Investigative Skills in Science
Research Proposal Form

Project Title: Investigation of the effect of different salt concentrations on the freezing point of water.

Class	**S2-0**	**Group:**	**A / B / C / D / E / F / G / H / J / K / L / M / N**

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Type of research:		
	1	Test a hypothesis: Hypothesis-driven research
	2	Measure a value: Experimental research (I)
X	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:**
Physics	**Other(OTH)**
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		11	Sustainable cities and communities
	3	Good health and well-being		12	Responsible consumption and production
	4	Quality education	X	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
	9	Industry, innovation, and infrastructure			

Describe briefly the local or global issues that you are trying to solve in about 100 words.
Our study is on the effect of salt concentrations on the freezing point of ice. This is important for the formation of ice in the winter in the North pole regions, as changes in Salinity will cause ice caps to form or disappear.

Research Plan

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1. INTRODUCTION:

Global warming is the long-term heating of Earth's climate system observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere (NASA, 2022). It is the cause of sea ice in the north pole to start melting.

Global warming has become such a big global threat that it has caught NASA's attention, in which they are now looking into global warming. Since the pre-industrial period, human activities are estimated to have increased Earth's global average temperature by about 1 degree Celsius, a number that is currently increasing by 0.2 degrees Celsius per decade (NASA, 2022). Because of this, sea ice has been decreasing in extent and thickness. (Maggy Hunter Benson,2022). On the other hand, the water level on seas is rising quickly. By 2040, Arctic sea ice may disappear altogether during the summer months (Maggy Hunter Benson,2022).

In this experiment, we are trying to determine if salt concentration can affect the freezing point of water. This could allow us to discover a new way to prevent the Arctic sea ice from melting, thus preserving the habitats of many animal species.

The bright surface of sea ice reflects a lot of sunlight out into the atmosphere and, importantly, back into space. Because this solar energy "bounces back" and is not absorbed into the ocean, temperatures nearer the poles remain cool relative to the equator(NOAA, 2021). This will also help to reduce the rate of rising sea levels. Glaciologists believe that, despite the massive ice loss, we do still have time to save the glaciers from their predicted disappearance. This will also help reduce the effects of these 4 problems, Sea level rise: Glacial melting has contributed to rising sea levels by 2.7 centimeters since 1961. Furthermore, the world's glaciers contain enough ice — about 170,000 cubic kilometers — to raise sea levels by nearly half a meter, Impact on the climate: Glacial thawing at the poles is slowing the oceanic currents, a phenomenon related to altering the

global climate and a succession of increasingly extreme weather events throughout the globe, Disappearance of species: Glacial melting will also cause the extinction of numerous species, as glaciers are the natural habitat of a number of animals, both terrestrial and aquatic and Less freshwater: The disappearance of glaciers also means less water for consumption by the population, a lower hydroelectric energy generation capacity, and less water available for irrigation(IBERDOLA,2022).

SALINITIES OF H20-SALT inclusions are most often determined by measuring the melting temperature of the ice in the inclusion and then referring this value to an equation or table describing the relationship between salinity and freezing-point depression. In the low-salinity range (less than about 10 wt%) the difference between the results of HALL et al. (1988) and previously published data for H20-NaCl is small, and the equations of POTTER et al. (1978) and HALL et al. (1988) agree within +O. 1 “C or +O. 1 wt%. However, the equations Of POTTER et al. (1978) and HALL et al. (1988) begin to diverge at higher salinities, and the magnitude of the difference increases with increasing salinity (Fig. 1; see also HALL et al., 1988, their Fig. 5). Based on their new experimental data, HALL et al. (1988) presented an equation relating to freezing temperature and salinity. Salinity = 0.00 + 1.78 θ -0.0442θ^2+0.00557θ^3, (1) where θ is the depression of the freezing point in degrees Celsius. Table 1 may be used to obtain the salinity corresponding to a measured freezing temperature for any temperature between 0.0 and the eutectic temperature of -21.2” C (Bodnar, R.J.,1993).

