SAMPLE PAGES FOR

PASSING THE NORTH CAROLINA EIGHTH GRADE EOG TEST IN SCIENCE

THE COMPETITIVE EDGE

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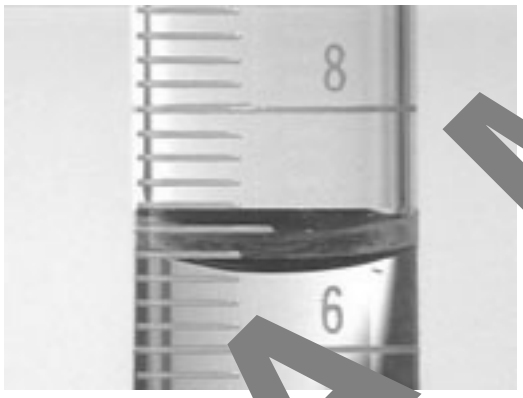
THE HYDROSPHERE

WATER

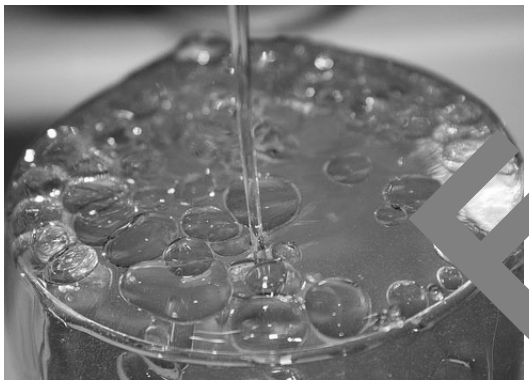
The most important compound in living things is **water**. Its formula is H_2O, which means there are two hydrogen atoms combined with one oxygen atom. The ability of water to form multiple hydrogen bonds gives it many of its properti**Cohesion** is an attraction between molecules of the same substance. Water is cohe e. Th is why some insects and spiders can walk on the water's surface. **Adhesion** is a traction of molecules of different substances. This causes water to have a meniscus in a graduated cylinder. A meniscus is the slight decrease in the center of the waterline at the top. This is due to water's attraction with the glass of the cylin r. Water is unique because it is very **polar**, which means it has a slight positive end d a sl nt negative end. This makes it able to dissolve so many substances that some peo all it a universal solvent.



A meniscus is the t decrease in the center of the wa line at the top caused by ad esion.

Some insects and spiders can walk on the water's surface because water is cohesive.

Water dissolves other molecules that are polar but does not dissolve nonpolar substances like fats and oils (*Oil and water don't mix.*). Substances that dissolve in water are **hydrophilic**, and substances that do not dissolve in water are **hydrophobic**. Water is also unique because it is very heat stable. It does not gain or lose heat easily, so it is important in the maintenance of homeostasis (temperature regulation).



Oil and water don't mix.

PRACTICE

1. Provide two reasons why water is a unique compound and is important to all organisms.

   1. _____

   2. _____

2. Explain cohesion and adhesion.

   _____

   _____

   _____

   _____

3. Why is water referred to as a universal solvent?

   _____

   _____

4. Explain hydrophilic and hydrophobic substances.

   _____

HEAT CAPACITY

Thermal energy is also called heat energy. The heat energy transferred during changes in temperature depends on the mass and type of the material as well as the amount of change in temperature that occurs. **Heat capacity** is the capacity of any amount of material to absorb energy. **Specific heat** is the amount of heat energy required to raise the temperature of one gram of substance by one degree Celsius or one Kelvin. Energy is measured in **joules** or **calories** so specific heat can be calculated in joules or calories.

Sample Problem:

How many joules of heat does it take to raise the temperature of 14.0 g of water from 30˚C to 40˚C?

Answer:

$q = cm(\Delta T)$

$q = (4.18 J/g^{\circ}C)\ (14g)\ (40^{\circ}C - 30^{\circ}C)$

$q = (4.18 J/g^{\circ}C)\ (14g)\ (10^{\circ}C)$

$q = 585.2\ J$

EQUATION FOR SPECIFIC HEAT:

$c = q/m\ (\Delta T)$ or $q = cm(\Delta T)$

c = specific heat

q = heat energy gained or lost

m = mass

ΔT = change in temperature

(ΔT = final temperature – initial temperature)

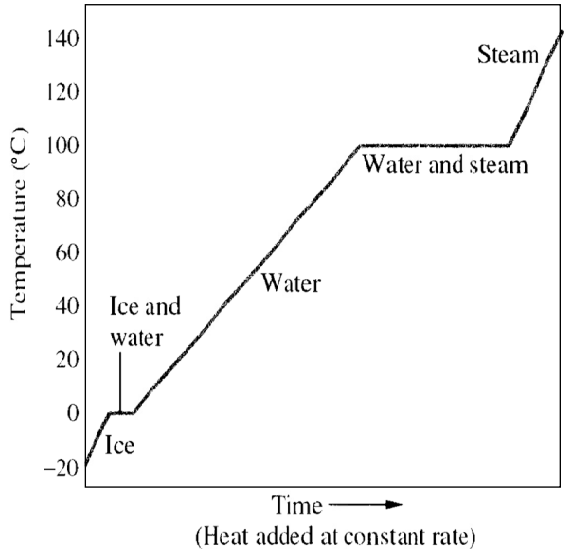
TABLE OF SPECIFIC HEATS AT 25˚C OR 298 K

Substance	Specific Heat (J/g˚C)
Water (liquid)	4.18
Water (gas)	1.85
Water (solid)	2.06
Ethanol	2.46
Aluminum	0.897
Copper	0.385
Gold	0.129
Iron	0.444

Notice the specific heat of metals is low while the specific heat of water is high. Water takes more energy to increase its temperature than metals do. This is due to strong hydrogen bonds between water molecules.

Heat capacity is measured by calorimetry. A **calorimeter** is used to measure heat and heat transfer. The heating curve for water shows the three phases of water heat energy at a constant time.

Notice at 100˚C, the graph has a straight line indicating no change in temperature. This is due to all of the energy being used to change the phase of the matter from a liquid to a gas.



According to the heating curve for water, there is no change in temperature during the phase change from ice to water and from water to steam.

PRACTICE

1. What is heat capacity?

2. Find the heat energy of 10.0 grams of copper that was heated from 30˚ to 50˚

3. How does heat capacity and specific heat differ?

4. What is a calorimeter?

5. Why does the temperature remain constant during a phase change?

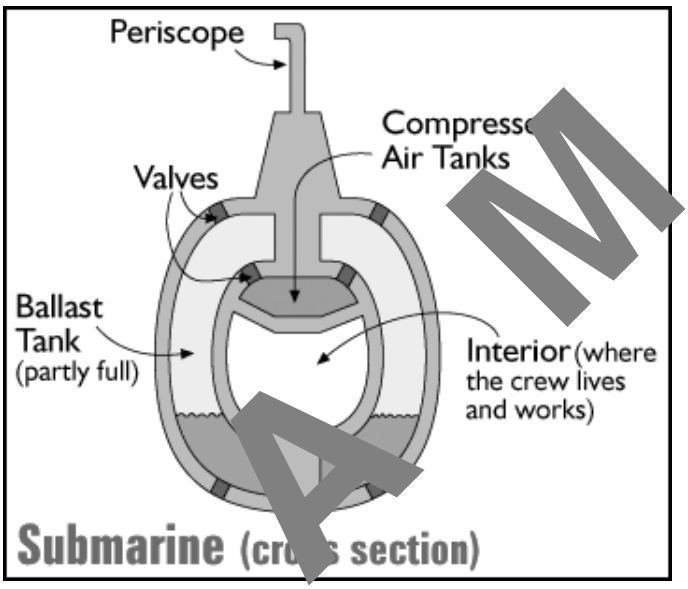
DENSITY

Density is the amount of mass in a unit of volume. The density of pure water is 1.0 g/cm^3 at 4˚C. If any substance is added to the pure water, the density of the water will change. Temperature also affects the density of water. As water heats above 4˚C, the molecules gain energy and move apart. Warm water has lower density than cold water. That is why warm water will float on top of cold water.

When you look at ice (solid water), the molecules are spaced farther apart than in liquid water. This allows the solid water (ice) to float in liquid water. Ice is less dense than liquid water.

Ice floats on liquid water because it is less dense than water.

BUOYANCY



Buoyancy provides an upward force on an object similar to floating. The magnitude of this force is equal to the weight of the displaced fluid. The buoyancy of an object depends on the object's volume and the density of the surrounding fluid. The greater the volume and density of the fluid, the more buoyant the object.

When a submarine surfaces, compressed air flows from the air flasks into the ballast tanks. The water is then forced out of the submarine until its overall density is less than the surrounding water (positive buoyancy). This enables the submarine to rise.

Another example would be to place a piece of wood in a tub. The piece of wood displaces some of the water, and the level of the water goes up. If you weighed the water that the wood displaces, it would equal the weight of the wood.

Every piece of wood does not displace the same amount of water. Some types of wood are heavier or denser than others. A piece of oak wood would displace more water and sit deeper in the water than a piece of pine.

Buoyancy is very important in allowing large, heavy ships to float. As the salinity (the amount of salts dissolved in seawater) increases, the density and the weight of the water displaced by an object increases. This allows the buoyant force to increase, making it easier for objects to float.

The logging industry uses rivers to float logs downriver to the mill since logs are buoyant.

PRACTICE

1. What is density?

2. What affects density?

3. Explain buoyancy.

4. How does a submarine stay buoyant?

5. How does the density of an object affect its buoyancy?

ACIDS AND BASES

Acids and **bases** are two useful groups of chemicals. The simplest **acid/base theory** defines an acid as a substance that produces hydrogen ions (H^+) in solution. Acids are made of hydrogen ions combined with one or more nonmetals. Examples of common acids are shown in this chart. Common materials that are acidic include vinegar, citrus fruits, tomatoes, tea, and carbonated drinks. Acids have very distinctive properties. They have a sour taste, turn blue litmus paper **red**, have a pH <7, and can neutralize bases. Acids react with active metals to produce hydrogen gas.

