

Build a Boat: A Lesson in Density and Buoyancy (For Volunteers)

AGE GROUP: K-8

IDEAL DURATION: 45 MIN

SUPPORT NEEDS: 1 VOLUNTEER PER 5 CHILDREN



EMERSON RELEVANCY:

DIFFERENT OBJECTS FLOAT OR SINK IN VARIOUS FLUIDS

BASED ON SEVERAL FACTORS. THE DENSITY OF THE FLUID VS. THE DENSITY OF THE OBJECT IS THE PRIMARY PRINCIPLE WITH REGARD TO AN OBJECTS BUOYANCY. IF THE OBJECT IS LESS DENSE THAN THE FLUID IN WHICH IS IT SITTING, THE OBJECT WILL FLOAT. EMERSON DESIGNS PRODUCTS FOR A VARIETY OF INDUSTRIES. PROBLEM SOLVING AND CREATIVE THINKING ARE VERY IMPORTANT AS WE DO RESEARCH & DEVELOPMENT, ESPECIALLY WHEN WE ARE TRYING TO MAKE INDUSTRY CHANGING PRODUCTS. WE ARE GIVEN UNIQUE PROBLEMS EVERYDAY BY CUSTOMERS AND WE NEED TO BE ABLE TO DESIGN VERSATILE SOLUTIONS THAT REQUIRE A STRONG UNDERSTANDING OF ALL ENGINEERING PRINCIPLES. ENFORCE THESE IDEAS AS YOU SPEAK ABOUT THIS EXERCISE AND WHAT WE DO HERE AT EMERSON.

DESCRIPTION:

FOR THIS EXPERIMENT, WE WILL BE PERFORMING TWO ACTIVITIES. THE FIRST ACTIVITY WILL BE CALLED "SINK OR FLOAT?" INSTRUCTORS WILL ENGAGE STUDENTS BY HAVING THEM FILL OUT A SIMPLE CHECKLIST WITH A VARIETY OF OBJECTS AND IF THEY BELIEVE THOSE OBJECTS WILL SINK OR FLOAT. THE INSTRUCTOR WILL THEN PLACE EACH OF THE OBJECTS INTO THE WATER TO DETERMINE IF THE STUDENTS PREDICTIONS ARE CORRECT (CONCEPTS TO DISCUSS HERE ARE THINGS LIKE WEIGHT, SHAPE, VOLUME, AND ULTIMATELY DENSITY. FOR MORE ADVANCED STUDENTS BUOYANCY AND ARCHIMEDES PRINCIPLE CAN BE DISCUSSED). THE SECOND ACTIVITY WILL BE THE ACTUAL "BUILD A BOAT" ACTIVITY. IN THIS PART OF THE ACTIVITY, STUDENTS

WILL HAVE ACCESS TO VARIOUS BUILDING MATERIALS (SMALLER CHILDREN WILL ONLY HAVE ALUMINUM FOIL) WITH WHICH TO BUILD A BOAT TO HOLD MARBLES. WE ARE GOING TO HAVE THEM SPLIT INTO TEAMS AND BUILD ONE BOAT PER TEAM. ONCE THEY HAVE COMPLETED BUILDING THE BOATS WE WILL HAVE THEM PUT THE BOATS INTO THE WATER AND WE WILL LOAD MARBLES UNTIL THE BOAT SINKS. THE TEAM THAT MAKES THE BOAT THAT HOLDS THE MOST MARBLES WINS!

OBJECTIVE:

THE GOALS OF THIS ACTIVITY ARE FOR PARTICIPANTS TO UNDERSTAND THE CONCEPTS OF WEIGHT, VOLUME, DENSITY, BUOYANCY, AND WATER DISPLACEMENT (FOR THE MORE ADVANCED STUDENTS), TO DESIGN A WATERCRAFT THAT WILL SUPPORT A GIVEN AMOUNT OF WEIGHT, AND TO INCORPORATE THE SCIENTIFIC PRINCIPLES OF FORCE AND MOTION WITH ENGINEERING DESIGN.

SUPPLIES FOR BOATS:

- **CLEAR PLASTIC BINS TO FILL WITH WATER**
- **ALUMINUM FOIL**
- **MARBLES**
- **STRAWS**
- **CRAFT STICKS**
- **MASKING TAPE**
- **CONSTRUCTION PAPER**
- **DOWELS**

SUPPLIES FOR SINK OR FLOAT:

- **CLEAR PLASTIC BINS TO FILL WITH WATER**
- **SINK OR FLOAT WORKSHEET.**
- **MARKERS FOR FILLING IN WORKSHEETS.**
- **OBJECTS TO SINK OR FLOAT (OBJECTS ARE TBD)**

STEP-BY-STEP INSTRUCTIONS (FOR ACTIVITY LEADER):

