SCIENCE 3D

BATTLE DEEP: SPERM WHALES

In this packet, sample student answers are provided in red and notes to teachers are in blue.

In the **STEM Project**, students will investigate the role of technology in science. They will define criteria and constraints required for sperm whale research and design solutions to help scientists put cameras on animals.

ACTIVITY I: SCIENCE AND ENGINEERING

Engineers often borrow designs from nature. The cameras attached to the sperm whales mimic the suction abilities of remoras, fish that can attach themselves to big fish and whales with suction-cup-like heads.

1. **Compare** and **contrast** the echolocation abilities of sperm whales and the sonar the team uses to measure sperm whale prey. Use online resources, lessons from the **Mission Video**, and the **Mission Reader** to help you.

Possible answers include:

Both make sounds that bounce off objects in the environment and use these echoes to create a "picture."

The sonar uses a computer to make a picture from the sound. In a sperm whale, this is done in the brain.

2. Think of different organisms you know about. Pick one, and **describe** how its abilities or features could be used by engineers to make a product or solve a design challenge.

Good answers should include a well-considered definition of the problem that is being solved, such as: Developing a swimsuit that slips through the water more efficiently.

They should also describe the organism and how its traits could be used. For example: Sharks have skin with scales that helps them move through the water. Using the shape and arrangement of the scales, I could design a swimsuit with a similar covering.

ACTIVITY 2: DEFINING THE PROBLEM

We recommend having students work in small groups to develop the list of criteria and constraints. Once students have completed their lists, have them present to the entire class and update their own lists. For the design solutions, students could create posters or PowerPoint presentations to share with the class.

To observe how sperm whales behave underwater, the team attaches cameras to the sperm whales. To develop these cameras, the engineers and scientists together define the problem and come up with a successful design. This is the *criteria*. The engineer then has to assess the limitations of the design. These are the *constraints*. But attaching a camera to a sperm whale may not be the only way to film sperm whale foraging at depth. After all, the team only caught a glimpse of a squid in the mouth of a whale. Time to get creative and dream up some new engineering solutions for the team!

1. **Write** several sentences to define the engineering challenges in getting video of sperm whales attacking giant squid.

The team needs to figure out how to build camera systems that can survive crushing depths of the ocean, gather video where there is no light, keep up with – or stay attached to – a fast and slippery whale, and retrieve the footage. The video also has to be able to run long enough to capture foraging events that are not very frequent.

2. Think about all the things the camera systems need to do. List the design criteria and constraints below. Consider the sperm whales diving condition.

Criteria:

Possible answers may vary widely but could include:

- must record enough video to see foraging
- must be attached to an animal and stay attached until it is time to release
- must be retrieved
- must survive crushing depths
- must record video in near-darkness
- must follow an animal long enough to see foraging
- must keep up with an animal
- must not disrupt normal feeding behavior

Constraints:

Possible answers may vary based on the engineering solution but may include:

- cannot be too large for animal
- cannot be too heavy to deploy on animals
- cannot be too expensive
- cannot consume too much power

3. Use the space below to describe your proposed solution. Include a general description and a drawing of the solution with labels that point out key features that are critical to its success.

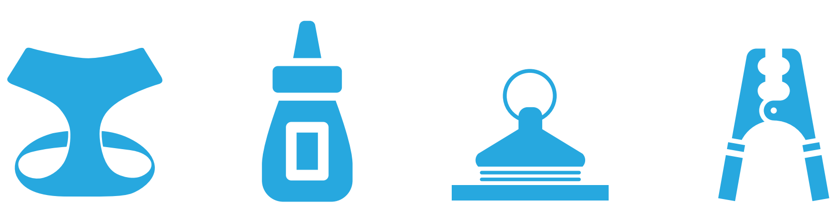
Answers can vary widely but should consider the criteria and the constraints that were listed.

