

Chapter 5 - Life in the Deep the Subtidal World

Ocean Tech

Marine Engineer:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A crescent moon in a black sky

Description automatically generated with medium confidenceSEASHORE STEWARDSHIP PLEDGE

I, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, do hereby solemnly pledge to be a good steward of the marine environment. This means that I will:

1. Listen to the instructors both in the classroom and in the

field.

1. Walk on the shore or dock with care to avoid hurting myself, others, and the sea life.
2. Treat all life forms with care and respect.
3. Use only wet hands to touch gently (using only two fingers) animals that I find.
4. Leave creatures attached to rocks and docks because

attempting to remove them can hurt them.

1. Not hold any aquatic life out of the water for more than one minute.
2. Leave no boulder overturned; I will carefully replace all

rocks that I look under and I will only turn over rocks

smaller than my head.

1. Return all organisms to their homes or where I found them.

Signed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dated: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

ORGANIZE YOUR EXPLORE TEAM

Salish Sea Explorers use teamwork to solve mysteries and save the day for sealife. Thank your last Teammates for their support and good ideas. Form a team and select one of these equally valuable roles, then start to explore!

Team Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Chief Scientist**  Research manager  -suggests research projects  -ensures proper scientific protocol  Project manager  -ensures each team member has a job and stays on-task, motivates team with positive encouragement  -Ensures project completion  Assists all other positions as needed | **Research Associate**  Conducts background research online, in books, interviews, videos, or magazines  Methods manager  -ensures research procedures are legit.  Recorder  -records and enters data in data tables  -records summaries of team’s work  Assists all other positions as needed |
| **Field/Lab Technician**  Materials manager  -gets supplies and makes sure they are in working order  -Keeps workstation organized  Infographic artist  -creates graphs from data table content  Assists all other positions as needed | **Science Communicator**  Reporter  Graphic artist  Presentation manager  -slideshow, poster, video, etc.  Translates complex science into words the general public can understand  Assists all other positions as needed |
| **Cultural Liaison** (for 5 person groups)  Researches and records input and perspectives of members of the local Coast Salish Tribe (US) and/or First Nations (Canada). Finds Indigenous stories, songs, art, or knowledge keepers who can teach us about keeping Salish Sea ecosystems balanced. | For long-term projects, switch roles every 4 weeks  **GO TEAM!** |

Chapter 5: Life in the Deep - Inspired Thoughts

What did this Explore chapter bring to mind? Use this space to free-write and/or draw your thoughts, ideas, imaginings, and questions about the subtidal world. What would you explore if you could get down there?

Ocean Tech Vocabulary

Circle or highlight unfamiliar words and add your own. Return to write or draw their definitions as you figure them out through use.

|  |  |
| --- | --- |
| Content Words | Definition |
| Subtidal  Substrate  Engineering  Engineer  Technology  Thrust  Drag/Friction  Gravity  Buoyant force  Prototype  ROV |  |

**A picture containing text, sign, dark

Description automatically generated**What do you Wonder?

What does the plastic bag on the sea floor make you wonder?

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Write one question you have about plastic garbage on the bottom of the sea:

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# How did they do that?

Nuu Chah Nulth and Kwakwaka’wakw peoples gathered dentalium shells from deep in the sea thousands of years ago and stayed dry doing so.

Diagram

Description automatically generated

What do you think they used to get these small mollusks from under the sand, 60 feet (18 meters) down?

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Icon

Description automatically generatedHow would you gather these shells?

1. Draw and label a diagram of technology you would use to gather

dentalium shells from in the sand on the sea floor 60 feet (18 meters)

below the surface. You may only include materials available 2,500 years

ago to coastal First Nations.

1. Post your design for others to see.
2. Vote on which design might work best for getting money from the sea!

# Money from the Sea Reflections

What is engineering?

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What makes someone an engineer?

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Were the Nuu-Chah-Nulth dentalium shell gatherers engineering?

