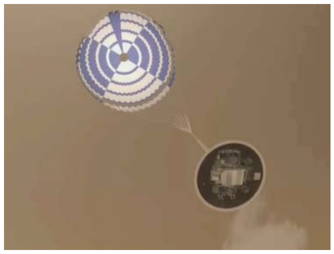
CURIOUSITY PARACHUTE DEPLOYMENT SYSTEM DESIGN BRIEF



NGSS:
- MS-ETS-ED (c), (e), and (f)
- HS-ETS-ED (b) and (d)

Context: In the real world, parachutes are designed with a specific payload or application in mind. Designers must consider payload weight, payload characteristics and drop conditions, as well as draw upon previous experiences and studies to create a successful parachute.

Need: In order for the Curiosity to safely land on Mars, it will use a parachute deployment system. You need to design a parachute that will protect Curiosity as it descends in the Martian atmosphere from the designated drop zone.

Specifications: the parachute must:

1. be made from a non-flammable material,
2. withstand temperatures from 0ºC to 100ºC, and
3. deliver the provided NASA payload of 200g without damaging it from a height of 2m.

During the design process, you must:

1. design, sketch, construct, and evaluate at least 2 prototypes,
2. record your evaluation data, and
3. write a statement that justifies, using your data, the prototype selected for final testing.

Resources:

People: You be working with your teammates as Parachute Engineers and Quality Control Specialists.

Tools/Machines/Materials: You may use any tool/machine/material available in the lab. All materials are specially coated to withstand the specified temperatures and are non-flammable.

Time: Your group has 45 minutes to design, test, and perfect your parachute deployment system.

Adapted from http://www.bc.k12.pa.us/science_technology/Technology/3.6/Para%20Design%20ppdb.htm

Evaluation:

	Exceeds	**Meets**	**Does Not Meet**
Design			
Prototypes	More than 2	2	1
Sketch		Both accurately reflect the prototype designs	Either one or neither accurately reflect the prototype designs
Materials		Non-flammable	Flammable
Data		Accurately and completely recorded	Inaccurately and/or incompletely recorded
Justification		Presents a clear reason for the prototype selected and is based on the data collected	The reason is not clear, the selection is not based on the data collected, no supporting data is included, and/or no statement is included
Performance			
Temperature Range	Withstands less than 0ºC and/or more than 100ºC	Withstands 0ºC and 100ºC	Does not withstand 0ºC and/or 100ºC
Payload Damage	No visible damage	Surface <5% marred	Surface >5% marred

Context/Challenge:
To minimize costs, project managers have decided to build a desalination facility on the Virginia Oceanographic Research Center (VORC) in order to provide all the fresh water the scientists will need for drinking, cooking, and other personal needs.

Criteria/Specification:
Design a desalination apparatus that produces a minimum of 20 mL of fresh water in 30 minutes.

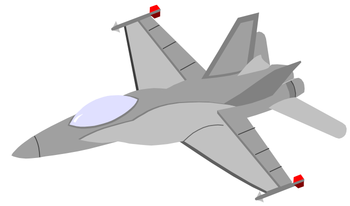
Resources:

Materials – hot plates, glass containers, tubing, various other supplies

Time – 1.5 hours to design, test, evaluate, modify, and retest

Evaluation:

	Fully Meets	Partially Meets	Does Not Meet
Amount of Fresh Water	Produces ≥ 20 mL of fresh water in 20 minutes	Produces <20 mL of fresh water in 20 minutes	Does not produce any fresh water in 20 minutes
Data	Complete, accurate data are collected	Accurate data are collected	No OR inaccurate data are collected
Sketch	Detailed, labeled sketch that accurately represents the design	Sketch that accurately reflects the design	Inaccurate OR no sketch
Explanation	Complete, accurate explanation of why the design works	Accurate explanation of why the design works	Inaccurate OR no explanation of why the design works



DESIGN PROTOTYPE: FLIGHT DISTANCE

Context: Over the years, people such as Orville and Wilbur Wright have attempted to solve the mysteries of flight.

Need: As part of the design process people have built small-scale models which they have attempted to fly. They have experimented with the notion that a flying machine may be made by folding a piece of paper at various angles.

Design Brief: Design and construct a flying vehicle that is capable of unassisted flight over a distance of 10 meters.

