BOAT DESIGN

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Target Grade/Subject

FOCUS QUESTION: Can a solid piece of clay, which normally sinks in fresh water, be used to build a boat that will float and carry a cargo of a metal ore?

OVERVIEW: Students will design and build a clay boat that will carry the native ore from Marquette, Mi through the Sault Saint Marie Locks to the processing mill in Dearborn, Mi. The boat's cargo will be nickel sulfide (old copper pennies) and be restricted to the size of the locks 30 *cm* by 15 *cm*.

LEARNING OBJECTIVES

DESIGN CRITERIA:

1. Design a boat that will transport the cargo.
2. The boat must be able to pass through the Sabin Locks (411 *m* x 24 *m*)
3. Build a boat from the design that will carry the cargo.
4. Demonstrate the boat can carry the cargo.

BENCHMARKS: (Michigan)

- Math N.FL.07.07 Solve problems involving operations with integers.
- Social Studies 7-G4.2.1 List and describe the advantages and disadvantages of different technologies use to move people, products and ideas throughout the world.
- Science S.IP.07.12 Design and conduct scientific investigations.
- Science S.IP.0714 Use metric measurement devices in an investigation.

MATERIALS:

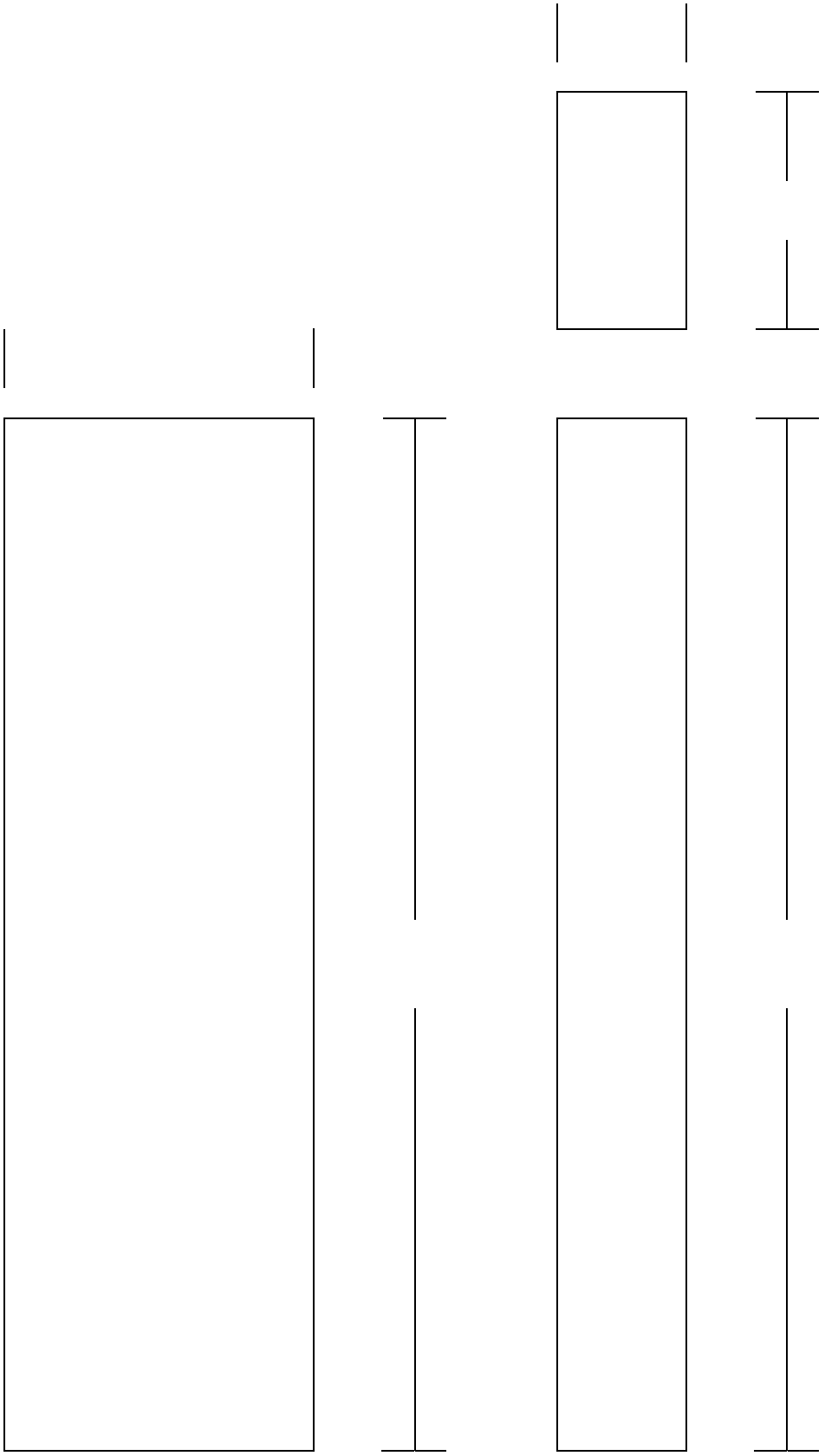
Florist clay 2*cm* x 2 *cm* x 10 *cm*	Aquarium filled with water
Metric ruler	50 pennies
Triple beam balance	rolling pin

