Investigative Skills in Science
Research Proposal Form

Project Title: Investigation of the effect of salt concentration on the buoyant force of a miniature ship

Class	**S2-07**	**Group:**	**E**

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Type of research:		
X	1	Test a hypothesis: Hypothesis-driven research The miniature vessel will have a higher buoyant force when floating on salt water compared to fresh water
	2	Measure a value: Experimental research (I)
	3	Measure a function or relationship: Experimental research (II)
	4	Mathematical modelling: Theoretical sciences and applied mathematics
	5	Observational and exploratory research

Category of research:	**Sub-category:**
Environmental Engineering (ENEV)	Water resources management (ENEV)
Reference	https://www.societyforscience.org/isef/categories-and-subcategories/all-categories/

Links to Sustainable Development Goals

Which of the 17 United Nations Sustainability Development Goals are you trying to address in this project? (You may indicate more than 1 goals)					
	1	No poverty		10	Reduced inequalities
	2	Zero hunger	X	11	Sustainable cities and communities
	3	Good health and well-being		12	Responsible consumption and production
	4	Quality education		13	Climate action
	5	Gender equality		14	Life below water
	6	Clean water and sanitation		15	Life on land
	7	Affordable and clean energy		16	Peace, justice and strong institutions
	8	Decent work and economic growth		17	Partnerships for the goals
X	9	Industry, innovation, and infrastructure			

Describe briefly the local or global issues that you are trying to solve in about 100 words.

In this investigation, we will be trying to innovate further in the shipping industry and how time and money could be saved by targeting the root of the problem, the design of the ships. By researching the effect of salt concentration on the buoyant force of a miniature ship, we could translate it to real life and try to build ships with higher efficiency, speed, and lower costs.

Research Plan

Project Title: Investigation of the effect of salt concentration on the buoyant force of a miniature ship.

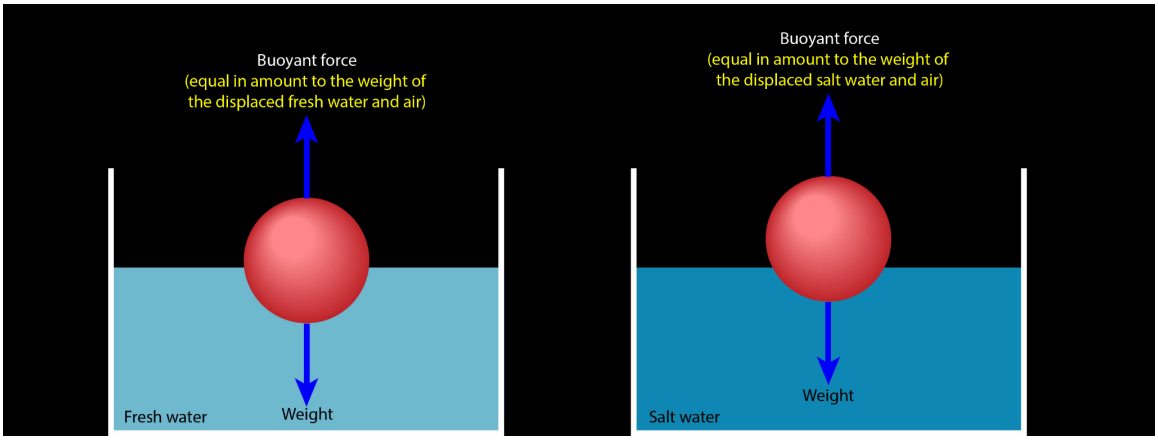
1. INTRODUCTION:

For thousands of years, we have used ships to transport people or objects. The volume of the ocean is over 1.37 billion cubic kilometres (Garrison, Tom S. Oceanography, 2005). With different seas around the entire world. With over 14 trillion US dollars worth of shipping trades (International Chamber of Shipping, 2022) , hundreds of thousands of ships pass through our ocean every single year. COVID-19 has shown that shipping and transport by sea is essential to our development and prosperity as a country. With this comes different salinity levels around the ocean, affecting the efficiency and speed of the vessel. Our earth has two significant kinds of water: saltwater and freshwater, which comprise 97.5% of the earth's water and 2.5% respectively (United States Environmental Protection Agency, 2015). Salinity describes how much salt is dissolved in a sample of water. The more salt dissolved in the water, the greater its salinity.