ACID: A substance that produces hydrogen ions (H^+) in solution.

Formula	Acid Name	Common Use
HCl	hydrocloric	stomach acid
HNO_3	nitric	industrial aci
H_2SO_4	sulfuric	battery acid
$HC_2H_3O_2$	acetic	vinegar

All acids consist of hydrogen combined with nonmeta

BASE: A substance that produces hydroxide ions (OH^-) in solution.

Formula	Name
NaOH	sodium hydroxid
KOH	potassium hydroxid
$Mg(OH)_2$	magnesium hydroxide
NH_4OH	ammonium hydroxide

All bases t of a metal combined ith oxide.

A base is defined as a substance that produces hydroxide ions (OH^-) in solution. Bases consist of a metal combined with hydroxide. Some examples are contained this chart. Common basic materials include soap, shampoo, lye, window cleaner, drain cleaner, and antacids. Bases have a slippery feel, turn red litmus **blue** (base blue), have a pH>7, and can neutralize acids.

When combined, acids and bases will produce water and a salt. This reaction is called **tralization**. The salt forms from the negative ion of the acid and the positive ion from the h The remaining hydrogen and hydroxide ions combine to form water.

HCl	+	**NaOH**	→	**NaCl**	+	**H_2O**
hydrochloric acid		sodium hydroxide (base)		sodium chloride (salt)		water

The concentrations of acids and bases are described by the **pH scale**. The range of pH values is 0 to 14. The lower the pH the more hydrogen ions are present (acidic solution). The higher the pH, the more hydroxide ions are present (basic solution). Pure water has a pH of 7. The amount of hydrogen ions present equals the amount of hydroxide ions present. Pure water is **neutral**. The pH values of common materials are shown below.

Some organic compounds change color in different pH solutions. These compounds are called **indicators** because they may be used to determine the pH of other materials. Two commonly used indicators are litmus and phenolphthalein. A description of their responses to acids and bases is shown below.

Material	pH	
stomach acid	1	
lemons	2	
grapes	3	acidic
tomatoes	4	
bananas	5	
milk	6	
water	**7**	**neutral**
eggs	8	
baking soda	9	
soap		
ammonia		
lye	14	

pH	Material
0 - 7	acid
7	neutral
7 - 14	base

Indicator	Acid Color	Base Color
litmus	red	blue
phenol-phthalein	no color	bright pink

PRACTICE

1. Which of the following materials could be used to neutralize vinegar? (Circle.)
   lemon juice, ammonia, HCl, tea, NaOH, water

2. Which of the following materials could be used to neutralize ammonia? (Circle.)
   NaOH, citrus juice, vinegar, HNO_3, baking soda, soap, water

3. Identify these solutions as acidic (A), basic (B), or neutral (N).
   pH = 12 _____
   pH = 2 _____
   pH = 7 _____

4. What ion does an acid produce in solution?

   _____

5. List three properties of acids.

   1. _____

   2. _____

   3. _____

6. What ion does a base produce in solution?

   _____

   _____

7. List three properties of bases.

   1. _____

   2. _____

   3. _____

8. What is the pH range of acids? of bases? of neutral solutions?

   _____

   _____

9. If a solution turns pink when tested with phenolphthalein, is it acidic or basic?

   _____

   _____

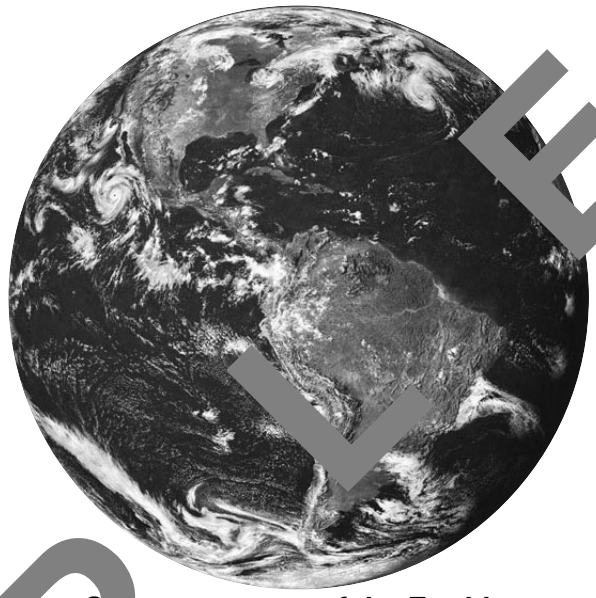
10. If red litmus paper turns blue when dipped into a solution, is the solution acidic or basic?

    _____

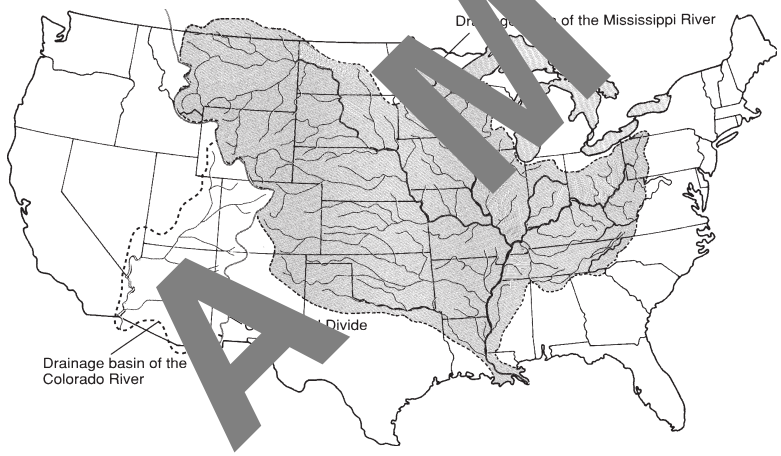
    _____

WATER AND THE ENVIRONMENT

All of the water on the Earth is called the **hydrosphere**. Water is a major resource of our ecosystem. From outer space, the Earth seems to have plenty of water. The pictures of our planet clearly show the blue color of the oceans. Water makes up about 70% of the Earth's surface, and about 97% of this water is **saltwater** from the oceans. This water is important for maintaining the ecosystem and environments for marine organisms, but it is not very useful to humans needing water to drink. Only 3% of all the water on Earth is **freshwater**. And about 67% of all freshwater is frozen in ice caps and glaciers. In the end, less than 1% of water on Earth is available as freshwater that we can use.



Seventy percent of the Earth's surface is covered by water.



The Mississippi River basin covers more than 1,245,000 square miles, including all or parts of 31 states and two Canadian provinces.

Freshwater is found underground in lakes, ponds, rivers, and as water vapor in the air. As rain falls to Earth, these sources are gradually replenished. The amount of water that soaks into the ground depends on how dry the ground is and what kind of soil is there. Some types of soils have more space between the particles than others. This is referred to as **pore space**. The more pore space, the more water the soil will hold.

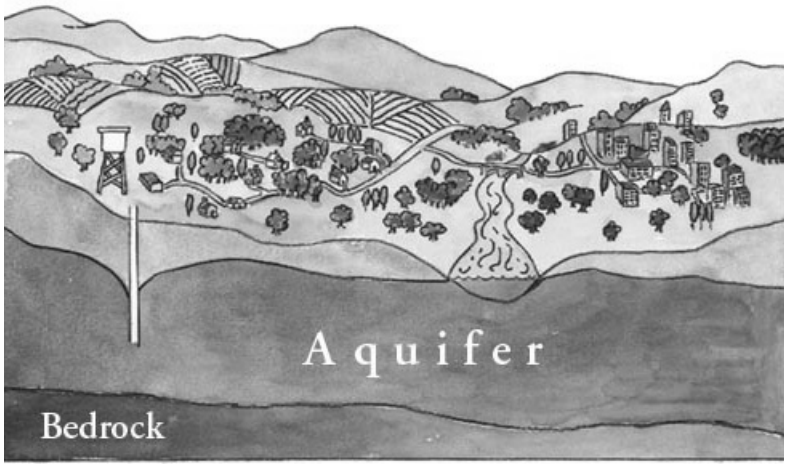
If the rain falls faster than the soil can absorb it, the water will collect on the surface and eventually move downhill across the land. This is called **surface runoff** and is a major source of erosion. Surface runoff always occurs from higher elevations to lower elevations. Small streams are formed, which carry water down to larger streams, which

carry water down to rivers. The area of land that holds all of the water sources that feed a river is called a river's **watershed**, or sometimes called the **drainage basin**. The largest watershed in the United States is that of the Mississippi River.

In a watershed, some water may collect in a low-lying place. This will form a body of freshwater called a **pond** or a **lake**, depending on its size. Lakes are usually larger than ponds. Technically, to be called a lake, the water must be so deep that sunlight does not reach the bottom. But many "lakes" are not this deep, and must have been named incorrectly. Lakes can be artificially created if people decide to dam a river. A lake that is formed by a dam is called a **reservoir**. This helps with water storage, flood control, and can generate hydroelectric power.

