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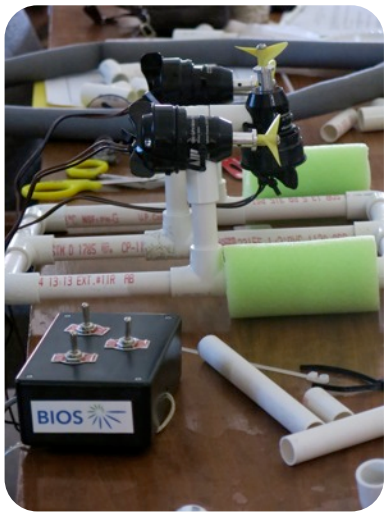
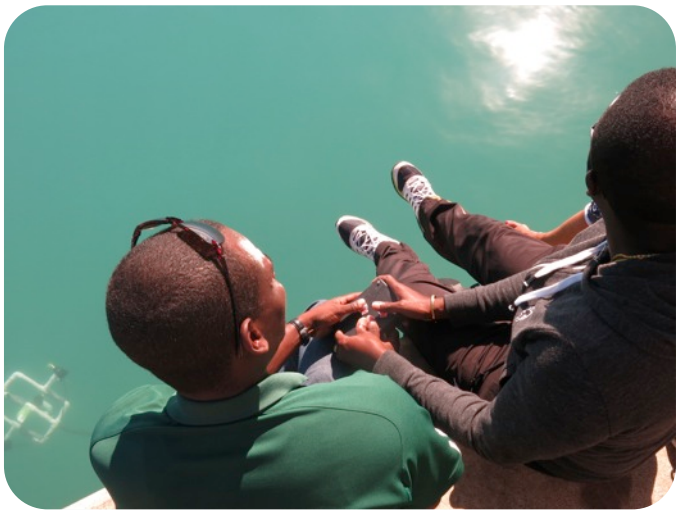
mid atlantic robotics in education





2015 ROV Angelfish Challenge Manual

March 7th 2015

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Table of Contents

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I. MARINE

Researchers at BIOS are expanding their ability to explore the ocean with the recent acquisition of undersea gliders, which are autonomous underwater vehicles (known as AUVs) programmed to travel thousands of miles at a time in pursuit of oceanographic data. To maximize the impact of this cutting-edge technology, BIOS has developed a multi-year underwater design and engineering program called Mid Atlantic Robotics IN Education (MARINE). This program is designed to engage Bermudian students of all ages.

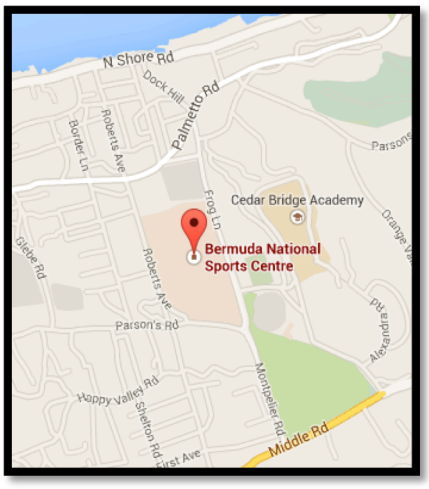
The program will focus on remotely operated vehicles (known as ROVs), hundreds of which are currently employed underwater around the globe by marine industries, underwater archaeologists, and scientific research programs. As Bermuda's students learn to build and test ROVs in the classroom, the MARINE program will support and enhance science, technology, engineering and mathematics (STEM) education. The experience of building ROVs will also foster critical thinking skills, individual and group problem solving skills, and technological fluency.

The MARINE program reflects BIOS's commitment to expand the use of underwater vehicles within ongoing efforts to study and understand the complexity of ocean processes. Complementing this new focus, Ocean Academy will lead ROV design challenges throughout BIOS's summer camps, and provide training and ROV kits to middle school classes during the school year. MARINE will be a key component of the HSBC Explorer program in 2015.