Therefore there are differences between the two water types, which directly impact the buoyancy of an object or vessel, affecting the speed and seaworthiness of the ship. We can use our research to better manage ballast water and may be able to find a solution to the massive ecological problems due to the different species spread throughout the world. Ballast water is crucial for the safe operation of ships. It is used to adjust the distribution and overall weight of the vessel to keep the vessel floating upright and in a safe, stable condition. Ballast water is used to compensate for different cargo loads that a ship may carry at other times, including changes in weight during loading and unloading. It also provides stability and manoeuvrability during a ship's voyage (Clear Seas Centre, 2021). This will lead to invasive species and the destruction of ecosystems. So with this research, we could potentially solve the problem using buoyant force and managing ballast water much better. Additionally, submarines manipulate buoyancy to sink and float. It uses ballast tanks to do this, when they want to sink they open up the ballast tanks of the submarines to let water in and let air escape, decreasing the buoyant force of the submarine and allowing it to sink. We could use our results of this investigation to aid the calculations of such processes (Nur Afande bin Ali Hussain, 2009)

For this study, the aim is to find out how the concentration of saltwater affects the buoyancy of a miniature ship using measurements. This study adopts a theory-based perspective with actual results from practical experiments using miniature vessels in a controlled environment. The only variable that changed was the salinity of the water. However, not many papers specifically explain the effects of salt concentration on buoyancy but how the water's salinity affects the object's density resulting in a buoyancy change. It has been found the higher the salt concentration of the water, the more the mass and, therefore denser (The University of Hawaii at Manoa, 2022). Thus a higher salt concentration, the higher the buoyant force of the vessel. Although this is a recognized fact, there are no detailed studies on how such information could help the shipping industry or how its ecological effects on the environment could be reduced.
(The formula for buoyant force is, $F_b=p_gv$. F_b=buoyant force. p=fluid density. g=acceleration due to gravity. v=Find volume.)

Thus, these studies have shown that the higher the salt concentration of the water, the higher the buoyant force on the vessel.



From: Lou Bloomfield, 2016

Fig 1: Shows how the buoyant force of the object is more when the object or vessel is on saltwater compared to freshwater. However, in order to verify our hypothesis, we will have to do an experiment to make sure the results are accurate and true.

1.4.2 Research Questions

Our Research Question is as follows:

How does the salt concentration of water affect the buoyant force of a miniature vessel?

1.4.3 Research Hypotheses

We decided to test the following hypothesis:

H1: We hypothesize that when the salt concentration of the water increases, the buoyant force acting on the miniature ship also increases

1.4.3.1 Independent variable

The independent variable is the salt concentration of the water.

1.4.3.2 Dependent variable

The dependent variable is the buoyant force acting on the vessel on saltwater and freshwater.

1.4.3.3 Controlled variables

(a) The sampling data should have the same environment (E.g. No wind)

