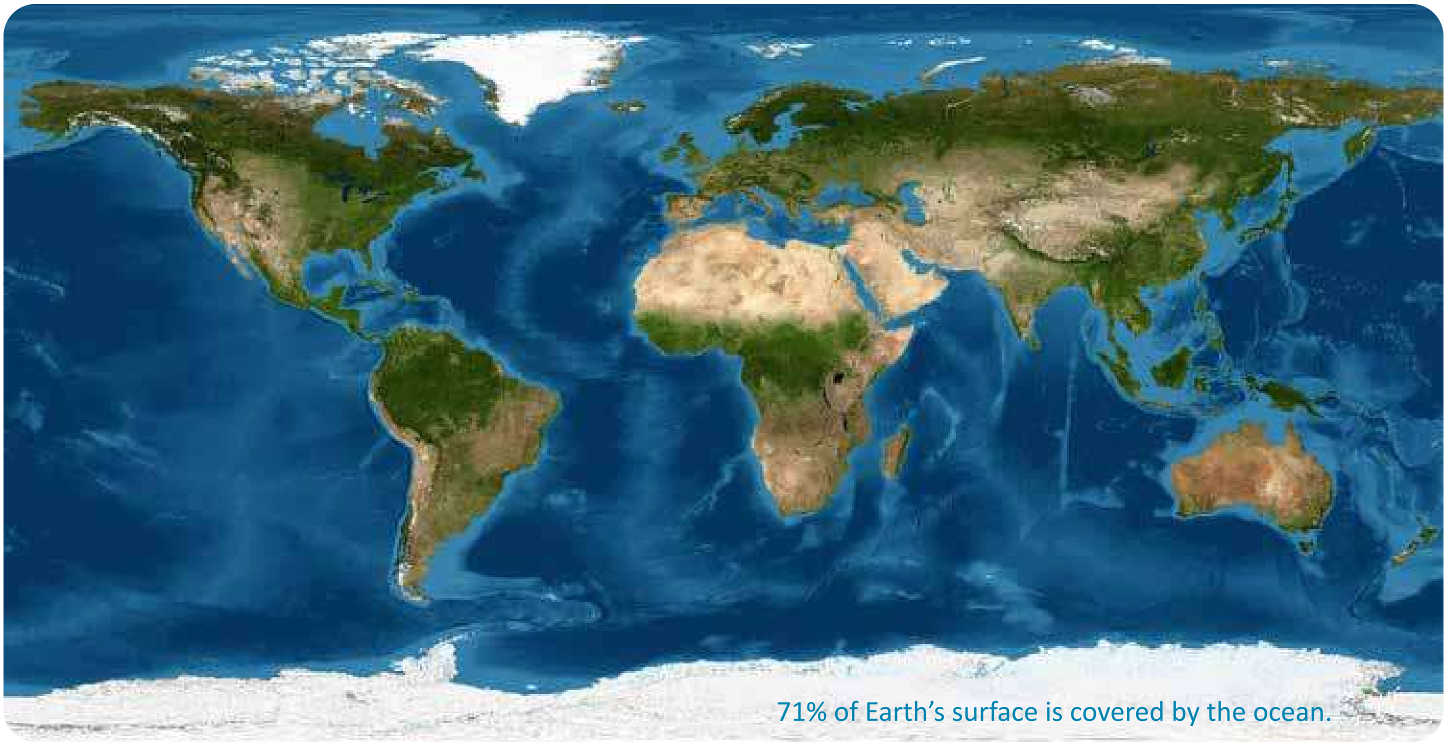
Explore the wonders of our blue planet with two exciting previews from the upcoming Marine Science course by SEA Publishing! In **"It’s a Big World Out There, and Most of It Is Under Water!"**, dive into Earth's largest ecosystem and discover its breathtaking landscapes, diverse life forms, and powerful forces shaping our planet. Then, in **"20 Amazing Ocean Facts"**, uncover mind-blowing details about the ocean’s depth, creatures, and global impact. These articles are just a glimpse of the engaging, in-depth content you can expect from this highly anticipated course, coming in 2025. Perfect for curious minds eager to learn about the science of our oceans!

Chapter 1

# Science for a Blue Planet

## It’s a Big World Out There, and Most of It Is Under Water!



71% of Earth’s surface is covered by the ocean.