II. 2015 ROV Angelfish Challenge

Where:
National Sports Center
#50 Stadium Cottage, Frog Lane
Devonshire DV01
Bermuda
+1 441-295-8085

When:
March 7th 2015 (Rain Date: March 8th)
9:00 am -1:00 pm



III. Eligibility

Middle school teachers are encouraged to submit an entry form for a team of **5-8** students; up to **four teams** may be entered per school (public or private). Each team will be provided with an Angelfish ROV kit that includes all of the robot's components.

A limited number of kits will be made available to P5 and P6 teachers who would like to enter a team into the competition. Based on availability of kits, as well as space limitations for the competition, entry forms will be considered on a first come first served basis.

Middle schools that would like to enter **more than four** teams will also be considered based on the number of kits available as well as space limitations for the competition.

Entry forms will be accepted until the deadline of **December 12th, 2014.** Kits will be delivered to designated leaders/teachers during the week of **January 12th, 2015.**

Figure 1: Angelfish ROV kit

IV. Rules and Regulations

Entries will be constructed using the following materials that are a part of the Angelfish ROV Kit:

Angelfish Kit

- 3 500-gallon-per-hour bilge pump motors
- 30 feet of tether
- Zip ties
- 3 propellers
- 3 propeller shafts with screws
- A control box with three double pull/double throw switches
- PVC pipe
- PVC connectors
- Floatation material
- Banana plugs to plug into a 12v DC power source
- Fuse
- Wire caps

Not included but required for successful assembly of kit

- Pipe cutters
- Soldering iron
- Solder (one coil)
- Screwdriver (flat head and Phillips head)
- Hand drill
- Drill bits for control box
- Additional zip ties may be needed
- 12 volt batteries will be provided at the challenge

No modifications may be made to the propellers, motors or tether system. The design of the PVC frame and control box is at the discretion of the team. Floatation may be added to frame and tether as the team chooses. Any modifications to anything other than the frame and box may lead to disqualification from the competition.

V. Resources

The Marine Advanced Technology Education (MATE) program has created a list of resources and teaching modules for design instruction and engineering principals of the Angelfish ROV. MATE has additionally created many videos that illustrate the entire process of assembling the kit, to aid teachers and sponsors in troubleshooting.

Videos can be streamed directly from the MATE website after sign up of initial free membership to MATE: http://www.marinetech.org/angelfish-videos/. Videos cover everything from wiring up your control box to inserting the fuse.

This team manual is an excellent source of information for terminology related to the Angelfish ROV:
http://www.marinetech.org/files/marine/files/Curriculum/Other%20Curriculum%20Resources/MIROV2MANUAL.pdf

VI. ROV Angelfish Challenge Day

The ROV Angelfish challenge will be scored in four phases and will be out of 150 points.

Phase One: Design

Phase One of the competition will be out of the water. Judges will score the ROV and team members out of 40 points for safety, design and explanation. Below is a list of suggested vocabulary that students should understand for the explanation section of phase one.

Buoyancy – The upward force that a fluid exerts that opposes the weight of an immersed object.

Neutral Buoyancy – When an object's density is equal to the density of the fluid in which it is immersed and the object has an equal tendency to float as it does to sink.

Negative Buoyancy – When an object's density is greater than the density of the fluid in which it is immersed, and the object sinks.

Positive Buoyancy – When an object's density is less than the density of the fluid it is in, and it floats.

Structure – Components that organize and keep disparate parts together.

Floatation – Components that enable the ROV to float or become positively buoyant.

Tether – Insulated connection between control box, power source and propellers.

Ballast – Components that help the ROV to sink or become negatively buoyant.

Power – Energy supply for the ROV.

Propulsion – Devices (motors and propellers, also called "thrusters") that transform electrical energy into motion.

Control – Directing the vehicle**;** the human interface with the machine.

Conductor – A material that allows electrons to flow easily through it.

Insulator – A material that prevents or slows down the flow of electrons. Plastic and rubber are good insulators.

Battery - Stores potential energy, and a stored source of electrons.

Volts(V) **–** A derived unit for electrical potential.

