Design your own underwater craft: Teacher instructions 

Imagine you are an engineer for Virgin Oceanic or WHOI. You and your team must develop a submersible that can reach Challenger Deep, 10,900 meters below the surface. **Draw up a blueprint to show your design idea**. Include a list of materials needed to build your submersible. The blueprint should indicate what parts are made of what materials if more than one type of material is used. Remember, a person and lots of cameras and other equipment must fit in there too! Incorporate ways for the passenger to see out and be able to record video while submerged.

\*\*\*You will **present** your Blueprint to the class and explain WHY you chose your materials and design.

 First, answer these **questions**: *these questions appeared in Modeling the Trieste activity. More detailed answers should be expected this time around.*

1. What do you, the designer, need to know about the machine before you can be sure it is safe to put in the water?

-*If it will float in the water,*

1. How can you find this information without actually putting the machine in the water?

*Calculate its density and compare it to the density of the sea water.*

1. If it does float, what must be done in order to make it sink?

*Add removable weight to it.*

1. How do you know how much weight should be added?

*Calculate the buoyant force (done in Trieste exploration) and add more weight than its buoyant force.*

1. What must be done to make the machine quickly return to the surface?

*Remove the weight using some kind of release mechanism and an upward thruster*

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| Materials: What kinds of materials support buoyancy?What kinds of materials will resist pressure? WHY? | *Plastic, Styrofoam, Wood, Syntatic Foam\** *Foams, Acrylic, soft plastics, Syntactic foam\***Due to the empty spaces between particles of foam, it will compress, but not break or buckle under extreme pressure. Syntactic foam\* is used in the Deepsea challenger because it is buoyant and maintains its shape and strength under pressure.* |
| Shape: What shapes are most buoyant?What shapes best resist pressure? How do you know?  | *Boat shapes or broad, flat shapes**Dome, conical, torpedo shapes**A ball of clay will sink, but when reshaped to be broad and flat can float. The windows of the Deepsea challenger are dome shaped so that the pilot can see out and the windows will not break under the extreme pressure.* |
| Will your sub be piloted or unpiloted?If piloted, where will the pilot sit?What equipment is in there with him/her?How much space should there be in order to stay buoyant and resist pressure?  | *The personnel sphere should be reinforced metal (steel or titanium) and will be located in the center of the craft since this will be the heaviest area. There cannot be much space or the craft will be too buoyant and susceptible to collapsing under pressure.**The pilot will need to see the screens from the video cameras outside the craft and a window to see out, needs controls to drive the craft, something that tells him how deep he is, a way to communicate with the surface, a way to drink water and receive recirculated oxygen.* |
| Orientation: What orientation (vertical/ horizontal) will be most buoyant and resist pressure? WHY? | *Having the craft torpedo shaped and oriented vertically, like the Deepsea Challenger, will make it go up and down faster because the shape reduces drag. However, the Trieste was shaped more like a boat and was oriented horizontally. I think this made it move up and down more slowly because the shape increases drag.* |
| Equipment and power source: Will your sub be tethered to a battery, or have a portable battery?How will the batteries be housed? | *It should not be tethered because it is going down 6 miles and that is too far. The battery should be a big lithium battery, or lots of little ones, surrounded by a protective layer of syntactic foam or oil like in the Deepsea Challenger so that it will resist pressure. Or a lithium polymer cell in( MTS Journal article)*  |
| Release mechanisms: What if you have to drop weight? How can this be done quickly? | Students can be inventive with this part of their design as there are many ways to implement a quick release mechanism. Brainstorm with them. |

Teacher Instructions:

Resources: Have students refer back to their project notebooks, in particular, the Under Pressure exploration “How Deep Can They Go?” <http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/oceanography_how_deep.html>

And the NOAA site for the list of different platforms with their specifications http://oceanexplorer.noaa.gov/technology/technology.html

Recall info from notes on Bill Nye episode on buoyancy: <https://www.youtube.com/watch?v=-U1YVZMifMM&feature=player_detailpage>

Students will:

Review the previously done exploration of how mass and volume effect density and buoyant force and observations gleaned during the “Designing Floats” activity.

Apply this knowledge when choosing materials, shape and orientation in design of their sub.

Actively brainstorm how they should design their submersible prior to drawing the blueprint. They can make mock-ups and fill out the attached sheet

If time allows, an introductory demo/ activity can be done to help students see how shape and orientation affect buoyancy. Using a ball of clay, the students can test the buoyancy of different shapes they mold. They can do this at home as well if you provide the clay and instruct them to write down their observations. This same demonstration is done in the Bill Nye episode on buoyancy but it may be helpful for students to do it themselves as well.

Have the students present the blueprints to the class as a way for them to elaborate on what they learned and how they connected it to the construction of the sub. They must provide the reasons for their choices in the design of their sub. The teacher can then evaluate the students based on what they say in their presentation and the blueprint they drew. The only materials needed are poster paper, rulers, pencils and imagination. While the dimensions of the design should be measured and proportionate, no calculations are necessary.

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| **Criteria** | **Points** |
| Materials list: Materials used supports connections to buoyancy and pressure resistance | 5 |
| Shape and Orientation: Supports connections to buoyancy and pressure resistance.  | 5 |
| Blueprint drawing: Student used a ruler, included details such as the relative size of compartments and what materials are used for each compartment, as well as any release mechanisms. The drawing is neat and legible and done on large paper.  | 10 |
| Presentation: The student can explain the logic behind their design and materials used in terms of buoyancy laws, pressure resistance and data/ sample collection. | 10 |