

Electricity and Water DO Mix

By

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Context of the Module:

This module is designed as a cooperative group project for an integrated sciences unit focusing on physics, electronics and career opportunities. Modifications and extension activities can continue throughout the semester-long course.

Pre-requisites:

No formal pre-requisites, but Algebra 1 is recommended. Knowledge of simple circuits may be introduced before students begin this unit.

Target Audience:

The target audience for this unit is high school science students.

Introduction or Mission:

In developing a relationship between the Electronics and Environmental Science classes, the mission of the Electronics class is to build a working ROV following the specifications determined by the goals of the Environmental Science curriculum. In the past, Environmental Science students determine water clarity from the water's surface using a Secchi disk. A research question to be addressed by this mission could be, "Is the water turbidity constant at depth?" If we could determine the turbidity of the water at different depths, students could determine the algal or sediment concentration in the water. In order to perform the proposed research questions, the ROV will need a camera, the ability to deploy and retrieve sediment sampling bottles, and be able to deploy a visibility target and measurement device.

Student Learning Outcomes:

Student Outcomes (Performance)	Knowledge and Skill guidelines/ Competencies	Job Description	SCANS	California Science Standards
Students will design and build a working ROV to demonstrate their ability to work in groups to solve a real-world problem	A4, A6	Marine Technician	Creative Thinking Decision making Interpret information	I&E 1.i, 1.m Physics 1.d
Students will survey the customer's requirements	D1, E1, E2	Marine Technician	Time management, acquiring information	I&E 1.a
Students will operate ROV equipment effectively	A1,A2, A5, A6, E1	Marine Technician Pilot	Use of Info. Technology	I&E 1.a Physics 1.b
Students will safely navigate the ROV to destination	B1, B2, B3	Pilot	Interpret information	I&E 1.d, 1.e, 1.h
Students will produce, maintain, and submit complete and accurate records of the building and design process, maintenance and operations following industry guidelines	D4, D5, A5, B2	Marine Technician	writing	I&E 1.a, 1.b, 1.c
Students will provide modifications of ROV system to meet changing needs of customer	F1, F3, F4	Marine Technician Electrician	Problem solving	I&E 1.a, 1.b, 1.c, 1.d
Students will manage and maintain computer software; build programs for ROV operations	C1, C2, C3	Marine Technician Computer programmer	Use of Information Technology	I&E 1.a, 1.c, 1.j
Students will look at models through history as research for their ROV model		Historian	Reading Writing	I&E 1.m
Students will design the electronics system aboard the ROV		Marine Technician Electrician	Mathematics	I&E 1.a, 1.l Physics 5.a, 5.b, 5.c, 5.e, 5.f, 5.g, 5.h
Students will work in a group to build their ROV		Marine Technician Pilot	Listening Speaking Responsibility	

			Self-management Sociability	
Students will maintain diagrams of each system of the ROV		Marine Technician Electrician	visualization	I&E 1.a
Students will be able to explain how a switch can change the direction of a motor		Electrician	Applying technology	I&E 1.a, 1.l Physics 5.a, 5.b, 5.c, 5.e, 5.f, 5.g, 5.h
Students will learn to solder		Marine Technician		I&E 1.a
Students will learn both linear and electrical measurement		Electrician Marine Technician		I&E 1.a Physics 4.c, 5.a, 5.b, 5.c, 5.e, 5.f, 5.g, 5.h
Students will calculate buoyancy, center of gravity and drag				I&E 1.e Chemistry 4.c

Warnings:

When using a hot glue gun, be sure to wear safety goggles, apron and gloves. Do not touch the tip of the hot glue gun when it is plugged in. When not in use, be sure hot glue that might drip is collected on a tray or paper so it doesn't drip onto workspace table.

When using a soldering iron, be sure to wear safety goggles, apron and gloves. Do not use the soldering iron without the teacher present and teacher approval. Use away from water.

When using a drill, be sure to wear safety goggles. Use a wooden block under the object you are drilling into and/ or a clamp to insure object being drilled stays motionless.

Keep batteries away from water. Double-check wire connections before using.

Time required:

Entire unit will take approximately 20 hours of class time (3 - 4 weeks)

Materials needed: (for each team)

Safety gear: goggles, gloves, apron

Expendable materials: 4 batteries, wire, 4-5 motors, tape (electrical), weights, plastic hangers, empty film canisters, nails, pvc pipe, copper pipe insulation

Reusable materials: journal, ROV books/ videos, soldering iron, hot glue gun, drill, wooden block, wire cutters, wire strippers, screw drivers, scissors, ties, glue, copies of rubric(s), access to computer

Procedures: (for each cooperative group ROV project)

1. Students are introduced to their mission, put into working teams based on individual roles. I recommend a team of 3-4 students.
- 2.
3. Teams are given their criteria for the project. As scientists in the field keep specific and detailed journals, it would be very useful in tracing thought patterns for teams to keep a journal following marine ROV industry guidelines.
4. Students meet with customer to determine specific needs for ROV. Customer might be student teams from such classes as Environmental Science, Oceanography or Biology.
- 5.
6. Students plan their initial design. In determining design, team decisions should be drawn, and process documented in team's journal.
7. Students lay out their initial design shape. Before putting materials together, decide as a team how large your ROV will be. Begin to visualize proportions.



8. Cut PVC pipe to create the structure of the ROV



9. Put together the structure of the ROV. Consider the Center of Gravity. Does the structure match your vision? This might be a good time to test your structure in water. Make revisions and adjustments.



10. Drill holes in the frame. Note - be careful using an electric drill. Students should always wear goggles. The purpose of the holes in the frame is to allow water to freely move through the ROV structure. Think about your ROV in the water. Where would air get trapped inside the PVC? This trapped air will cause a change in your ROV's buoyancy. Test your structure again.



11. Plan where you will attach your motors. Think about how placement of motors will effect the ROV's Center of Gravity and Center of Buoyancy.



12. Plan where flotation will be added and how much will be necessary to create a slightly positive buoyancy. If possible, test out placement of the motors and flotation.

13. Modify propellers as necessary. Attach propellers to motors. In order to slide propeller over the shaft of the motor, you can use a hammer and gently tap the propeller onto the shaft. You could also use the soldering iron to heat the shaft. This process will allow the propeller to melt slightly and slide on. You may need to add some super glue to keep the propeller on the axel after it has cooled. Note: if you are using the soldering iron, be sure to wear safety goggles.

14. Plan the electrical system for your ROV. You will need to decide how you will run the wires on the ROV, how you will connect the ROV to the battery box, and how you will connect the ROV and battery box to your control box.



15.

16. You will also need to design your control box. As you design this system, check for power flow and how to ground the system

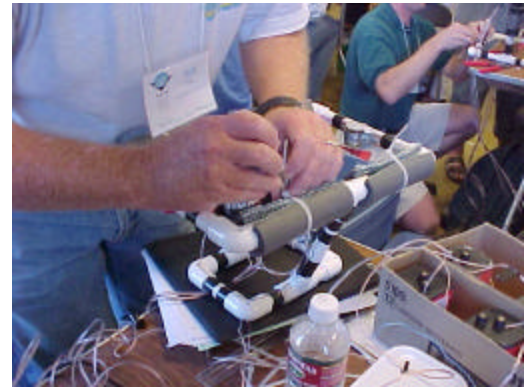


17.

18. Attach wires using electrical tape. Check your system before soldering. Before you can check your electrical system, have your teacher check your wiring. When ready, check the system by hooking up the battery box, control box and ROV and checking each of the motors and any appendage tools to ensure that they operate as you intended.

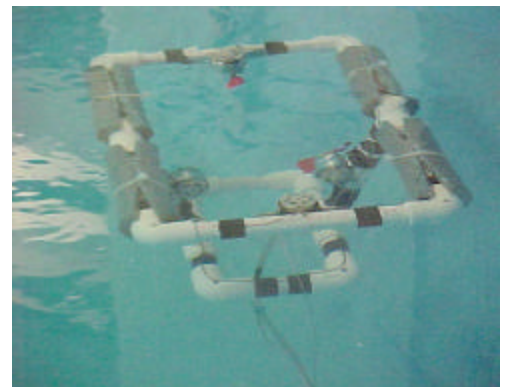


19. Attach flotation using plastic twist ties or tape. If using twist ties, be sure to cut the excess ends off so as to leave no sharp edges exposed.



20.

21. Test your ROV. You may decide to make modifications after you test your basic design. You may also decide to add an additional sled of tools. With each modification, remember to check your Center of Gravity, Center of Buoyancy and power drain.



1.

Journaling the Process: (Data Collection)

Number and date the pages of the team journal

List the processes you try and whether or not they work

Diagram each system (structure, power, buoyancy control, sensor/ navigation, control systems, propulsion system)

Include wiring diagram

Make a 3-view drawing of your finished ROV

Discussion Questions:

How do you know where the Center of Buoyancy is?

How does the Center of Bouyancy effect the construction of a container ship?

How can you determine the displacement of water of a given object?

How does the displacement of water compare to the mass of the object?

Do you think the structure of a ROV effects its efficiency? Why?

How could you determine where the Center of Bouyancy and Center of Gravity is on

an ROV? How do these points relate to each other?

What are the different types of switches, and how can a switch be used to reverse

the direction of a motor?

Why does a motor change direction when you change the battery polarity?

Lesson Extensions:

See attached [MATE Module](#) to view how the above lesson fits into a larger unit of study. Unit culminating task is included.

Example Assessment:

Student Objective: Students will be able to explain how a switch can change the direction of a motor

Outcome: Student will know how a switch can change the direction of a motor

Evidence: Student will make a poster illustrating how motor direction can be reversed using a switch

Rubric:

Rubric Level	Criteria
4	1. Contains complete and accurate information 2. Communicates clearly and enhances the content 3. Exhibits care resulting in a neat, attractive product 4. Current flow and motor direction are indicated with no errors
3	5. Contains accurate information 6. Communicates the content clearly 7. Exhibits care with some lapses 8. Current flow and motor direction are indicated with few errors
2	9. Contains some inaccurate information 10. Communicates some of the content 11. Exhibits little or no care 12. Current flow and motor direction are indicated with some errors
1	13. Contains inaccurate information 14. Communicates little or none of the content 15. Exhibits no care 16. Current flow and motor direction are not indicated, or done with major errors