech Tool Ideas:

Conductive Connections, Micro:bit, Formcard, Instamorph

Career Connections:

Fashion Designer
Electrician
Inventor

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. How might you alert drivers with light and/or sound?
2. Will designs of certain colors be more effective?
3. Where might the technology be worn or attached? Should it be detachable?
4. Should the device be water resistant?
5. Does the device need to be washable?
6. How will you market your design?

Unit Extension Ideas

Connect to the NGSS Standards!

Using student's designs, explore how their wearable technology illuminates an object and makes that object visible in darkness. The set-up might be observing the design through a pinhole in a box, comparing visibility when off versus on.

1

- ❑ **PE:** Waves and Their Applications in Technologies for Information Transfer: 1-PS4-2. Make observations to construct an evidence-based account that objects in darkness can be seen only when illuminated.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS4.B: Electromagnetic Radiation
- ❑ **CCC:** Cause and Effect

Student's wearable technology design should include the principles of illumination via reflection to make that object visible in darkness. When sharing out, have students explain the scientific principles that make their design visible.

4th

- ❑ **PE:** Waves and Their Applications in Technologies for Information Transfer: 4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
- ❑ **SEP:** Developing and Using Models
- ❑ **DCI:** PS4.B: Electromagnetic Radiation
- ❑ **CCC:** Cause and Effect

Compare materials based on their ability to reflect, absorb, or transmit light (or sound). Using this information, have students design wearable technology devices and explain how their model uses the scientific properties of waves (light and or sound) to work.

6-8

- ❑ **PE:** 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.
- ❑ **SEP:** Developing and Using Models
- ❑ **DCI:** PS4.A: Wave Properties, PS4.B: Electromagnetic Radiation
- ❑ **CCC:** Structure and Function

Explore popular devices used for safety and fitness. Identify and explain how each device uses wave properties and principles to transmit and capture information and energy: chemical processes (battery cells, solar cell energy capture), wave properties (light, sound, digital information sent as wave pulses), and electromagnetic radiation (photoelectric materials emit electrons).

9-12

- ❑ **PE:** Waves and their Applications in Technologies for Information Transfer. HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit, store or capture information and energy.
- ❑ **SEP:** Obtaining, Evaluating, and Communicating Information
- ❑ **DCI:** PS3.D: Energy in Chemical Processes, PS4.A: Wave Properties, PS4.B: Electromagnetic Radiation, PS4.C: Information Technologies and Instrumentation
- ❑ **CCC:** Cause and Effect

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PROTOTYPE

CIRCUITS & HARDWARE

Community Need

Technology changes so fast. Smart devices need to be upgraded often. Often the old device is thrown away and we end up with a lot of waste. New upgraded devices can be expensive. Could there be a more environmentally friendly design?

Tech Tool Ideas:	Career Connections:
Kano	Inventor
Piper	Computer Engineer
Raspberry Pi	Designer

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. Could smart devices be modular?
2. What are the components of a smart device? What pieces are for protection? What is the computer? Where is the software? Should it look beautiful?
3. How will the components of your new smart device connect and work together?
4. How is a smart device connected to and part of the internet of things (IoT)? Is it secure?
5. What will your new design be? (Is it a phone, tablet, or something else?)
6. Will your device save the consumer money?
7. How does your design environmentally friendly?
8. Can you pitch your idea?

Unit Extension Ideas

Connect to the NGSS Standards!

Is owning the newest toy or ordering takeout good for the environment? Where does all our trash go? Students explore how their families may have positive or negative impacts on the environment (land, water, air, and animals). How can we reduce, reuse, recycle, and redesign? For a negative impact, students design and communicate a solution with a model/sketch.

K

- ❑ **PE:** 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.
- ❑ **SEP:** Obtaining, Evaluating, and Communicating Information
- ❑ **DCI:** ESS3.C: Human Impacts on Earth Systems, **EDP:** ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Cause and Effect

Find and compare two similar products that are options for consumers to purchase. Products are rated by their possible impacts on the environment: land, vegetation, streams, ocean, air, and even outer space. Communicate information in a product review.

5th

- ❑ **PE:** Earth and Human Activity: 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- ❑ **SEP:** Obtaining, Evaluating, and Communicating Information
- ❑ **DCI:** ESS3.C: Human Impacts on Earth Systems
- ❑ **CCC:** Systems and System Models

Examine human environmental impacts of pollution caused by consumerism on the air, water, or land. Find a solution that exists. Students then design a plan to monitor the impact of that solution. Explain the proposed method for monitoring and use feedback to improve the method..

6-8

- ❑ **PE:** Earth and Human Activity: MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** ESS3.C: Human Impacts on Earth Systems
- ❑ **CCC:** Cause and Effect

Student evaluate their redesign (or another solution) on how it reduces impacts of human activities on natural systems. Evaluate the solution by its cost, safety, reliability, aesthetics and consider social, cultural, and environmental impacts. For evaluation, students may also consider the local and global impacts of pre-production and materials sourcing such as quantities and types of pollutants released, changes to biomass, species diversity, or areal changes in land surface.

9-12

- ❑ **PE:** Earth and Human Activity: HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- ❑ **SEP:** Science and Engineering Practices
- ❑ **DCI:** ESS3.C: Human Impacts on Earth Systems, **EDP:** ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Stability and Change

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PROTOTYPE

CIRCUITS & HARDWARE

Community Need

New rides are being designed for next year's county fair. The rides, like bumper cars and roller coasters, need to change in both speed and direction. Design for safety! Riders should never fall out of the rides!

