

K-12 Guam STEM Design Challenge QUESTS,

demonstrating Next Generation Science Standards Performance Expectations

[Folder with all K-12 design challenges](#)

ELEMENTARY

Grade	Design Challenge and Anchor Question	Description	NGSS Performance Expectation with engineering
K	<p>Use different sails to catch the wind</p> <p>How can you design sails for sailboats and windsurfing boards that cause them to sail faster and farther on windy days?</p>	<p>Water activities that use sails to move across the water are common on Guam. When you go to the beach, you might see traditional and competitive proas, large and small sailboats, and windsurfers on their boards.</p> <p>*Design the sail for a boat or board that causes it to sail faster and farther on a windy day. The sails can be different sizes, shapes, and direction to the wind.</p>	<p>K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.*</p>
1 st	<p>Use light to communicate</p> <p>How can you use light to communicate with friends, family, or others nearby when you can't use your voice, a phone, or a written message?</p>	<p>When storms come or power is out, one option is to use light to communicate across distances.</p> <p>*Design a "light language" that uses a flashlight, mirror, or other light source to communicate with a partner from a distance. The distance must be greater than you could use for talking or writing messages.</p>	<p>1-PS4-4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.*</p>
2 nd	<p>Create models of flower pollination or seed dispersal by animals</p> <p>How can you create models to teach others about how an animal helps a plant disperse seeds or how an animal pollinates island flowers?</p>	<p>Some native plants on Guam rely on specific animals to help with pollination and/or seed dispersal. However, many pollinators and seed eaters no longer exist on the island, and some plant populations are decreasing.</p> <p>*Create a model (physical or picture) that mimics how pollination or seed dispersal by animals happens on Guam. Choose between a model of the flower and structure of the animal that helps pollinate the flower OR a model of the seed and how the animals disperse it.</p>	<p>2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*</p>



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3 rd	<p>Create models to teach others about an invasive animal near school</p> <p>How can we create models of an invasive species and the traps being used to control them so we can teach others what they can do to help the native species and stay safe?</p>	<p>Non-native plants and animals can cause severe changes to local environments and affect people’s lives.</p> <p>*Create models of and educational materials about an actual invasive animal seen around the school or community, and the trap or other way being used to control it. Use these models and materials to teach others about how to be a part of current island efforts to reduce the harm done by the animal.</p>	<p>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.*</p>
4 th	<p>Innovative ways to communicate for help</p> <p>Which are the most effective ways to send nonverbal messages asking for help in three different emergency situations?</p>	<p>People can find themselves in a variety of different situations when they need to send out messages for help. With the severe storms on Guam and distances across island, roads can get washed out, and electricity may not be available. Cell phones may not be effective or available solutions.</p> <p>* Select and compare how effective several ways of communicating are in different emergency situations.</p>	<p>4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information.*</p>
5 th	<p>Forecast and prepare for extreme weather on Guam</p> <p>How can we forecast weather patterns around Guam that are changing as the climate changes, and how can we help people prepare for extreme weather events?</p>	<p>Guam is experiencing more extreme weather conditions because of the changing climate. Residents and tourists need to know what to do to be safe in these situations. Different weather instruments are needed to gather the data that are used to create weather and climate models.</p> <p>*Build multiple weather instruments and collect data for a week and compare your results to those provided on Guam weather service sites. Once you have an understanding of the different kinds of data, create a model that illustrates severe weather events that result from weather and climate change, and share this information in a Weather Alert Day report that informs the community about how to respond in an extreme weather condition.</p>	<p>5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.</p> <p>DCI: ESS2.A: Earth Materials and Systems Earth’s major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways ...</p>



MIDDLE SCHOOL

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Physical science	<p>Design a container that keeps food and medicines at safe temperatures</p> <p>How effective are different coolers at keeping perishable foods and medicines at safe temperatures during BBQs and power outages?</p>	<p>Coolers are containers to keep food cool when gathering for picnics on the beach or out in a boat. Sometimes refrigerators stop working during an electrical brownout or severe storms.</p> <p>*Design, build and test a container that will keep food and drinks cold (at a constant temperature) for a specific length of time.</p>	MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*
Life science	<p>Design a school rain garden</p> <p>In areas that flood on school grounds, how can we get rainwater to soak in rather than run off or create big puddles?</p>	<p>In the rainy season so much rain falls that it has no place to go and can create big puddles or flooding, leading to erosion.</p> <p>*Design and create a school-site rain garden using native plants where soil and other sediments allow more water to drain to reduce flooding or erosion.</p>	MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*
Earth/ space science	<p>Reduce beach and ocean plastic pollution</p> <p>How can we help reduce plastic pollution on our beaches and in the ocean around Guam?</p>	<p>The plastic debris is accumulating on the beaches both from on island and from the ocean where it is brought in by the tides. Recycling on Guam is an ongoing issue and plastics in particular. Some islands have banned single-use plastics (plastic straws, bags, and water bottles).</p> <p>*Design a plan to monitor and reduce the plastic debris that is found on our beaches and within our oceans.</p>	MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*