In a nutshell, salt is a great ice melter because it causes “freezing point depression.” This means that salt helps in lowering the freezing point and, consequently, the melting point of water (the main component of snow and ice). In its pure state, water freezes at 0°C or 32°F. By using salt, that freezing point can be lowered which forces the ice to melt and prevents the water from freezing or re-freezing. With 10% salt solution, water freezes at 20°F (-6°C) With 20% salt solution, water freezes at 2°F (-16°C) It must first be combined with water to start the melting process. Fortunately, ice and snow are generally covered with a thin film of water. As salt touches this water, it starts to dissolve – subsequently lowering the freezing point and melting the ice surrounding it (Kissner, 2019).

Hence these studies indicate that the salinity of water affects the freezing point of water. If this hypothesis holds, we would have a convenient way of knowing how fast the polar ice caps would melt as global temperatures increase, and we could use this to reduce the rate of the polar ice caps melting by getting rid of or increasing salt levels. However, to verify our hypothesis, we would need to experiment to show the relationship between salinity and the melting point of water.

1.4.2 Research Questions

Our Research Question is:

How do different salt concentrations affect the freezing point of water?

1.4.3 Research Hypotheses

Our hypothesis is that the freezing point of water will decrease as the salt concentration increases.

1.4.3.1 Independent variable

The independent variable is the salt concentration in the water.

1.4.3.2 Dependent variable

The dependent variable is the freezing point of water

1.4.3.3 Controlled variables

a) The location of the sampling should be the same

b) the amount of water in each sample should be the same.

c) The sampling period should be around the same time.

d) Type of container should be the same

2. Method

2.1 Equipment list:

- Temperature sensor x9
- Table salt (500g) x2
- metal containers x 9
- Refrigerator (-22 degrees Celsius)
- Electronic balance
- 2 pairs of cryo gloves
- 2 pairs of thongs
- pencil x9
- foam box (can carry 3 metal containers) (only required if the refrigerator is not allowed)
- a canister of liquid nitrogen (only required if the refrigerator is not allowed)
- lab coat x2 (only required if the refrigerator is not allowed)
- goggles x2 (only required if the refrigerator is not allowed)