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Were *YOU* engineering in this challenge? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Could *we* use engineering to get to the subtidal zone?**

*A picture containing dark, swimming, equipment, ocean floor

Description automatically generated*

*95% of the ocean is*

*unexplored, never*

*seen by human eyes.*

*-NOAA*

**Identify the Problem**

1. Subtidal area name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Do you think there could be plastic “marine debris” on the seafloor there?

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1. Pick the coolest living thing you read about in chapter 5 of Explore the Salish Sea. How might plastic garbage impact that life form? What would you like to do about it?

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A picture containing sign, dark

Description automatically generatedTurn and talk with your Explore Team about what you would do about that marine debris if you had the right ocean technology for the mission.

1. Share your Team’s idea for an underwater mission, then help the class narrow down the mystery or problem to solve. Form that into your Essential Question.

Write our Essential Question Here:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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A picture containing graphical user interface

Description automatically generated**Design! -** The Right ROV for the Job

Sketch an idea for a ROV that could accomplish your chosen mission. Use your wild imagination!

Show and label:

* what its frame is made of
* its size (height, width, and length)
* how it would be controlled
* how it would move
* components to help your mission

A picture containing graphical user interface

Description automatically generated Engineer it! ROVs: Pilots Wanted

1. Engineer an ROV arm using materials from around your home or classroom
2. Complete the mission in the following CHALLENGE CARDS…if you can!

Challenge 1

Graphical user interface, text

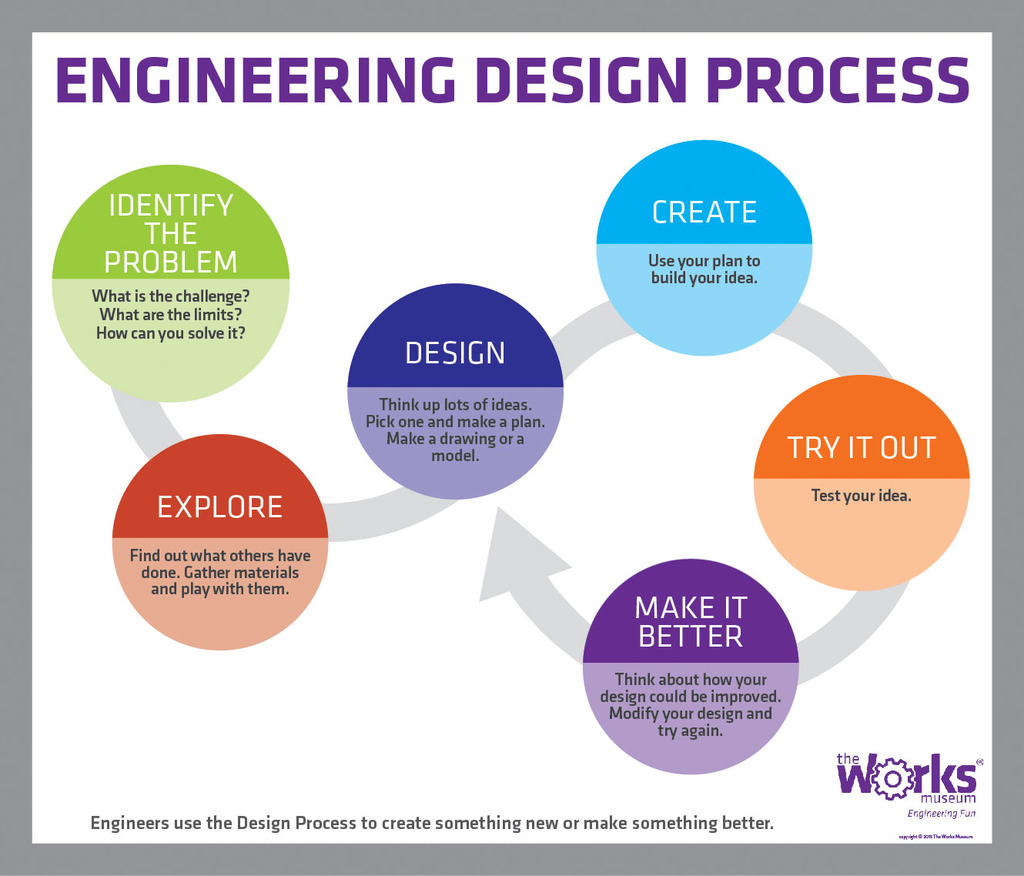
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Graphical user interface, text, application

Description automatically generatedChallenge 2

Graphical user interface, text, website

Description automatically generated Challenge 3



Engineers work in teams!

