15th International Mathematics and Science Olympiad (IMSO)

SCIENCE EXPERIMENT

Zhejiang Province, China
28 September - 4 October 2018

PART I

FLOATING AND SINKING

Introduction:

Archimedes of Syracuse (c. 287 - 212 BC) was an ancient Greek mathematician, physicist, engineer, inventor, and astronomer. Archimedes is considered as one of the greatest mathematicians and inventors of all time. Sometime around 250 BC, he discovered a very important relationship between the upward buoyant force of an object immersed in a fluid and the weight of the fluid that is displaced by the object. This is known as Archimedes' Principle.

Archimedes' Principle states that the upward force (known as the buoyant force) an object immersed in a fluid has is equal to the weight of the fluid displaced.

$F_{buoyant}$ on object = W_{fluid}
$= m_{fluid}\, g$ (where g = acceleration due to gravity $\approx$ 10 m/s^2)
$= \rho_{fluid}\, V\, g$ (where ρ_{fluid} = density of the fluid, V = volume of the fluid displaced)

AIM OF THE EXPERIMENT

The aim of this experiment is to determine the density of an unknown liquid X using Archimedes' Principle.

WHAT YOU WILL NEED

- ✓ Iron stand with clamp
- ✓ Spring balance
- ✓ 250 ml graduated cylinder
- ✓ 250 ml Beaker
- ✓ A pair of scissors
- ✓ String
- ✓ Modelling clay
- ✓ Beaker containing Liquid X
- ✓ Cloth/paper towels (for drying)

Note:

Be careful when handling glasswares. Broken glasswares will result in deductions.

Do not drink or taste liquid X.

Do not eat or taste the modelling clay.

WHAT YOU WILL DO

1. Use your spring balance and measure 50 g of modelling clay.

2. Use the graduated cylinder to measure the volume of the plasticine (*V*). Record all measurements in the space provided in your answer booklet.

3. Attach the 50 g plasticine again to the spring balance. Fill a beaker with 250 ml of liquid X and lower the spring balance so that the modelling clay is completely submerged in liquid X, but not touching the beaker. (Refer to set up)

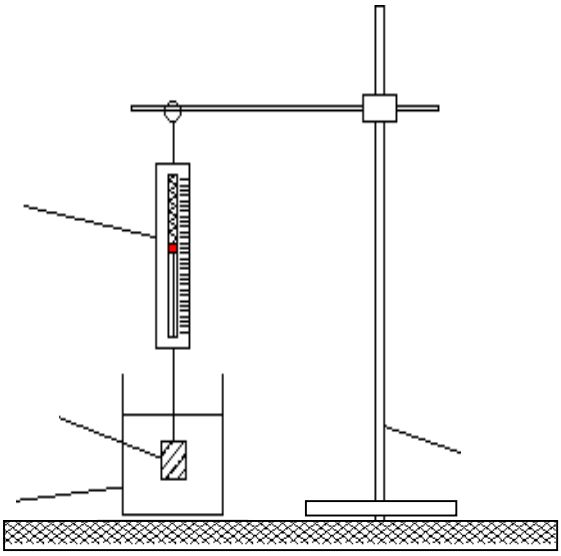
4. Record the new mass of the modelling clay on the spring balance.

5. Determine the mass of liquid X displaced by the modelling clay (m_X) by calculating the difference in the mass reading of the plasticine before and after submerging in liquid X.

7. Repeat steps 1 to 5 using 70 g and 100 g of modelling clay.

8. Plot a graph of mass of liquid displaced against volume of modelling clay on Graph 1.

Set-Up:



QUESTIONS:

(a) What is the correlation between the mass of liquid X displaced and volume of the modelling clay?

(b) From this relationship, how do you determine from your graph the density of liquid X? Calculate the density of liquid X?

(c) From your measurements, what values do you plot in order to determine the density of the modelling clay? Plot the values on Graph 2. From your graph, calculate the density of the modelling clay.

(d) Will this experiment work for masses that float partially in the liquid? Explain briefly and state the modifications needed.

Answer Sheet

PART I: FLOATING AND SINKING

RESULTS

Table of Readings:

Volume, V (ml)	Mass of modelling clay in air (g)	Mass of modelling clay in liquid X (g)	Mass of liquid X displaced, M_X (g)

QUESTIONS

(a) What is the correlation between the mass of liquid X displaced and volume of the plasticine?

[2 points]

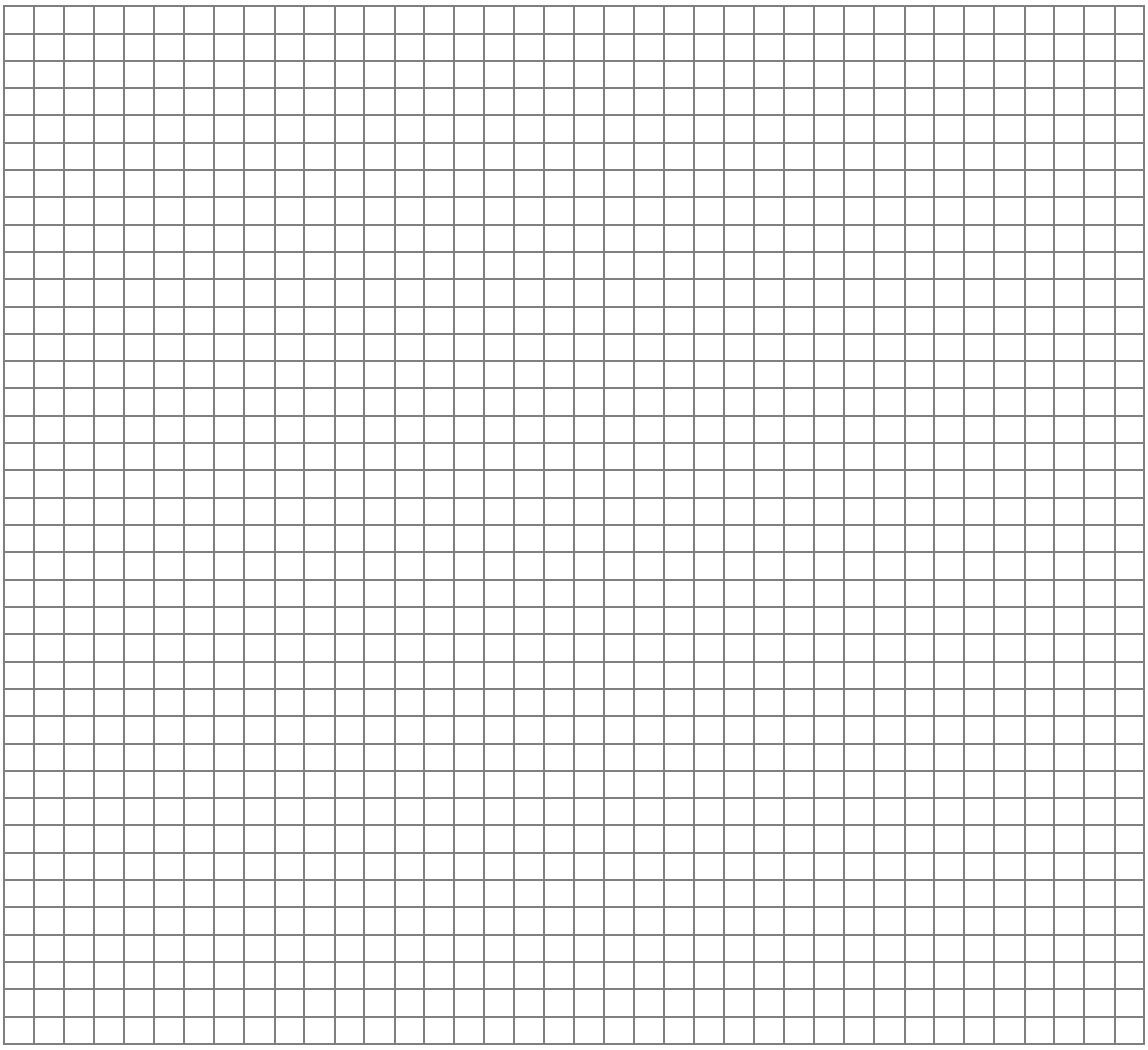
(b) From this relationship, how do you determine from your graph the density of liquid X? Calculate the density of liquid X?

[3 points]

(c) From your measurements, what values do you plot in order to determine the density of the modelling clay? Plot the values on Graph 2. From your graph, calculate the density of the modelling clay.

(d) Will this experiment work for masses that float partially in the liquid? Explain briefly and state the modifications needed.

GRAPH 1: FLOATING AND SINKING



GRAPH 2: FLOATING AND SINKING