An **ecosystem** is a community of living things, like plants, animals, and tiny organisms, that interact with each other and the nonliving parts of the environment.

The ocean is Earth’s largest ecosystem, covering more than 71% of the planet's surface and stretching from bright, shallow waters to dark, unexplored depths miles below. Within this watery world lies an incredible range of life, landscapes, and forces that shape our planet in ways scientists are only beginning to understand.

The ocean is home to an incredible variety of life. Tiny plankton, essential to marine food webs, drift near the surface, while the enormous blue whale, the largest animal on Earth, glides through open waters. Some fish create their own light in the deep, and other strange creatures thrive in places where sunlight never reaches.

Underwater landscapes are just as diverse. Bright coral reefs burst with color and life, while towering seamounts rise from the ocean floor, shaped by underwater volcanoes. At mid-ocean ridges, new seafloor forms, creating rift valleys. In the deepest parts of the ocean, such as the Mariana Trench, trenches plunge farther below sea level than Mount Everest rises above it.

The forces at work in the ocean are powerful and far-reaching. Currents like the Gulf Stream move massive amounts of water, affecting weather and climate worldwide. The ocean floor experiences underwater earthquakes and volcanic eruptions that can trigger tsunamis or form new land over time. Tides, caused by the moon's gravitational pull, make sea levels rise and fall each day, shaping shorelines and coastal ecosystems.


## Watch

V1-1:
*20 Amazing Ocean Facts That Will Blow Your Mind!*

## Oceanography

Understanding the natural and physical processes of our ocean-covered planet requires learning about oceanography. **Oceanography** explores the ocean as a system, encompassing the fields of marine geology, marine chemistry, physical oceanography, and marine biology. By integrating these areas of study, oceanography helps us uncover the complex interactions that shape our oceans and sustain life on Earth.

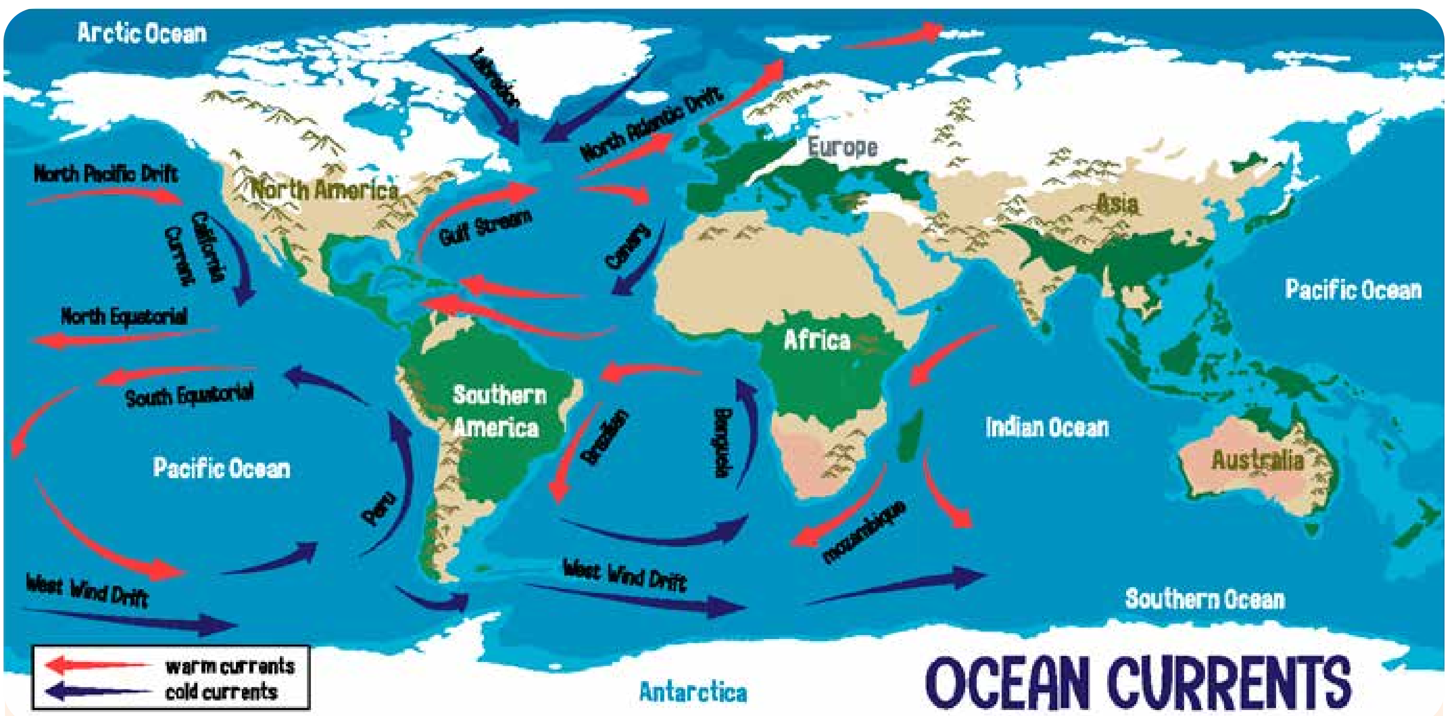
This oceanographer is studying marine geology while mapping the ocean floor.

