



**Prize Winner**

**Scientific Inquiry**

**Year 3-4**

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## Scientific Inquiry:

### Why Ships Float: The Science Behind The Mystery

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#### Background

This year, our family is going on an exciting cruise to the South Pacific aboard the Carnival Splendor, a giant ship with impressive dimensions. The Carnival Splendor is approximately 290 meters (951.44 feet) long, 38 meters (124.67 feet) wide, and has a gross tonnage of around 113,323 tons (113323000 kg). It can carry up to 3,006 passengers and 1,150 crew members.

We know that heavy metals sink and light objects float on water. But then how such a massive ship, made of heavy materials, can float and even carry the weight of thousands of people and tons of cargo. We were curious to understand "**How do giant heavy ships float on the water surface?**"

#### Our Hypotheses and predictions:

Based on our knowledge and our daily observation we noted the below hypothesis and predictions for why an object sink or float.

Hypothesis	Prediction
Objects float or sink based on their weight.	Heavy objects made of metal sink and light objects float
Objects float or sink based on their shape.	Compact objects sink and flat thin sheet like objects float

We think the heavy ship floats because of its shape.

We planned to conduct set of experiments to check what objects float or sink. With these experiments we aim to understand the science behind the mystery of how ships like Carnival Splendor stay afloat.

#### Experiment 1: Float or sink?

##### Materials

- A large transparent container
- Water
- Various objects of different weight and Materials: a metal spoon, plastic spoon, a plastic toy, a small wooden block, metal toy, marble, Lego blocks
- Objects of different shape but same materials: made from modelling clay
- Aluminium foil

## Method:

1. Fill the large transparent container with water.
2. One by one, place the various objects of different weight and shape into the water
3. Predict if the objects will float or sink and observe whether they float or sink.
4. Record the observations.

## Observation and Results:

### Heavy and light objects:



Object	Prediction Float (✓) Sink (X)	Observation Float (✓) Sink (X)
plastic spoon	✓	✓
metal spoon	X	X
plastic toy	✓	✓
metal car	X	X
wooden block	✓	✓
plastic bowl	✓	✓
metal bowl	X	✓

We thought that the objects made of metal are heavy. So, they will sink and objects made of plastic and wood are light so they will sink. But the metal bowl did not sink.

## Compact Vs Flat objects



Object	Prediction Float (✓) Sink (✗)	Observation Float (✓) Sink (✗)
play dough (lump)	✗	✗
play dough (flat)	✗	✓
marble	✗	✗
marble on aluminium foil	✓	✓

First, we predicted the objects that are compact will sink because they become heavy. The thin flat objects become lighter. So, they sink.

We took play dough tub and divided it into two equal size. We made a ball out of one and turned the other into a flat boat shape

But when we were putting the play dough in water that was flat, we thought it is the same weight as the ball. So, it will sink.

We also tried a marble and a same weight marble on a flat aluminium foil. The marble was compact and it sank. But the marble on aluminium foil floated as we predicted from our play dough experiment.

## Discussion:

Our metal bowl was heavier than the spoon and made of metal but it floated. The metal bowl had flat surface.

The play dough was heavy and when it was in ball shape it sank but when it was turned in a flat thin walled object, it floated.

## Conclusion:

The objects when turned into flat/thin sheet wall, then they float.

## But Why?

We still had not understood why do the object when turned to flat shape they float. The boats or ship float because they are made up of flat sheets of metal. But how can they carry heavy weight?

We watched a few videos to find the answer. It was still not easy to understand. So, our mum made helped us to do another experiment to understand this.

## Experiment 2:

### Materials:

Aluminium foil tray

Weights of 250 g (we used packets of 250g cumin seeds)

Ruler

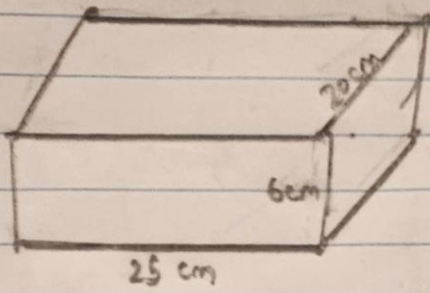
Water filled sink

### Method:

1. Fill the sink with water.
2. Measure the height of water.
3. Measure the volume of aluminium foil tray.
4. Convert the volume in weight.
5. Place the aluminium tray in the water. It will float as of is light and made of flat sheet.
6. Predict how much weight it will carry before it sinks.
7. Place weights of 250g, one at a time in to the tray until the tray start to sink.
8. Measure the height of water and count the total weight
9. Compare the weight with the volume of the tray.
10. Calculate the difference in the height of water and the amount of water displaced.

Observation and results:

Aluminium Tray Volume:



Aluminium foil tray

Tray volume =  $25\text{cm} \times 20\text{cm} \times 6\text{cm}$   
 $= 3000\text{cm}^3$

$$\begin{array}{r} 1 \\ 25 \\ \times 20 \\ \hline 500 \\ + 000 \\ \hline 500 \\ \times 6 \\ \hline 3000 \end{array}$$

Volume to Weight conversion:

Volume  $\rightarrow$  weight.