Pitch – The theoretical forward movement of a propeller during one revolution.

Phase Two- Navigation

ROVs will be deployed into the water at the beginning of Phase Two to complete a navigation obstacle. This obstacle involves:

1. Achieving neutral buoyancy
2. Navigation through the first PVC frame on a tall base
3. Navigation through the second PVC frame on a short base
4. Navigating in reverse back through both frames
5. If reverse is not possible, robots may turn around and are permitted to move back through rings in a forward motion
6. Returning to the surface

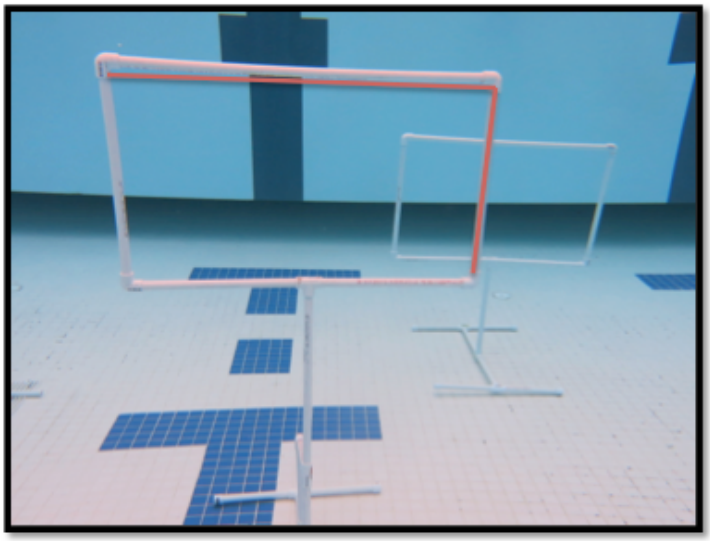


Figure 3: PVC navigation frame dimensions

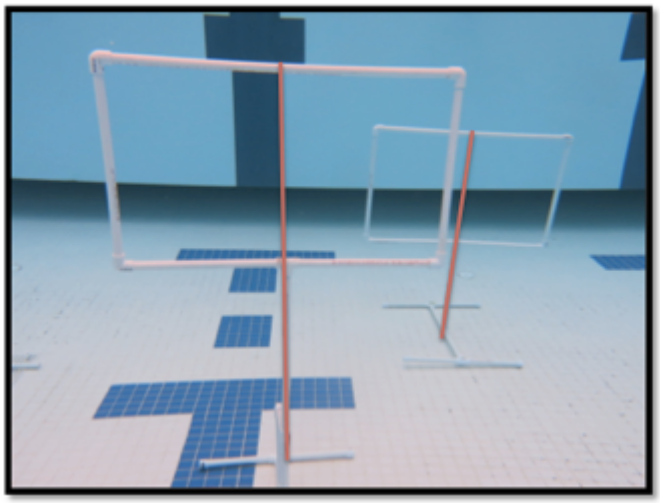


Figure 4: PVC frame heights from bottom of pool to top of navigation frame. The frames are ~3 feet

