22nd International Mathematics and Science Olympiad (IMSO)

Group and Individual Experiment Test

Kedah, Malaysia
07 October 2025

Instructions:

1. Do not turnover this page until you are told to do so.
2. Write your ID Number and Seat Number on each space provided in the answer sheet.
3. Write your answer only on the separate answer sheet. There are 6 pages in the answer sheet.
4. Follow all the instructions carefully.
5. There are **two experiments** in this test. Make sure to answer BOTH papers to get full points.
6. For the group experiment: **ONLY** the procedure of the experiment is done by group. The paper must be answered **individually**.
7. Complete all the sections in English. There are **Section I, II** and **III** for the Group Experiment and **Section I, II,** and **III** for the individual experiment.
8. The marks awarded for each section or question is shown in brackets, [ ].
9. There are 6 printed pages in this booklet, excluding this cover page.
10. You have 120 minutes to complete this test.

INDIVIDUAL EXPERIMENT

Why do Ships Float?

Objectives

1. To demonstrate that **average density** (mass ÷ volume) determines flotation, not just the material's density.
2. To compare the flotation behavior of two equal-mass clay models
3. To apply Archimedes' Principle to explain why large ships float even though they are made of heavy materials like steel.

Materials

A. modelling clay
B. 250mL beaker
C. 500mL water

Procedure

NOTE: You are given forty-five (45) minutes to accomplish this experiment, after this you will be directed to work on your group experiment.

1. Make two (2) equal mass models from clay.
    a. Model **A** should be a compact clay ball or block.
    b. Model **B** should shape the same mass of clay into a boat-like hull. Ensure there are no holes.

2. Fill the beaker with water until the 150 mL line. Submerge each model fully (without touching sides). Record displaced volume by subtracting initial level from final level.

3. Place Model A and B gently into a beaker of water.

4. Observe which model floats or sinks.

5. Do 3 trials each for Model A and B.

6. Compute for the Average Density.

Average Density = Mass ÷ Displaced Volume.

Section I. Data Table

Table 1. _____

Trial for Model A	Mass (g)	Displaced volume (cm^3)	Average density (g/cm^3)
1	20.0		
2	20.0		
3	20.0		

Table 2. _____

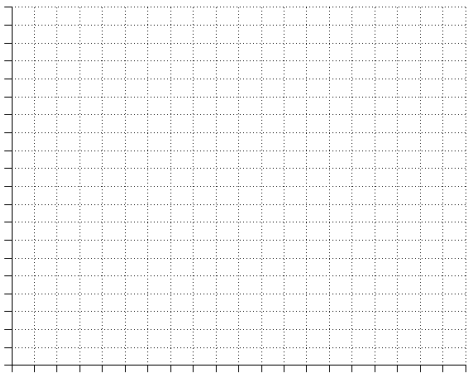
Trial for Model B	Mass (g)	Displaced volume (cm^3)	Average density (g/cm^3)
1	20.0		
2	20.0		
3	20.0		

Table 3. _____

Model	Observation after submerging the model
A	
B	

Section II. Graph

Plot a graph comparing the average densities of Model A and Model B. Then, Draw a horizontal line at 1 g/cm³ (density of water) to show which objects float (below line) and sink (above line).



Section III. Guide Questions

1. A steel block sinks in water, but a steel ship with the same mass of steel floats. Explain why.

2. Define **average density** and explain its relation to flotation.

3. In this experiment, why did the hollow model float while the solid model sank? Use Archimedes' Principle.

4. Identify two possible sources of error and suggest one improvement.

5. A loaded ship sinks deeper into water compared to when it is empty. Why does this happen, and when will it eventually sink?

6. Using your graph, predict whether a new clay model with average density **0.9 g/cm³** will float or sink. Explain.

THIS IS NOT YET THE END OF YOUR EXPERIMENT TEST
TURN TO **PAGE 4** FOR THE GROUP EXPERIMENT

GROUP EXPERIMENT

How Enzymes Make Reactions Faster

Objective

This experiment aims to test how different amounts of yeast affect the speed of balloon inflation when hydrogen peroxide breaks down and to connect this reaction to real-life applications.

Materials

A. A cup of 360mL of 3% hydrogen peroxide
B. A packet of active dry yeast
C. Warm water
D. Three identical clear plastic bottles
E. Three balloons
F. 10 mL graduated cylinder
G. ruler (in cm), stopwatch, marker, small cups

Procedure

By Group:

Note 1: The warm water will be distributed to your group by the invigilators.

1. Using the bottles you used in the first experiment, label the bottles as **A**, **B**, and **C**. Then, pour 120 mL of hydrogen peroxide into each bottle.

2. Label the small cups as **A**, **B,** and **C**. In the three small cups, prepare the yeast mixtures. Stir each cup 5–10 seconds.

	Content of the cup
Cup **A**	10 mL warm water
Cup **B**	¼ tsp yeast + 10 mL warm water
Cup **C**	1 tsp yeast + 10 mL warm water

3. Quickly pour the content of cup **A** into bottle **A**, immediately stretch the balloon over the mouth of the bottle and start the stopwatch. Record height at 0, 1, 2, 3, 4, 5, 6 min. **Record everything on the data sheet.**

Note 2: Measure balloon height from the bottle mouth to the highest point of the balloon (cm).

4. Repeat for Cup **B** and **C**.

Individually:

5. Draw a line graph of your result.

6. Compute for the initial rate for each condition using the first two minutes.

Initial rate = (height at 2 min – height at 0 min) ÷ 2

Section I. Data Table

Table 1. _____

Time (min)	Bottle A (cm)	Bottle B (cm)	Bottle C (cm)
0			
1			
2			
3			
4			
5			
6			

[1 mark]

Table 2. _____

Time (min)	Observation after 5 minutes
A	
B	
C	

[1 mark]

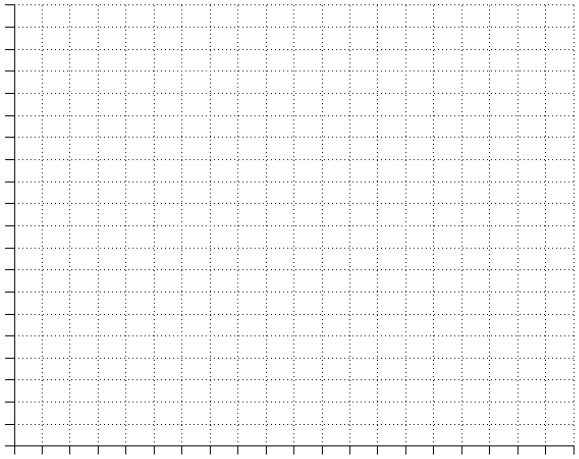
Table 3. _____

Time (min)	Height at 2 min	Height at 0 min	Initial Rate
A			
B			
C			

[1 mark]

Section II. Graph

Graph your results on the answer sheet.



Section III. Guide Questions

1. Which bottle acted as the control?
2. Using the initial rate, which balloon inflated fastest?
3. Which reached the highest final height at 6 min?
4. By what percent did the fastest initial rate exceed the Control? Assume that the initial rate of the control is 0.7.
5. Based on this experiment and your knowledge of biological catalysts, provide a detailed scientific explanation for your observations during the experiment.
6. Identify two (2) possible sources of error for this experiment.
7. Why do our bodies need the enzyme catalase, and what might happen if we did not have it?
8. When doctors use hydrogen peroxide to clean small wounds, why do bubbles appear?
9. Yeast is also used in bread-making. How is the gas released in bread different from the gas produced in this experiment?

--- END OF EXPERIMENT TEST ---