Specifications

1. The vehicle will only consist of one piece of 216 mm by 279 mm paper.
2. The flying vehicle must be capable of unassisted flight over a distance of 10 meters.
3. Thrust will be provided by one hand.
4. The vehicle may not land directly on its "nose" or upside down.
5. Designers will be given three attempts at the designated time to achieve the desired results.

Resources

People: You will work by yourself as the designer, fabricator, and evaluator.

Tools/Machines: There are no tools or machines available to work with.

Materials: One piece of 216 mm by 279 mm (8 1/2" by 11") paper.

Energy: You may use the energy generated by your prolific brain cells and the thrust provided by one hand.

Capital: You have absolutely no capital (money) to work with.

Time: You have the remainder of this science class and the first 15 minutes of the next science class to design, construct, evaluate, redesign, evaluate, etc. your vehicle prior to the scheduled performance test.

Reporting: In your science notebook, put your best working model and drawings of successful and unsuccessful designs. Explain why the different models worked and didn’t work.

Parachute Design Brief

Context/Challenge: The design of a parachute is very important, especially in an extreme sport such as skydiving because someone's life is dependent on the parachute functioning correctly. Engineers thoroughly test the materials and designs of parachutes to ensure that they open as intended and reliably, and are strong enough to withstand the air resistance needed to slow skydivers to safe landing speeds. **You are going to jump out of a plane 10,000 feet in the air. What type of material do you want your parachute to be made of and what size do you want it to be?**

Criteria/Specification: You are tasked with determining the best type of material and size of parachute needed to aid "a person" in landing safely on the ground from a height of 2 meters. The parachute must:

1. Show good craftsmanship and creativity,
2. Fall slowly to the ground, and
3. The person must land gently.

During the design process, you must:

1. Design, sketch, construct, and evaluate at least 2 prototypes,
2. Record your evaluation data, and
3. Write a statement that justifies, using your data, the prototype selected for final testing.

Resources:

Materials: Tissue paper, napkins, construction paper, newspaper, paper towels, string, fishing wire, weights

Tools: Scissors, tape

Time: You have 25 minutes to design, test, and perfect your parachute deployment system.

Evaluation:

Criteria	Advanced (4)	Proficient (3)	Developing (2)	Beginning (1)
Design	Student sketched the design and construction shows good craftsmanship and creativity.	Student sketched the design and the parachute is constructed well.	Student did not sketch the design and/or the parachute does not work.	Student did not sketch the design and the parachute is not constructed.
Data	Parachute falls very slowly to the ground and lands gently. Data is recorded.	Parachute falls gently to the ground. Data is recorded.	Parachute falls quickly to the ground. Data is recorded.	Parachute not tested. Data is not recorded.
Redesign	Student creates a second parachute that works much better than the first one.	Student creates a parachute that works slightly better than the first one.	Student is unsuccessful in improving their original design.	Student does not attempt to improve original design.
Justification	Student's justification is clearly reasoned and based on data.	Student's justification is based on data.	Student's justification is not clear or is not based on data.	Student does not write a justification.
Teacher Comments:				

Adapted from:
https://www.teachengineering.org/view_activity.php?url=collection/wpi_/activities/wpi_design_a_parachute/design_a_parachute.xml

Platform Design Brief

Context and Need:
The scientists will need to make long-term observations of plant and animal marine life to get the answers to their research questions. Limitations on diving time due to decompression problems make this impossible in many cases. By living and working underwater, the scientists will be able to have as much time as they need to make their observations. Still, living and/or working underwater is not a simple task, but designing a safe, convenient environment can solve many of these problems.

The self-sustaining research station to be built off the coast of Virginia will require a platform to serve as the foundation for the structure. The platform has to be able to withstand the movement of sediment and the water and not collapse, thus, losing or damaging the payload. This offshore platform can be a fixed or floating, underwater, partially underwater, or above the water structure.

Challenge:
Construct a platform to serve as the foundation for the research station.

Criteria:
The platform must:

- be no larger than 30.5 cm x 25.4 cm x 30.5 cm; and no smaller than 15 cm x 13 cm x 15 cm
- be able to hold a designated payload of 10 golf balls;
- be able to withstand the movement of sediment and water simulated in the tank and not collapse, for 2 minutes; and
- be constructed with only the materials and tools provided.

During the engineering design process,

1. Complete a detailed design and sketch before constructing your model
2. Test, evaluate, and improve your model within the allotted time (remember to sketch each iteration of your model)
3. Record your data
4. Present a final design solution, justifying your selection **based on the data collected**

Resources:

People:
You will be working with your teammates as Platform Engineers and Quality Control Specialists.