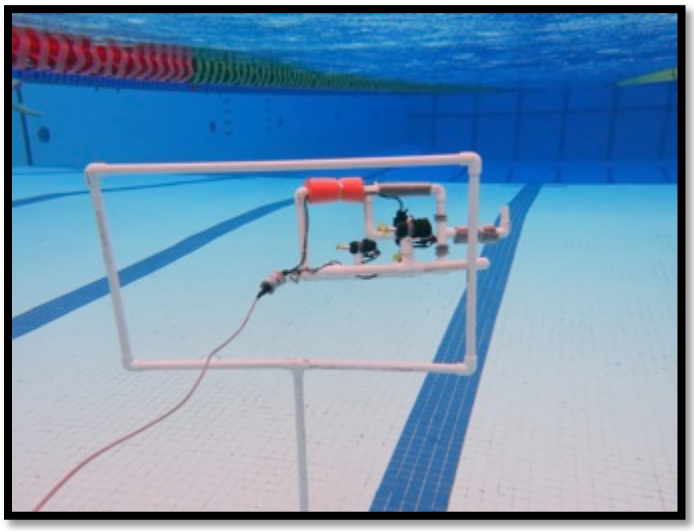


Figure 5: Angelfish ROV navigating through second navigation frame

For the navigation challenge the ROV will move forward through the center of the tall navigation frame and then through the center of the short navigation frame. Then the ROV will move in reverse through both navigation frames before returning to the surface. The ROV and tether may bump and move the frame. The task must be completed in 2.5 minutes. Point values are outlined in the Scoring Rubric found in the Appendix of this manual.

Phase Three - Pick up

ROVs should have a modified PVC piece that will allow for the ring pick up challenge. There will be four yellow rings for the pick up challenge, and one bonus ring. The top of the rings float, and will be located on a stand or on the bottom of the pool. The team has 2.5 minutes to collect as many of the rings as it can using the ROV. The ROV can return to the surface as many times as desired, and it can bump into and move the frame. The ROV must return the rings to the surface for the task to be considered complete. There will be a five-point bonus if the group can collect all four rings in 2.5 minutes. There will be a 3-point bonus if ROV can also pick up smaller ring within the 2.5 minutes. When time is called, the ROV must return to the surface and any rings attached to its nose will be counted. Rings will not be counted if still attached to the

frame. If rings are knocked off the stand onto the bottom of the pool, they can still be retrieved for full point value.

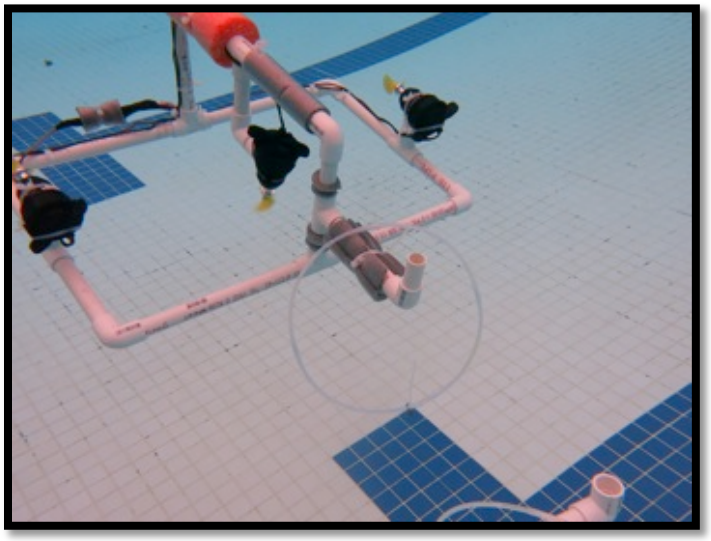


Figure 6: Example of modified PVC piece for ring pick up

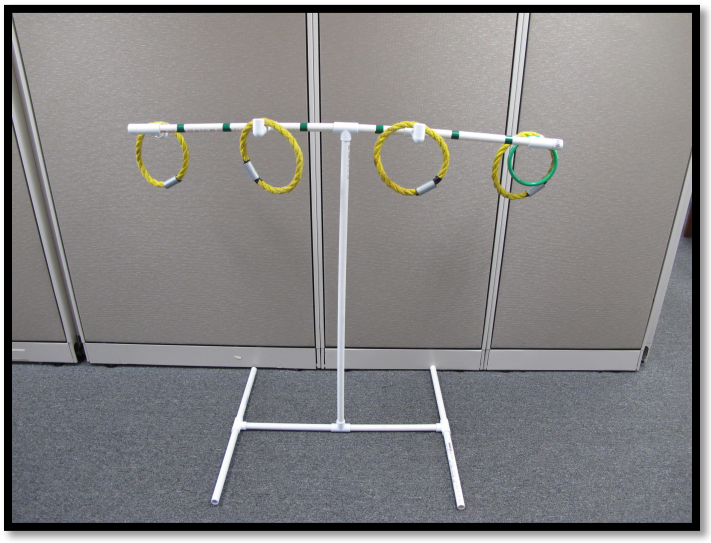


Figure 7: Pick up ring stand (3 feet high and 3.5 feet across)