It’s time to get organized. Consider your interests and strengths and take on an engineering and ROV piloting job your Explore Team needs to complete your mission.

Our Team’s ROV name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

My Engineering Job Title: My Dive Mission Job Title: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| --- | --- | --- |
| **Engineering Job Title** | **Duties** | **Engineer Name** |
| Chief Structural Engineer | Responsible for sound construction of ROV frame and components, the “bones and muscles” of the ROV |  |
| Chief Electrical Engineer | Responsible for wiring complete circuits for motor controls, cam- era, and sensors |  |
| Chief Communications Officer | Responsible for communications with other teams, instructor, and scientific community. |  |
| Chief Field Operations Officer | Transports ROV to test site, as- signs and oversees ROV operation positions: Pilot, Tether Technician, Spotter, Data Manager. |  |
| Chief Mechanical Engineer | Responsible for sound mechanical design, weight, balance, neutral buoyancy, and ability to operate in 3-D space |  |

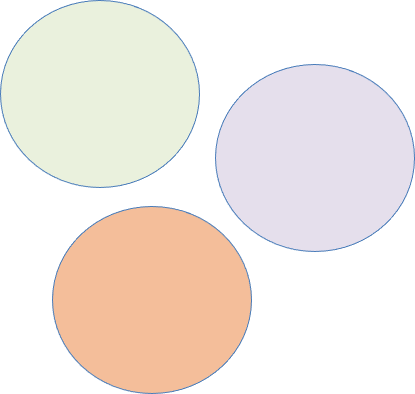
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| --- | --- | --- |
| **Dive mission Job Title** | **Duties** | **Engineer Name** |
| Pilot | Operates controls to drive the ROV |  |
| Tether Technician | Manages tether to keep it out of the way of the ROV and organized topside |  |
| Spotter | Monitors ROV movements and directs pilot |  |
| Handler and  Mechanic (split this job for 5 person teams) | Transports ROV to test site, de- ploys and retrieves ROV on missions/troubleshoots and makes repairs in the field |  |

Take a moment to consider where you are in the design process.

Write and sketch mini diagrams in the circles below to record the steps

you’ve taken so far. You’ve already begun engineering!

IDENTIFY THE PROBLEM



DESIGN

EXPLORE

**CREATE**

**TRY IT OUT**

**MAKE IT BETTER**

Repeat any steps!

A picture containing linedrawing

Description automatically generated

Re-Design

You know the process, you’ve organized your team, and have some great ideas. You’re ready to compare and combine designs! Or you can select the one you think will do work the best. Not sure which to choose? Build two and put them to the test.

What to do: Hold a Team Talk to select the best parts of each ROV design in your team then combine them into one ROV that:

* achieves neutral buoyancy
* is equipped to accomplish your mission

Sketch and label your revised idea for your ROV here. Include motor mounts, motors, and attachments for your mission.

ROV Design Log 1 Date\_\_\_\_\_\_\_\_\_\_

What did you discover today with your Explore Team’s ROV design? What functions could it perform with its design features?

What do you like about your design and/or design process? List positive things under the plus and things that could be changed under the triangle\*

\*a triangle is a Greek symbol for a delta, where a river enters the sea and forms a triangle shape of sand. A delta is a site of constant change, so this is the symbol for change

+ Δ

Notes - additional thoughts and ideas

Try it out!