(b) The sampling data should be taken from the same miniature vessel

(c) The sampling duration of the experiment should be the same

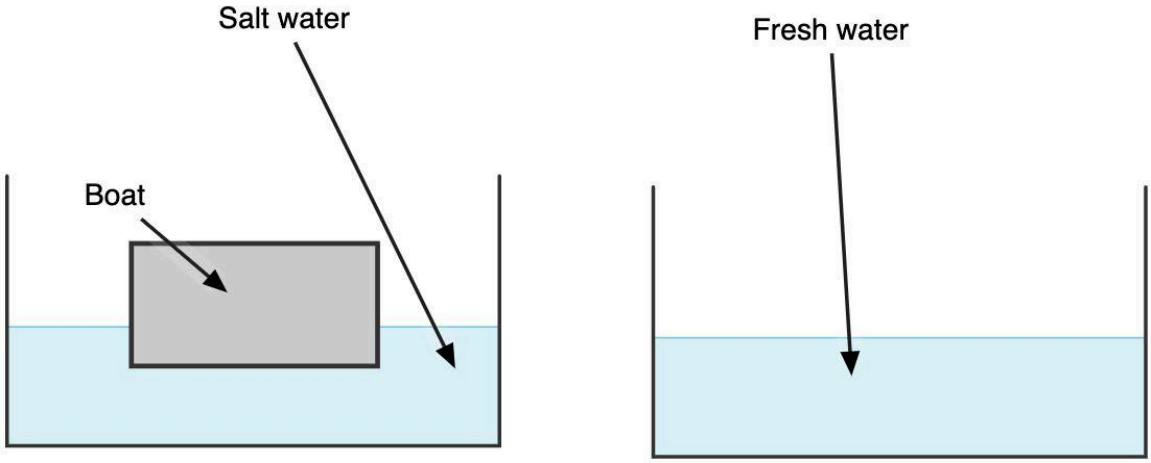
(d) The amount of water in the container

2. Method

2.1 Equipment list:

- 3 litres of pure water with a salinity level of 0
- 1x 2 litre container with marking at the said in 1cm increments(Using the 20cm ruler)
- 1x plastic miniature vessel
- 20cm ruler
- Salinity meter
- Electronic scale
- 1 litre Measuring beaker
- 300g of sea salt
- 1 stirring rod
- Towel
- Marker

2.2 Diagrams



(made in https://chemix.org/)

Figure 1: Experimental setup

2.3 Procedures: Detail all procedures and experimental design to be used for data collection

1. Place the container on a flat surface.
2. Measure the mass of the plastic miniature vessel using the electronic balance.
3. Measure 3 litre of water using the measuring beaker.
4. Pour 3 litre of the water into the two litre container.