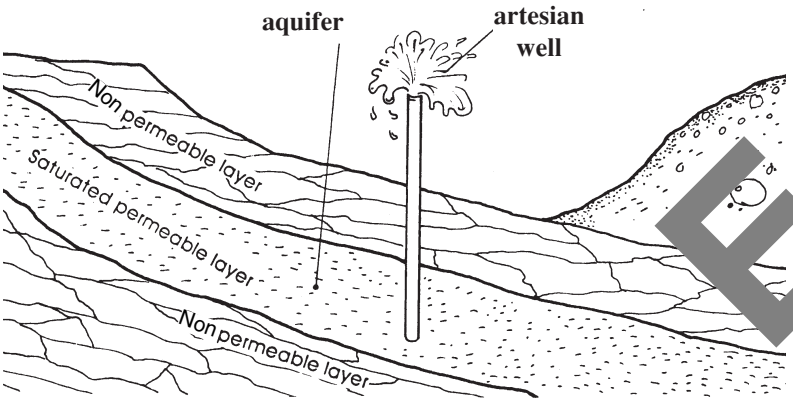
Much freshwater is below the surface of the Earth. Water from underground zones is referred to as **groundwater**. The level of the water underground is called the **water table.** In some areas, you do not have to dig too deep to reach the water table. Near a large body of water, like a lake, the water table is near very deep, and wells are shallow. In other places, you might have to dig a well thousands of feet deep in order to tap the water table. Sometimes the groundwater will even come up to the surface of the Earth and form a swamp, lake, or spring. There is 30 times more groundwater than water in all of the streams, rivers, ponds, and lakes in the world.

Groundwater was once rain or snow. The water that does not runoff or get used by plants gradually seeps through the soil down towards the water table. It will continue moving downward unless there is an opening to the surface, such as a spring. Groundwater can also move through rocks that have a series of cracks and openings. These are called **permeable rocks**. Sandstone is a permeable rock. Some rocks are impermeable, like shale. Since rocks lie in layers, one layer of rock may contain trapped water. If this is the case, then the rock with the trapped water is referred to as an **aquifer**. An aquifer can also exist if soil filled with groundwater lies above a layer of nonpermeable rock.



Many communities use aquifers as their water source.

A well can be drilled into an aquifer. As water is pumped from the well to the surface, more water moves into the hole. In some places an aquifer carries water from a higher altitude to a lower altitude. If the aquifer is trapped between the two layers of non-permeable rock, then pressure will build up at the lower altitude. Water may flow without any pumping. If a well is dug in this case, it is called an **artesian well**. These are wells from which water flows without pumping.



Water flows from artesian wells without pumping.

PRACTICE

1. What happens to rain when it falls to the surface of the Earth?

2. Describe the ways that humans can access groundwater for use.

3. What is the advantage of creating a reservoir?

4. What is the hydrosphere? Explain the breakdown of fresh- and saltwater on the Earth.

5. What is pore space?

6. Explain the freshwater found below the surface of the Earth.

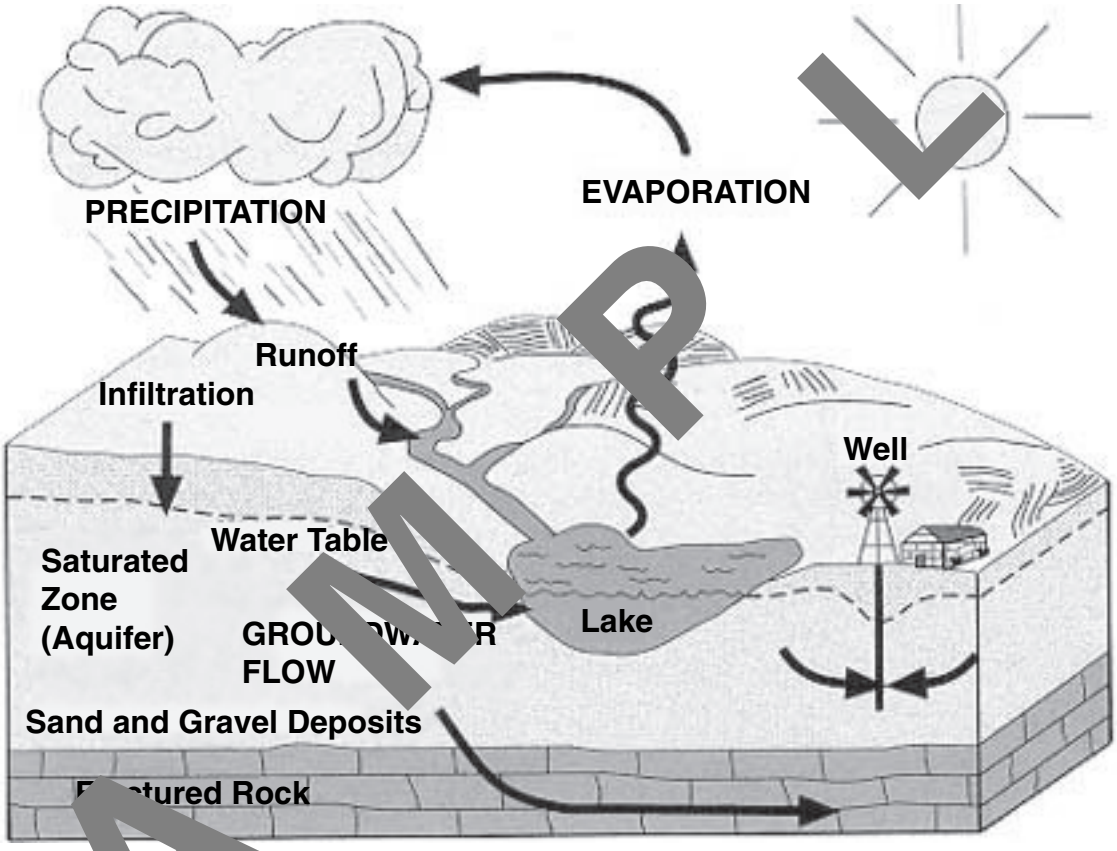
7. What is an aquifer?

8. What is an artesian well?

9. Explain a drainage basin.

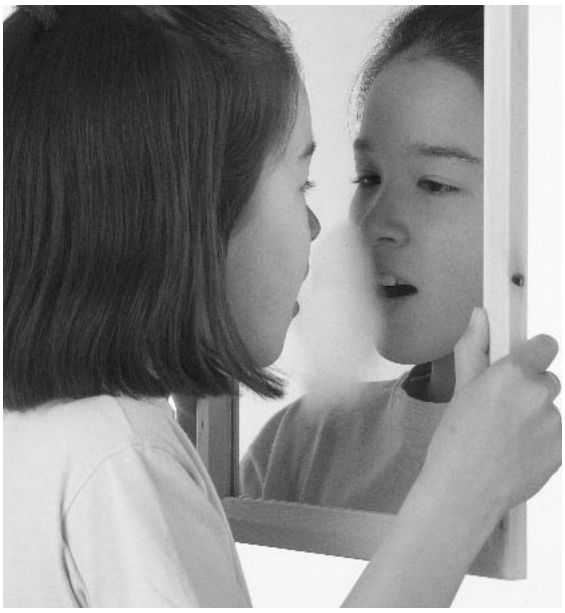
THE WATER CYCLE

The Water cycle (also called the hydrological cycle) is a continuous process of water moving from air to ground. Precipitation, evaporation, sublimation, transpiration, and condensation are the steps in the Water cycle that continue over and over again. It provides us with water in different forms - gas (water vapor), liquid (water), and solid (ice). Water covers more than 70% of the surface of the Earth, and there is more water stored in gaseous form in the atmosphere than there is water in all of the rivers on the Earth.



In the water cycle, precipitation flows into groundwater or surface water and then evaporates into the atmosphere. The evaporation then becomes precipitation and the cycle continues.

Water vapor can form as the sun heats bodies of water or moist land, when the water molecules in liquid form gather greater energy. If the energy of movement is great enough, the water molecules will escape and become water vapor. This process is called **evaporation**. If you have ever noticed a puddle in your backyard after a rain, it will gradually evaporate into the air. If the temperature is hot, it will evaporate faster.



Your mirror will "fog up" when you breathe on it. The water vapor condenses into tiny droplets of water.

The sun also causes water molecules in ice and snow to escape directly into the air bypassing the liquid state in a process called **sublimation**. Some of the water in the Water cycle is used by plants. The groundwater is absorbed by the roots, and any unneeded water escapes into the air through tiny openings called stomata in the leaves in a process called **transpiration**.

When the temperature of the air drops, the water vapor molecules slow down. During this process, they will once again return to a liquid state. This is called **condensation**. If you take a hot shower, you may notice that your bathroom mirror will "fog up." This is actually water vapor that has condensed into tiny droplets of water on your mirror. Eventually the water vapor droplets will evaporate and clear up.

Water that falls to the surface of the Earth is called **precipitation**. This includes snow, ice, hail or rain. Some clouds, like cumulonimbus clouds, result in the formation of precipitation. The tops of some clouds are made of ice crystals. Air movement can mix these ice particles with water droplets from the lower layers. The ice crystals become heavier, until they fall towards the Earth. Falling through cold air creates **snow**, falling through warm air results in **rain**, and falling through warm air and through a patch of cold air results in **sleet**. **Hail** forms when updrafts hurl ice crystals upward again and again. As the crystals fall, they become coated with water, and the water freezes into an icy outer shell. The process repeats itself adding more layers to the hailstones. Eventually the hailstones wll fall to the ground. Dew and frost are not considered to be precipitation, because they form directly on the surface of the Earth. Water that falls to Earth provides a source of life for organisms and contributes to the process of weathering and erosion of minerals and rocks. Much of the precipitation goes into the ground and is called groundwater. If it does not go into the ground it is called runoff. Runoff water is also called surface water. Runoff and groundwater can return to the ocean by first draining into a stream and then into rivers and finally into the ocean.

The Water cycle is an important component of an ecosystem. The cycle is a never-ending process that has continued since the Earth was formed. Water evaporates from the surface of the Earth from oceans, lakes, ponds, rivers, and moist land. This water vapor condenses and forms clouds. When the clouds contain more water than they can hold, precipitation in the form of snow, ice, hail or rain falls to the Earth. As much as two-thirds of all precipitation evaporates back into the atmosphere.

