15th International Mathematics and Science Olympiad (IMSO)

SCIENCE EXPERIMENT

Zhejiang Province, China
28 September - 4 October 2018

PART II

MAXIMUM VOLUME OF THE CARGO

Archimedes Principle has very important applications with regards to boats and ships floating on water and the maximum cargo that can be loaded. In general:

Mass of the boat and cargo $\leq$ Mass of the water that the boat displaced

In this experiment, design and conduct an experiment in order to determine the maximum volume of a precious kind of sand that can be carried by your small plastic boat on fresh water (density = 1.0 g/ml) before the boat sinks so as to decide the storage space required (and of course, your sand must stay dry). You are given only a small sample of the precious sand as well as the following items below to carry out your test. Remember, your sample of sand should not touch the water as it will take extremely long to dry!

✓ Plastic cup containing a small sample of the sand
✓ Boat (Plastic container that floats on water)
✓ Standard masses and paper clips
✓ Electronic mass balance
✓ 100 ml measuring cylinder, 250 ml measuring cylinder
✓ 250 ml beaker
✓ 30 cm Ruler
✓ Water
✓ Plastic container (for testing)
✓ Cloth (for drying)

AIM OF THE EXPERIMENT

The aim of this experiment is to design the procedure, conduct the experiment, and determine the maximum volume of sand that can be carried by the boat.
In your plan, write down the measurements and apparatus used very clearly including any necessary calculations. **You need not use all the apparatus given.**

QUESTIONS:

(a)   Sea water has a slightly higher density than water (about 1.03 g/ml). Would you expect the volume of sand that can be carried to be smaller than, equal to or larger than the volume you determined for fresh water in your previous design? Explain.

(b)   Your boat is to transport the sand across the seas (salt water) but the harbors between the two ports contains fresh water. Will it be better to carry out the test still using fresh water or should salt water be used or should both be used and determine the average? Explain briefly.

PART II: MAXIMUM CARGO

Design:

PART II: MAXIMUM CARGO

Results:

QUESTIONS:

(a)   Sea water has a slightly higher density than water (about 1.03 g/cm^3). Would you expect the volume of sand that can be carried to be smaller than, equal to or larger than the volume you determined for fresh water in your previous design? Explain.

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(b)   Your boat is to transport the sand across the seas (salt water) but the harbors between the two ports contains fresh water. Will it be better to carry out the test still using fresh water or should salt water be used or should both be used and determine the average? Explain briefly.

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