$1000\text{cm}^3 = 1000\text{gm}$

$3000\text{cm}^3 = 3000\text{gm}$

Weight carried by aluminium tray in water until sink:



Object	Prediction	Observation
Aluminium foil tray (empty)	float	float
Aluminium foil tray (with weight)	7-9 x 250g packs = 1750g - 2250g	13 x 250g packs = 3250g

Our tray was floating until 12 packs of 250g. It sank when we placed one more pack.

The total weight on the tray when it sank was 3250g.

$$3250g > 3000g$$

The tray sank when we had more weight than its volume.

Change in water height and water displaced:



The height of water without anything in the water sink = 9cm

The height of water after the tray sank = 10.5cm

Sink measure = 57cm x 36cm

Water displaced = sink length x sink width x difference in height of water

$$\begin{array}{r}
 57 \\
 \times 36 \\
 \hline
 342 \\
 + 1710 \\
 \hline
 2052
 \end{array}$$

$$= (57\text{cm} \times 36\text{cm}) \times (10.5\text{cm} - 9\text{cm})$$

$$= 2052\text{cm} \times 1.5\text{cm}$$

$$= 3078\text{cm}$$

We measured the height of water before placing anything in the water. When the tray sank with weight, we took one of the packs of 250g out and measured the height of water again. Then we measured the length and width of the sink and calculated the water volume that was displaced.

**Water displaced was about the same as the volume of the tray.**

### Discussion:

This helped us to understand that the object will sink if it has more weight than the volume.

From our experiment and the videos we watched, we learnt that :



- When objects are placed in water they have a force of gravity that pushes them down and the force from water that pushes them in the opposite direction.
- The force from water in upward direction is called the Buoyance Force. The Buoyance Force is equal to the water is displaced by an object.
- The maximum volume of water an object can displace is equal to the volume of the object itself.
- If the weight of an object is less than its volume, then it floats.

This explained that the heavy objects when turned in to thin sheet their volume is expanded and they can float until filled with the less weight than their volume.

Now we understood the Archimedes Principle of Buoyancy well that we watched on the YouTube videos.

### Archimedes Principle:

***The upward buoyant force that is exerted on a body immersed in a fluid, whether fully or partially, is equal to the weight of the fluid that the body displaces.***

***If the buoyant force is less than the object's weight, the object will sink. If the buoyant force equals the object's weight, the object will remain suspended at that depth.***

### Resources:

Carnival Splendor size: <https://www.cruisemapper.com/wiki/753-cruise-ship-sizes-comparison-dimensions-length-weight-draft>

Why Do Ships Float? <https://youtu.be/CvWrkxzCiaY?si=1WtTDNKpWpZgBfgR>

Buoyancy: What Makes Something Float or Sink? <https://youtu.be/nMIXU97E-uQ?si=z3nnredORYFPscbv>

Archimedes Principle: Explained in Really Simple Words  
<https://youtu.be/wChr0hCga5g?si=9CEz6pL5Hfdlyjlh>

Eureka, what is buoyancy? What is Archimedes principle?  
<https://youtu.be/zXSONWLehs?si=oLFmUIMPewNOX3ab>

Archimedes' Principle: <https://courses.lumenlearning.com/suny-physics/chapter/11-7-archimedes-principle/#:~:text=If%20the%20buoyant%20force%20is,remain%20suspended%20at%20thatt%20depth.>

### Acknowledgement:

Mum helped with taking photos while we were conducting the experiments.

Ishi helped with typing and adding pictures in the document. Mum and Ishi reviewed the final document and helped uploading on the OSA website.

## Appendix:

Our Carnival Splendor trip: It was amazing to see the giant ship in real and now we knew the Science behind the mystery of this giant ship floating. It was really a floating city. We had a great fun on the Cruise!



# OSA RISK ASSESSMENT FORM

for all entries in ()  Models & Inventions and  Scientific Inquiry

This must be included with your report, logbook or entry. One form per entry.

STUDENT(S) NAME: \_\_\_\_\_ ID: \_\_\_\_\_

SCHOOL: \_\_\_\_\_

Activity: Give a brief outline of what you are planning to do.

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## Are there possible risks? Consider the following:

- Chemical risks: Are you using chemicals? If so, check with your teacher that any chemicals to be used are on the approved list for schools. Check the safety requirements for their use, such as eye protection and eyewash facilities, availability of running water, use of gloves, a well-ventilated area or fume cupboard.
- Thermal risks: Are you heating things? Could you be burnt?
- Biological risks: Are you working with micro-organisms such as mould and bacteria?
- Sharps risks: Are you cutting things, and is there a risk of injury from sharp objects?
- Electrical risks: Are you using mains (240 volt) electricity? How will you make sure that this is safe? Could you use a battery instead? *\*Only batteries can be used for Models & Inventions entries*
- Radiation risks: Does your entry use potentially harmful radiation such as UV or lasers?
- Other hazards.

**Also, if you are using other people as subjects in an investigation you must get them to sign a note consenting to be part of your experiment.**

Risks	How I will control / manage the risk

(Attach another sheet if needed.)

**Risk Assessment indicates that this activity can be safely carried out**

RISK ASSESSMENT COMPLETED BY (student name(s)): \_\_\_\_\_

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SIGNATURE(S): \_\_\_\_\_

By ticking this box, I/we state that my/our project adheres to the listed criteria for this Category.

TEACHER'S NAME: \_\_\_\_\_

SIGNATURE: \_\_\_\_\_ DATE: \_\_\_\_\_