

HOW DO SHIPS FLOAT? GRADE 8 AND UP READING

Science
Applicability



Improve students'
literacy skills

Sub Plan



Teach With
Fergy

Reading Comment



Extremely satisfied - Great resource to work on student reading comprehension and it tied into the topic I was teaching. My students have been struggling with reading and I've been incorporating more reading into my lessons. Thank you for the resource.



SCROLL
to take a look inside!

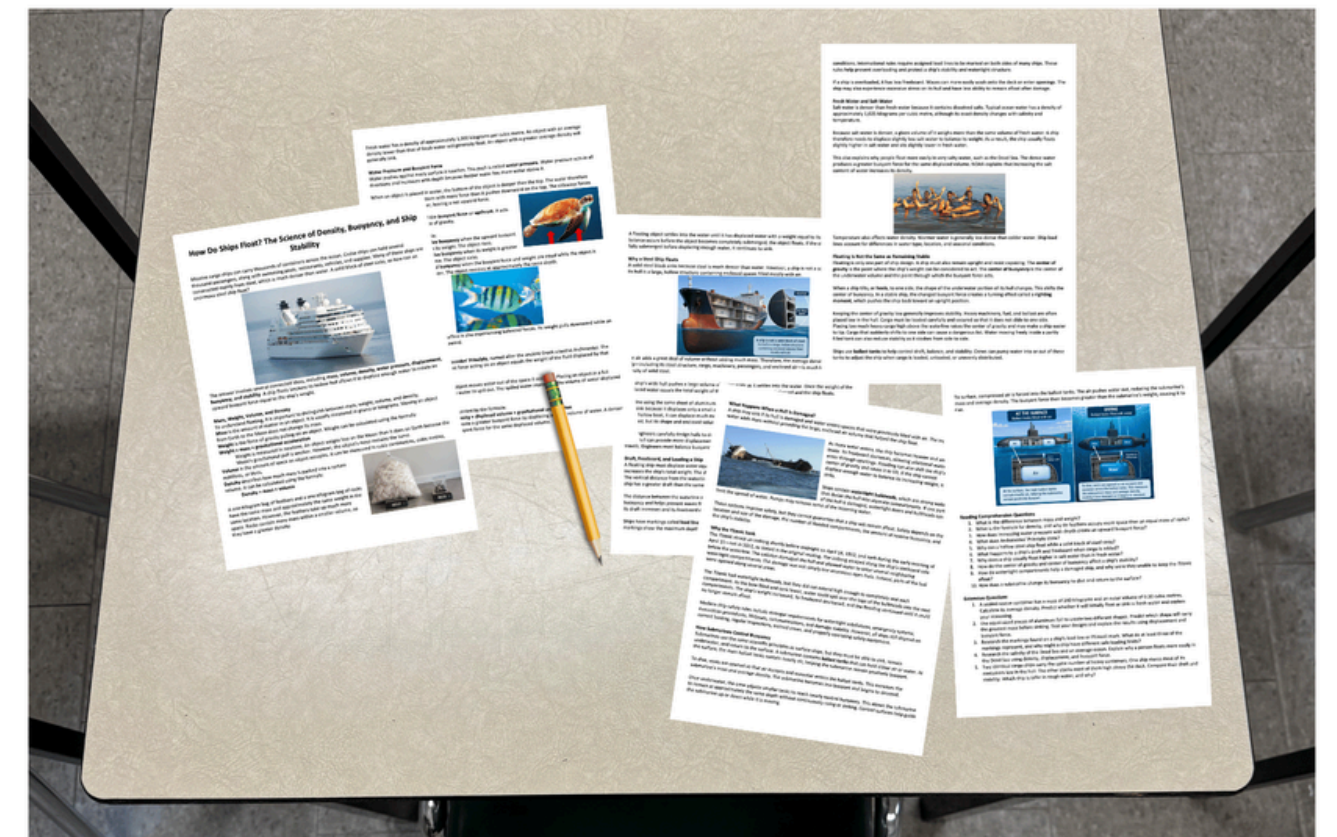


THE PROBLEMS YOU FACE

- **Limited time to teach scientific literacy and strengthen students' reading and analysis skills.**
- **Need meaningful extension activities to engage fast-moving learners.**
- **Difficulty creating effective last-minute sub plans that still support student learning.**

NO-PREP - PRINT/UPLOAD

- **CLASSROOM READY - No Prep, Ready-to-Use:** Print or assign digitally with Google Docs, Microsoft Word, and PDF formats for flexible classroom use
- **Questions and Answer Key**
- **Includes Varied Question Types:** Knowledge, thinking, connecting, application, and open-ended questions.



What Will Your Students Learn?

READING COMPREHENSION ARTICLE & QUESTION BUNDLE

Article with
Comprehension
Questions

Grade 8 and Up

Print & Digital

- Differences Between Mass, Weight, Volume, and Density
- How Density Determines Whether Objects Float or Sink
- How Water Pressure Creates an Upward Buoyant Force
- Archimedes' Principle and Water Displacement
- Why Steel Ships Can Float
- How Hull Shape and Enclosed Air Affect Buoyancy
- How Cargo Changes a Ship's Draft and Freeboard
- Load Lines and Safe Ship Loading
- Why Ships Float Higher in Salt Water
- Centers of Gravity and Buoyancy
- How Ships Remain Stable and Resist Capsizing
- Ballast Tanks and Watertight Compartments
- How Hull Damage and Flooding Can Sink a Ship
- How Submarines Control Their Buoyancy

Reading Comprehension Questions

1. What is nuclear energy, and what are the two main ways it can be released?
2. How does a nuclear fission power plant produce electricity?
3. What happens during nuclear fusion, and where does this process naturally occur?
4. Why is nuclear fusion not currently used to produce commercial electricity?
5. What was the purpose of the Manhattan Project?
6. How do fossil fuel and nuclear fission power plants similar, and how are they different?
7. How do they differ?
- 8.
- 9.
- 10.

Extended Questions

1. Massive cargo ships can carry thousands of containers across the ocean. Cruise ships can hold several thousand passengers, along with swimming pools, restaurants, vehicles, and supplies. Many of these ships are constructed mainly from steel, which is much denser than water. A solid block of steel sinks, so how can an enormous steel ship float?
- 2.
- 3.
- 4.

How Do Ships Float? The Science of Density, Buoyancy, and Ship Stability



The answer involves several connected ideas, including mass, volume, density, water pressure, displacement, buoyancy, and stability. A ship floats because its hollow hull allows it to displace enough water to create an upward buoyant force equal to the ship's weight.

Mass, Weight, Volume, and Density

To understand floating, it is important to distinguish between mass, weight, volume, and density. Mass is the amount of matter in an object. It is usually measured in grams or kilograms. Moving an object from Earth to the Moon does not change its mass. Weight is the force of gravity pulling on an object. Weight can be calculated using the formula: $\text{Weight} = \text{mass} \times \text{gravitational acceleration}$. Weight is measured in newtons. An object weighs less on the Moon than it does on Earth because the Moon's gravitational pull is weaker. However, the object's mass remains the same. Volume is the amount of space an object occupies. It can be measured in cubic centimeters, milliliters, or liters. Density describes how much mass is packed into a certain volume. It can be calculated using the formula: $\text{Density} = \frac{\text{mass}}{\text{volume}}$. A kilogram is a unit of mass. A liter is a unit of volume. A cubic centimeter is a unit of volume. A milliliter is a unit of volume. A gram is a unit of mass. A newton is a unit of force. A joule is a unit of energy. A watt is a unit of power. A volt is a unit of electrical potential. A coulomb is a unit of electrical charge. A hertz is a unit of frequency. A meter is a unit of length. A second is a unit of time. A kilogram is a unit of mass. A liter is a unit of volume. A cubic centimeter is a unit of volume. A milliliter is a unit of volume. A gram is a unit of mass. A newton is a unit of force. A joule is a unit of energy. A watt is a unit of power. A volt is a unit of electrical potential. A coulomb is a unit of electrical charge. A hertz is a unit of frequency. A meter is a unit of length. A second is a unit of time.

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Your Reading

How Do Ships Float? The Science of Density, Buoyancy, and Ship Stability

Massive cargo ships can carry thousands of containers across the ocean. Cruise ships can hold several thousand passengers, along with swimming pools, restaurants, vehicles, and supplies. Many of these ships are constructed mainly from steel, which is much denser than water. A solid block of steel sinks, so how can an enormous steel ship float?



The answer involves several connected ideas, including **mass**, **volume**, **density**, **water pressure**, **displacement**, **buoyancy**, and **stability**. A ship floats because its hollow hull allows it to displace enough water to create an upward buoyant force equal to the ship's weight.

Mass, Weight, Volume, and Density

To understand floating, it is important to distinguish between mass, weight, volume, and density.

Mass is the amount of matter in an object. It is usually measured in grams or kilograms. Moving an object from Earth to the Moon does not change its mass.

Weight is the force of gravity pulling on an object. Weight can be calculated using the formula:

Weight = mass × gravitational acceleration

Weight is measured in newtons. An object weighs less on the Moon than it does on Earth because the Moon's gravitational pull is weaker. However, the object's mass remains the same.

Volume is the amount of space an object occupies. It can be measured in cubic centimetres, cubic metres, millilitres, or litres.

Density describes how much mass is packed into a certain volume. It can be calculated using the formula:

Density = mass ÷ volume

A one-kilogram bag of feathers and a one-kilogram bag of rocks have the same mass and approximately the same weight in the same location. However, the feathers take up much more space. Rocks contain more mass within a smaller volume, so they have a greater density.



Fresh water has a density of approximately 1,000 kilograms per cubic metre. An object with an average density lower than that of fresh water will generally float. An object with a greater average density will generally sink.

Water Pressure and Buoyant Force

Water pushes against every surface it touches. This push is called **water pressure**. Water pressure acts in all directions and increases with depth because deeper water has more water above it.

When an object is placed in water, the bottom of the object is deeper than the top. The water therefore pushes upward on the bottom with more force than it pushes downward on the top. The sideways forces mostly balance one another, leaving a net upward force.

This upward force is called the **buoyant force** or **upthrust**. It acts against the downward force of gravity.

Three outcomes are possible:

- An object has **positive buoyancy** when the upward buoyant force is greater than its weight. The object rises.
- An object has **negative buoyancy** when its weight is greater than the buoyant force. The object sinks.
- An object has **neutral buoyancy** when the buoyant force and weight are equal while the object is completely underwater. The object remains at approximately the same depth.



A ship floating calmly at the surface is also experiencing balanced forces. Its weight pulls downward and equal buoyant force pushes upward.

Archimedes' Principle

Buoyancy is explained by **Archimedes' Principle**, named after the ancient Greek scientist Archimedes. Archimedes' principle states that the buoyant force acting on an object equals the weight of the fluid displaced by the object.

Displacement occurs when an object moves water out of the space it occupies. Placing an object in a container of water causes some water to spill out. The spilled water represents the volume of water displaced by the object.

The buoyant force can be represented by the formula:

Buoyant force = fluid density × displaced volume × gravitational acceleration

This means that an object can create a greater buoyant force by displacing a larger volume of water. Fluid also produces a greater buoyant force for the same displaced volume.

A floating object settles into the water until it has displaced water with a weight equal to its own weight. If this balance occurs before the object becomes completely submerged, the object floats. If the object becomes fully submerged before displacing enough water, it continues to sink.

Why a Steel Ship Floats

A solid steel block sinks because steel is much denser than water. However, a ship is not a solid block of steel. Its hull is a large, hollow structure containing enclosed spaces filled mostly with air.



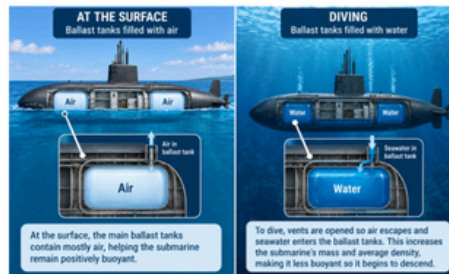
The air adds a great deal of volume without adding much mass. Therefore, the average density of the entire ship—including its steel structure, cargo, machinery, passengers, and enclosed air—is much lower than the density of solid steel.

The ship's wide hull pushes a large volume of water aside as it settles into the water. Once the weight of the displaced water equals the total weight of the ship, the forces become balanced and the ship floats.

Imagine using the same sheet of aluminum foil to make two objects. If the foil is tightly crushed into a ball, it may sink because it displaces only a small amount of water before becoming submerged. If it is shaped into a wide, hollow boat, it can displace much more water and may even carry cargo. The amount of material has not changed, but its shape and enclosed volume have.

Ship engineers carefully design hulls to displace enough water while also moving efficiently through waves. A wider hull can provide more displacement and stability, but it may also create greater resistance as the ship travels. Engineers must balance buoyancy, stability, speed, cargo capacity, fuel use, and safety.

To surface, compressed air is forced into the ballast tanks. The air pushes water out, reducing the submarine's mass and average density. The buoyant force then becomes greater than the submarine's weight, causing it to rise.



Reading Comprehension Questions

- What is the difference between mass and weight?
- What is the formula for density, and why do feathers occupy more space than an equal mass of rocks?
- How does increasing water pressure with depth create an upward buoyant force?
- What does Archimedes' Principle state?
- Why can a hollow steel ship float while a solid block of steel sinks?
- What happens to a ship's draft and freeboard when cargo is added?
- Why does a ship usually float higher in salt water than in fresh water?
- How do the center of gravity and center of buoyancy affect a ship's stability?
- How do watertight bulkheads help a damaged ship, and why were they unable to keep the *Titanic* afloat?
- How does a submarine change its buoyancy to dive and return to the surface?

Extension Questions

- A sealed rescue container has a mass of 240 kilograms and an outer volume of 0.30 cubic metres. Calculate its average density. Predict whether it will initially float or sink in fresh water and explain your reasoning.
- Use equal-sized pieces of aluminum foil to create two different shapes. Predict which shape will carry the greatest mass before sinking. Test your designs and explain the results using displacement and buoyant force.
- Research the markings found on a ship's load line or Plimsoll mark. What do at least three of the markings represent, and why might a ship have different safe loading limits?
- Research the salinity of the Dead Sea and an average ocean. Explain why a person floats more easily in the Dead Sea using density, displacement, and buoyant force.
- Two identical cargo ships carry the same number of heavy containers. One ship stores most of its containers low in the hull. The other stacks most of them high above the deck. Compare their draft and stability. Which ship is safer in rough water, and why?

conditions. International rules require assigned load lines to be marked on both sides of many ships. These rules help prevent overloading and protect a ship's stability and watertight structure.

If a ship is overloaded, it has less freeboard. Waves can more easily wash onto the deck or enter openings. The ship may also experience excessive stress on its hull and have less ability to remain afloat after damage.

Fresh Water and Salt Water

Salt water is denser than fresh water because it contains dissolved salts. Typical ocean water has a density of approximately 1,025 kilograms per cubic metre, although its exact density changes with salinity and temperature.

Because salt water is denser, a given volume of it weighs more than the same volume of fresh water. A ship therefore needs to displace slightly less salt water to balance its weight. As a result, the ship usually floats slightly higher in salt water and sits slightly lower in fresh water.

This also explains why people float more easily in very salty water, such as the Dead Sea. The dense water produces a greater buoyant force for the same displaced volume. NOAA explains that increasing the salt content of water increases its density.



Temperature also affects water density. Warmer water is generally less dense than colder water. Ship load lines account for differences in water type, location, and seasonal conditions.

Floating Is Not the Same as Remaining Stable

Floating is only one part of ship design. A ship must also remain upright and resist capsizing. The **center of gravity** is the point where the ship's weight can be considered to act. The **center of buoyancy** is the center of the underwater volume and the point through which the buoyant force acts.

When a ship tilts, or **heels**, to one side, the shape of the underwater portion of its hull changes. This shifts the center of buoyancy. In a stable ship, the changed buoyant force creates a turning effect called a **righting moment**, which pushes the ship back toward an upright position.

Keeping the center of gravity low generally improves stability. Heavy machinery, fuel, and ballast are often placed low in the hull. Cargo must be loaded carefully and secured so that it does not slide to one side. Placing too much heavy cargo high above the waterline raises the center of gravity and may make a ship easier to tip. Cargo that suddenly shifts to one side can cause a dangerous list. Water moving freely inside a partly filled tank can also reduce stability as it sloshes from side to side.

Ships use **ballast tanks** to help control draft, balance, and stability. Crews can pump water into or out of these tanks to adjust the ship when cargo is loaded, unloaded, or unevenly distributed.

What Happens When a Hull Is Damaged?

A ship may sink if its hull is damaged and water enters spaces that were previously filled with air. The incoming water adds mass without providing the large, enclosed air volume that helped the ship float.



As more water enters, the ship becomes heavier and sinks lower. Its freeboard decreases, allowing additional water to enter through openings. Flooding can also shift the ship's center of gravity and cause it to tilt. If the ship cannot displace enough water to balance its increasing weight, it sinks.

Ships contain **watertight bulkheads**, which are strong walls that divide the hull into separate compartments. If one part of the hull is damaged, watertight doors and bulkheads can limit the spread of water. Pumps may remove some of the incoming water.

These systems improve safety, but they cannot guarantee that a ship will remain afloat. Safety depends on the location and size of the damage, the number of flooded compartments, the amount of reserve buoyancy, and the ship's stability.