PRACTICE

1. Why are rain and snow considered precipitation but not dew or frost?

2. Describe the process of condensation and evaporation.

3. Describe the process of sub[illegible]tion.

4. Describ[illegible]ocess of transpiration.

5. Explain how snow, rain, hail and sleet form.

6. Why is the Water cycle an important component of an ecosystem?

7. Describe how precipitation, condensation, and evaporation interact in the water system.

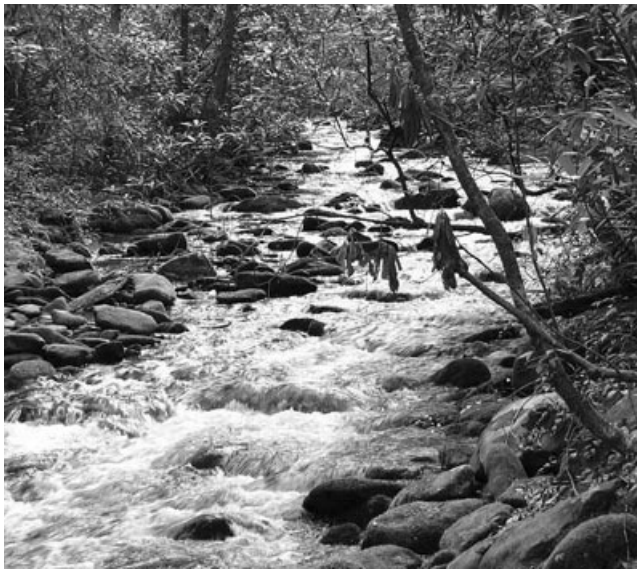
ECOSYSTEMS

Ecology is the branch of science that studies how living things interact with one another and with their environment. All the plants and animals living in a given area, together with the nonliving parts of the environment, make up an ecosystem. Nonliving, or **abiotic**, factors of an ecosystem include soil, water, climate, and sunlight. **Biotic** factors are all of the living things in the ecosystem. They include plants, animals and other living organisms. Ecosystems are typically self-sufficient and independent of other ecosystems.

Freshwater Ecosystems

Only 3% of the surface water on Earth is freshwater. There are two types of freshwater ecosystems—flowing water and standing-water.

Flowing-water ecosystems that flow over land are rivers, creeks, streams, and brooks. Organisms that live in these environments are adapted to the rate of flow. For example, fish have streamlined bodies that help them move against the current. Rivers usually begin in hills or mountains where the



Streams are flowing-water ecosystems.

flow is strong so this area would have little plant life. The further downstream one goes, the more plant and animal life would be found. The slower the flow, the better for plants to establish themselves and for animals like beavers and others to establish a home.

The most common **standing-water ecosystems** are lakes and ponds. There is not a constant in and out flow of water, and there is also water circulating to provide heat, oxygen, and nutrients through the ecosystem. Lakes and ponds provide relatively stillwater habitats for organisms such as plankton which would wash away. (Plankton is the tiny, free-floating or swimming organism in freshwater or seawater that is the base of many aquatic food webs.)

A pond is shallow enough for sunlight to reach the bottom, permitting the growth of rooted plants at its deepest point.

A **pond** is a body of water shallow enough to allow plant roots to reach the bottom. Plants such as cattails may grow in the pond as well as around the perimeter. The temperature of a pond remains the same from top to bottom, and few waves are found here.

A lake is any body of water that has a limit of effective light penetration for organisms except near the shore.

A **lake** is bigger than a pond, and is too deep to support plant roots except near the shore. Some lakes are big enough for waves to be made. Unlike a pond, the temperature of the water in a lake during the summer is not the same from top to bottom. The water is warmer near the top of the lake. Because of this, most of the creatures found in a lake are in the top layer.

Wetlands

A wetland is an ecosystem in which water either covers the soil or is present at or near the surface for at least part of the year. Wetlands are very productive areas for insects, fishes, amphibians, and migratory birds.

The three types of freshwater wetlands are bogs, marshes, and swamps. A **bog** is a wetland that forms in depressions where water collects and is usually covered with sphagnum moss. A **marsh** is a shallow wetland along rivers that usually contains grasslike plants such as cattails. A **swamp** is a wetland that is covered in water year-round. Swamps contain slow moving water, scrubs, and trees.

Wetlands support a variety of life.

Estuaries

An **estuary** is a wetland where rivers meet the sea. It is a partially enclosed body of water where seawater and freshwater meet and mix. Examples of estuaries include bays, mud flats, swamps, and inlets.

Brackish water is saltier than fresh water, but not as salty as seawater. It results from mixing of seawater with freshwater in estuaries.

Life in an estuary is influenced by the **rise and fall of the tides.** Mammals, birds, fish, reptiles, shellfish, and plants live and interact in this ecosystem to create very complex food webs. The soil, sand, and mud in an estuary are full of rich decaying matter in which plants thrive. During the day, when the tide is out, creatures such as clams and oysters close their shells for protection. Crabs and small fish hide from predators. Some animals, like birds, are active during the low tide in the daytime because the supply of food is easier to get to. At night when the tide returns, the estuary comes alive. Many estuary creatures are active only at night. The returning seawater floods the estuary bringing protection from predators.

Estuaries are **spawning areas** for commercial fish and shellfish such as shrimp and crabs. Many animals are born, feed and grow in estuaries, head out to sea to mature, and return later to reproduce. They are also nesting, feeding, and resting areas for many migratory birds.

Estuaries also act as **natural buffers** between the land and the ocean. Like barrier islands, they protect the mainland and people from the major force of heavy storms. Hurricane Katrina's extensive damage to New Orleans was partly due to buffers being removed by developers.

Salt Marshes

Salt marshes occur in places where the land meets the sea, such as barrier islands and other coastal areas. The marshes are exposed to water at different times of the day or year. Sometimes the marsh has little water, and sometimes the marsh is full. The salinity, or salt content, of a marsh depends on whether it is located close to the ocean or further upstream in the estuary. The water level and salinity level determine which plants and animals make their homes there.

Microscopic organisms like bacteria, fungi, and algae make their home in the decaying marsh grasses. Animals like oysters and clams that filter-feed live here because of the availability of plankton. Fish and crabs move through the marsh at high tide. Birds and predatory animals visit at specific times for their catch. The plants of the salt marsh provide shelter from predators, especially for young animals who use the salt marsh as a nursery.

PRACTICE

1. What is ecology?

2. Explain abiotic and biotic factors.

3. How are aquatic ecosystems determined?

4. Compare and contrast freshwater ecosystems.

5. What is a wetland, and what benefits from wetlands?

6. Explain the three types of freshwater wetlands.

7. Explain an estuary ecosystem.

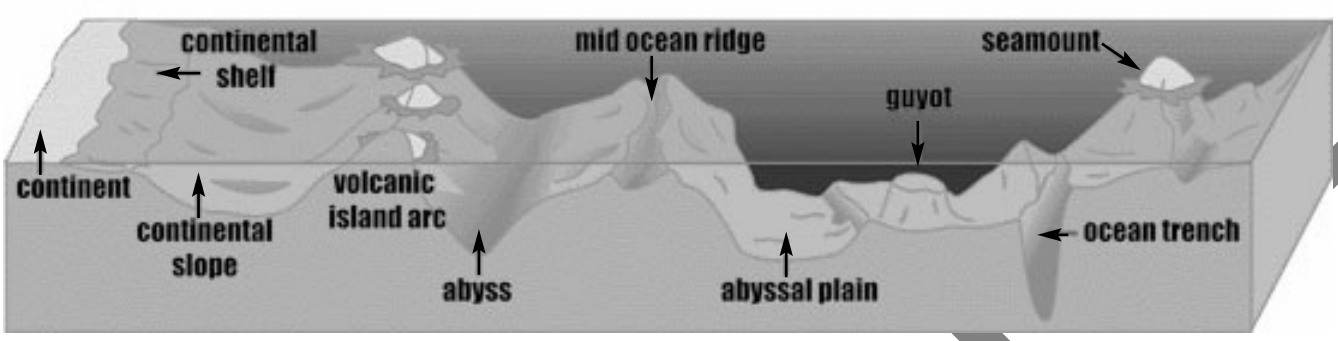
8. Explain salt marshes.

9. What are natural buffers, and why are they important?

THE OCEAN

When you think of the Earth, you may think of the land on which people live. However, this is only a tiny portion of our planet. Nearly three-quarters of the Earth is covered in water, most of which is found in the oceans. Below this water is the ocean floor. The ocean floor is similar to the land you see on the continents. It has mountains, plains, and canyons.

Some mountains are built when plates push together. Others are built when plates move apart. The place where two plates meet is called a **plate boundary**. Plate boundaries are very active places. The pushing and pulling at these boundaries is responsible for the shape of the land. Plates mostly move apart on the ocean floor. Because of this movement, the ocean floor is not flat.



Pretend you have a special diving suit that allows you to walk across the floor of the Atlantic Ocean. If you walked off the coastline of Nags Head and into the ocean, you would be standing on the continental shelf. The **continental shelf** is a gently-sloping rock platform that borders the continent. It slopes down to a depth of about 180 meters. Rocks, pebbles and sand which have washed off of the land have collected on the shelf.

Eventually, you and the debris fall down the next major descent, the continental slope. The **continental slope** is a sharp tilt that drops 3,800 meters down. At the bottom of the slope, you land in a pile of debris that has collected there. This pile builds a softer, upward slope called the **continental rise**.

You must go up and over the continental rise to reach the ocean floor called the **abyssal plain**. Here, you cross over great plains, or large flat areas of land. You also encounter deep, narrow valleys called **trenches**. Next, you come to a series of underwater mountains called the **Mid-Atlantic Ridge**. Most mountains of the Mid-Atlantic Ridge stand about 2,000 meters high. In some places, the mountains are high enough to break the surface of the water. The Azores Islands, located off the coast of Portugal, are formed from the highest peaks of the Mid-Atlantic Ridge.