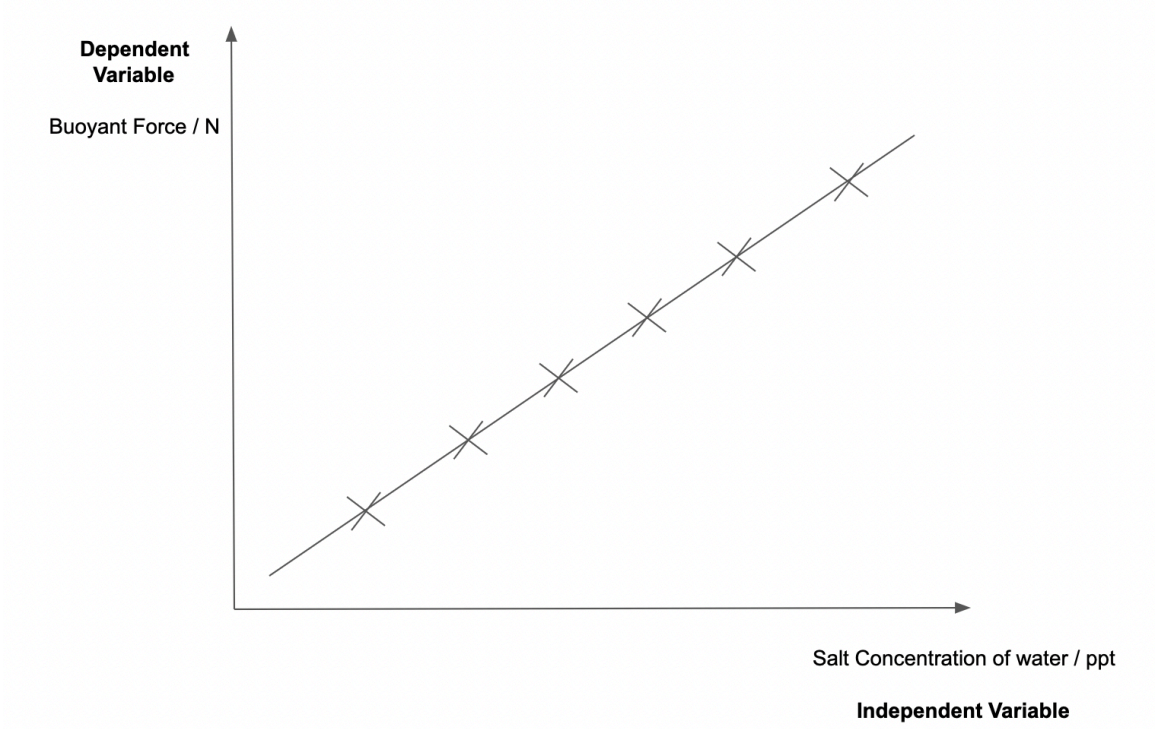
5. Use the salinity meter to measure the water to make sure no salt is present.
6. Place the miniature plastic vessel into the water
7. Use the measurements in cm on the side of the container to see the volume of which the vessel is submerged and record it.
8. Take out the miniature vessel and dry it with a towel.
9. Place the vessel in the water two more times and record the water displaced.
10. Using these results find the buoyant force three times using the densities given in the last step. (Buoyancy force is calculated through $F_b=V_{pg}$, V is the volume of the object, p is the density of the fluid and g is gravitational acceleration)
11. We will take p to be 1g/ml, and take gravitational acceleration as 9.81 Newtons/kilogram to find the buoyant force
12. After calculating the buoyant force 3 times, find the average buoyant force
13. Repeat steps 2 to 12 five more times, however changing it so different quantities of salt are added each time, 105g of sea salt, 120g of sea salt, 135g of sea salt, 150g of sea salt and 165g of sea salt. Additionally, pour out the water that was used in the last experiment and use a towel to dry the container.
    (Use the electronic balance to measure the mass of the salt each time the experiment is repeated and use a stirring rod to make sure all salt is dissolved in the water)
14. Tabulate and plot the graph of all 6 results and find out the effect of salt concentration on the buoyant force of a miniature ship

2.4 Data Analysis: Describe the procedures you will use to analyze the data / results.

15. Tabulate the data and calculate the average buoyant force acting on the miniature vessel:

Experiment	Independent variable	Dependant variable			
	Salt Concentration / ppt (Parts per thousand)	Buoyancy Force / N (newtons)			
		Reading 1	Reading 2	Reading 3	Average
1	0				
2	105				
3	120				
4	135				
5	150				
6	165				

16. Below is a graph of the average buoyant force of the miniature vessel against the salt concentration of the water.



17. From the graph, we can find out the effect that the salt concentration of the water affects the buoyant force of the miniature vessel.

2.5 Risk, Assessment and Management: Identify any potential risks and safety precautions to be taken.

Table 1: Risk Assessment and Management table

Risk	Assessment	Management
As we are handling and using salt, there is a chance it enters the eyes and causes sufficient pain to the individual.	Low	Be alert when handling salt. Wear safety goggles to prevent the salt from entering the eyes if it enters the eyes. Immediately head to the eyewash and other group members to alert the teacher.
As we are handling water, there is a possibility that the water could spill on electrical appliances and potentially cause a fire	Medium	Be alert when handling the water. Take precautions to prevent the water from spilling. For example, be careful when handling and moving the containers of water.
As we are handling water, there is a possibility that the water could spill on electrical appliances and deliver a shock to the student	Medium	Be alert when handling the water while moving around.
As we are handling a glass measuring beaker, there is a chance we could break the glass.	Low	Use proper lifting and moving techniques. Hold the glass firmly in your hands. Gently place the glass object on the hard surface.

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