Figure 8: Four rings in pick up challenge (6.5 inch internal diameter)

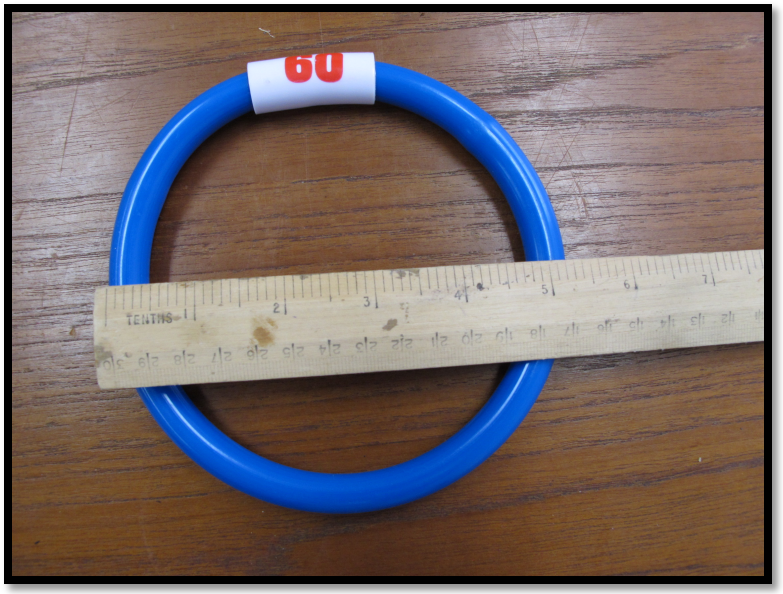


Figure 9: One bonus ring (5 inch internal diameter)

Phase Four: Speed

The speed round will be the final phase of the challenge. Teams will enter a modification area where 1” pieces of PVC and PVC elbows will be available for teams to use as added flotation. The team is allowed to add foam to the frame and tether and modify their engine mounts for the surface speed challenge. Teams will have a set amount of time in the modification area (~3 minutes) before traversing the 25 meter pool. Teams will traverse the pool to the finish line one at a time. Teams will then enter photo, certificate and interview area where they are encouraged to then cheer on their fellow teams. Teams can then return to testing area if desired to continue to use the test course before final judging.

Battery Sources

Phase 2,3,4 will have battery hook ups for each team to a 12 volt battery that will be checked by judges over the course of the completion, Banana plugs will be able to clip in and out to the battery easily at each phase of the completion. Batteries will be labeled for which plug will go to which power source for safety. Judges will be on hand to aid students in getting set for the challenge.

Figure 10: 12 volt car battery with hose clamp mounts to fit banana plugs at phase 2,3 and 4.

VII. Judging

There will be two judges present during each phase of the contest, as well as two snorkelers/divers in the water for each of the water-based phases. Scores will be tabulated during individual phases, and final tallying will be done at the scorers' table. Based on final point score the following prizes will be awarded.

Best Overall Team (total highest score)
Best Design (best overall score in Phase 1)
Navigation Challenge Winner (best overall score in Phase 2)
Pick-Up Challenge Winner (best overall score in Phase 3)
Speed Challenge Winner (best overall score in Phase 4)
Best Team Spirit (based on judge team leaders)

Please note that one team can only win in one category only for the challenge. At noon prizes will be awarded for the above categories.

VIII. Frequently Asked Questions

Is this event open to the public?

Yes, this event will be free and open for the public to attend. Families and friends of competitors can view much of the challenge from the bleachers, and there will be information available about the other educational opportunities BIOS offers. The concessions stand at the National Sports Center will be open during the challenge.

Are the Angelfish kits reusable?

Yes, almost everything is made from highly durable parts that can be used over and over again. The motors are waterproof bilge pump motors that should run for ten or more years; the control boxes are strong and water tight (but don't submerge them). Everything else can be taken apart and reused.