**Marine geology** focuses on the structures and processes of the ocean floor, including underwater volcanoes, deep-sea trenches, and layers of sediment that build up over time. These processes include volcanic eruptions, earthquakes, and sediment movement, which slowly shape the seafloor. By studying these features, scientists learn about Earth's geological history and how the ocean floor has changed over millions of years.

A marine chemist might study how the changing chemistry of the ocean is affecting marine organisms.

**Marine chemistry** focuses on the chemistry of seawater and the substances found in it. Marine chemists study how these substances interact with each other, marine life, and the physical and geological processes of the ocean. They also investigate how human activities, such as pollution and climate change, affect the ocean's chemistry, including oxygen levels, acidity, and nutrient cycles. By studying these changes, marine chemists help us understand how to protect and preserve ocean ecosystems.

**Physical oceanography** is the study of how the ocean moves and changes. It focuses on currents, waves, tides, and the ocean's physical features at different depths. Physical oceanographers study how these processes work together to move water, affect weather and climate, and support marine life. Their work helps us understand the powerful systems that shape our ocean-covered planet.

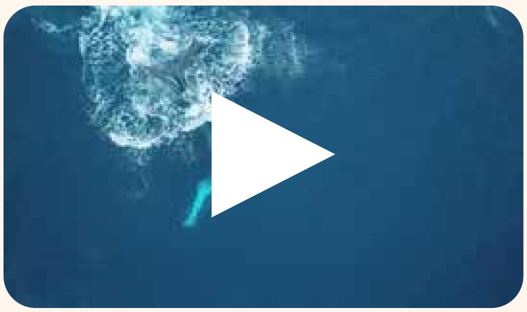



Oceanographers study how currents in the ocean affect climate and weather.

**Marine biology** is the study of life in the ocean, focusing on how species adapt to saltwater environments, find food, reproduce, and survive. Marine biologists also study how marine organisms interact with each other and their surroundings, helping us understand the delicate balance of life in our oceans.

## How Do Your Limbs Move?

When you study marine biology, you will learn interesting facts, like how whales swim. Whales are mammals, just like you are a mammal. Think about how you move your arms and legs when you swim. Is the way you move your limbs more like how a whale swims or how a fish swims? What about the way you walk? Do you walk side-to-side or back-and-forth? Think about other species of mammals, and how whales move in comparison. Even though whales now live in water, they retain the basic body plan of their land-dwelling ancestors.



### Watch

V1-2:
*How Does a Whale Move?*

### MINI BIOGRAPHY: MEET A MARINE PIONEER: SYLVIA EARLE

Sylvia Earle is a famous marine biologist and oceanographer known as "Her Deepness" for her record-breaking dives. In 1979, she set a world record by diving 1,250 feet (381 meters) solo in a special diving suit off the coast of Hawaii, walking along the ocean floor at a depth no one had reached before or since. Over her career, Earle has led more than 50 expeditions and spent over 7,000 hours underwater. She was the first woman to serve as chief scientist for NOAA (National Oceanic and Atmospheric Administration) and has tirelessly advocated for **Hope Spots**, which are protected marine areas worldwide. Earle believes understanding the ocean helps us protect it for future generations.