Tech Tool Ideas:

Sphero
K'NEX
littleBits

Career Connections:

Civil Engineer
Physicist
Machinist
Programmer

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. What are different kinds of amusement park rides? What makes rides extra fun?
2. How can gravity and ramps help increase or decrease speed?
3. Could a string on a wheel help pull riders up a ramp?
4. What can be used to change the direction of the riders?
5. How can code and/or electronics help to automate the ride?
6. How will you keep riders safe?

Unit Extension Ideas

Connect to the NGSS Standards!

Design a ride with a pull/push or a collision. Build and test parts of the ride. Through observation, draw conclusions about the cause and effect relationships between pushes/pulls or collisions on changes in speed (faster, slower, or stopping) and direction.

K

- ❑ **PE:** Motion and Stability: Forces and Interactions: K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** PS2.A: Forces and Motion, PS2.B: Types of Interactions, PS3.C: Relationship Between Energy and Forces
- ❑ **CCC:** Cause and Effect

When not in motion, gravity pulls objects downward while Earth pushes upward, keeping objects in place. Horizontal forces can move this balanced object. In a bumper car ride, draw unbalanced forces to predict how horizontal forces of different sizes can cause an object to move (or stay put). Using evidence from several trials, design a safety mechanism for bumper car riders when they experience an unbalanced force.

3rd

- ❑ **PE:** PE: Motion and Stability: Forces and Interactions: 3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** PS2.A: Forces and Motion, PS2.B: Types of Interactions
- ❑ **CCC:** Cause and Effect

Engineer a Sphero chariot that can carry mass. For each trial, change the mass of the vehicle being moved with the same code, and measure the distance traveled. Graph mass versus distance and make observations about motion. Infer and diagram the sum and direction of forces acting on the vehicle.

6-8

- ❑ **PE:** Motion and Stability: Forces and Interactions: MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** PS2.A: Forces and Motion
- ❑ **CCC:** Stability and Change

Engineer a device for Sphero to exert force on the mass of an object by pulling or pushing. Using the accelerometer and graph with Sphero, design an experiment to collect data that shows the mathematical relationship: The net force on a macroscopic object is proportional to its mass and its acceleration.

9-12

- ❑ **PE:** HS-PS2-1: Motion and Stability: Forces and Interactions: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
- ❑ **SEP:** Analyzing and Interpreting Data
- ❑ **DCI:** PS2.A: Forces and Motion
- ❑ **CCC:** Cause and Effect

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PROTOTYPE

CIRCUITS & HARDWARE

Community Need

Sometimes there aren't enough pollinators for farming! This might be because there are too many crops to pollinate or there are not enough pollinators due to the effects of pesticides or diseases. Beehives have been rented by the truckload to help pollinate fields of crops, but this is expensive and not always possible. Tools that mimic pollinators of flowers or help to disperse seeds are needed.

Tech Tool Ideas:

Recyclables
K'NEX

Career Connections:

Inventor
Agroecologist

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. What is biomimicry?
2. Is there a local plant that currently struggles with pollination or seed dispersal?
3. Will your tool design focus on pollination or seed dispersal?
4. What parts of a pollinator aid in pollination? Or how are seeds dispersed in nature?
5. Is a certain size or texture of material needed for pollinating or dispersing seeds?
6. Can the same sized tool be used on all flowers or seeds?
7. What specific plant(s) is your tool designed for?

Unit Extension Ideas

Connect to the NGSS Standards!

Diagram and/or build a tool to mimic the function of an animal in dispersing seeds or pollinating plants. Explain and demonstrate how your device is used.

2nd

- ❑ **PE:** Ecosystems: Interactions, Energy, and Dynamics: 2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.
- ❑ **SEP:** Developing and Using Models
- ❑ **DCI:** LS2.A: Interdependent Relationships in Ecosystems; EDP: ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Structure and Function

What will happen to plants if the organisms that pollinate are not healthy, move, or die? Research: What plants need pollinators? Are there plants that would not be affected if pollinators did not survive? What plants do people eat that need pollinators? Students diagram two scenarios and create a list of benefits and drawbacks for each: (1) No pollinators and no solution (2) A solution for pollinators, such as a pollination tool.

3rd

- ❑ **PE:** Biological Evolution: Unity and Diversity: 3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI:** LS2.C: Ecosystem Dynamics, Functioning, and Resilience, LS4.D: Biodiversity and Humans
- ❑ **CCC:** System and System Models

Research the specialized features of plants and animals necessary for pollination and/or seed dispersal that contribute to their probability of reproduction and survival. Explain how the information was used in the solution design. Predict potential impact of the design on organisms.

6-8

- ❑ **PE:** From Molecules to Organisms: Structures and Processes: MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI:** LS1.B: Growth and Development of Organisms
- ❑ **CCC:** Cause and Effect

Attach estimated values (area, volume, number) to quantify the scale of each issue. Then, outline a cause and effect web of relationships of human impact on biodiversity due to our methods of societal food production. Possible issues to computationally explore: human population growth, food surplus and scarcity, monetary needs, soil health, crop rotation, monoculture farming, pesticides, insect health, organic methods, fertilizers, water use, water quality, clear cutting, slash and burn, wildlife corridors, aquifer level, etc. Explore how food production impacts ecosystems and biodiversity.

9-12

- ❑ **PE:** Biological Evolution: Unity and Diversity: HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
- ❑ **SEP:** Using Mathematics and Computational Thinking
- ❑ **DCI:** LS4.C: Adaptation, LS4.D: Biodiversity and Humans
- ❑ **CCC:** Cause and Effect