If trialing kits in salt water, be sure to thoroughly rinse them after use with freshwater to prevent rusting and corrosion.

Will teachers be able to keep the kits?

Yes, the teachers will be able to keep the kits for subsequent use in their classrooms.

I have never soldered before, what should I do?

If you are unfamiliar with soldering, we suggest watching the video below. One of the problems that can occur with cheap soldering irons is that they may not get hot enough or they may get too hot. Make sure you have a good quality soldering iron and follow the safety advice provided with your soldering iron.

Here is a useful video on soldering components to circuit boards:
http://www.youtube.com/watch?v=I_NU2ruzyc4&feature=youtu.be

Notes on solder: Leaded solder is easier to use because of its lower melting point so the soldering iron does not have to be as hot or held to the board as long. Lead-free solder has more flux (acid) in it, which can irritate the eyes if touched by unwashed hands after soldering. W*e recommend 60/40 Rosin Core Solder in .032" (0.08mm) diameter.* This is available at Godet and Young and Gorham's.

Can a camera be added to the kit?

Unfortunately the Angelfish kit does not have this capability. In future competitions, kits will become more complex and will have the potential to add more technology such as a camera.

Can a fourth motor be added to the Angelfish Kit?

While the Angelfish kit has the capacity to run using four motors, competitors will only be able to use three motors during the challenge.

Can the tether be lengthened so the ROV can go deeper?

No, all of the skills will be able to be completed with the tether length provided. It is possible following the competition that teachers can increase tether length for future use of the Angelfish ROV.

Can our school practice?

Yes, teams can practice using their ROV in fresh or salt water. Please note the ROV will perform differently in fresh vs. salt water. Teams will have the opportunity to trial the race course on the day of the challenge in the testing area. If you are in need of testing before the day of the challenge, please let Kaitlin know.

If you run into problems with your kit or have any questions, please contact Kaitlin (Kaitlin.baird@bios.edu) or JP (jp.skinner@bios.edu) for help!

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ROV Angelfish Challenge
Phase One

OceanAcademy

Team Name: _____

Total Score: _____/40

Task Element	Safety	Design	Explanation
Rubric Points	SCORE: _____/10	SCORE:_____/10	SCORE:_____/20
Excellent (10/10 points) Or (20/20 points)	**TASK: Vehicle and control system present no safety hazards** • All power cords are secured • Fuse and banana plugs are kept free from water • Control box is closed and secured • No sharp objects that could injure someone in the water • Connections have electrical tape, no bare wiring visible	**TASK: ROV is designed cleanly with only the components of the Angelfish kit** • Design aesthetics present • All three propellers are working • Control box is configured correctly • All connections are secure • PVC structure is secure	**TASK: Members display teamwork in explaining their design** • Team collaboratively explains the ideas behind their design clearly and concisely • Team collaboratively explains the main components of their ROV with thorough understanding of the vocabulary
Good (8.5/10 points) Or (17/20 points)	Task is completed but fails to meet one of the bulleted criteria	Task is completed but fails to meet one of the bulleted criteria	• Students display a general understanding of how they constructed their ROV • Students can explain concepts of the ROV, but not necessarily with the appropriate vocabulary • One individual is selected to be the speaker for the group
Room for Improvement (6.5/10 points) or (15/20 points)	Task is completed but fails to meet more than one of the bulleted criteria	Task is completed but fails to meet more than one of the bulleted criteria	• Students do not have a strong grasp of the process they used to design and construct their ROV • Students lack conceptual knowledge about ROV function

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ROV Angelfish Challenge
Phase Two