After testing and making improvements, sketch your two, revised prototypes here. Rate them with a P for Pass or F for Fail for each of these variables.

|  |  |
| --- | --- |
| PROTOTYPE | VARIABLES (Score = Pass/Fail) |
| 1 | Neutrally buoyant 30 cm  below the surface \_\_\_\_\_\_\_\_  Floats evenly with  balanced weight \_\_\_\_\_\_\_\_  Moves up and down \_\_\_\_\_\_\_\_  Moves forward and aft \_\_\_\_\_\_\_\_    Turns left and right \_\_\_\_\_\_\_\_ |
| 2 | Neutrally buoyant 30 cm  below the surface \_\_\_\_\_\_\_\_  Floats evenly with  balanced weight \_\_\_\_\_\_\_\_  Moves up and down \_\_\_\_\_\_\_\_  Moves forward and aft \_\_\_\_\_\_\_\_    Turns left and right \_\_\_\_\_\_\_\_ |

ROV Design Log 2 Date \_\_\_\_\_\_\_\_\_

What did you add and improve today? How did it go? What worked and

didn’t work? What will you change for next time?

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Notes

**A picture containing object, mirror

Description automatically generated**Nature Detective Activity: May the Forces Be With You!

Play with the objects at each station and record your observations

|  |  |
| --- | --- |
| **Station 1:**  **Just Ducky Word Bank**  Gravity  Buoyant Force | Sketch of duck, water,  and arrows showing  directions of forces |
| **Station2:**  **Displacement Word Bank**  Mass  Density  Volume (amount of space an object takes up) | Mass of foil ball \_\_\_\_\_\_\_\_\_ g  Level of water without foil ball \_\_\_\_\_\_\_\_\_\_ mL  Level of water with foil ball \_\_\_\_\_\_\_\_\_\_\_ mL  Mass of water displaced by the foil ball \_\_\_\_\_\_\_\_\_\_ g  Thoughts\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| **Station 3: Pressure and Compression Word Bank:**    Water pressure (use twice)  Compressed  Expanded  Negatively buoyant  Positively buoyant  Mass  Heavier | Air has \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. I know this because the full balloon weighed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ than the empty balloon. When I squeezed the bottle I increased the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the “diver” became \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The air inside the dropper got \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. When I let go I decreased the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the dropper became \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_. The air inside the dropper got \_\_\_\_\_\_\_\_\_\_\_\_\_ |
| **Station 4: Thrust and Friction Word Bank:**  Potential energy  Kinetic energy  Thrust  Friction  A picture containing text  Description automatically generatedGravity  Lift | The wound up rubber band stores \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. This energy transfers to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ when released. The twists in the rubber band  provide the source of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that moves the plane. Moving through air slows the plane because of \_\_\_\_\_\_\_\_\_\_\_\_\_. The plane is pulled toward the earth by \_\_\_\_\_\_\_\_\_\_\_\_\_\_. The wings hold the plane aloft with \_\_\_\_\_\_\_.  Without gravity and friction, would the airplane ever stop?\_\_\_\_\_ |
| **Station5:**  **Balance Point Word Bank**  Center of gravity  Balance  Ballast  Stabilize | Draw each object you test. Mark its balance point with an x. |

Newton’s Laws of Motion Review

1. How did Newton’s first law, an object in motion will remain in motion and an object at rest will remain at rest (inertia) apply to the rubber band-powered airplane?

How will Newton’s first law apply to your ROV?

1. How will Newton’s second law, the strength of the force = the object’s mass x acceleration (F = m x a) apply to your ROV?

If you have just one size of motor, what will changing the mass of your ROV do to its acceleration?

1. How did Newton’s third law, for every action there is an equal, but opposite reaction, apply to the Explore Stations? Describe two.

Make it Better

How will Newton’s third law apply to your ROV? Apply what you’ve learned about forces and motion to make improvements to your ROV. Hold a Team Talk to share ideas. When you’re ready, draw your refined design, but this time, to scale.

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Scale: 1 square = \_\_\_\_\_\_ cm Now build and try out your design!

Remember, it’s okay to fail soon and fail often. Then redesign, rebuild, retry.