Tools/Machines
Glue gun
Payload (golf balls)
Metric ruler (one per group)

Materials:
Straws (limit 5)
Coffee stirrers (limit 5)
Craft sticks (limit 5)
Plastic building sticks (e.g., Mod-L-Stix)
Pipe cleaners (limit 5)
Plastic bottles (limit 2)
Styrofoam plates, egg cartons and cups
Plastic cups
Glue for glue gun (one per group)
Glue sticks (one per group)
Craft wire (one 10 cm. length per group)
Washers
Nuts and bolts
Paper and binder clips
PVC elbows and various length sections
Frisbee (limit one per group)
Cable ties (limit 5)
Pool noodle sections (pre-cut) – limit 4
Cardboard
Safety pins
Roll of duct tape (one per group)

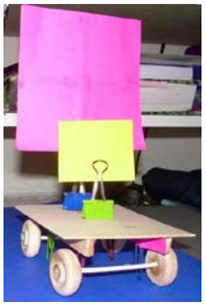
Time:
Your group has 45 minutes to design, test, and redesign and retest your platform.

<u>Evaluation</u>: This rubric will be used to evaluate your design

Specifications	Meets	Partially meets criteria	Does Not Meet
Sketch	Accurately reflects the model design	Partially reflects the model design	Does not accurately reflect the model design
Data	Accurately and completely recorded	Incompletely recorded	Inaccurately recorded
Time	Fully completed within the designated timeframe	Design was tested but there was not time for redesign and retesting	Not completed within designated time frame and not tested
Justification	Presents a clear reason for the model selected and is based on the data collected	The reason for the model selection is not clear and the selection is not supported by the data collected.	The reason for model selection is not provided, and the selection is not based on the data collected or no supporting data is included
Dimensions	Within specified dimensions		Outside specified dimensions
Payload	Holds target payload	Holds partial target payload	Does not hold target payload
Sediment and Water Movement	Structure does not collapse with sediment and water movement	Structure partially collapses with sediment and water movement	Structure fully collapses with sediment and water movement

Standards of Learning:
Science – 5.1, 5.5, 5.6, 5.7
English- 5.1, 5.2, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9
Mathematics – 5.4, 5.5, 5.6, 5.8, 5.10, 5.11, 5.14, 5.15

Wind-powered Hybrid Vehicle DESIGN BRIEF



Context: In the real world, electric cars are used to transport people and cargo.

www.youtube.com/watch?v=MCDPl6Woyfc

Need: In the event of no electricity how can you modify an electric car to harness the power of the wind? You will design a wind-powered hybrid vehicle to deliver a designed cargo to a destination.

Specifications: the wind-powered car must:

1. be constructed with the materials provided
2. deliver the provided cargo safely, undamaged to a destination
3. deliver the cargo within 5 minutes

During the engineering design process, you must:

1. complete a detailed design, sketch and construct a model
2. test, evaluate and improve your model within the allotted time
3. record your data
4. present a design solution

Resources:

People: You be working with your teammates as Wind-Powered Hybrid Vehicle Engineers and Quality Control Specialists.

Tools/Machines/Materials: You may use any tool/machine/material provided.

Time: Your group has 45 minutes to design, test, and perfect your hybrid vehicle.

Materials:

Cardboard	Q-tips or Small Wooden Dowels
Popsicle Sticks	Plastic Bags
Paper Clips	Hot Glue Gun/Glue
Small Binder Clips	Masking Tape
Construction Paper	Wheels

Evaluation:

	Meets	**Does Not Meet**
Sketch	Accurately reflect the model design	Does not accurately reflect the model design
Data	Accurately and completely recorded	Inaccurately and/or incompletely recorded
Justification	Presents a clear reason for the model selected and is based on the data collected	The reason is not clear, the selection is not based on the data collected, no supporting data is included, and/or no statement is included
Delivery of payload	Delivers to destination	Does not deliver to destination
Payload Damage	Payload is not damaged	Payload is damaged

VISTA

Adapted from http://austinkids.files.wordpress.com/2009/10/sailing_cart_instructions1.pdf and *Science Scope*, Feb. 2013,Vol. 36, Integrating Science and Engineering Practices in An Inquiry-Based Lesson on Wind-Powered Cars, page 54