## Thought Question

If you could explore any part of the ocean, where would you want to go and why?

## Interconnecting Spheres

Scientists often divide Earth into four connected spheres: the **hydrosphere** (water), **atmosphere** (air), **geosphere** (solid earth), and **biosphere** (all living things). While the focus of this course is on the hydrosphere, you will learn that the ocean is closely connected to the other three spheres, creating a dynamic, interconnected planet.

Imagine standing at the Kaloko-Honokōhau National Historical Park on the north Kona coast of Hawai'i, surrounded by these four spheres. The air you breathe is part of the atmosphere. The ocean influences the atmosphere in powerful ways. Look up at the clouds floating in the sky. Those clouds are made of water, likely evaporated from the nearby ocean, now floating miles above in the atmosphere. This air layer also contains molecules that protect the planet from harsh solar radiation, a fortunate shield for the turtles sunning on the shore.

Then there is the geosphere. It includes the rocks, soil, sand, and even the lava that formed this island in Hawaii. The watery waves crashing into the rocks are breaking down bits of this solid Earth. Tiny particles are swept along the coastline, where they eventually settle on the ocean floor. This continuous process not only shapes the shoreline but also alters ocean chemistry in ways essential to ocean life.

The turtles (can you see both?) and the algae (the green on the rocks and floating on the water) are part of the biosphere that depends on the ocean. In this course, you will learn about the organisms that make the ocean their home, from tiny plankton drifting in the water to large predators like sharks and orcas. Some organisms, like coral and sponges, attach to the seafloor, while others, like fish and jellyfish, move freely through the water. Each of these species plays a role in the marine food web, helping to keep ocean ecosystems in balance.


## Watch

V1- 3:
*Interconnected 4 Spheres*

## Check for Understanding

Image Credit NASA

Did you know that Earth is nicknamed the "Blue Marble"? It was given this name because of how it looks from space. The blue seen in the photo is ocean water. Even the white swirling clouds are made of water. On Earth, all living things need water, including humans. For that reason, when looking for life on other planets, **astrobiologists** at NASA look for the presence of water on them.

In the photo below there are three spheres you can see and one you cannot. From the list, label the three spheres you can see and identify the one that is not visible in the photo. List: Hydrosphere, Atmosphere, Geosphere, and Biosphere.

Next time you go outside, try to observe examples of each sphere. Notice how water, plants, animals, and rocks interact. How many of the Earth's spheres can you find in one place?

Very large and very small numbers are a big part of understanding the ocean's vastness and complexity, and scientific notation makes it all manageable! This **contextual math** add-on, specially designed for *Marine Science* from SEA Publishing, introduces the essentials of scientific notation through real-world ocean examples. Integrating contextual math into a science course provides significant benefits for learning both subjects. It reinforces interdisciplinary thinking, deepens understanding of science concepts, and strengthens math skills.

## Chapter 2

# Scientific Notation: A Better Way to Write Very Big or Very Small Numbers

Science often deals with numbers that are incredibly large or very small. For example: The ocean contains approximately **5,700,000,000,000,000,000,000 cups of water**. Writing out that number with all its zeros is impractical! Instead, scientists use **scientific notation**, a shorthand method for writing VERY big or VERY small numbers.

### For EXAMPLE,

According to research on the global ocean size spectrum, the total mass of phytoplankton in the ocean is estimated to be around 1 gigaton ($10^{15}$ grams) of wet weight, meaning the mass of phytoplankton is roughly 1,000,000,000,000,000 grams.

$$10^{15} \text{ grams} = 1{,}000{,}000{,}000{,}000{,}000 \text{ grams}$$

***Which is easier to understand?***

The average size of the smallest phytoplankton, picophytoplankton, is less than 3.0 µm. They are found worldwide in both fresh- and marine waters.

$$3\ \mu\text{m} = 0.000003\ \text{m} = 3\times10^{-6}\ \text{m}$$

***You are likely unfamiliar with the unit µm, so it can be helpful to put the number in terms of meters. Which of these is easier to understand, 0.000003 m = 3×10⁻⁶ m, in terms of how small picophytoplankton are?***

## WHY USE SCIENTIFIC NOTATION?

1. **Save Time**: It is easier than writing millions of zeros, or even 20 zeros.
2. **Understand Scale**: Scientific notation helps compare numbers of very different sizes.