VOCABULARY:

Buoyant Force	Pressure
Water displacement	Density

STUDENT INSTRUCTIONS:

1. Determine the clay's mass _____ *g*
2. Determine the clay's volume.
   Length = _____ *cm* Vol = Length *x* Width *x* Height
   Width = _____ *cm* Vol = _____*cm x* _____*cm x* _____ *cm*
   Height =_____ *cm* Vol = _____ cm^3
3. Calculate the density.
   Density = mass/volume Density = _____*g*/_____cm^3
   Density = _____ g/cm^3
4. Design a boat.
5. Show dimensions from three views
   Top View Side View Rear View



6. Calculate the area of the boat.
   Length = _____ *cm*
   Width = _____*cm*

   Area = Length *x* Width
   Area = _____ *cm x* _____ *cm*
   Area = _____ cm^2

7. Calculate the pressure of the boat.
   Force = _____*N*
   Area = _____ cm^2

   Pressure = $\frac{\text{Force}}{\text{Area}}$

   Pressure = $\frac{\_\_\_\_\_ N}{cm^2}$

   Pressure = _____ *p*

8. Use the boat diagram and construct a boat. Make sure the boat's dimensions math the dimensions of the diagram. When the boat is completely built, test the boat. Make any changes to will allow the boat to float. Show any changes on the boat diagram.

9. Test your boat. Carefully place the boat on the water. Carefully add the cargo, placing one penny in the boat at a time.

10. Count the total cargo. _____ pennies

Discussion Questions

1. How does the changing the boat's surface area affects the ability of the boat to increase the amount of cargo being transported?

2. Instead of using clay, what other materials could be used to build a boat?

3. Would a fully loaded boat float easier in the Atlantic Ocean or in the Great Lakes? Give the reason(s) for you answer.

4. Annually there is a cement canoe race on the Kalamazoo River. List the factors that are necessary to design a cement canoe that will float.

Assessment Rubric

Boat Design 10 pts

- Will fit through the Sault Ste. Marie Locks (Sabin Locks) (4pts)
- Complete design (using metric measurements) (6pts)
  Top View (2pts)
  Side View (2pts)
  Rear View (2pts)

Boat Construction 10 pts

- Built to design
  Length (2pts)
  Width (2pts)
  Height (2pts)
- Floats empty (4pts)

Carries Cargo 10 pts

- Full cargo 50 pennies (10pts)
- 45 – 49 pennies (9pts)
- 40 – 44 pennies (8pts)
- 35 – 39 pennies (7pts)
- 30 – 34 pennies (6pts)
- less tan 30 pennies (5pts)

Questions 10 pts

- Question #1 (2pts)
- Question #2 (2pts)
- Question #3 (2pts)
- Question #4 (4pts)

Total points 40