**Student Worksheet: Hard-to-Reach Problems with ROVs**

**Directions**: This activity will ask you to think critically about how engineering practices can be used to monitor environmental issues or solve real-world problems. You will learn about how remotely operated vehicles, or ROVs, in the Galápagos have discovered unknown deep-sea reefs before you propose other ways that remotely operated vehicles can be used. You will then work in groups to use engineering design processes to create an ROV that investigates a real-world problem in your local environment. Your group’s ROVs should collect data or samples to monitor one or more aspects of the environmental problem. Finally, your group will create a model of its ROV as a tangible final product.

**ROVs in the Galápagos Islands**

For homework, read the *Science News* article “[See the wonders of two newfound deep-sea coral reefs off the Galápagos](https://www.sciencenews.org/article/two-new-deep-sea-coral-reefs-galapagos)” and answer the following questions. This homework assignment should take students no more than 30 minutes.

1. What is the importance of the discovery made in the article?

2. What device was used to make this discovery?

3. What is a potential scientific question that scientists may have used for this investigation?

4. Based on the article, what information or data did this device collect? What other kinds of information or data could this type of device collect?

5. Give three examples of environments or places where remotely operated vehicles might be useful. Explain how ROVs would be useful in each of these environments.

6. What technology or resources do you think this device may require?

7. What kind of planning, knowledge or skills may be required to create this type of device?

8. Think of a place that might be difficult for scientists to access and study in your local area. Why might scientists want to study this place?

**Determining the ROV’s purpose**

Review the answers to your homework in a group. You will be working with your group to design a ROV that addresses an environmental problem provided by your teacher. Using a computer, research the provided environmental problem and answer the following questions. After answering the following questions, draw your model. Be sure to label your illustration to include any measurements and the locations of the power source and other components. In the next section of the activity, you will create a model of your ROV based on your illustration.

1. Use at least three reputable sources to learn about the hard-to-reach local environment. What aspects of this hard-to-reach location would make this environment difficult to monitor in person?

2. Why would scientists need to monitor this environment?

3. Develop a scientific question about this hard-to-reach environment that scientists could investigate using a ROV.

4. Design an investigation that utilizes a ROV to focus on one aspect of the problem. What will the ROV do in this investigation?

5. What type of data would the ROV collect?

6. How does it record this data or collect this sample? Be as detailed as possible.

**Developing a design for your ROV**

When building an ROV, there are many factors to keep in mind. Use the following questions to guide you in building your model.

1. How is it powered? Will all electronic components use the same power source? Be as detailed as possible.

2. Do any components need to be watertight? If so, how will you keep the water out?

3. How will you retrieve the ROV if it malfunctions?

4. Are there any size limitations? If so, what are the size limitations? How will this affect your design?

5. Are there any weight limitations? If so, what are the weight limitations? What could happen if your ROV is too light or too heavy?

6. Does your ROV need to be buoyant? If so, how will you make the ROV buoyant?

7. Are there any additional design features that you feel are important to ensure that the ROV is successful in completing its task?

**Modeling ROVs**

Using the illustration of your ROV, create a model using the provided materials. Upon completing your model, you will present your model to the class. This informal presentation should include the answers you provided to the questions posed in the previous section of the activity. Your model will then be observed for labeling, mobility and size and tested for durability upon impact when dropped.

Use the following checklist to ensure that your ROV model contains all necessary components and meets the requirements:

□ All components of your model are clearly labeled.

For components that are not available, create placeholders. For example, where will your battery be housed? If you are not using a real battery, create a small box labeled “Battery” to install in your model. Create a placeholder for every item in your model illustration that you do not physically have. This may include sensors, cameras, sample collection devices, gears and mechanical parts, etc.

□ Your model can move in its intended environment.

For example, if using wheels for model mobility, can your wheels move? Is the model able to turn or can the model only move forward and backward?

□ Does your model fit within the size parameters you set?

□ If using circuitry, does your circuit work and does your model function as intended?

□ Will your model be able to absorb the impact of a fall?

□ Is there a way to retrieve your model in case the ROV fails while in use?