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| **Lesson Title** | Will it sink or will it float? |
| **Length of Lesson** | 2 days |
| **Created By** | Shane A Irvin |
| **Subject** | Geometry and MathSL |
| **Grade Level** | 9—12th |
| **State Standards** | Identify the difference between permutations and combinations and use them to solve real-world problems. |
| **DOK Level** | DOK3 |
| **DOK Application** | Inquiry, Building/Design, Focus |
| **National Standards** | Apply appropriate techniques, tolls, and formulas to determine measurements. |
| **Graduate Research Element** | The graduate element really is centered on the idea of how basic fluid statics works. In my graduate degree, flow rate and our ability to transport equipment on stream are imperative on how fast and accurately we sample. The boat can only hold so much equipment and this requires us to plan ahead. |

**Student Learning Goal:**
The students learning goal is to be established as using area and volume in current studies and apply the applications to basic physics and mechanic issues. The students will be focused on why area affects how much a floating object can hold in weight before sinking. At the same time there is a fine line in design where the boat covers too much area and the center of gravity gets too weak. This is the challenge presented to the students.

Using supplies given to them, the students will be required to design and build a floating apparatus that will be put into a contest with the rest of the class. The goal is to see which boat can hold the most weight, while also being the lightest and cheapest. Lightest will be determine by scales and cheapest will be determine by supplies used. Each supply will have a price tag on it and the students will be charged for every item they purchase.

**Materials Needed (supplies, hand-outs, resources):**
The needed material will be aluminum foil, pennies, wooden septums, cotton balls, writing utensil, water, huge bucket

**Lesson Performance Task/Assessment:**
The assessment for the lesson will be centered on the contest and the students' ability to stay within the acceptable parameter by not overspending a budget. Whatever the weight is will not be a determiner of assessment.

The students will be asked why they chose specific designs, what they think is special about the design, why they think their design will work, what their predictions are on their design and build?

These questions are not intended on being a gradable portion of this lesson but rather to get the students thinking about what they are doing and to really get them to make sure their design is serious and not something just thrown together for credit.

**Lesson Relevance to Performance Task and Students:**
The students have many forms of relevance to this lesson, in particular with irregular geometry and the study of area. Displacement is simply the study of a volume over a specific area. While their study of volume is not specifically strong, with help, the students can focus on the area aspect of displacement.

The students will be able to see a comparison in what they have done with irregular shapes in the past and apply it to their design. This free thinking process should allow the students the ability to think fast and come up with some great designs.

**Anticipatory Set/Capture Interest:**
The students will be show a few pictures of some amazing ships that float but yet weigh hundreds of thousands of pounds. There will also be water in a huge pail at the front of the class. This will for sure get the students attention as they will probably want to do hands on activities.

**Guided Practice:**
Guided Practice for this lesson will be broken into two days, with the first day concerning the lecture and the students designing process and testing. The second day will be the contest for the students. The contest has an entire day dedicated to it in case the students have to test multiple times during day one.

DAY 1: The students will be introduced to the lesson using pictures of big cruise ships and aircraft carriers. The students will be asked why they think the big heavy pieces of steal float. They will be asked for specifics on why they float. The hope is to get answers, like Styrofoam, or big tanks of air. The students will be surprised to learn that it has to do with the amount of area the boat covers that keep it afloat.

The advanced students will be shown the basic Archimedes principle.

$$\frac{\text{density of object}}{\text{density of fluid}} = \frac{\text{weight}}{\text{weight} - \text{apparent immersed weight}}$$

The students will be given the density of water and the object. They will do quick math and see how the equation works.
After this the students will start designing and building their floating apparatus. They will have the remainder of class to accomplish this.

DAY 2: The students will be allowed a short time to finish the building process and present the project and the cost of the project to the teacher. The students will then start to test their project.

Each team will get a set number of pennies and apply them to the apparatus on the water until the apparatus sinks. The pennies will be calculated minus one and that will be the teams' charted weight. The contest will go until all students have gone. The top two teams will be charted and will face off.

**Independent Practice:**
The students' independent practice will be the design and building process of their floating apparatus. The students will be on their own on this to try and spur creativity and design style.

Since Day 2 is only the contest, the independent practice will only take place on Day 1. The practice will consist of a paper drawing (design), the built apparatus, and a list of supplies used with the cost of the supplies (a mock price list will be given to the students)

**Remediation and/or Enrichment:**
Remediation:
In situations that remediation is needed the student can see the instructor for one on one tutoring. The student can also be paired with a high performing student with full understanding of the lesson.

Enrichment/Extension:
All of these extensions depend on the students' ability and knowledge of the subject matter. The student will have the opportunity to explain specifics about their boat, in particular area. If the students are advanced enough, they can explain what forces they feel are acting on the boat.
**Check(s) for Understanding:**
The students will be assessed after the lesson by asking them questions about density, displacement, and why they feel that area places a key role in displace. The students will answer the questions at the best of their abilities and will only be assessed on their ability to use deductive and inductive reasoning during the activity.

**Closure:**

The teacher can close the lesson by explaining why some boats floated and some sank. The teacher can create a spreadsheet and track the teams and plot a comparison for the students to see.

The graduate student will do the above as well as talk about how deductive reasoning is imperative in graduate research.

**Possible Alternate Subject Integrations:**
Physics

**Teacher Notes:**
The assigned rules worksheet is attached with this lesson plan. As well as a quick slide of pictures for the beginning of the lesson.