2.2 Diagrams

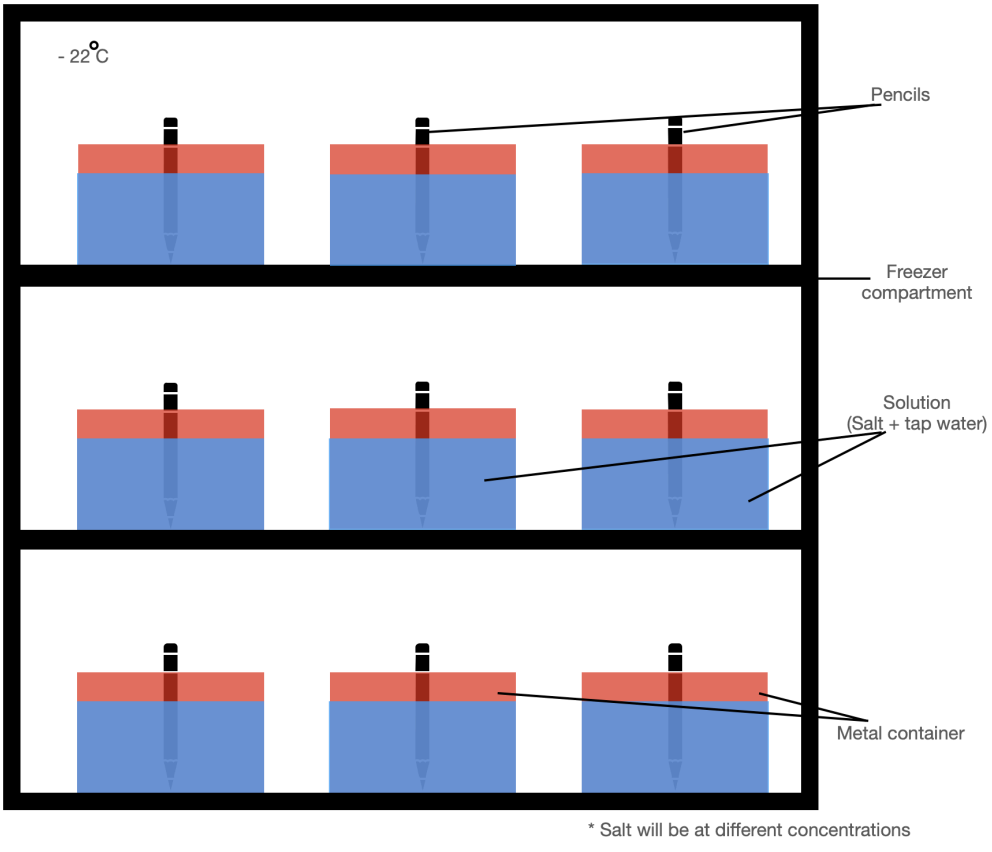


Figure 1: Experimental setup (using refrigerator)

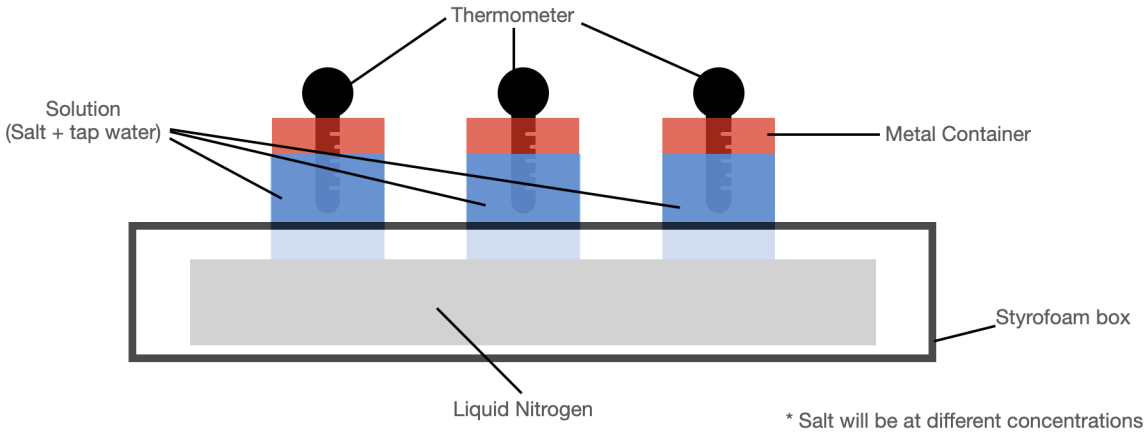


Figure 2: Experimental setup (using liquid nitrogen)

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

procedure b is if the refrigerator is not allowed to be used.

1. Prepare 9 metal containers
2. Ensure that the tap water is room temperature
3. Pour 200ml of tap water into each metal container(use a beaker to measure 100ml of water).
4. Add 0g, 10g, ~~20g, 30g, 40~~g, 50g, 54g, 58g, 60g of fine salt into each metal container respectively.
5. Stir the mixture well to ensure that the fine salt is dissolved in the tap water.
6. make a hole in the center of the solution. Place a pencil in the hole and ensure that it is tight.
7. set the freezer to -22 degrees Celsius.
8. Place each metal container into the freezer.
9. check the setups in the freezer every 30 min to ensure that it has not been changed.
10. Ensure that solution has frozen. Take the metal container out of the freezer 2 at a time using a pair of thongs. Ensure that you are wearing thick rubber gloves during the process.
11. Pencil out of the frozen solution slowly, to prevent the solution from cracking.
12. Insert a thermometer into the frozen solution of the 2 beakers through the hole.
13. Watch carefully and note the temperature and the time taken in which the frozen solution starts to melt. The melting point is the freezing point.
14. Repeat steps 9 to 11 for the rest of the beakers.
15. Clean up the solution after the experiment.
16. Repeat the experiment at least 3 times for each solution.