OceanAcademy

Team Name: _____ Total Score: _____/40

Task Element	Neutral Buoyancy	Return Mission	Overall Strategy
Rubric Points	SCORE: _____/20	SCORE: _____/10	SCORE: ____/10
Excellent (10/10 points) Or (20/20 points)	**TASK: ROV is able to establish neutral buoyancy, navigate (forward and reverse) through two challenges, and meet time requirement.** • No need for in-water assistance • Tether is not pulled, pushed or manipulated and is guided by one team member • ROV does not knock over the frame, but may bump into or move frame • ROV does not touch the sides or bottom of pool • ROV completes the challenge in less than 2.5 minutes (150 seconds)	**TASK: ROV is able to transition to the surface** **ROV is retrieved by PVC frame** • No need for in-water assistance • Tether is not pulled, pushed or manipulated and is guided by one team member • ROV does not touch the sides or bottom of pool *ROV may touch sides of the pool for the final retrieval of PVC frame*	**TASK: Team displays excellent communicative strategy to complete Phase Two tasks**
Good (8.5/10 points) Or (17/20 points)	Task is completed but fails to meet one of the bulleted criteria	Task is completed but fails to meet one of the bulleted criteria	Team displays moderate communication to complete Phase Two tasks
Room for Improvement (6.5/10 points) or (15/20 points)	Task is completed but fails to meet more than one of the bulleted criteria	Task is completed but fails to meet more than one of the bulleted criteria	Team displays limited communication to complete Phase Two tasks

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ROV Angelfish Challenge
Phase Three

OceanAcademy

Team Name: _____

Total Score: _____/40 (+5) (+3)

Task Element	Pick Up Challenge	Return Mission	Overall Strategy
Rubric Points	SCORE: _____/20 5 point bonus for all yellow ring pick-up 3 point bonus for pink, green, blue ring	SCORE: _____/10	SCORE: ___/10
Excellent (10/10 points) Or (20/20 points)	**TASK: ROV is able to navigate and pick up as many rings as possible in 2.5 minutes. ROV can pick up rings and return to the surface as many times as necessary within time limit.** **Only rings that are successfully brought to a team member on the platform will be counted** • ROV does not knock over the frame, but may bump into or move frame • No need for in-water assistance • ROV returns to the surface when time is called • Tether is not pulled, pushed or manipulated and is guided by one team member	**TASK: ROV returns to the surface and is retrieved by PVC frame.** **ROV is retrieved by PVC frame** • No need for in-water assistance • Tether is not pulled, pushed or manipulated and is guided by one team member • ROV does not touch the sides or bottom of pool *ROV may touch sides of the pool for the final retrieval of PVC frame*	**TASK: Team displays excellent communicative strategy to complete Phase Three tasks**
Good (8.5/10 points) Or (17/20 points)	Task is completed but fails to meet one of the bulleted criteria	Task is completed but fails to meet one of the bulleted criteria	Team displays moderate communication to complete Phase Three tasks
Room for Improvement (6.5/10 points) or (15/20 points)	Task is completed but fails to meet more than one of the bulleted criteria	Task is completed but fails to meet more than one of the bulleted criteria	Team displays limited communication to complete Phase Three tasks

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ROV Angelfish Challenge
Phase Four

OceanAcademy

Team Name: _____

Total Score: _____/30

Task Element	Positive Buoyancy	Speed and Retrieval	Strategy
Rubric Points	SCORE: _____/10	SCORE: _____/10	SCORE: ___/10
Excellent (10/10 points)	**TASK: ROV is modified to be positively buoyant** **Students can use small pieces of PVC, elbows, and floatation to modify their ROV** **Team employs excellent communicative strategy with modified ROV in speed challenge**	**TASK: ROV completes speed challenge of 25 meters in less than 60 seconds and is successfully retrieved by PVC frame** • No need for in-water assistance • Tether is not pulled, pushed or manipulated and is guided by one team member • ROV does not touch the sides or bottom of pool • ROV is positively buoyant *ROV may touch sides of the pool for the final retrieval of PVC frame*	**TASK: Team employs excellent communicative strategy to complete Phase Four tasks**
Good (8.5/10 points)	Task is completed Team displays moderate communication to complete speed challenge	Task is completed but fails to meet one of the bulleted criteria Or Time to traverse the pool is over 60 seconds but less than 90 seconds	Team displays moderate communication to complete Phase Four tasks
Room for Improvement (6.5/10 points)	Task is completed Team displays limited communication to complete challenge	Task is completed but fails to meet one of the bulleted criteria Or Time to traverse the pool is over 90 seconds	Team displays limited communication to complete Phase Four tasks