Why the *Titanic* Sank

The *Titanic* struck an iceberg shortly before midnight on April 14, 1912, and sank during the early morning of April 15—not in 1012, as stated in the original reading. The iceberg scraped along the ship's starboard side below the waterline. The collision damaged the hull and allowed water to enter several neighboring watertight compartments. The damage was not simply one enormous open hole. Instead, parts of the hull were opened along several areas.

The *Titanic* had watertight bulkheads, but they did not extend high enough to completely seal each compartment. As the bow filled and sank lower, water could spill over the tops of the bulkheads into the next compartments. The ship's weight increased, its freeboard decreased, and the flooding continued until it could no longer remain afloat.

Modern ship-safety rules include stronger requirements for watertight subdivision, emergency systems, evacuation procedures, lifeboats, communications, and damage stability. However, all ships still depend on correct loading, regular inspections, trained crews, and properly operating safety equipment.

How Submarines Control Buoyancy

Submarines use the same scientific principles as surface ships, but they must be able to sink, remain underwater, and return to the surface. A submarine contains **ballast tanks** that can hold either air or water. At the surface, the main ballast tanks contain mostly air, helping the submarine remain positively buoyant.

To dive, vents are opened so that air escapes and seawater enters the ballast tanks. This increases the submarine's mass and average density. The submarine becomes less buoyant and begins to descend.

Once underwater, the crew adjusts smaller tanks to reach nearly neutral buoyancy. This allows the submarine to remain at approximately the same depth without continuously rising or sinking. Control surfaces help guide the submarine up or down while it is moving.

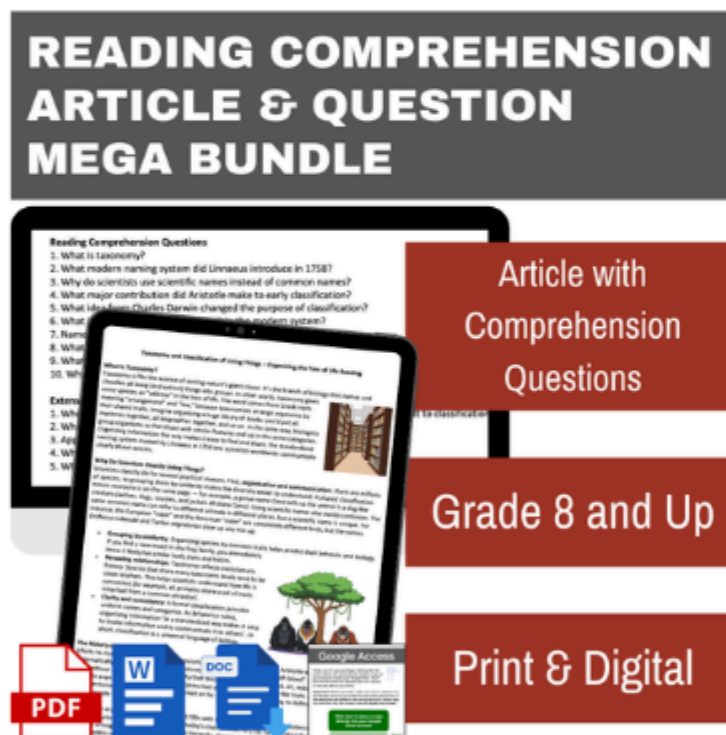
Comprehension and Extension Questions

Full Answer Key Included



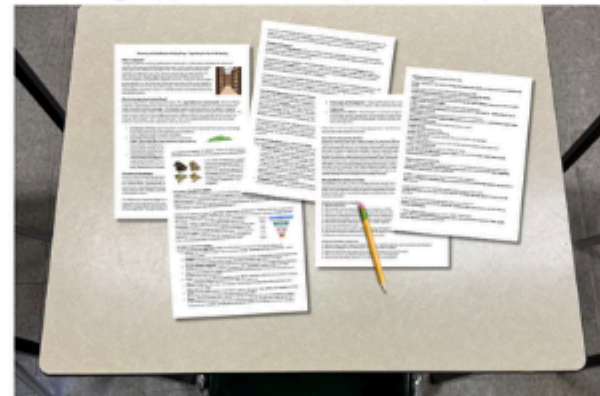
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- **Includes Varied Question Types:** Knowledge, thinking, connecting, application, and open-ended questions.



★★★★★ Extremely satisfied - It is a good supplemental activity either for review and at the same time introducing some concept. I also use this for sub plan. It is well presented, organized and interesting.

★★★★★ Extremely satisfied - This a great resource. I used this for a sub plan. It was fun and engaging for my students.

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