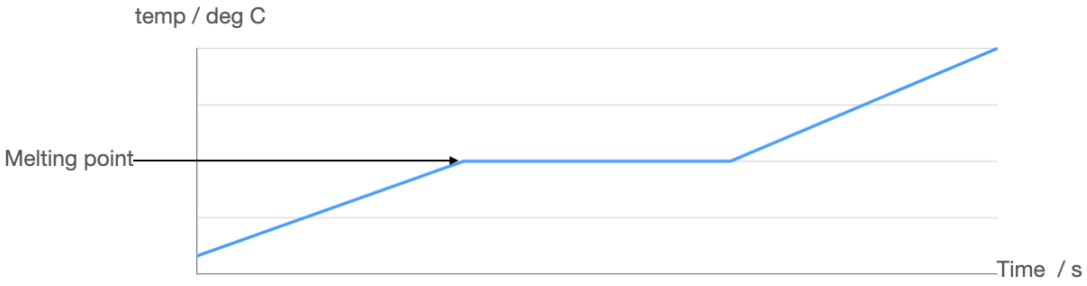
6b. Place a temperature sensor into the solution
7b. Place 3 metal containers into the foam box
8b. Wear protective gear. (gloves,lab coat and goggles)
9b. Pour liquid nitrogen into the foam box
10b. Wait until the temp remains constant for a longer time (This indicates the melting/freezing point of the solution)
11b. Take out the containers using thongs
12b. repeat the experiment with the 6 other solutions.
13b. repeat the whole experiment at least one more time.

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

17. Plot a table of melting point against the different concentrations of salt.

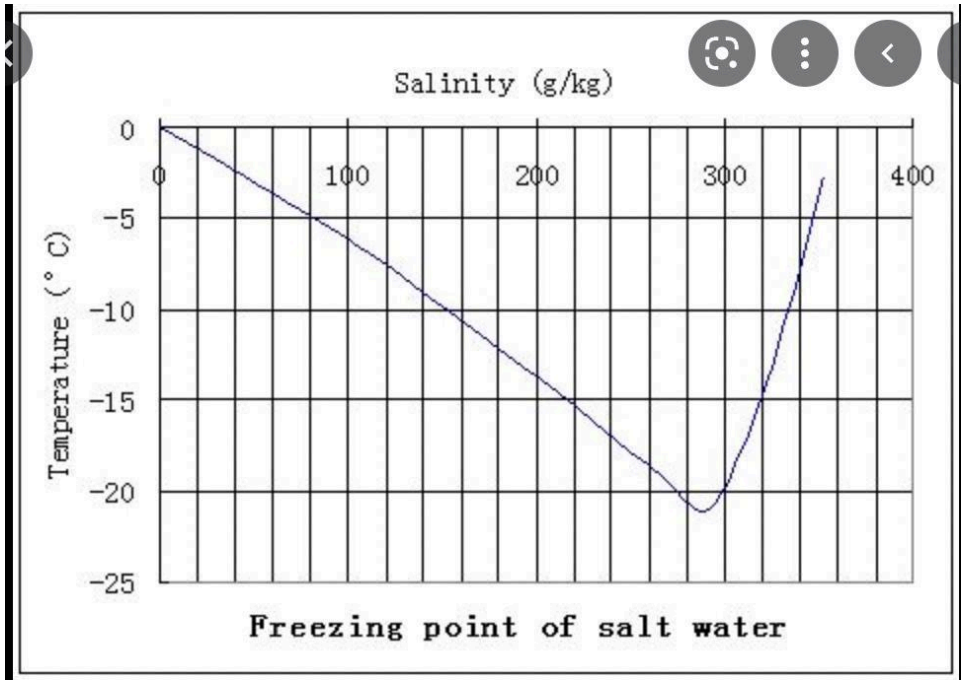
Expt.	Concentration of Salt	Melting point 1	Melting point 2	Average melting point	Std dev	Error

18. The graph below shows the melting point against the concentration of salt.



The melting point is when the temperature remains constant for a longer duration

The graph below shows the supposed results of the experiment.



19. From the graph above we can find out that the freezing point of water will decrease up to a certain point, in which the freezing point starts to increase again, after adding a certain amount of salt.

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 going to put our hands near below 0 degrees celsius. there is a risk we might get frostbite.	High	Students must wear gloves when carrying out the experiment. Students should also use thongs where possible.
As we are using metal containers there is a possibility that the metal will cause a cut when we grab it.	low	Wear gloves when carrying out the experiment.
As we are going to use liquid nitrogen, it can cause asphyxiation.	high	To prevent asphyxiation hazards, we have to make sure that the room is well ventilated when using cryogens indoors.

6. References

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