- 1. HAVE THE CLEAR PLASTIC CONTAINERS PRE-FILLED WITH WATER.**

- 2. SETUP EACH TABLE TO CONTAIN ALL THE SUPPLIES NEEDED FOR THE BUILD A BOAT EXERCISE (FOR THE YOUNGER CHILDREN WE WILL ONLY BE USING ALUMINUM FOIL).**
- 3. HAND OUT THE SINK OR FLOAT WORKSHEETS TO EACH STUDENT IN THE CLASS ALONG WITH A MARKER.**
- 4. BEGIN TALKING ABOUT THE EXERCISE OF DETERMINING WHY CERTAIN OBJECTS SINK AND WHY OTHER OBJECTS FLOAT. HAVE THE KIDS MAKE PREDICTIONS ABOUT EACH OBJECT AND WHETHER IT WILL SINK OR FLOAT AND HAVE THEM MARK THEIR PREDICTION ON THEIR SHEET.**
- 5. TEST EACH OBJECT WHILE ENGAGING THE KIDS ON CONCEPTS OF WEIGHT, MASS, VOLUME, DENSITY, AND BUOYANCY (HAVING TWO OBJECTS OF THE SAME VOLUME BUT DIFFERENT WEIGHT IS VERY GOOD FOR DESCRIBING DENSITY). MAKE SURE THEY WRITE DOWN THE RESULTS OF THE TESTS. IF THEIR PREDICTIONS ARE CORRECT ASK THEM WHY THEY THOUGHT THAT, IF THEY ARE WRONG ASK THEM WHY THEY THOUGHT THAT AND CORRECT THEIR REASONING.**
- 6. THE LAST ITEM TO BE TESTED SHOULD BE THE ALUMINUM FOIL ITSELF. TRY MAKING THE ALUMINUM INTO A FEW DIFFERENT SHAPES TO SHOW THAT THE SHAPE OF THE OBJECT AFFECTS ITS DENSITY AND THEREFORE ITS BUOYANCY (A BALL OF ALUMINUM WILL SINK WHEREAS A PIECE FOLDED INTO A BOAT SHAPE WILL FLOAT).**
- 7. HAVE THE KIDS SPLIT INTO TEAMS TO DESIGN THEIR BOATS. HAVE THEM MAKE A TEAM NAME SO WE CAN TRACK WHO MAKES A BOAT THAT HOLDS THE MOST MARBLES. REMIND THEM THAT THEY CAN USE MATERIALS OTHER THAN JUST ALUMINUM FOIL TO AFFECT THE RIGIDITY OF THE FRAME WHICH WILL HELP IT HOLD MORE WEIGHT. GIVE THEM 10 MINUTES OR LESS TO DESIGN THEIR BOATS. IF THEY WANT TO TRY DIFFERENT DESIGNS THAT IS FINE AS LONG SOMEONE IS HELPING THEM LOAD THE MARBLES INTO THE BOAT.**
- 8. ONCE THE FINAL BOATS ARE READY WE CAN LOAD THE MARBLES TO SEE WHICH ONE HOLDS THE MOST MARBLES. CONTINUE TO REINFORCE THE IDEAS ABOUT BUOYANCY DURING THIS PART OF THE EXERCISE.**
- 9. AS EACH TEAM FINISHES WE WILL RECORD THE # OF MARBLES TO KEEP TRACK OF WHO WINS.**

ENGINEERING CONSTRAINTS:

- **15 MINUTES TO EXPLAIN/DEMO, 15 MINUTES TO BUILD, 15 MINUTES TO TEST/REDESIGN/RE-TEST**
- **GIVEN THE TIME CONSTRAINTS, THIS ACTIVITY SHOULD BE PERFORMED AS A GROUP EXERCISE SO THAT WHEN WE TEST THE BOATS IT DOES NOT TAKE TOO LONG.**

QUESTIONS FOR DESIGN THINKING:

1. **WHAT WAS THE MOST IMPORTANT PART OF YOUR DESIGN?**
2. **WHAT MATERIAL WAS LEAST EFFECTIVE FOR YOUR DESIGN?**
3. **WHAT MATERIAL COULD HAVE BEEN USED TO MAKE YOUR DESIGN BETTER? (THIS COULD BE A MATERIAL THAT WASN'T OFFERED)**
4. **WHAT WOULD YOU DO DIFFERENTLY NEXT TIME?**

OTHER RESOURCES:

1. Float or Sink: <https://youtu.be/nMIXU97E-uQ>
2. Steve Spangler (Coke vs. Diet Coke): <https://youtu.be/MzsORE0ae10>
3. Archimedes Principle: https://www.youtube.com/watch?v=_p-hwElkrIk
4. Science Max | Tinfoil Boat: https://youtu.be/Tn7_Pa6-Xs4

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OBJECTIVE:

THE GOALS OF THIS ACTIVITY ARE TO UNDERSTAND WHY OBJECTS SINK OR FLOAT AND TO DESIGN A BOAT THAT WILL HOLD AS MANY MARBLES AS POSSIBLE BEFORE SINKING.



ENGINEERING CONSTRAINTS:

- TIME AVAILABLE – 30 MINUTES
- MATERIALS AVAILABLE
 - ALUMINUM FOIL
 - MARBLES
 - STRAWS
 - CRAFT STICKS
 - MASKING TAPE
 - CONSTRUCTION PAPER
 - DOWELS

QUESTIONS FOR DESIGN THINKING:

- WHAT SHAPES WORK BETTER?
- WHAT MATERIALS ARE MORE BUOYANT?