The Mid-Atlantic Ridge marks a place where two giant plates spread apart. As the plates spread, molten rock from beneath the Earth's crust wells up to fill in the gap. The hot rock, or **magma**, forces its way up through the deep trench in the ridge. When it reaches the surface, the magma is called **lava**.

When the lava cools, it turns into new crust. A new crust forms and the old crust is pushed aside, making the ridge area wider and wider. If you collected a sample of rock from the middle of the ridge and a sample from farther out, you would find the rock from the middle to be younger. This means it arose from beneath the crust more recently.

Hydrothermal vents are geysers on the seafloor. Here, bacteria use the energy stored in sulfur compounds to produce food. This process is called chemosynthesis. **Chemosynthesis** is the basis for entire ecosystems on the ocean floor. Around the hydrothermal vents, communities of animals will form using chemosynthetic bacteria as their basis.

Ocean Water

When speaking of marine ecosystems, **salinity** must be explained. Salinity is the amount of salt in a given mass of water. Salinity is measured by parts per thousand (ppt). For example, if you have 1,000 g of water that contains 21 g of salt, then the water has a salinity of 21 ppt. Ocean water usually has a salinity of between 32 and 37 ppt. The proportions and amount of dissolved salts in seawater remains in equilibrium. This has been the case for millions of years.

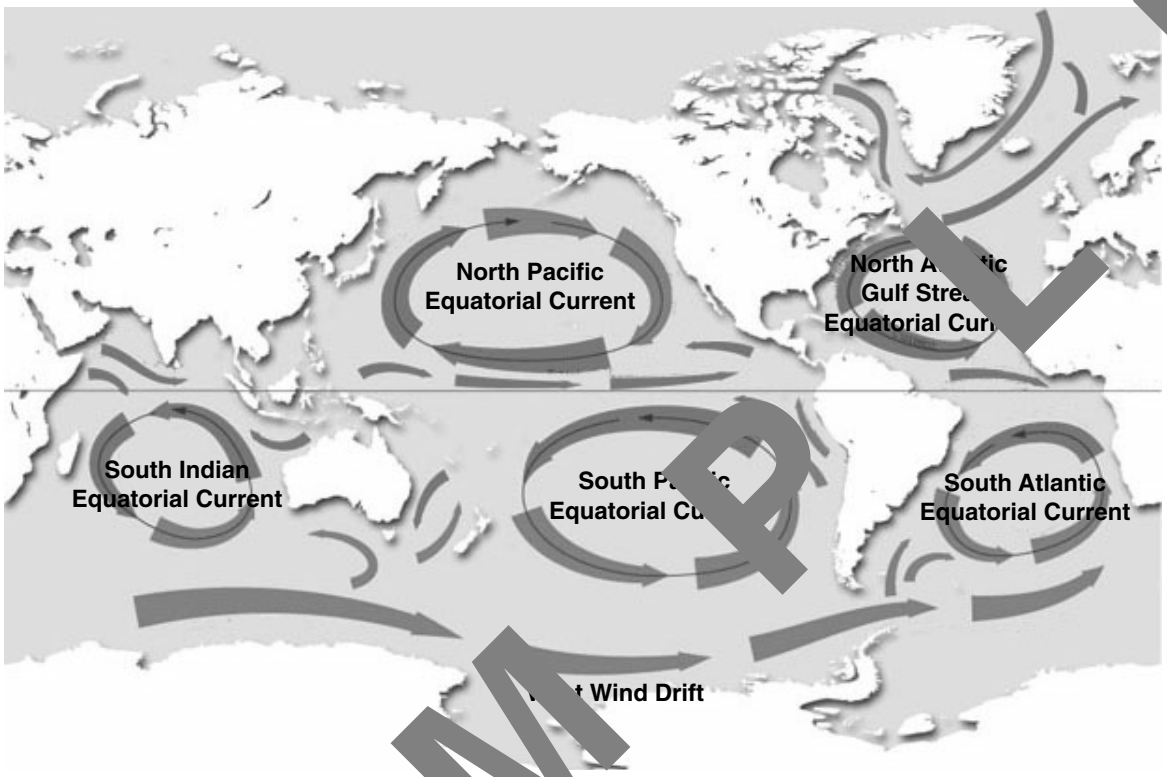
Ocean water contains many dissolved minerals. Most of the dissolved minerals are produced by the mid-ocean ridges. When magma pushes up along these ridges, it carries minerals and water from the Earth's interior. Rivers also contribute dissolved minerals into the mineral count of the ocean when they carry dissolved minerals from the land into the ocean.

Ocean water contains **calcium**. Organisms like clams and oysters use the calcium to make their shells. Others use the calcium to make bones.

Oxygen, carbon dioxide, and nitrogen from the Earth's atmosphere are dissolved in ocean water. Most of the **dissolved oxygen** enters the ocean water directly from the atmosphere and is located near the surface of the ocean. Oxygen is also produced by organisms in the ocean that carry out photosynthesis. Most of these organisms are found above 200 m where sunlight reaches them. **Carbon dioxide** is absorbed directly into ocean water from the atmosphere. It reacts with water molecules to form a weak acid called **carbonic acid**. Carbonic acid helps control the acidity levels of the ocean. Organisms in the ocean also give off carbon dioxide during respiration. The most abundant dissolved gas in the ocean is **nitrogen**. Certain bacteria combine nitrogen with oxygen to form nitrates which are important nutrients for plants.

Ocean Currents

When you think of the ocean you might think of one giant pool of water. It might surprise you to learn that giant rivers of water flow through the ocean. These rivers are called **ocean currents**. Ocean currents move more water than the largest rivers on land. There are warm water currents and cold water currents. Warm ocean currents get their power from three main sources: heat from the sun, strong winds, and the spinning of the Earth on its axis.

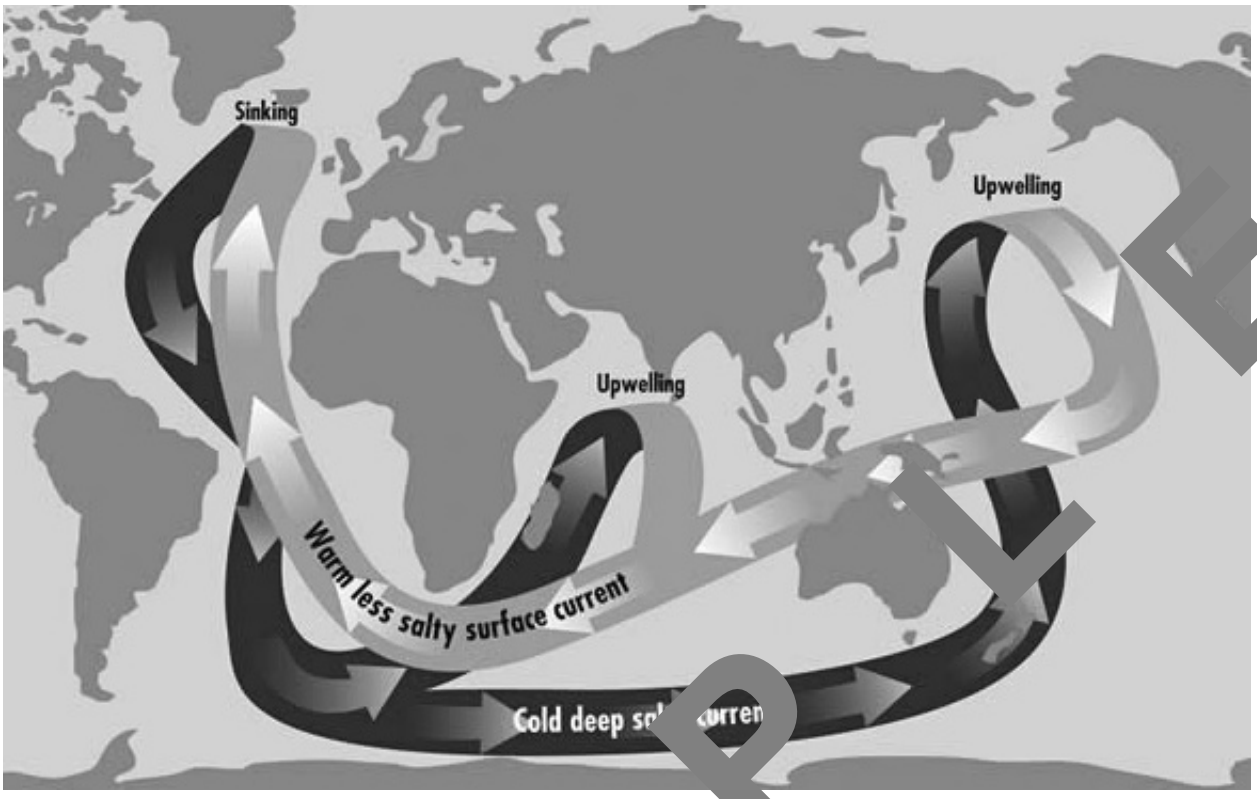


Ocean currents are rivers of hot or cold water within the ocean. The currents are generated from the forces acting upon the water like the Earth's rotation, the wind, the temperature and salinity differences and the gravitation of the moon.

When water at the ocean's surface is heated by the sun, it expands, or spreads out. Steady winds push the water, making it flow. The spin of the Earth causes water to flow in certain directions.

The **Gulf Stream** is a warm ocean current that grazes the coast of North Carolina. The Gulf Stream moves at a speed of 160 kilometers per day. Winds from the southeast push the ocean river in a northwest direction. Eventually, this current spreads, slows, and splits. Part of the current reaches northward to the United Kingdom and Norway. The other part channels south toward the Canary Islands.

Cold ocean currents run deep below the surface of the ocean, where the water is not warmed by the sun. These cold, heavy currents creep along the bottom of the ocean until they reach the tropics. Here, as winds blow warm surface water out to sea, the cold water rises to fill in the gap.



Deep, cold water is brought to the surface by an upwelling.

An **upwelling** is a current in the ocean that brings deep cold water to the surface of the ocean. This happens along coasts where winds cause surface water to move away from the land. Wind that blows parallel to the coast carries water away from the land. When this surface water is pushed away from the coast, deep water rises up to the surface to take its place. This cold, deep water will continue to replace the surface water as it is pushed away. In this cold water are high concentrations of nutrients produced when organisms die and decay at great depths. Tiny marine organisms flourish on these nutrients, and fish are attracted to the upwelling areas. Upwelling can also affect the climate of certain coastal areas. For example, the cool summers and great fogs of San Francisco are attributed to upwelling.

Ocean currents have a great impact on **weather**. For example, if winds are weak, then surface water will not be blown aside. This means cold water currents cannot rise. Instead, warm water currents spread out under the weak wind conditions, causing an El Niño. During an El Niño, the surface temperature of the Pacific Ocean rises. This causes changes in air movement and air temperature, resulting in severe storms in some areas and droughts in other areas.

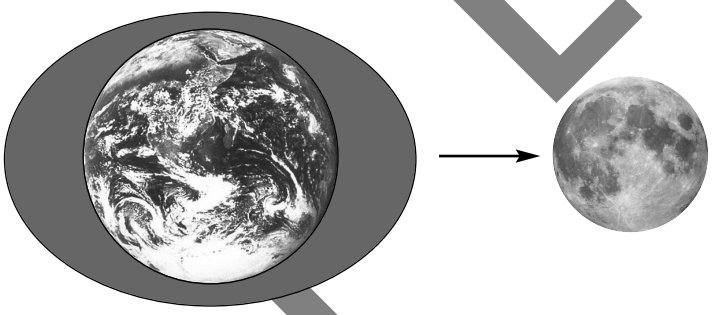
Tides

Ordinary waves are caused by the wind. **Tides**, on the other hand, are giant, slow-moving waves caused by the moon. Tides result in water level changes at the shoreline. Most beaches experience two high and two low tides each day. Each tide change is about 6 hours apart.

Tide Table for Topsail Beach, North Carolina

June 10				June 11				June 12			
High Tide		Low tide		High Tide		Low tide		High Tide		Low tide	
A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
7:34	8:10	1:38	1:40	8:37	9:15	2:47	2:45	9:41	10:20	3:52	3:49

Earth and ocean with NO moon



Earth's oceans influenced by the gravitational pull of the moon

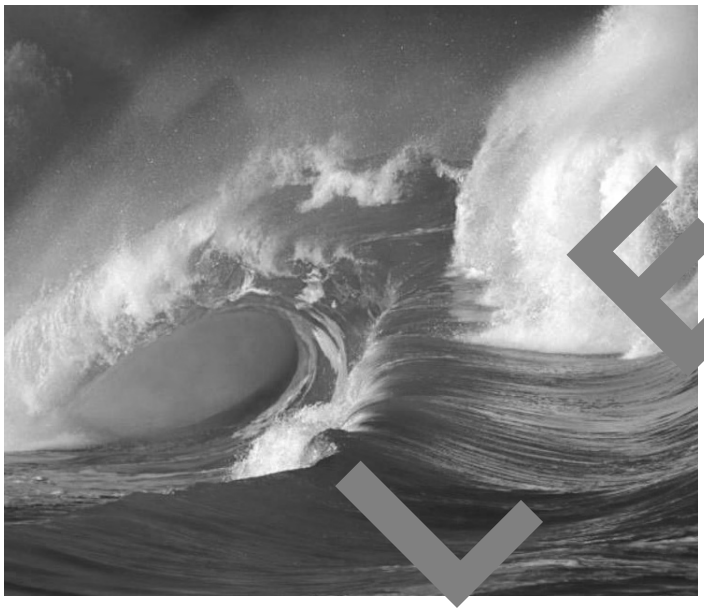
The moon is held close to the Earth by the pulling force of gravity. As the moon orbits the Earth, its gravity tugs at the Earth. This tug causes the surface of the ocean to bulge outward. This bulge causes high tides. The bulge follows the moon, and as the moon continues its orbit, the ocean left behind experiences a low tide.

Waves

Have you ever looked out at the ocean on a windy day? If so, you have noticed choppy water. On a light breezy day, you see a much calmer surface.

Wind is a form of energy that blows across the surface of the ocean. This energy causes water to move up and down as the wave passes. Waves do not move water forward as you might think. Imagine a boat floating in the ocean. It may bob up and down as waves pass, but it returns to where it started. As the wave arrives, it lifts both the water and the boat up and forward. As the wave leaves, the water and boat move down and back. Waves simply move water and objects in a circle.

Waves behave differently in shallow water, like at the beach. Here, the bottoms of waves catch on the ocean floor. The bottom part of the wave is slowed down but the top is not. This causes the water at the top of a wave to fall forward, or break.



The water at the top of a wave falls forward.

PRACTICE

1. Define the term plate boundary.

2. Describe the Earth's cru

3. Describe how crust is added to the ocean floor.

Describe the continental shelf.

5. Describe the continental slope.

6. Describe the continental rise.

7. What events occur at the Mid-Atlantic Ridge?

8. Explain ocean currents.

9. Explain waves.

10. Explain tides.

11. What is the majo cause of an El Niño?

12. Describe how a wave moves water.

13. What is the major force that causes tides?

14. Explain upwelling.

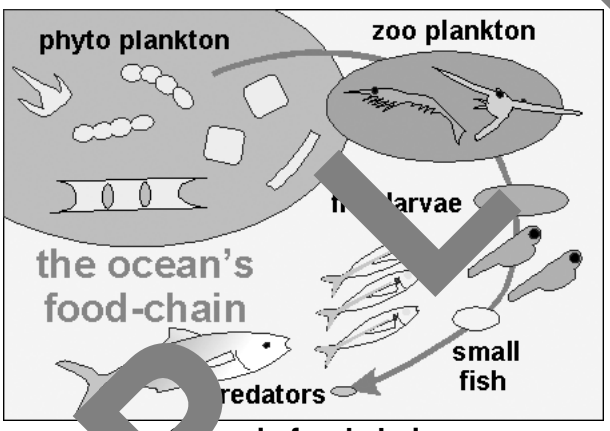
15. Explain hypothermal vents and why they a[illegible]tant.

16. Define salinity.

17. Explai[illegible]alcium, oxygen, carbon dioxide, and nitrogen in ocean water are importa[illegible]

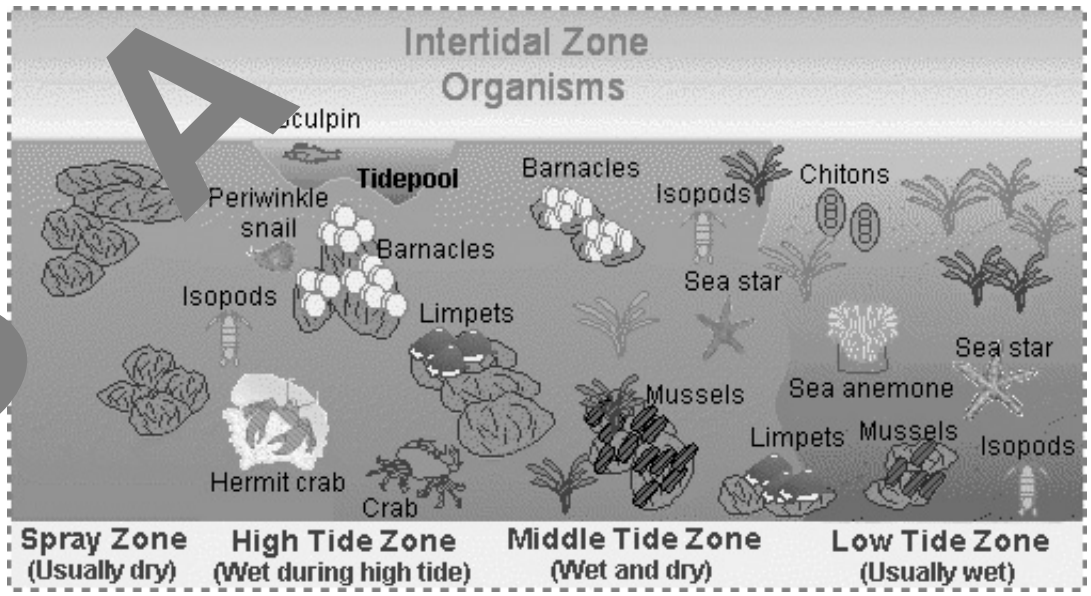
MARINE ECOSYSTEMS

A marine ecosystem is made of saltwater, and sunlight penetrates only a short distance through the water. It has two major zones, the **photic** or well-lit upper layer and **aphotic** or permanently dark layer. Photosynthesis can take place and algae and other producers (seagrasses and microscopic organisms called **phytoplankton**) can grow in the photic zone which goes to a depth of approximately 200 meters. Producers in the ocean are eaten by other organisms (consumers) for nutrients and energy. **Zooplankton**, microscopic animals in the ocean that cannot produce their own food, eat phytoplankton. The zooplankton is then eaten by larger organisms which are then eaten by other organisms. This is an **oceanic food chain**. Bacteria are the only producers that can survive in the aphotic zone. Besides the photic and aphotic zones, biologists divide the ocean into **ocean zones** that are classified based on depth and distance from shore. These zones are the intertidal, coastal ocean, and open ocean.



eanic food chain

Intertidal zone (area of the coastline that the ocean completely covers during high tide and is just below the waterline during low tide) organisms are exposed to regular and extreme changes in their surroundings. They are submerged in ocean water twice a day,



and the remainder of the time, are exposed to air, sunlight, and temperature. (Estuaries are considered a special class of intertidal zones.) Organisms such as snails, sea urchins and stars, barnacles, and seaweed attach themselves on rocks and are constantly being hit by waves and strong currents in the rocky intertidal zone. The **rocky intertidal zone** is a most interesting community in temperate regions where there are exposed rocks along the shoreline. There is much competition among the organisms here which leads to zonation. **Zonation** is the horizontal banding of organisms that live in a particular habitat. Each band in the rocky intertidal zone can be recognized by the difference in color or shape of the organisms. Mussels, barnacles, and rockweed will form distinct bands dominated by these species.

The **coastal ocean** area extends from the low-tide mark to the outer rim of the continental shelf, is always covered by water, and is shallow enough for photosynthesis to take place. The coastal zone is rich in plankton and other organisms. Kelp forests (giant brown algae) are common in the coastal areas along the coasts of California and the Pacific Northwest. Whales, snails, and sea otters enjoy the kelp forests for food. **Coral reefs** are also common in the tropical coastal oceans. Coral reefs are made of coral animals (relatives of jellyfish) whose hard calcium carbonate skeletons make the structure.

Coral reefs are made of coral animals.

The open ocean zone covers 90% of the world's oceans.

The **open ocean** zone begins at the end of the continental shelf and continues outward into the ocean. It covers 90% of the world's oceans and ranges in depth from 500 meters to 11,000 meters. Fish of all sizes and shapes live in this area. Animals that live in the deepest depths are exposed to total darkness, frigid temperatures, and extreme pressure.

Marine Resources

There are many resources that can be found in the ocean. Those on the continental shelf are easy to extract, but those in the deep abyssal region are not. Scientists are still trying to figure out how to conquer these areas.

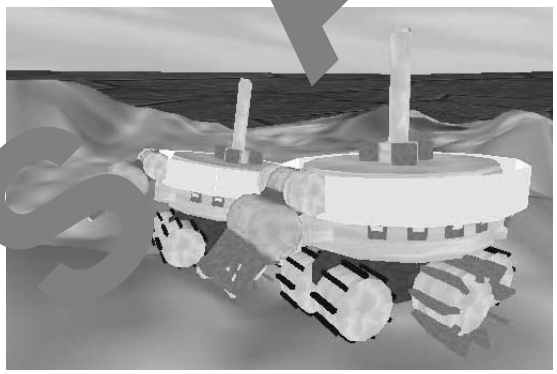
Offshore oil rigs drill for petroleum deposits.

Petroleum and natural gas deposits are found in the continental shelf. About one-third of the world's oil comes from under the seabed. Wells are drilled into the seafloor from floating vessels or fixed platforms to extract these substances.

Phosphorite which is made into fertilizer and limestone that is used for cement is also extracted from the continental shelf. Sand and gravel can also be dredged from the shelf and used by construction companies.

Placer deposits occur where rivers and the ocean meet. Rivers deposit great amounts of minerals onto the continental shelf from land. These placer deposits contain gold, titanium, and some gemstones that are mined in some coastal regions.

In deeper areas of the ocean, hypothermic vents continuously deposit sulfur, iron, copper, zinc and silver along the mid-ocean ridges. Due to the extreme depth of the ocean, mining these materials is almost impossible due to the expense to recover them.



Robotic mining machines are being designed.

Scientists at the University of Toronto are working with two Canadian mining companies in hopes that a deepwater mining operation may be formed. Even though this is just in the "talking stage," designs for robotic mining machines are being tested.

PRACTICE

1. How are the three major ocean zones divided? Explain and give examples.

2. Explain photic and aphotic.

3. What is zonation?

4. What marine resources can be found on/in the continental shelf?

5. What are placer deposits? Why are they important?

6. Why is recovering marine resources in the deepest areas of the ocean so difficult?

7. Why might the studies at the University of Toronto be important?

8. Explain the oceanic food chain.

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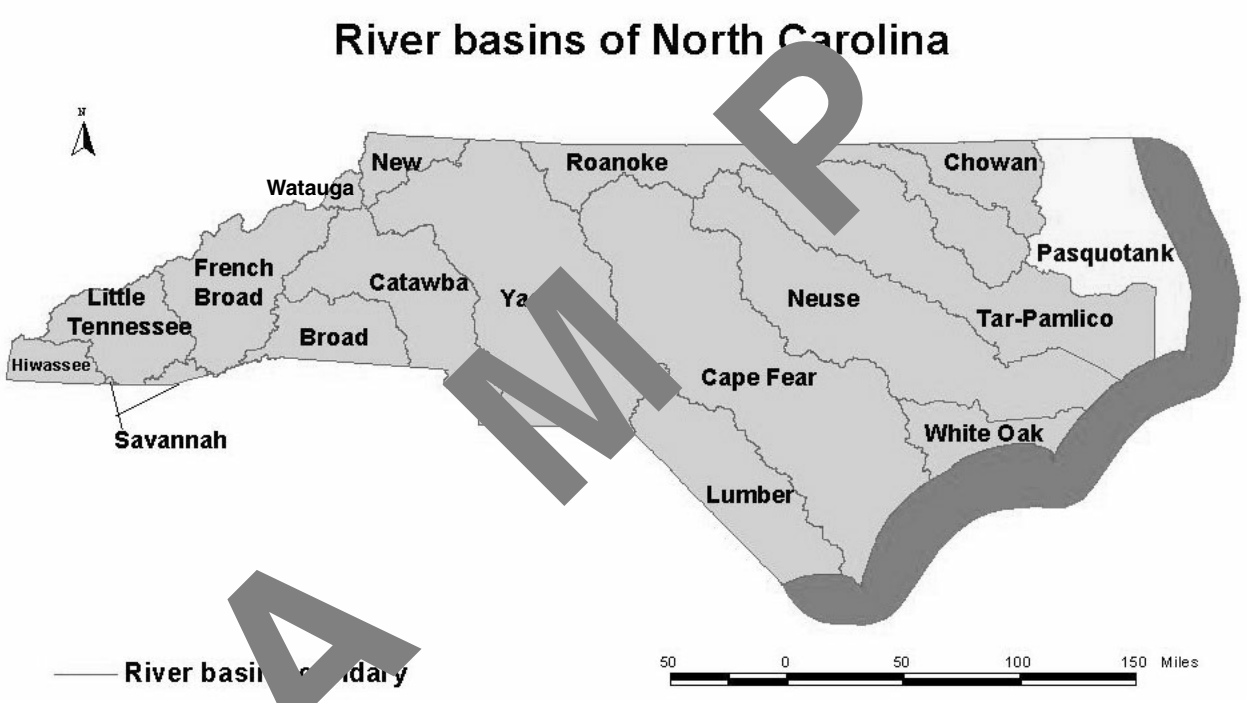
NORTH CAROLINA RIVER BASINS

The region of land drained by a river and its tributaries (streams that feed a river) is called a **river basin**. There are seventeen river basins in North Carolina.



The state of North Carolina is very concerned about the "health" of its rivers because the rivers provide drinking water for thousands of people.

Scientists are constantly monitoring the Earth's water systems. A **water system** is a region of water such as a lake, river, or parts of an ocean. They are trying to determine if conditions are normal for those systems. There are certain factors, **abiotic** (non-living) and **biotic** (living), that they are examining. These factors are called **indicators**. If these indicators are too far from the normal range, the water systems are considered unhealthy.

Here are some of the indicators used by scientists to monitor water systems:

1. **Water temperature**: A water system must fall within a narrow temperature range for its organisms to live. If the water warms up or cools down too much or too quickly, organisms will leave or die.

2. **Dissolved oxygen:** Water systems contain dissolved oxygen that supports life. Oxygen must be at a certain level for organisms to live. If the oxygen level in water change, the organisms will leave or die.

3. **pH:** The pH is the measure of the acidity of water. Acid rain and bacteria change the pH of water.

4. **Nitrates:** In order to have a healthy water system, chemical compounds called nitrates must be present. Animals, plants, and algae eat nitrates. Large amounts of nitrates introduced into the water system by pollutants, cause the algae populations to explode, using up all the extra nitrates. They die, are decomposed by bacteria, and then the bacteria use up all the dissolved oxygen in the water system. When all the dissolved oxygen is used up, animals suffocate in a process called **eutrophication**.

Fish will suffocate when all the dissolved oxygen is used up.

5. **Turbidity:** The clarity of the water in the water system is turbidity. Water that is clear has low turbidity; water that is murky has high turbidity. Turbidity is dependent on algae growth and sediments introduced by runoff. Where there is high turbidity, there are decreased rates of photosynthesis.

6. **Bio-indicators:** Scientists use bio-indicators to determine the health of the water system. They look at the amount of chlorophyll in water samples as well as the populations of fecal coliforms (bacteria in feces).

Scientists use different techniques to gather data. They run lab tests to determine chlorophyll, fecal coliform, and nutrient levels. Water quality meters measure dissolved oxygen, pH, and turbidity.

Water Availability

With the population increasing in certain areas of North Carolina, water availability has become an issue. The coastal plain of North Carolina depends almost solely on the **Northern Atlantic Coastal Plain Underground Aquifer System** for its drinking water. With increased withdrawals related to population growth and the drought of the last few years, new regulations have been established that will require this area to start withdrawing water from rivers or lakes to cut down on the withdrawal from the aquifer system.