HIGH SCHOOL

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Life science- Biology	<p>Reduce harm from an invasive species after tracking impact in a citizen science project (Version 2)</p> <p>How can we gather data about an invasive species around school that will help us design a project to reduce the harm it is causing our native species?</p>	<p>Create a Guam iNaturalist citizen science project to gather data on one or more of Guam’s invasive species around our school and community. Then use this data to design a project that reduces its harm to native species. This could be removing coral vine (chain of love) that is suffocating native species, participating in (or creating a new) a beekeeping project near school, or setting traps or other control equipment and procedures with island experts.</p>	<ul style="list-style-type: none"> ● HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* ● HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
Life science- Biology	<p>Design an invasive species game (Version 1)</p> <p>How is our island being impacted by non-native invasive species?</p>	<p>Design an interactive game that teaches students about the impacts of one or more invasive species on Guam’s environment, plants, people, and other animals. Once you have completed your game, teach and facilitate playing the game with younger students or community members. Encouraged extension: Participate in a project or other solution to reduce the impact of an invasive species.</p>	<p>HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*</p>
Life science- Biology	<p>Mitigate Impacts of Island Development and Deforestation by Increasing Native Plants</p> <p>How can we help increase our native species and ecosystem biodiversity that are threatened by island development, deforestation, and invasive species?</p>	<p>Use the iNaturalist and SEEK apps to gather baseline data on the number and diversity of native and invasive plant and animal species on school or near school grounds. Based on the data and other expert advice, you can choose a project to try to increase native plant numbers and diversity by designing a place to plant native plant on or near school grounds, remove an invasive plant or animal species (coral vine/chain of love or an animal species), or work with a local business, park, government, or homeowners to help them increase native species, reduce harm from development or deforesting land.</p>	<ul style="list-style-type: none"> ● HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. ● LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

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Life science-Biology Earth science Marine science	<p>Design and grow a seagrass nursery to help restore ocean beds around Guam</p> <p>How can we increase seagrass in the ocean around Guam to reduce the impacts of climate change by absorbing and storing carbon dioxide from the ocean water, and to create wildlife habitat?</p>	<p>Design a nursery to grow seagrass found in the ocean around Guam. Work with local experts to collect and grow the seagrass, and to transplant the new plants into the oceans to help restore declining seagrass beds that are home to many animals and are carbon absorbers to reduce climate change.</p>	<p>HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.</p> <p>HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.</p> <p>HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. [a natural extension]</p>
Earth/space science	<p>Evaluate the help-harm balance of sunscreen to people and Guam’s coral reef ecosystem</p> <p>Understanding that the sun can be both beneficial and harmful, what are the risks and benefits of using different sunscreens to people, and to our coral reefs and other marine life?</p>	<p>Evaluate which of the locally available sunscreens are the most effective to prevent people from getting sunburned but not damaging to the local and marine environments. Create a solution in the form of a technology-generated media campaign to encourage tourists and residents to use reef-safe sunscreen. (examples: social media post, infographic, signs for stores or hotels, app, video public service announcements, interviews on local news outlets, write and record a song, etc.)</p>	<p>HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*</p>
Earth Science Physical science Marine science	<p>Build Buoys and Interpret Data from Drift Buoys in the Pacific Ocean</p> <p>What are ocean buoys telling us about water in the Pacific Ocean near Guam? How can we build a buoy to mark a location or to collect data about an island water source?</p>	<ul style="list-style-type: none"> ● Build a marker and/or a drifting buoy that you could launch in an island water source (river, lake, ocean close to shore) to collect data or mark a location, and/or build a marker buoy with plastic bottles ● Analyze data from buoys monitored by NOAA’s National Data Buoy Center 	<ul style="list-style-type: none"> ● HS-ESS2-2: Analyze tools and technologies in order to make valid and reliable scientific claims. ● HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth’s materials. ● HS-ESS3-6: Use computational representations of phenomena to support claims or explanations. ● HS-PS4-2: Evaluate questions about the advantages of using digital transmission and storage of information.

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Physical science	Design a crash-safe car How can safety features in cars reduce driver and passenger injuries by minimizing the forces of a collision?	Design, build, and test how well different car designs hold up in different kinds of crashes (head-to-head, read-end, t-boned) and the passengers sustain little or no injuries.	HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.*
Physical science	Design Technology Powered by Solar Energy How can we use the energy of the sun to power devices that are important to our everyday lives?	Design a solar battery charger that will allow people to power and charge everyday devices that are portable, durable, and efficient.	<ul style="list-style-type: none"> ● 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.* ● HS-PS4-5. Photoelectric materials emit electrons when they absorb light of a high-enough frequency.
Physical science	Design More Protective Sunglasses How can we design more effective sunglasses to protect our eyes from UV radiation?	You are newly hired engineers at the Guam Vision Company that specializes in the development of sunglasses. You and your group have on the counter in front of you the company's current model that needs to be updated to meet changing customer needs of living on a tropical island. Through surveys, we have found that our customers want the light intensity and glare to be further reduced as well as increased attenuation of UVA and UVB radiation. At the end of this challenge, you will present your sunglasses in the form of an advertisement to sell your product.	<ul style="list-style-type: none"> ● HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media ● HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. ● HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.



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