## A FEW THINGS YOU NEED TO KNOW IN ORDER TO USE SCIENTIFIC NOTATION.

- **What is an exponent?** An exponent is a special number that tells us how many times the number it is attached to is multiplied by itself!
- Exponents used with the number 10 are called **powers of 10** and they are extra easy to use, because the exponent matches the number of zeroes!

  $10^6$ = 10 x 10 x 10 x 10 x 10 x 10 = 1,000,000 = one million
- The cool thing about scientific notation is that **even though it changes how a number LOOKS, it doesn't change the VALUE of that number**.

  So, $10^1$ = 10 = ten (it's not multiplied at all!)

  $10^2$ = 10 x 10 = 100 = one hundred

  $10^3$ = 10 x 10 x 10 = 1,000 = one thousand
- Scientific notation works for ANY number that is a multiple of ten!

  50 = 5 x 10 = 5 x 101300 = 3 x 100 = 3 x 102

  4,750 = …now we're getting tricky…

## REWRITING USING SCIENTIFIC NOTATION

1. **To use scientific notation**, we need the first digit to be in the **ones** place, so we will wave our magic wand to move the decimal all the way over until it is between the first and second digits of our number

   …so we move the decimal to the left until we have **4.750**

2. **Next**, it's time to count - how many places did you move the decimal?

   **3**

3. That number will be our exponent, so the **power of ten** will be…

   **$10^3$**

4. **Rewrite** the number.

   **4,750 = 4.75 x 103**

Now, it is definitely not shorter to write 4.75 x $10^3$ than it is to write 4,750

But what if we're talking about giant numbers like the number of cups of water in the ocean?

5,700,000,000,000,000,000,000 cups, I don't even know how to say that number, and it's so hard to write out! **Scientific notation to the rescue!**

## REWRITING 5,700,000,000,000,000,000,000 USING SCIENTIFIC NOTATION

**Here is the process, step by step:**

**Step 1:** Add a decimal to the number as it is written.

- *Example*: 5,700,000,000,000,000,000,000.

**Step 2:** We need the first digit (5) to be in the **ones** place. To do that, move the decimal point until there's one digit to the left of it.

- *Example*: 5,700,000,000,000,000,000,000 becomes 5.7

**Step 3:** Count how many places the decimal point moved.

- In this case, the decimal moved 21 places.

**Step 4:** The number of places the decimal point moved will be **the power of 10** we need to multiply by our number.

- The result is $\mathbf{5.7 \times 10^{21}}$.

## APPLIED MATH IN CONTEXT

**Amount of Salt in Ocean Water**

There are **11,300,000,000,000,000,000,000 teaspoons** of salt dissolved in the $5.7 \times 10^{21}$ cups of water in the ocean. Write this number in scientific notation.

**Number of Marine Microorganisms**

It is estimated that there are about **7,000,000,000,000,000,000,000,000,000 (7 octillion) marine microorganisms** in the ocean. Write this number in scientific notation.

**The Ocean's Surface Area**

The surface area of all the oceans on Earth is approximately **360,000,000,000,000 square feet**. Write 360,000,000,000,000 in scientific notation.

## HOW SCIENTIFIC NOTATION WORKS FOR VERY SMALL NUMBERS

Here is the process, step by step:

**Step 1:** The number already has a decimal, so this step has been done for you.

- *Example*: 0.000003

**Step 2:** We need the first digit (3) to be in the **ones** place. Add a zero after the decimal point.

- *Example: 3.0*

**Step 3:** Count how many places the decimal point moved.

- *Example: The decimal point moved 6 places to the right.*

**Step 4:** Because it moved to the right, to show how small the number is, put a negative sign in front of this number. This is the power of 10. **A negative exponent shows that the number is less than 1. It does not mean it is a negative number.**

- *Example:* $10^{-6}$

**Step 5:** Write the number using scientific notation.

- *Example:* $3 \times 10^{-6}$

## APPLIED MATH IN CONTEXT

**Size of a Virus in Ocean Water**

The ocean is full of viruses. They are much too small for you to see. The average size of a virus in ocean water is **0.00000002 meters**. Write this number in scientific notation.