ACTIVITY 3: BUILD YOUR CAMERA

Now it is time to design some camera systems of your own! We can start with a sperm whale camera. Here are some things to remember:

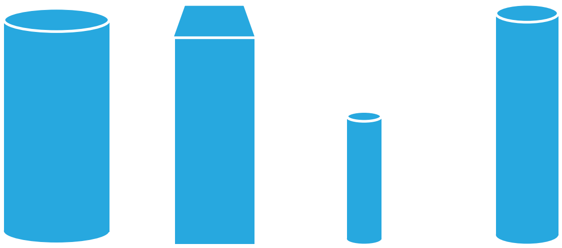
- Sperm whales dive deep, sometimes to about 2000 m (1.25 mi).
- Square designs crush more quickly than cylindrical designs.
- The camera system should be small relative to the size of the animal.
- Deep sea animals can't see red lights well, but red light doesn't go as far as blue or white.
- Headlights require battery power.
- Heavier cameras are more difficult to deploy.

ATTACHMENTS



Harness Glue Suction Cup Clamp

HOUSINGS



CRUSH			
3,000 m	800 m	200 m	1,200 m

MASS			
1 kg	0.6 kg	0.25 kg	0.8 kg

TRACKING TRANSMITTER = 0.1kg

BATTERIES

TIME			
3 h	6 h	11 h	22 h

MASS			
0.05 kg	0.1 kg	0.2 kg	0.4 kg

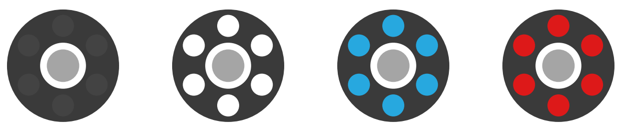
FLOATATION

High Density	High Density	Low Density	Low Density

CRUSH			
3,000 m	800 m	200 m	1,200 m

LIFT			
1.8 kg	1.2 kg	1.8 kg	0.75 kg

DOME AND HEADLIGHTS (FRONT VIEW)



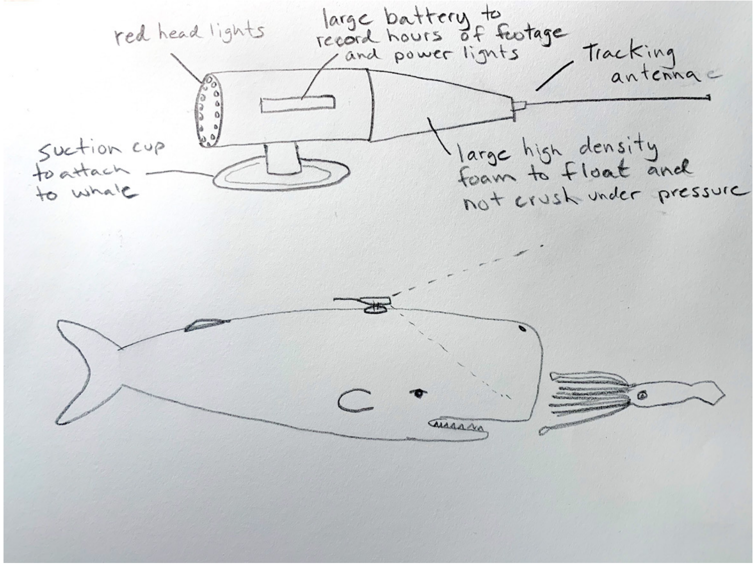
HEADLIGHTS			
None	White	Blue	Red

TIME LOST TO POWER			
0 h	2 h	1.5 h	0.5 h

DEPLOYMENT POLE

1. Use the information on the previous pages to **draw** a diagram of the camera you would build to study sperm whales. Label each piece of your camera and explain why you chose each part. Be sure to think about how you will attach the camera to the sperm whale and include it in your drawings.

Accept well-reasoned answers. See example below:



2. For one of the next missions, the team wants to see how baby bull sharks catch their food. Baby bull sharks are only about 1.3 m (4.3 ft) long. They live in water that is less than 10 m (32 ft) deep, so there is plenty of light. Because bull sharks are cold-blooded, they do not have to feed very often. Use this information to **draw** a baby bull shark camera. Label each piece of your camera and explain why you chose each part. Be sure to think about how you will attach the camera to the shark and include it in your drawing.

Accept well-reasoned answers. See example below: