#37

HYDROLOGY

Hydrology Vocabulary

Tributaries	
Flood plains	
Upwelling	
Headwaters	
Floodplain	
Mouth	
Wetlands	
Hydrosphere	
Aquifer	
Healthy Lake	
Neretic	
Benthos	
Point Source	
Non-Point Source	
Bioindicators	
Phytoplankton	
Intertidal	
Drought	
Precipitation	
Turbidity	
Adhesion	
Cohesion	
Capillary Action	
Specific Heat	
Density	

Buoyancy	
Surface Tension	
Salinity	

Properties of Water

3.01

Getting the Idea

Key Words.....
polarity
cohesion
surface tension
adhesion
solvent
universal solvent
density
buoyancy
specific heat

Water, which covers nearly 70% of Earth's surface, is one of the most abundant substances on Earth. Water is also is one of the most important substances to organisms. Water has many unique properties that allow it to support life on Earth. In fact, water is so important to life that many scientists look mainly for water on other planets to determine if the planet can sustain life.

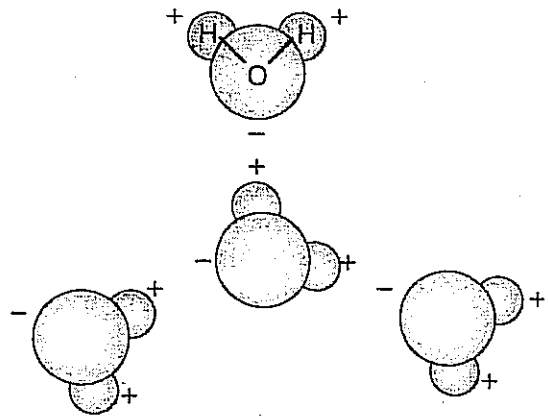
Water Molecules and Polarity

Water (H_2O) is a simple molecule made up of two hydrogen (H) atoms attached to one oxygen atom (O). Each hydrogen atom shares one electron with the oxygen atom. However, the atoms do not share electrons equally. Oxygen attracts electrons more strongly than does hydrogen, so oxygen tends to pull the shared electrons closer to its nucleus. This arrangement gives a water molecule a slightly negative charge near the oxygen atom and a slightly positive charge near each hydrogen atom. This uneven distribution of charges across a molecule is called **polarity**.

The polar nature of water molecules causes the molecules to attract each other. Like weak magnets, a positive pole (H) on each water molecule attracts the negative pole (O) on a neighbor water molecule. This attraction causes water molecules to form temporary bonds. These bonds form and break easily, and help water to stick together.

Did You Know

Cohesion allows raindrops to get larger and larger as they blow around inside clouds. Surface tension pulls on each raindrop to make it round. When a drop becomes large enough, gravitational forces pull the raindrop down to Earth's surface.



Cohesion and Adhesion

The tendency for water molecules to form weak bonds and stick together is called **cohesion**. Because of cohesion, water molecules remain joined together as they move within or between the cells of organisms.

A special example of cohesion is surface tension. **Surface tension** is a force that acts on the particles at the surface of a liquid. In liquid water, each water molecule is pulled in all directions by other water molecules. At the surface of the water, however, the attractive force of other water molecules pulls only downward and sideways. This force causes molecules at the surface to be held more tightly together, forming a kind of skin at the water's surface. Small insects, such as water striders, can walk on water by taking advantage of this surface tension.

Water molecules are not attracted only to each other. **Adhesion** is the tendency of water to stick to other substances. You see adhesion at work when you add water to a graduated cylinder. At the surface, water creeps up slightly at the sides of the cylinder, forming a curved surface called a meniscus. Adhesion allows water to stick to the sides of blood vessels or to the vascular tubes in plants. Both adhesion and cohesion allow water to move in one continuous column from a plant's roots to its leaves.

Water as a Universal Solvent

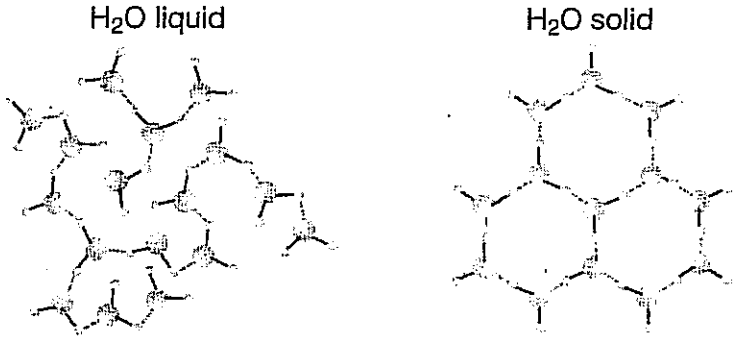
A **solvent** is a substance in which another substance dissolves. Water is called the **universal solvent** because it can dissolve more substances than any other known substance. The main property of water that makes it such a good solvent is its polarity.

Some compounds form from attractions of electrically charged particles called ions. Water attracts and bonds with the ions in these compounds. As water pulls the ions into solution, the compound dissolves. For example, water attracts and forms bonds with the Na^+ and Cl^- ions in a crystal of salt (NaCl). As water pulls these ions into solution, the crystal dissolves. The ability of water to dissolve many substances allows water to deliver essential nutrients to cells in plants, animals, and other organisms.

Density and Buoyancy

Density is a measure of the mass of a substance per unit volume. The density of a substance changes with temperature. For example, cold water is denser than warm water. If you pour cold water into a container of warm water, the cold water will sink to the bottom.

Density changes as the physical state, or phase of a substance, changes. Most substances become denser as they freeze because their particles pack more closely together. Water, however, expands when it freezes. Expansion occurs because molecules organize into a six-sided arrangement as water becomes ice. This arrangement causes ice to have a greater volume and a lower density than liquid water.



Because it has a lower density, ice floats in liquid water. You can observe this property on lakes in areas that have cold winter climates. Ice forms a protective layer at the top of the lake. Fish and other lake organisms remain alive in the liquid water beneath the ice.

Buoyancy is the ability of a fluid to exert an upward force on an object that is immersed in the fluid. Buoyancy is the property that allows fish, whales, and other organisms to float in water. All

Test Tips . . .
After reading a multiple-choice question, answer the question in your head before you look at the answer choices. This may help you to pick the correct answer quickly.

liquids exert an upward force, called the buoyant force, on objects. If the upward, buoyant force on an object is greater than the downward, gravitational force, the object will float. Any substance with a lower density than liquid water will float in water. Wood, oil, and wax are examples of substances that float. Metals are denser than water, so they sink. A metal boat is able to float because its shape provides areas that can fill with air, which is less dense than water. The air helps to lower the density of the entire boat, which, in turn, allows the buoyant force of the water to keep the boat afloat.

Specific Heat and a Constant Environment

Specific heat is the amount of energy needed to raise the temperature of 1 kg of a substance by 1°C. The unit of specific heat is joule per kilogram per degree Celsius (J/kg • °C). The specific heat of water is very high—4,184 J/kg • °C. Therefore, water takes a long time to heat up or cool down. This property of water allows lakes, streams, and ocean ecosystems to maintain stable temperatures, even if air temperatures change dramatically. The high specific heat of water also helps your body to maintain a constant internal environment.

LESSON REVIEW

1. Which form of water has the highest density?

   A. ice

   B. warm water

   C. cold water

   D. water vapor

2. How are nutrients transported in water?

   A. as compounds

   B. as ions

   C. as molecules

   D. as solids

3. Which of the following describes the tendency of a water molecule to stick to other water molecules?

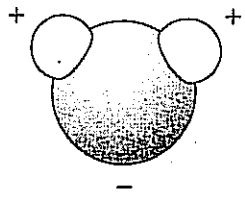
   A. cohesion

   B. density

   C. adhesion

   D. buoyancy

4. The diagram shows a water molecule.



   What do the charges on either end of the molecule indicate about the molecule?

   A. Water is a polar molecule.

   B. Water is a nonpolar molecule.

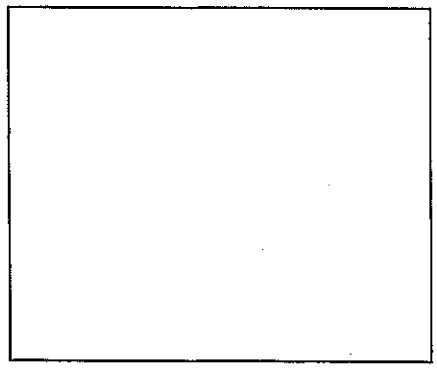
   C. Water is an ionic compound.

   D. Water is an ion.

Name_____ Date_____

Properties of Water
Notes

1. Draw a water molecule in the box below. Label each of the atoms and show the charges.



2. Water is "sticky" because…

3. Why is water called the ***universal solvent***?

4. Water is the only natural substance found in all 3 states 1)_____, 2) _____, and 3)_____ at the temperatures normally found on Earth.

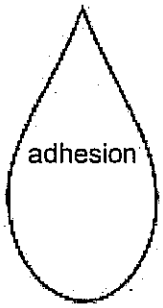
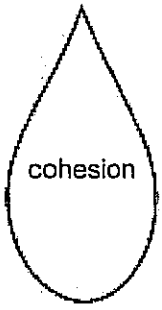
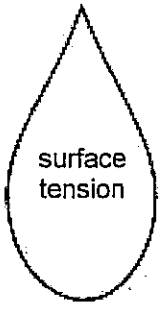
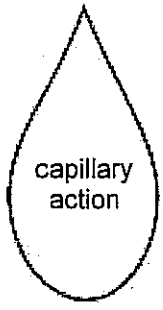
5. Complete the following chart:

Water Property	°F	°C
Freezing Point		
Boiling Point		

6. Why does ice float on liquid water?

7. Why is water said to have a high ***specific heat index***?

8. Complete the following chart:

Property	Definition	Example
 adhesion		
 cohesion		
 surface tension		
 capillary action		

9. What characteristic of water causes it to display ***all*** of the properties described above?

Name _____ Period _____ Date _____

CHAPTER 1 | THE WATER PLANET

Chapter Test C

Key Concepts

Choose the letter of the best answer. (4 points each)

____ **1.** Which of the following best describes what Earth would be like without water?
- **a.** About $\frac{3}{4}$ of Earth would be covered by land.
- **b.** About $\frac{1}{2}$ of Earth would be covered by land.
- **c.** There would be no life at all on Earth.
- **d.** Only plants that live on land would survive.

____ **2.** How much of the total water on Earth is found in the oceans?
- **a.** 3%
- **b.** 24%
- **c.** 76%
- **d.** 97%

____ **3.** In which water cycle process does liquid water become water vapor?
- **a.** condensation
- **b.** evaporation
- **c.** precipitation
- **d.** transpiration

____ **4.** Gravity causes water to flow from
- **a.** plants to the atmosphere
- **b.** larger to smaller bodies of water
- **c.** divides into drainage basins
- **d.** aquifers through artesian wells

____ **5.** For a lake that turns over twice a year, a warm layer of surface water that does not mix with colder, denser water underneath exists during the
- **a.** summer
- **b.** fall
- **c.** spring
- **d.** winter

____ **6.** Most lakes on Earth's surface form when
- **a.** fresh water turns over in ponds
- **b.** rain and snow seep into the ground
- **c.** water collects in depressions in the land
- **d.** natural eutrophication takes place

____ **7.** Most of the fresh water on Earth's surface is
- **a.** solid
- **b.** liquid
- **c.** gas
- **d.** vapor

____ **8.** Most of the volume of an iceberg is
- **a.** beneath the ocean surface
- **b.** above the ocean surface
- **c.** beneath the ground surface
- **d.** above the ground surface

____ **9.** In the ground, the highest level that is saturated with water is called the
- **a.** permeable layer
- **b.** impermeable layer
- **c.** water surface
- **d.** water table

____ **10.** How is an artesian well like a spring?
- **a.** Pumps are used to start the flow of water from it.
- **b.** Water flows naturally from it without pumping.
- **c.** It contains water stored in impermeable rocks.
- **d.** The water in it is salt water.

Structure of the Hydrosphere

3.02

Getting the idea

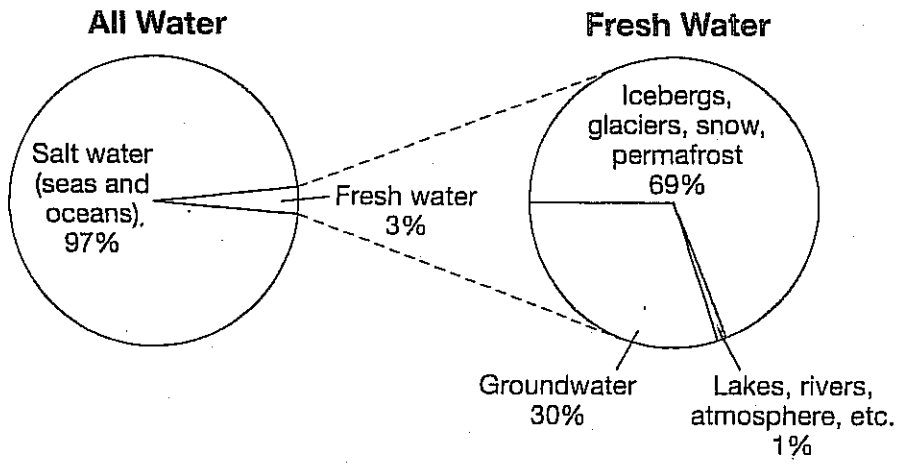
Key Words

hydrosphere
salinity
glacier
groundwater
aquifer
wetland
watershed
river
tributaries
lake

Earth's continents are surrounded by water. Deep blue oceans cover more than two-thirds of Earth's surface. On land, water flows in rivers and streams, and fills up lakes and ponds. Wetlands hold water like a sponge. Water trickles through rock underground to form groundwater.

The Hydrosphere

The **hydrosphere** is the part of Earth that contains water. Most water in the hydrosphere is in liquid form. About 97% of Earth's water is salt water found in the oceans. The remaining 3% is fresh water frozen in polar ice caps, glaciers, snow, and permafrost, and liquid water found in groundwater, lakes, wetlands, rivers, and the atmosphere.



The Global Ocean

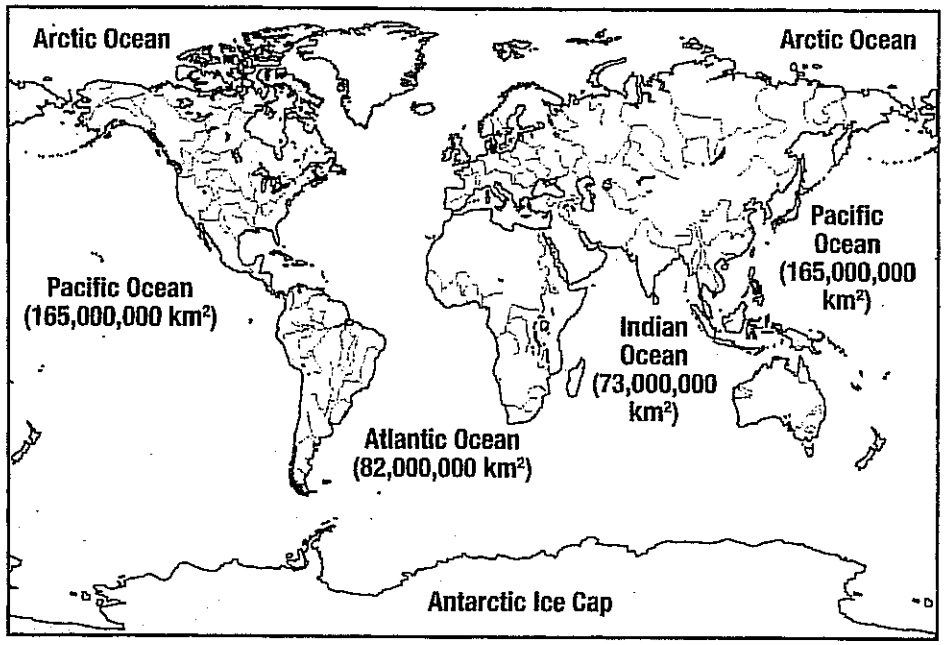
Oceans cover about 71% of Earth's surface. All ocean water is connected in a global ocean. However, the continents divide this ocean into four parts—the Pacific Ocean, the Atlantic Ocean, the Indian Ocean, and the Arctic Ocean.

Did You Know

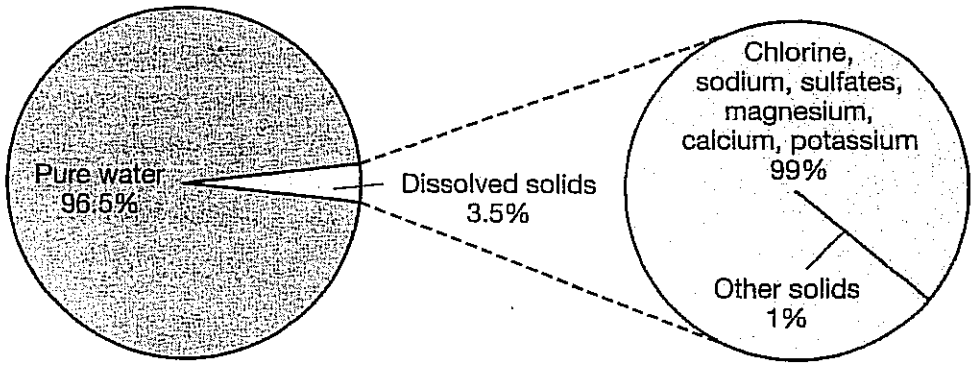
Salinity levels in the ocean vary, depending on the amount of fresh water entering the ocean, evaporation rates, and ocean circulation. For example, salinity levels are low where the Amazon River in South America empties into the Atlantic Ocean. Salinity levels are high in the Mediterranean Sea, where high evaporation rates and limited circulation take place.

The Pacific Ocean is the largest and deepest of the oceans. It covers a surface area of 165 million square kilometers and has an average depth of 4,282 meters. The deepest part of the ocean is in the Marianas Trench region of the Pacific Ocean. Here the water is about 11,033 meters deep.

The other three oceans on Earth are much smaller than the Pacific. The Atlantic Ocean is the second largest ocean, with half the volume of the Pacific Ocean. The Indian Ocean, between Africa, Australia, and Asia, is the third-largest ocean. The smallest ocean is the Arctic Ocean. Much of this ocean is covered by sea ice.



Ocean water tastes salty because of dissolved salts contained in the water. **Salinity** is the concentration of salts in a liquid, such as water. Salinity increases as more salts are dissolved in water. Ocean water has a salinity of about 3.5%, which means that every 100 grams of ocean water contains an average of 3.5 grams of dissolved salts. Sodium chloride, or ordinary table salt, makes up about 86% of the dissolved salts in ocean water.



Temperatures in the oceans vary, depending on latitude and depth. Waters near the equator receive more energy from the sun, and surface temperatures can reach about 25°C. Waters near the poles generally remain near freezing, 0°C. The sun warms the upper layers of ocean water to a depth of about 300 meters. Below that depth, water temperature drops quickly. In the deep ocean below 700 meters, water temperatures can range from 1°C to 4°C.

Freshwater Resources

Most of Earth's fresh water is frozen in the polar ice caps. Ice covers nearly all of Antarctica. Ice also covers most of the Arctic Ocean, near the North Pole. Glaciers contain large amounts of frozen water. A **glacier** is a mass of ice and snow that moves slowly over Earth's surface.

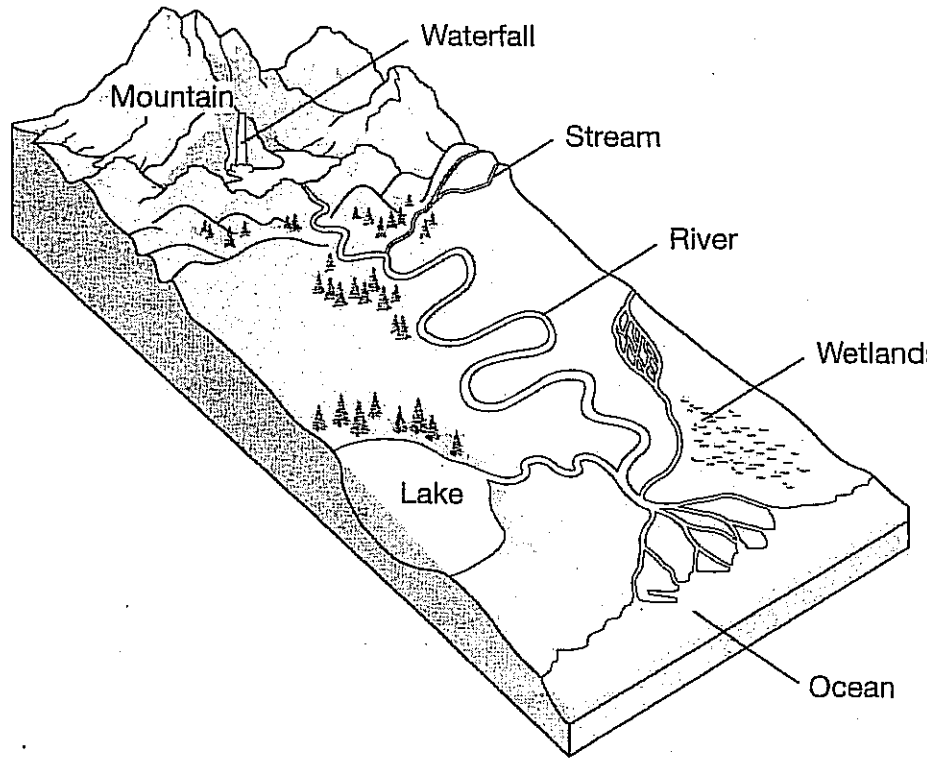
Nearly one-third of Earth's fresh water is **groundwater**, water located below Earth's surface. Groundwater forms when surface water moves down through soils and sediment to collect in spaces between underground rock particles. An **aquifer** is a rock layer that stores water and allows water to flow through it. Drinking water and water for irrigation often come from aquifers. Wells are used to bring this water to the surface.

Most of Earth's surface water is located in rivers, streams, lakes, and wetlands. **Wetlands** are land areas that remain wet for all or part of the year. Wetlands act as sponges in the landscape, collecting and holding rainwater to prevent flooding. They also filter pollutants and sediment out of water. Wetlands can improve the quality of water that will eventually become drinking water for communities.

Earth's surface waters flow through areas called watersheds. A **watershed** is an area of land where precipitation collects and then

Test Tips . . .
After filling in bubbles on an answer sheet, be sure to erase any stray marks on the sheet before turning it in.

drains into a single collection place, often a lake or an ocean. Watersheds are sometimes called drainage basins or river basins. The main function of a watershed, or drainage basin, is to move water from higher to lower elevations.



North Carolina's Surface Waters

A **river** is a large, flowing stream of water that is fed by other smaller streams, or **tributaries**. The watershed, or river basin, is the area of land drained by a river and its tributaries. North Carolina contains 17 river basins. The Cape Fear River Basin is the largest in North Carolina. It covers 9,324 square miles of land area and contains streams that drain 29 of North Carolina's 100 counties. The New River, flowing through Allegheny, Ashe, and Watauga counties, is one of the oldest rivers in the world.

Towns and cities often develop around rivers and lakes to take advantage of easily accessible fresh water for drinking and use in industry. A **lake** is a low area of land where surface water run-off accumulates. Lakes vary greatly in size. Some major lakes of North Carolina include Lake Mattamuskeet, Lake Phelps, Lake Waccamaw, and Lake Michie. Rivers and lakes, along with aquifers, provide drinking water to cities and towns. Lake Michie and the Little River reservoir are water sources for the city of Durham, North Carolina.

DISCUSSION QUESTION

Why might groundwater be cleaner than surface water?

LESSON REVIEW

1. Where is most of the fresh water on Earth located?

   A. in the oceans

   B. in polar ice caps

   C. in rivers and streams

   D. in groundwater

2. Which of the following affect ocean water temperatures?

   A. latitude and longitude

   B. depth and distance from land

   C. latitude and depth

   D. wind and rain

3. What are two sources of fresh water used by cities for drinking water?

   A. glaciers and lakes

   B. rivers and ocean water

   C. wetlands and polar ice

   D. aquifers and rivers

Questions:

1. What types of water make up the freshwater on earth?

2. What percent is the freshwater of the total water on earth?

3. What types of water are reasonably available as a drinking water source?

4. Is all of the ground water available as a drinking water source? Why?

5. Is all of the icecap/glacier water available as a drinking water source? Why?

6. Why is it important to protect the quality of the earth's freshwater supply?

7. What places in the world have a shortage of water? Why?

8. What could people do to have more water in places where water is limited? Give examples and ideas why they may be using the method(s) you suggest.

Name Period Date

CHAPTER 2 | FRESHWATER RESOURCES

Chapter Test C

Key Concepts

Choose the letter of the best answer. (4 points each)

____ **1.** Why is water so important to life on Earth?

a. It is the only substance that exists as a solid, liquid, and gas.

b. It is the only substance that cycles among Earth's spheres.

c. It is critical to industry, agriculture, and recreation.

d. It is necessary for most life functions.

____ **2.** Which of these would be the most effective way for a farmer to produce food for the global population yet still conserve water?

a. Use untreated wastewater to irrigate crops.

b. Withdraw water from nearby rivers and lakes.

c. Use drip irrigation.

d. Use spray irrigation.

____ **3.** What is aquaculture?

a. raising fish in controlled environments

b. harvesting fish from rivers, lakes, and oceans

c. the process of removing salt from ocean water

d. the process of supplying water to grow crops

____ **4.** The EPA standard for barium in drinking water is 2 parts per million. Which of these describes the maximum allowable concentration of this pollutant in drinking water?

a. More than 2 parts barium are present in 1 million parts.

b. Exactly 2 parts barium are present in 1 million parts.

c. Less than 2 parts barium are present in 1 million parts.

d. Two million parts barium are present in 1 million parts.

____ **5.** What is the purpose of using sand, gravel, and chlorine during drinking water treatment?

a. Chlorine causes dirt and bacteria to stick together; sand and gravel remove bacteria from the water.

b. Chlorine removes dirt from the water; sand and gravel kill some of the bacteria in the water.

c. Sand and gravel cause dirt and bacteria to stick together; chlorine kills all bacteria in the water.

d. Sand and gravel filter dirt from the water; chlorine kills some of the bacteria in the water.

____ **6.** Which of these would be the most practical method for treating the water used at a large rural school?
- **a.** a septic tank
- **b.** a city sewer system
- **c.** a desalination plant
- **d.** a hydroelectric dam

____ **7.** What causes most pollution of fresh water?
- **a.** untreated wastewater from city sewage systems
- **b.** ships that spill or dump their fuel into local rivers
- **c.** runoff carrying chemicals into water bodies
- **d.** broken septic systems on small farms

____ **8.** What condition exists during a drought?
- **a.** a long period of higher than normal rainfall
- **b.** a long period of lower than normal rainfall
- **c.** a long period of lower than normal temperature
- **d.** a long period of higher than normal temperature

____ **9.** Which of these is a good way to conserve water at home?
- **a.** Take short showers rather than full baths.
- **b.** Install a modern septic tank system.
- **c.** Drink less water than your body needs.
- **d.** Water the lawn during the hottest part of the day.

____ **10.** How do countries limit the pollution of fresh water?
- **a.** by banning irrigation
- **b.** by desalinating seawater
- **c.** by building dams
- **d.** by making laws and treaties

Evaluating Water System Health

3.05

Getting the Idea

Key Words.....
pH
turbidity
algal bloom
nitrates
bio-indicators

River and lake water must have certain qualities to support life. Scientists monitor water systems over time to identify problems and improve water system health.

Indicators of Water System Health

Scientists use a variety of physical, chemical, and biological indicators to determine the health of a water system. These indicators include temperature, dissolved oxygen (DO), pH, turbidity, bio-indicators, and the presence of nitrates.

Physical Indicators

Temperature, dissolved oxygen, pH, and water clarity are physical indicators used to determine water system health. A healthy water system has moderate to cool temperatures, high dissolved oxygen, low acidity, and clear water.

Aquatic organisms obtain the oxygen they need from the water in which they live. Cold water can hold more dissolved oxygen than warmer water can. Thus, dissolved oxygen levels are related to water temperature.

Measurements that show high water temperature or low dissolved oxygen are indicators of an unhealthy water system. As water temperatures increase, the dissolved oxygen levels decrease. This can cause stress to fish and other water organisms, making them more vulnerable to disease. The low dissolved oxygen content in very warm water—temperatures above 29°C to 32°C—can result in enough stress to cause fish kills.

High or low pH readings are signs of an unhealthy water system. The indicator **pH** measures how acidic or basic water is. Neutral water has a pH of 7.0. Most aquatic life functions best in water at a neutral or slightly basic (8.0 to 9.0) pH. Some swamp organisms do well in more acidic water, with a pH from 3.0 to 5.0. Water may

become too acidic (low pH) from acid rain. Water may become too basic (high pH) from an overgrowth of algae.

Turbidity is a measure of how clear water is. High turbidity, or unclear water, is a sign of an unhealthy water system. Silt and sediment that enter water in run-off can increase turbidity. **Algal blooms**, rapid growth of algae encouraged by too many nutrients in the water, also cause high turbidity. When turbidity is too high, the particles in water may keep plants and algae from getting enough light to perform photosynthesis. Too many particles in water can also clog the gills of fish.

Chemical Indicators

Nitrates are a chemical indicator of water system health. **Nitrates** are nitrogen compounds used for growth by plants and algae. Fertilizers often contain nitrates. These nutrients can enter water systems in run-off from farm fields, feedlots, golf courses, or lawns. Nitrates help land plants grow, but too many nitrates in water may cause an algal bloom.

Algal blooms harm water systems. Some algae release chemicals that are toxic to other organisms. Algal blooms cause high turbidity. They may also lead to lower dissolved oxygen levels in water. As the overgrown algae starts to die and decompose, the process of decomposition removes oxygen from the water. High nitrates can indicate an unhealthy water system.

Biological Indicators

Bio-indicators are organisms or parts of organisms that are used to assess ecosystem health. Trout are a sensitive fish species. The presence of such species in water can show that a water system is healthy. The presence or abundance of certain shellfish or insects can also show water system of health. Another bio-indicator is the condition or health of water organisms. If fish suffer from disease, their condition shows that the water system is unhealthy.

Many bio-indicators measure the presence and abundance of different kinds of algae. For example, water with high levels of chlorophyll *a* indicates water with high numbers of algae. This may suggest that an algal bloom is occurring. In some cases, a high number of algae can indicate a healthy water system. This occurs when the algal species present are a good food source for animals and do not cause toxic blooms.

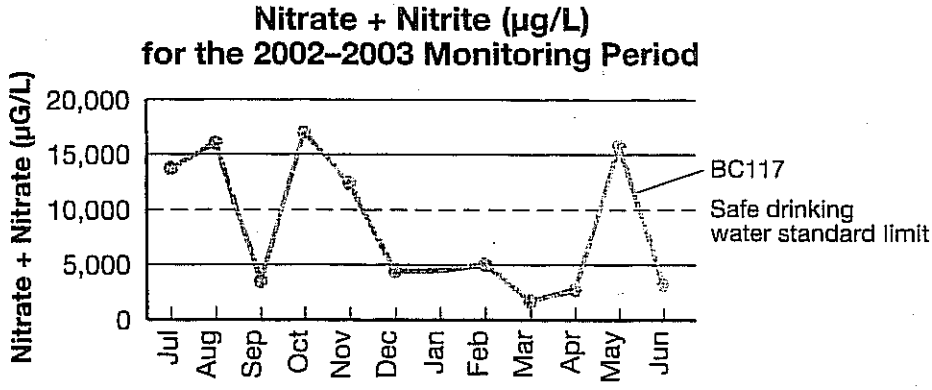
Did You Know

At the mouth of the Cape Fear River, the Cape Fear estuary extends for 56 km. Salt water from the ocean and fresh water from the river mix in this zone. This area is an important nursery for crabs, shrimp, and fish.

Monitoring the Lower Cape Fear River Watershed

Scientists use physical, chemical, and biological indicators to monitor the Lower Cape Fear River watershed in North Carolina. Each month, scientists take samples from at least 34 sites in the rivers, streams, swamps, lakes, and estuary in this watershed.

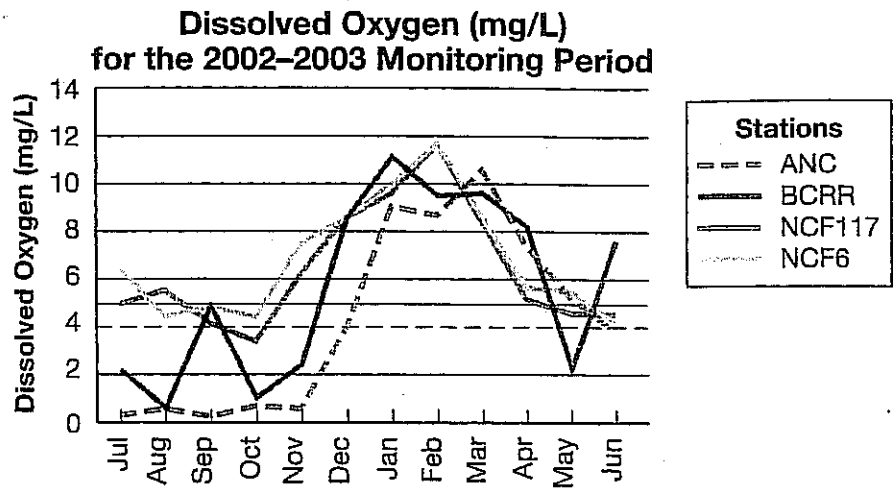
Three types of sites are sampled in the Lower Cape Fear River watershed. Reference sites are areas that may be less affected by pollution sources. Sensitive sites are areas that may be more sensitive to pollutants. Trout streams, areas that have sturgeon (a large game fish), and estuaries are sensitive sites. Affected sites are areas close to a known pollution source. Affected sites may be near cities or roads, in areas with high concentrations of farms or hog feedlots, or downstream from a factory or wastewater treatment plant.



The graph shows nitrate and nitrite concentrations in water at sampling station BC117. (Nitrites are nitrogen compounds.) This is an affected site, located below a wastewater treatment plant and in an area of failing septic systems. This area had the highest nutrient levels in the Lower Cape Fear River watershed. Nitrogen levels were often above the 10,000 micrograms per liter (µg/L) standard that is set for safe drinking water. Nutrients were also at a level that could cause algal blooms.

Test Tips . . .

If each answer choice has more than one part, be sure that all parts of the answer you choose correctly answer the question.



The graph above shows dissolved oxygen levels at four sites in the Lower Cape Fear River watershed. These sites are in a less developed part of the watershed that is affected by failing septic systems and some run-off from cities. All of these sites rated poor for dissolved oxygen. The lowest levels of dissolved oxygen occurred in the summer and fall. Two of the sites also had higher nutrient levels during some of the year.

Data collected from the Lower Cape Fear River watershed can help scientists to identify rivers, streams, and other waters in the system that are unhealthy. Scientists can then identify the sources of the problem and work to reduce or eliminate pollutants from those sources. Such monitoring programs are an important tool for making sure that the health of water systems is protected or improved.

LESSON REVIEW

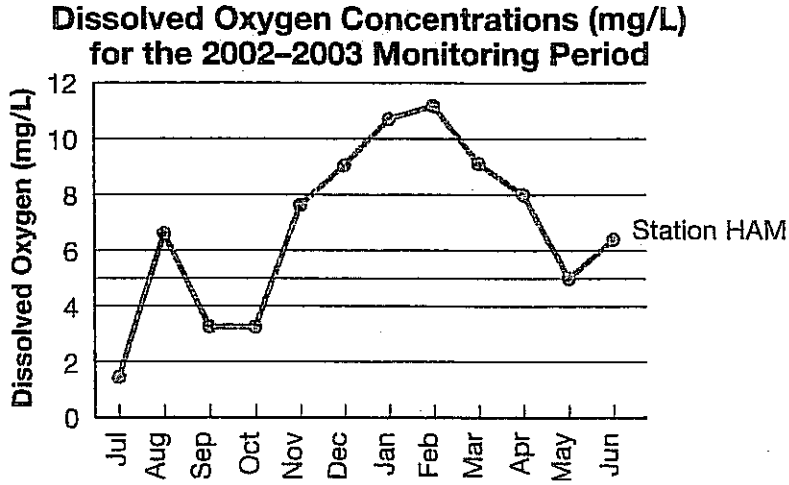
1. Which of the following are indicators of a healthy water system?

   A. high nitrates, high chlorophyll *a*, and low temperature

   B. low temperature, high dissolved oxygen, and neutral pH

   C. low pH, high nitrates, and low dissolved oxygen

   D. low turbidity, high chlorophyll *a*, and high temperature



2. The graph shows dissolved oxygen concentrations at a sampling site in the Lower Cape Fear River watershed. What is the most likely cause of the low dissolved oxygen concentrations seen in July?

   A. high nitrates

   B. low turbidity

   C. high temperatures

   D. algal blooms

3. What does it mean when a scientist says a lake has a high turbidity?

   A. The water has a lot of particles in it.

   B. The water is very clear.

   C. The water is very basic.

   D. The water can support many organisms.

Lesson 25

How Humans Affect Water

3.07

Getting the Idea

Key Words
pollutant
point-source pollution
non–point-source pollution

Like other living things, you need water for survival. All organisms need water to carry out their life processes. Many organisms also make their homes in water environments. Because water is so important to life on Earth, it is essential that Earth's water resources be used wisely and protected from damage by harmful substances.

Pollution

Many human activities can release pollutants into water. A **pollutant** is any substance or form of energy that can cause harm to the environment and make it unfit for use by organisms. Toxic chemicals, human and animal wastes, and substances such as fertilizers and pesticides that run off the land and into rivers, lakes, and the ocean are some examples of pollutants. All of these substances can reduce water quality and damage ecosystems. Cleaning up water systems can be very difficult and expensive. Thus, being aware of harmful activities that can harm ecosystems and working to prevent pollution are the best and most cost-effective ways to protect Earth's waters.

Sources of Water Pollution

Water pollutants can come from many different sources. Sometimes it is possible to identify where a pollutant comes from. Pollution that comes from a single identifiable site is called **point-source pollution.** Oil spilling from a supertanker into an ocean or river is an example of point-source pollution. Other examples of point-source pollution of ground and surface water systems are listed in the chart on the next page.

Sometimes the source of a pollutant is not easily identified. Pollution that comes from many places or a source that is not easily identified is called **non–point-source pollution.** Substances making up non–point-source pollution can be carried into water

Did You Know

The largest source of water pollution in the state of North Carolina is run-off from paved areas and roads. This run-off can carry oil, gasoline, pesticides, fertilizers, sand, and sediment into water systems.

ecosystems in water or air, or from land. Some common causes of this type of pollution are shown in the chart on the next page.

Sources of Water Pollution

Point-Source Pollution	Non–Point-Source Pollution
• Damaged wastewater pipes or systems • Accidental release of raw sewage from wastewater treatment plants • Leaking underground oil tanks • Release of chemicals from paper mills or other industry into streams • Release of dishwater or sewage from homes directly into water systems • Release of heated water from power plants or industrial sources into streams	• Chemical run-off from agricultural fields, golf courses, and lawns • Waste run-off from feedlots • Soil and silt from farms • Sand, grit, oil, and gasoline from city streets • Salts from irrigation of farm fields • Mercury pollution from coal-burning plants • Acid rain

Because point-source pollution comes from a single identifiable source, this type of pollution is easier to control or eliminate. By contrast, non–point-source pollution can come from many different unknown sites. This makes controlling of eliminating non–point-source pollution much more difficult.

Nutrients and Water Pollution

Nutrients contribute to both point-source and non–point-source water pollution. Phosphorus and nitrogen (in the form of nitrates) are nutrients in fertilizers. These nutrients are carried into water systems as run-off from golf courses, lawns, and farm fields. Animal wastes from feedlots and human wastes from damaged sewer systems can also release nutrients into water systems.

Too much phosphorus or nitrates in water ecosystems can lead to harmful algal blooms. The microscopic organism *Pfiesteria* is a type of alga that can reproduce quickly, or "bloom," in the warm, nutrient-rich waters of estuaries. In large numbers, these algae produce a chemical that is toxic to fish. The chemical is also harmful to people who breathe or touch the toxin. People may become dizzy, get headaches, or develop sores on their skin from *Pfiesteria* poisoning.

High nutrient levels in water can also lead to low dissolved oxygen levels. When algae and other aquatic plants grow in large

Test Tips . . .
If a test question asks you to pick the best answer, read all answer choices carefully. Every choice may be correct in some way, but one will be most correct.

numbers, they run out of resources and begin to die. As decomposers break down the remains of these organisms, they use up much of the oxygen in the water. As less oxygen becomes available to fish, they get stressed and are more likely to get diseases. Too little oxygen can also cause death in fish and other aquatic organisms.

Economic Trade-offs

Agriculture is an important industry in North Carolina. Farms and hog feedlots are common in the North Carolina landscape. Agricultural industries help support the North Carolina economy. However, these operations can also damage water systems.

Good farm and feedlot practices can protect North Carolina's rivers, lakes, and estuaries. Many farmers use plowing techniques that reduce erosion and the amount of run-off from fertilizers. Some farmers limit their use of fertilizers. Feedlot operators often use lagoons, pits that store animal wastes, to prevent nutrients from these wastes from leaking into the groundwater supply.

Other industries can also work to protect North Carolina's waters and aquatic ecosystems. Paper and chemical companies can ensure that the water they release has been treated properly. All industries can work to reduce the production of wastes that might pollute water. Such practices can protect both the economic and environmental health of North Carolina.

Local Water Issues

Individuals also can reduce or eliminate sources of pollution that can damage local water systems. People can reduce their use of fertilizers and pesticides on lawns to prevent chemicals from running into local streams and lakes. They can sweep up and collect sand and sediment from streets or sidewalks to keep these materials from entering storm drains. Homeowners can make sure that their wastewater pipes do not empty directly into a lake or stream. Car and truck owners can keep vehicles in good working order and check to make sure they do not leak oil, gas, or other fluids. Everyone can play a role in protecting water systems.

DISCUSSION QUESTION

All pollutants come from specific sources. How can there be non–point-source pollution?

LESSON REVIEW

1. Which of the following is a possible effect of high nutrient levels in water systems?

   A. fish kills

   B. increased water temperature

   C. less algae

   D. healthier fish

2. Which of the pollutants below is an example of non–point-source pollution?

   A. wastewater from a leaking pipe

   B. chemical run-off from lawns

   C. oil from a leaking underground tank

   D. chemicals released from a paper mill

3. What is the difference between point-source and non–point-source pollution?

   A. Point-source pollution comes from pipes; non–point-source pollution comes from run-off.

   B. Point-source pollution refers to oil pollution; non–point-source pollution refers to chemical pollution.

   C. Point-source pollution causes little damage to water; non–point-source pollution causes great damage to water.

   D. Point-source pollution comes from one site; non–point-source pollution comes from many sites.

4. Which of the following is a clear example of point-source pollution?

   A. trash floating in ocean water

   B. feedlot wastes in a river

   C. oil spill from a supertanker

   D. salts from irrigation

DISCUSSION QUESTION

What are three resources that you obtain from oceans?

LESSON REVIEW

1. Which of these processes is responsible for ***increasing*** dissolved oxygen levels in the oceans?

   A. respiration
   B. photosynthesis
   C. topography
   D. harvesting kelp

2. Which of the following is added to ocean water as a result of respiration?

   A. oxygen
   B. dissolved nutrients
   C. minerals
   D. carbon dioxide

3. Scientists on a ship are using sonar to map the ocean floor. They send out a sound pulse at Point A that takes 4 seconds to return to the ship. At Point B, the sound pulse takes 8 seconds to return. What conclusion can be drawn about the depth of the water at Points A and B?

   A. They are the same depth.
   B. Water at Point A is twice as deep as that at Point B.
   C. Water at Point B is twice as deep as that at Point A.
   D. Water at Point B is half as deep as water at Point A.

Name _____ Date _____ Per _____

WORKSHEET 19-1

_____ **1.** Pollution that enters from a specific location is known as _____ pollution.

A. pesticide **B.** fertilizer **C.** point source **D.** nonpoint source

_____ **2.** Pollution that enters a body of water from a large area is called _____ pollution.

A. pesticide **B.** fertilizer **C.** point source **D.** nonpoint source

_____ **3.** Chemicals that help plants grow are called _____.

A. Pesticides **B.** fertilizers **C.** pollutants **D.** sewage

_____ **4.** Water containing human waste is known as _____.

A. Pesticides **B.** fertilizers **C.** pollutants **D.** sewage

_____ **5.** Substances used by farmers and landowners to destroy pests are called _____.

A. Pesticides **B.** fertilizers **C.** pollutants **D.** sewage

_____ **6.** Point-source pollution enters water _____.

A. from many different sites
B. from a specific location
C. slowly through seeping soil along pipelines
D. from unknown sources

_____ **7.** Water from the atmosphere is considered a(n) _____.

A. Point source **B.** direct source **C.** indirect source **D.** nonpoint source

_____ **8.** What is the largest source of water pollution in the United States?

A. Car exhaust **B.** burning fields **C.** factory smoke **D.** sediment

_____ **9.** What is the difference between pesticides and fertilizers?

A. Pesticides benefit by nourishing the plant, but fertilizers harm them with chemicals.
B. Both benefit plants – one by nourishing them, one by protecting them.
C. There is no difference.
D. Fertilizers benefit by nourishing the plant, but pesticides harm them with chemicals.

_____ **10.** How can algae affect a lake?

A. When algae die and decompose, they can use up all the oxygen in the lake.
B. They can cause fish to die.
C. They can overtake a lake due to high levels of nitrogen and phosphorus.
D. all of the above

_____ **11.** How do sewage-treatment plants treat sewage?

A. They kill harmful bacteria.
B. They lower nitrogen and phosphorous levels.
C. They remove solid material.
D. all of the above

Name _____ Date _____ Per _____

WORKSHEET 19-1

_____**12.** After metals are released into water bodies, they _____.

A. evaporate within a year
B. are washed out naturally
C. remain in the environment for a long time
D. disappear immediately

_____**13.** What has caused more than 130 metric tons of mercury to end up in the Amazon River?

A. It has been eroded off the banks of the river.
B. Factories have dumped it into the river.
C. miners looking for gold
D. decomposing animals in the river

_____**14.** What precautions have been taken to protect the environment from gasoline as a polluting agent?

A. New and old underground tanks must have special equipment that detects leaks.
B. Tanks today must be made of only one layer of steel.
C. The gasoline has been watered down.
D. Tanks have been taken out of the ground and stored on land.

_____**15.** What act did the U.S Congress pass in 1972 to provide funds for sewage treatment?

A. Safe Drinking Act
B. Clean Act
C. The Montreal Protocol
D. Water Pollution Control Act

____**16.** What was the main cause of the joint U.S.-Canadian effort to reduce water pollution?

A. Demonstrations
B. The pollution of Lake Erie
C. political pressure
D. the thinning of the ozone layer

_____**17.** What can a citizen do to help reduce water pollution?

A. pour hazardous chemicals down the drain
B. find out where hazardous chemicals should be disposed of
C. pour hazardous chemicals on the ground
D. throw the containers in the trash

_____**18.** What does it mean to conserve water?

A. to use more **B.** to use less **C.** to use the same amount **D.** to not use any

_____**19.** What ingredient in fertilizers can cause an overgrowth of algae?

A. Nitrogen **B.** carbon **C.** oxygen **D.** hydrogen

____**20.** Conserving water may help reduce water pollution by _____.

A. Reducing water in the atmosphere
B. increasing pH in the soil.
C. reducing the need for water treatment.
D. reducing acid rain.

Marine Ecosystems

3.03

Getting the Idea

Key Words

benthos
plankton
nekton
intertidal zone
neritic zone
coral reef
upwelling
oceanic zone
hydrothermal vents
estuary

Millions of species of living things make their home in Earth's oceans. These species live in diverse environments, ranging from the shallow shoreline to the deep, dark ocean floor. Some organisms swim freely in the ocean, whereas others float or live attached to surfaces. Regardless of where they live or how they move, each species is adapted to its environment.

Ocean Life

Organisms that live in the ocean are classified into three main groups. These groups are based on how the organisms move and where they generally make their home in the ocean. **Benthos** are organisms that live on or near the ocean bottom, sometimes attached to surfaces. **Plankton** are tiny organisms that are moved by ocean currents. By contrast, **nekton** are free-swimming organisms that can move independently of currents. Examples of organisms belonging in each group are listed in the table.

Types of Ocean Organisms

Group	Definition	Examples
Benthos	Plants and animals that live in, on, or near the ocean bottom	Kelp, sponges, worms, algae, fungi, clams, snails, starfish, sea urchins
Plankton	Small and microscopic organisms that move with the currents	Krill, some crustaceans, algae, protozoa, jellyfish, some mollusks, eggs or larvae of larger species
Nekton	Swimming animals that can move independently of the currents	Fish, whales, seals, some sea birds, snakes, eels, shrimp, octupus, squid

Ocean Ecosystems

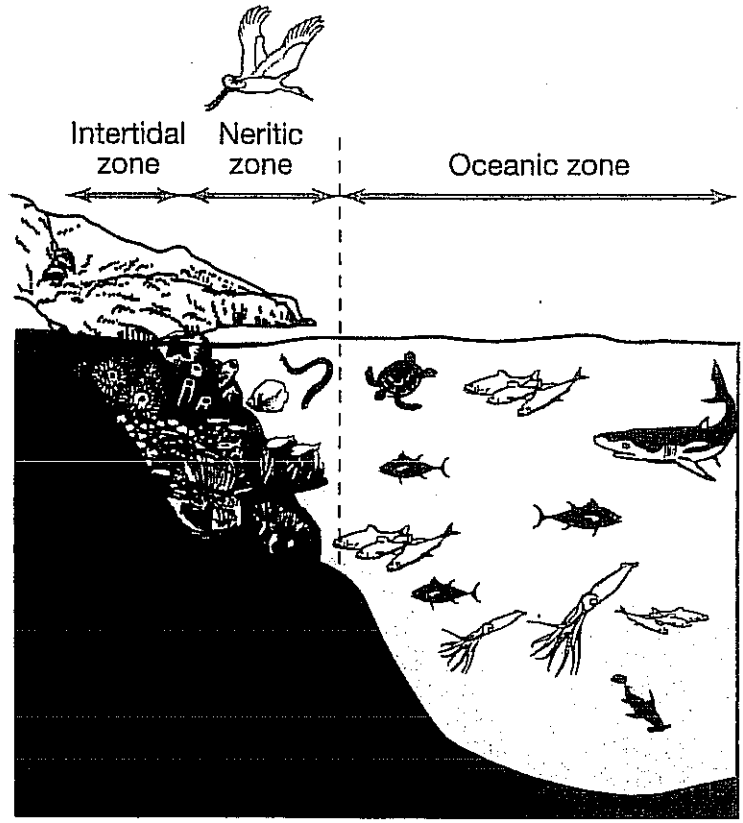
Conditions of the ocean change greatly with distance from the shoreline. For example, sunlight easily penetrates the shallow ocean waters near the shoreline to light the ocean floor. Water depth

generally increases with distance from the shoreline. Changes in depth are accompanied by changes in conditions such as pressure, sunlight, and temperature. As the environment changes, the organisms able to survive in each environment also change.

The ocean is divided into three distinct life zones: the intertidal zone, the neritic zone, and the oceanic zone. The main factors that determine the location of each life zone are water depth and distance from the shoreline. Each life zone differs in conditions such as depth, temperature, pressure, and the amount of sunlight it receives. Organisms living in each zone are adapted to that region's conditions.

The **intertidal zone** is the shoreline area that falls between the high tidemark and the low tide mark. Most organisms living here are adapted to being underwater at high tide and exposed to air at low tide. A few, however, such as sea anemones and sea stars, make their homes in tide pools, low areas that remain filled with water at low tide.

Many organisms of the intertidal zone have adaptations to prevent them from being washed into the ocean by waves. Crabs and clams, for example, burrow into sand. Seaweeds have structures called holdfasts that help them stay rooted. Barnacles create tough shells that they cement to rock in order to withstand waves.



Did You Know

The bacteria that live in hydrothermal vent communities make their own food by chemosynthesis. These bacteria, which serve as the food for tube worms and clams, serve as the producers for this unique ecosystem.

The **neritic zone** is the ocean area that slopes down from the edge of the shoreline toward the ocean floor. Water depth in this zone ranges from a few meters to about 200 meters. The shallow waters of the neritic zone allow light to penetrate almost to the ocean floor. Temperatures and salinity also stay fairly constant. These conditions allow the neritic zone to provide home to more kinds of organisms than either of the other life zones.

Two major ecosystems within the neritic zone are coral reefs and kelp forests. Coral reef ecosystems most often develop in warm, shallow areas of the neritic zone. A **coral reef** is a limestone deposit formed from coral shells. Corals are tiny organisms that live attached to each other in large groups called colonies. As corals die, their skeletons are left behind to create raft-like areas called reefs. Living corals and other organisms can attach to the reef or live in spaces within the reef. Algae, sea anemones, clownfish, sponges, sea stars, and sea urchins often live in coral reefs. Many free-swimming fish visit reefs to find food.

Kelp forests develop in colder, near-shore areas of the neritic zone. Kelp are large brown algae that attach to the sea floor and grow toward the surface. Kelp grow in large numbers, forming a kind of ocean forest. Sea urchins and their main predator, sea otters, are abundant in kelp forests. A variety of fish, sea cucumbers, turtles, abalones, sea stars, and sea anemones also live in kelp forests.

Kelp can grow very quickly—some more than 30 centimeters per day. **Upwelling**, the movement of nutrient-rich waters from the deep ocean into shallow areas, brings nutrients that help some kelp forests to thrive. Upwelling occurs when winds blow warm surface waters away from shore.

The **oceanic zone** is made up of the open waters of the ocean. This zone extends from the ocean's surface to its deepest waters. Sunlight can penetrate only the top 200 meters of the oceanic zone. Thus, all producers, such as phytoplankton, and most consumers live in these surface waters. Whales, dolphins, squids, jellyfish, and fish live in the oceanic zone. Some organisms, such as hatchetfish and krill, travel between the surface and deep waters of this zone. Krill are tiny, shrimplike animals that are an important food source for whales and other ocean animals.

The floor of the deep ocean is called the abyss. High pressure, low temperature, and the absence of light characterize this area. Worms, bacteria, sea urchins, and some fish live in this zone. Many of these organisms survive by eating organic material that rains down from the surface. Whole ecosystems also survive on dead whales and other marine life that sinks to the ocean floor.

In some parts of the abyss are deep-sea hydrothermal vent communities. **Hydrothermal vents** are cracks in the ocean crust that release mineral-rich water that has been heated by Earth's interior. Water temperatures near hydrothermal vents can reach up to 360°C. Bacteria near the vents make food using chemicals in the vent water. Tubeworms and clams near the vents use these bacteria for food.

Where Rivers Meet Oceans

Unique ecosystems called **estuaries** form where salty ocean water mixes with fresh water from rivers. Salinity in estuaries changes constantly, depending on rain amounts and coastal storms. Estuaries are generally protected from ocean waves by barrier islands, reefs, or sand spits. The calm waters of the estuary contain an abundance of dissolved oxygen, nutrients, and minerals, supplied by the river water. Seagrasses provide ample food and shelter. Fish, shrimp, crabs, and other shellfish thrive in these conditions. In fact, estuaries serve as nurseries for many of these animals.

DISCUSSION QUESTION

What would happen to an estuary if the barrier islands, reefs, or sand spits near the estuary were removed?

LESSON REVIEW

1. Where are coral reefs located?

   A. in the oceanic zone

   B. in estuaries

   C. in the intertidal zone

   D. in the neritic zone

2. Which of the following organisms could ***not*** live on the ocean floor of the oceanic zone?

   A. fish

   B. algae

   C. bacteria

   D. worms

3. How do nutrients move in the ocean as a result of upwelling?

   A. from deep, colder areas to warm, shallow areas

   B. from warm, shallow areas to deep, colder areas

   C. from the neritic zone to the intertidal zone

   D. from the ocean floor into estuaries

Name Period Date

CHAPTER 4 | OCEAN ENVIRONMENTS

Chapter Test A

Key Concepts

Choose the letter of the best answer. (5 points each)

____ **1.** The narrow margin between the low tide and high tide marks is called
- **a.** a habitat
- **b.** an estuary
- **c.** the intertidal zone
- **d.** the deep zone

____ **2.** Fresh water from rivers mixes with the ocean's salt water in
- **a.** wetlands
- **b.** mangrove swamps
- **c.** estuaries
- **d.** salt marshes

____ **3.** What is a wetland?
- **a.** barren land near a coast
- **b.** developed land near a coast
- **c.** farmland near a coast
- **d.** soggy land near a coast

____ **4.** One way that governments protect organisms in coastal areas is by passing laws that
- **a.** prohibit habitats along shorelines
- **b.** prohibit dumping along shorelines
- **c.** increase pollution released along the coast
- **d.** increase development of wetland areas

____ **5.** Which of these describes the waters in many near-shore environments?
- **a.** dark and full of life
- **b.** dark with very little life
- **c.** sunlit and full of life
- **d.** sunlit with very little life

4. Which example of non–point-source pollution would probably contain the highest level of nitrates?

   A run-off from roads

   B run-off from golf courses

   C trash dumped in oceans

   D silt from a construction site

5. Which of the following causes water molecules at the surface of a lake to exhibit surface tension?

   A The surface water molecules are pulled in all directions by other water molecules.

   B. The surface water molecules are pulled sideways only by other water molecules.

   C. The surface water molecules are pulled only downward by other water molecules.

   D. The surface water molecules are pulled both downward and sideways by other water molecules.

6. Which statement is ***not*** true about the world's oceans?

   A The Pacific Ocean is the largest ocean.

   B All oceans are connected.

   C Oceans cover more than three-fourths of Earth's surface.

   D Ocean temperatures vary depending on latitude.

7. Which of the following is an example of non–point-source pollution?

   A sewage spill from a wastewater treatment plant

   B acid wastewater from a pickle factory

   C gasoline run-off from roads

   D oil from a leaking underground tank

8. Why can high water temperatures reduce water quality for fish and other organisms?

   A High temperatures can lower water pH.

   B High temperatures can lower dissolved oxygen levels.

   C High temperatures can decrease turbidity.

   D High temperatures can decrease nutrient levels.

EOG Review

1. Which technology can show concentrations of phytoplankton in the oceans?

   A GPS
   B GIS
   C remote sensing
   D computerized buoys

2. Which of the following describes a connection between an aquatic and terrestrial food web?

   A A mosquito emerges from a swamp and is eaten by a frog.
   B A polar bear catches and eats a seal in the Arctic.
   C A leaf falls in the forest and is decomposed by bacteria.
   D A hawk catches and eats a mouse.

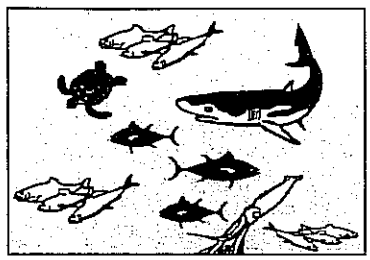
3. According to the chart, which conditions would allow the survival of trout?

Select Water Quality Standards

Measure of Water Quality	Trout Free Waters	Trout Waters
Chlorophyll *a*	< 40 µg/L	< 15 µg/L
Dissolved oxygen	> 5.0 mg/L daily avg.	> 6.0 mg/L
pH	6.0–9.0	6.0–9.0
Temperature	< 29°C –32°C	< 20°C

   A 18°C and 5 µg/L chlorophyll *a*
   B 5.5 mg/L DO and pH of 7.0
   C pH of 8.5 and 23°C
   D 20 µg/L chlorophyll *a* and 6.6 mg/L DO

9. The diagram shows organisms that live in the ocean. What is true about all of the organisms shown?



A They are all phytoplankton.

B They are all zooplankton.

C They are all nekton.

D They are all benthos.

10. What is the definition of an estuary?

A an area where fresh water mixes with salt water

B an area that is protected by barrier islands

C an area where fish and shellfish can develop

D an area with seagrasses

11. What happens to wastewater when it first enters a treatment plant?

A It goes into a holding tank to allow particles to settle out.

B It passes through a screen or filter that separates out large solid materials.

C It is treated with chlorine.

D It goes into a tank full of bacteria that decompose the waste.