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2015 ROV Angelfish Challenge
Mid Atlantic Robotics IN Education (MARINE)
March 7, 2015

8:30-9:00	Arrivals and check in (upper deck) Test area open
9:00-12:00	Upper deck tables open
9:00-1:00	Event open to public
9:15	Students at test area tables
9:30	Official welcome ROV Angelfish Challenge begins
9:30	Wave 1 Enters Phase 1
9:45	Wave 1 Enters Phase 2 Wave 2 Enters Phase 1
10:00	Wave 1 Enters Phase 3 Wave 2 Enters Phase 2 Wave 3 Enters Phase 1
10:15	Wave 1 Enters Speed Challenge Set up Wave 2 Enters Phase 3 Wave 3 Enters Phase 2 Wave 4 Enters Phase 1
10:30	Wave 1 Enters Phase 4 Wave 2 Enters Speed Challenge Set up Wave 3 Enters Phase 3 Wave 4 Enters Phase 2 Wave 5 Enters Phase 1
10:45	Wave 1 Enters Photo Area Wave 2 Enters Phase 4 Wave 3 Enters Speed Challenge Set up Wave 4 Enters Phase 3 Wave 5 Enters Phase 2 Wave 6 Enters Phase 1

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11:00	Wave 1 Returns to table to await results Wave 2 Enters Photo Area Wave 3 Enters Phase 4 Wave 4 Enters Speed Challenge set up Wave 5 Enters Phase 3 Wave 6 Enters Phase 2 Wave 7 Enters Phase 1
11:15	Wave 1 Supporting Wave 6 Wave 2 Supporting Wave 7 Wave 3 Enters Photo Area Wave 4 Enters Phase 4 Wave 5 Enters Speed Challenge Set up Wave 6 Enters Phase 3 Wave 7 Enters Phase 2
11:30	Wave 1 Supporting Wave 6 Wave 2 Supporting Wave 7 Wave 3 Returns to Table Wave 4 Enters Photo Area Wave 5 Enters Phase 4 Wave 6 Enters Speed Challenge set up Wave 7 Enters Phase 3
11:45	Wave 1 Supporting Wave 6 Wave 2 Supporting Wave 7 Wave 3 Moves toward speed challenge for final Wave 4 Remains in speed challenge in the area for final teams Wave 5 Enters Photo Area Wave 6 Enter Phase 4 Wave 7 Enters Speed Challenge set up
12:00	Wave 1 In Speed Challenge Area Wave 2 In Speed Challenge Area Wave 3 In Speed Challenge Area Wave 4 In Speed Challenge Area Wave 5 In Speed Challenge Area Wave 6 Enters Photo Area Wave 7 Enters Phase 4

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12:00 Top vendors close
12:15 Wave 7 Enters Photo Area
All score sheets to judges

12:30 Group photo on stairs of diving boards

12:45-1:00 Concluding remarks: Kaitlin Baird/JP Skinner, Chris Brown
Participation awards: all teams
Awards ceremony: certificate presentation by Chris Brown

Waves

Wave 1	Wave 2	Wave 3	Wave 4
Somersfield Academy 1	Clearwater Middle 1	BHS	Somersfiled 3
Sandys 1	Bermda Home School Association 1	Warwick Academy 2	Sandys 2
Warwick Academy 1	Saltus 1	Somersfield 2	St. Georges Prep 1
	East End	Saltus 2	Clearwater Middle 2
Wave 5	Wave 6	Wave 7	
Clearwater Middle 3	Somersfield Academy 4	Clearwater Middle School 4	
Sandys 3	Saltus 3	Bermda Home School Association 2	
St. Georges Prep 2	Sandys 4	Saltus 4	
Warwick Academy 3	Warwick Academy 4		

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