ROV Build Log Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

+ Δ

Notes

ROV Dive Log 4 Date **\_\_\_\_\_\_\_\_\_\_\_**

+ Δ

Notes

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| Model ROV Self Evaluation Rubric | NO | SOMEWHAT | YES |
| I built a model ROV |  |  |  |
| My model ROV was balanced flat when hung by a string |  |  |  |
| I navigated my ROV through an obstacle course without being able to see it |  |  |  |
| My ROV successfully collected a sample from a sediment-covered seafloor (Challenge Card 2) |  |  |  |
| My model ROV successfully deposited a payload |  |  |  |

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| --- | --- | --- | --- |
| Working ROV  Self Evaluation Rubric | NO | SOMEWHAT | YES |
| Our Explore Team selected or combined designs for an actual ROV from competing designs |  |  |  |
| I drew our ROV design to scale |  |  |  |
| Our Explore Team built and tested two competing prototypes of our ROV |  |  |  |
| Our ROV was neutrally buoyant 30 cm below the water’s surface |  |  |  |
| Our ROV could move  up,  down,  forward,  reverse,  turn left and right. |  |  |  |
| Our ROV met these mission criteria: |  |  |  |

**Icon

Description automatically generated Option: Use your ROV for scientific research!**

Follow the arrows to each of the possible steps in your scientific process.

![Diagram

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAwADAAAD/4RDoRXhpZgAATU0AKgAAAAgABAE7AAIAAAAKAAAISodpAAQAAAABAAAIVJydAAEAAAAUAAAQzOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAE1pcmEgTHV0egAABZADAAIAAAAUAAAQopAEAAIAAAAUAAAQtpKRAAIAAAADOTIAAJKSAAIAAAADOTIAAOocAAcAAAgMAAAIlgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Research Title: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Choosing Variables:

One changed (manipulated/independent) variable:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

One measured (responding/dependent) variable:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

At least three controlled variables, or things to keep identical for all trials of both

treatments

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
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**Research Question**: Focus and simplify your research by beginning your questions

with one of these sentence starters: Is, Are, Do, Does, Will…

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**Hypothesis/Prediction**:

We predict that if \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

then\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

because\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Diagram: Draw a labeled illustration of the experiment or survey. Show all materials in action.

Procedure: Number step- by-step directions for how to do the experiment.

* 1. Tell how you will set up the experiment.
  2. Tell how you will compare the changed/manipulated variable.
  3. Tell how you will measure the measured variable.
  4. Tell how often you will take and record measurements.
  5. Tell how many times you will repeat each test/observation.

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**Results:** Tables, graphs, and brief description of outcome

**Data table**

1. Label columns and rows, including units (in parentheses)!
2. Conduct at least 3 trials to get a representative sample
3. Include a space for the calculated average (mean)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  | Mean |
|  |  |  |  |  |
|  |  |  |  |  |

**Graph:**

1. Label axes (x-axis = changed (manipulated) variable, y-axis = measured

(responding) variable) and write a Title that describes what the graph shows.

1. Number axis (use more than half the graph height, use even intervals, consider scale)
2. Plot data

y-axis title \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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x-axis labels \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

x-axis title. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**A picture containing sign, dark

Description automatically generated Get C.E.R.I.A.s Forum Notes**

Brief and concise description of your results:

|  |  |
| --- | --- |
| Claim  answer your research question | Evidence  What does the graph show us?  Do the math, what are the numerical differences between the two measured variables? |
| Reasoning  Explanation of why you think your results turned out the way they did (includng potential errors). | Implications  How does this new information impact the world or change the way we think? |
| Applications  How could this information be applied to the way we manage our watershed? | Science-based recommendations  What do you advise your community leaders based on your results? |

|  |  |  |  |
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| **ROV Research Rubric** | NO | SOMEWHAT | YES |
| Our Explore Team performed scientific research using an ROV (ours or a community partner’s) |  |  |  |
| We created/wrote:   * a testable question * a hypothesis * a changed and   measured variable   * a materials list * a procedure   a data table. |  |  |  |
| Our experimental design included at least 3 replicate trials (repeated tests) |  |  |  |
| Our Explore Team contributed our data to a class graph |  |  |  |
| I argued using evidence including:   * a claim * evidence from data * reasoning * implications and applications of our results   recommended actions |  |  |  |

These stamps certify achievement of the following:

Mechanical Engineer

Electrical Engineer

Structural Engineer

Ace ROV Pilot

Radical Research Scientist

A close - up of a robot

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