**Concentration of Carbon Dioxide in the Ocean**

The concentration of carbon dioxide dissolved in ocean water is about **0.00039 grams per liter**. Write this number in scientific notation.

**Thickness of Ocean Surface Layer**

The thickness of the ocean's top layer, where sunlight penetrates, is approximately **0.0002 kilometers**. Write this number in scientific notation.

## EXPANDING NUMBERS FROM SCIENTIFIC NOTATION

Sometimes, we need to do the opposite: Convert a number written in scientific notation back into standard form. Here is how:

**Step 1:** Look at the exponent on the 10. This tells how many places to move the decimal point.

- A **positive exponent** means moving the decimal to the **right** (for large numbers).
- A **negative exponent** means moving the decimal to the **left** (for small numbers).

**Step 2:** Move the decimal point accordingly.

- Add zeros as placeholders, if necessary.

**Example 1**: Expand $\mathbf{5.7 \times 10^{21}}$

The exponent is **21**, so move the decimal **21 places to the right**.

The expanded number is **5,700,000,000,000,000,000,000**.

**Example 2**: Expand $\mathbf{9.0 \times 10^{-8}}$

The exponent is **-8**, so move the decimal **8 places to the left**.

The expanded number is **0.00000009**.

## APPLIED MATH IN CONTEXT

**Amount of Plankton in a Liter of Water**

A liter of ocean water can contain about $\mathbf{4.5 \times 10^{6}}$ **plankton**, a type of very small organism that lives in the ocean. Convert this number to standard form.

**Diameter of a Water Molecule**

The approximate diameter of a water molecule is $\mathbf{2.8 \times 10^{-10}}$ **meters.** Convert this number to standard form.

**Distance Across the Ocean Basin**

The width of the Pacific Ocean is approximately $\mathbf{1.2 \times 10^{4}}$ **kilometers.** Convert this number to standard form.

**Why Practice Both?**

**Being able to switch between standard form and scientific notation helps you better understand very large and very small numbers. It is like switching between two languages. You will use whichever one makes the most sense in the moment!**

## ANSWER KEY

### Scientific Notation Practice (Big Numbers)

**Amount of Salt in Ocean Water**

- **Given**: 11,300,000,000,000,000,000,000 teaspoons of salt.
- **Solution**: 1. Move the decimal 22 places to the left.
  2. Write as $\mathbf{1.13 \times 10^{22}}$

**Number of Marine Microorganisms**

- **Given**: 7,000,000,000,000,000,000,000,000,000 microorganisms.
- **Solution**: 1. Move the decimal 27 places to the left.
  2. Write as $\mathbf{7.0 \times 10^{27}}$.

**The Ocean's Surface Area**

- **Given**: 360,000,000,000,000 square feet.
- **Solution**: 1. Move the decimal 14 places to the left.
  2. Write as $\mathbf{3.6 \times 10^{14}}$.

**Size of a Virus in Ocean Water**

- **Given**: 0.00000002 meters.
- **Solution**: 1. Move the decimal 8 places to the right.
  2. Write as $\mathbf{2.0 \times 10^{-8}}$.

**Concentration of Carbon Dioxide in the Ocean**

- **Given**: 0.00039 grams per liter.
- **Solution**: 1. Move the decimal 4 places to the right.
  2. Write as $\mathbf{3.9 \times 10^{-4}}$.

**Thickness of Ocean Surface Layer**

- **Given**: 0.0002 kilometers.
- **Solution**: 1. Move the decimal 4 places to the right.
  2. Write as $\mathbf{2.0 \times 10^{-4}}$.

### Expanding Numbers from Scientific Notation

**Amount of Plankton in a Liter of Water**

- **Given**: $4.5 \times 10^{6}$
- **Solution**: 1. Move the decimal 6 places to the right.
  2. Write as **4,500,000**.

**Diameter of a Water Molecule**

- **Given**: $2.8 \times 10^{-10}$.
- **Solution**: 1. Move the decimal 10 places to the left.
  2. Write as **0.00000000028**.

**Distance Across the Ocean Basin**

- **Given**: $\mathbf{1.2 \times 10^{4}}$.
- **Solution**: 1. Move the decimal 4 places to the right.
  2. Write as **12,000.**