Northern Atlantic Coastal Plain Underground Aquifer System

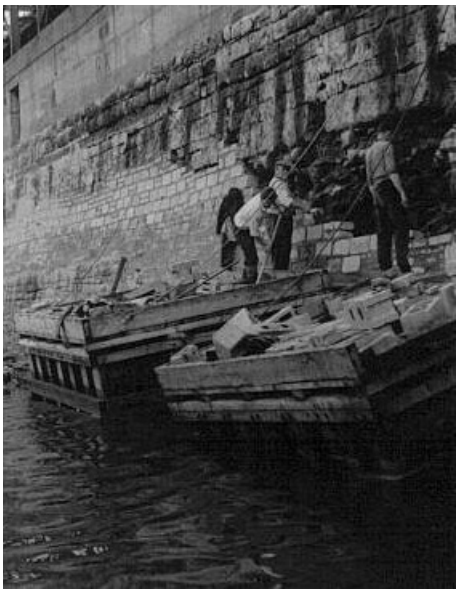
Water quality and availability on the whole in North Carolina are good to excellent. Scientists will continue to monitor the quality, and all citizens must work to provide the water that is needed by the rising population.

Local governments within North Carolina are required to develop local water supply plans for each drainage basin that supplies water to the public. Average daily usage must be monitored. The plans usually cover a twenty-year period, and daily use should not exceed 80% of the water supply.

Monitoring the Hydrosphere

The water supply is very important to the lives and livelihoods of all people. Governments realized many years ago that the freshwater supplies had to be protected by laws because of the **pollutants**, substances that have a negative effect on an ecosystem, that were being introduced into the water system.

One of the first laws introduced was **The Rivers and Harbors Act of 1899**. This law was an attempt to regulate water pollution. It required when any work was done in water that ships used for navigation, such as bottom dredging, the wildlife of that area must be considered.



Wildlife must be considered when doing ship repairs in the water.

Pollution increased in the 1960s and 70s, and in 1972, the United States Congress passed the **Federal Water Pollution Control Act**. It was later renamed the Clean Water Act and limited the types of pollution that can be discharged into streams and lakes. In 1970, the **Environmental Protection Agency (EPA)** was formed by Congress to enforce water pollution limits.

Not only was there a concern for freshwater pollution, but also for pollution in the oceans. In 1972, some of the nations of the world signed the **United Nations Law of the Seas** which limits the pollution released into the oceans. Today, there are still nations who have not signed this agreement.

The Impact of Humans on Water Quality

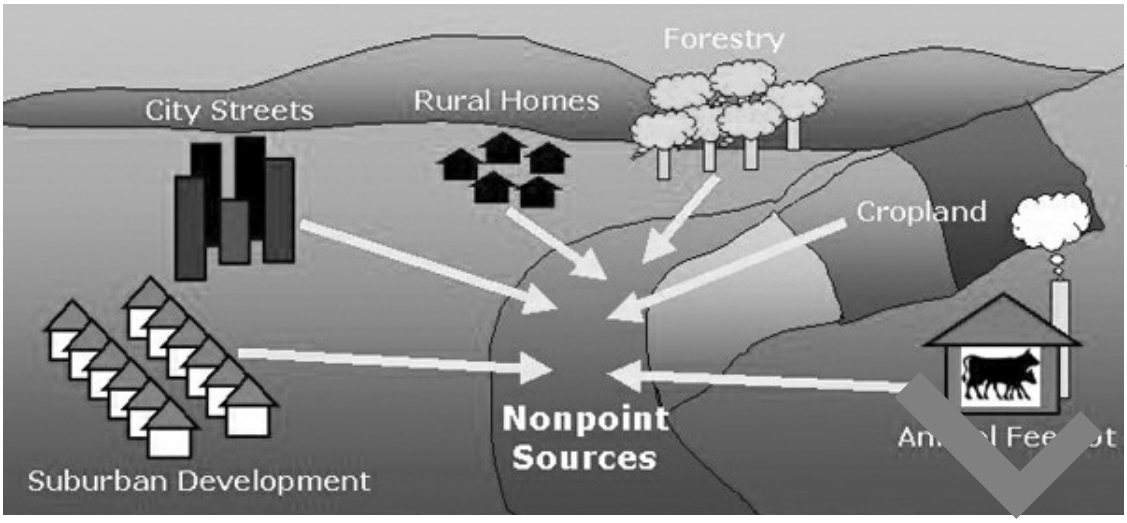
As in the rest of the world, the human population in North Carolina is growing. As it grows, so does the pollution which lowers our water quality.

Where do these pollutants come from? There are two sources: point and nonpoint.

A **point source** is a single identifiable source of pollution. Pipes through which factories or treatment plants release water and pollutants into a river are examples. Point source pollution is mostly controlled by water-quality standards which limit the kind or amount of pollutants each point source can discharge into a body of water.

Pipes releasing substances in rivers are point source pollutants.

A **nonpoint source** is an activity that takes place over a large area and results in the release of pollutants from many areas. Common nonpoint sources are agriculture, forestry, residential and urban development.



Common pollutants from nonpoint sources are:

1. sediment from farmland, lawns, gardens, forestry activities, roadways, construction sites, and stream-bank erosion.
2. nutrients from lawns, gardens, farmland, livestock operations, wildlife, septic systems, and waste applications to farmland.
3. bacteria from wildlife, livestock, septic systems, farmland receiving waste applications, and urban runoff.
4. man-made chemicals from roadways, mining operations, farmland, lawns, gardens, and forestry.

Possible Effects of Pollution on North Carolina Waters

Let us look at the **Neuse River Basin of North Carolina** as an example of the effects of pollution.

Because of the downward-sloping nature of the state's geography, pollutants from industry, wastewater treatment plants, and agriculture are carried in water runoff to the eastern part of the state. This is where the elevation is the lowest. Some of this pollution ends up in the Neuse River Basin. The Neuse River is a beautiful east-coast wetland ecosystem. A wetland ecosystem is one where much of the ground is wet or flooded.

Much of this runoff into the Neuse River Basin could have been blocked if the natural ecosystem of the Basin had been left intact. However, early Carolinians of the 18th and 19th centuries cleared thousands of acres of hardwood forest to plant corn, tobacco, and other crops. If these early settlers had not cleared the land, the presence of lush vegetation could have trapped contaminated soil before it reached the waterways.

Neuse River Basin

People use the water from the Neuse River Basin for drinking, fishing, swimming, agriculture, and industry. Runoff from higher areas eventually affects the water quality of this complex ecosystem. For example, eroded farmland containing high levels of nitrogen and phosphorus travels downstream and is deposited in the Basin. This changes the oxygen concentration which, in turn limits aquatic plant growth. Changes in the primary producers disturb all members of the food web, including endangered leatherback turtles and the red-cockaded woodpecker.

Wetlands serve as filters and purify the water that runs through them. Because of this, it is against the law in North Carolina to fill in wetland areas. There are hundreds of miles of wetlands along our coast that are protected. In order to build on or near a wetland, an individual must apply for and receive special permits. This ensures that habitats are not destroyed and runoff is minimized. Wetlands are very important for our sounds and oceans.

Industry and agriculture are important to the livelihood and lives of all citizens. Everyone must work together to insure that our water sources are kept as free of pollution as possible. **The North Carolina Department of Water Quality** sets limits on the amounts of water pollution emitted by factories and sewage treatment plants. These places must treat their wastewater to keep pollution at or below certain levels. But when it comes to nonpoint source pollution, the North Carolina Department of Water Quality has a tough job. It is really hard to pinpoint pollution that comes from many small sources.

To reduce nonpoint source pollution, the citizens of North Carolina must help by reducing the amounts of fertilizers and insecticides/pesticides put on lawns, by washing cars on lawns instead of on driveways, by recycling oil, and by properly disposing of antifreeze and paint.

Water Stewardships

Water stewardship involves looking after a body of water and keeping it clean. Stewardship involves not only the federal, state, and local government agencies, but also businesses and YOU.

If you notice a strange color or odor or coating on the surface of a water system near you, you should report this to a local agency. They will take the necessary steps needed to test the water. Water samples to measure the amount of nutrients, chemicals, and substances necessary to support life will be taken.

Everyone must be involved to keep our water systems clean and safe.

Everyone must be good stewards to keep our water systems clean and safe. These resources are important to all life.

PRACTICE

1. What is a river basin?

2. Why has water availability become an issue in North Carolina?

3. Why must there be changes in water availability in the coastal areas of North Carolina?

4. What are indicators?

5. Explain the 6 indicators used by scientists to monitor water systems.

1.

2.

3.

4.

5.

6.

6. When did the government realize that laws would need to be passed regarding water sources?

7. What was The Rivers and Harbors Act of 1899?

8. Explain the Federal Water Pollution Control Act.

9. What is the purpose of the EPA?

10. What has been done in regards to ocean pollution?

11. Define point and nonpoint sources.

12. Name the 4 common pollutants from nonpoint sources.

    1.

    2.

    3.

    4.

13. Explain how pollution has affected the Neuse River Basin.

14. How do wetlands help with pollution?

15. What is the job of the North Carolina Department of Water Quality?

16. What is water stewardship? How can you be a steward?

Chapter 3 Review

1. If a 10 gram piece of metal required 4000 joules of heat to raise its temperature by 20˚C, what would the specific heat be?
   A 2 J/g˚C
   B 20 J/g˚C
   C 0.5 J/g˚C
   D 0.05 J/g˚C

2. A joule is a measure of _____.
   A distance
   B energy
   C density
   D volume

3. Find the heat energy when 2.0 g water is heated from 20˚C to 30˚C. The specific heat of water is 4.18 J/g˚C.
   A 25 J
   B 42 J
   C 84 J
   D 420 J

4. Which of the following is used to measure heat energy?
   A balance
   B graduated cylinder
   C calorimeter
   D colorimeter

5. What is the source of energy for the Earth's Water cycle?
   A the wind
   B the sun
   C gravity
   D the magnetic field

6. Water that falls to the surface of the Earth, either in solid or liquid form, is called _____.
   A dew
   B frost
   C precipitation
   D condensation

7. Water that is in the form of a gas is called_____.
   A water vapor
   B oxygen
   C ice
   D condensation

8. When you exhale on a cold day and see your breath, it is due to _____.
   A evaporation
   B condensation
   C precipitation
   D runoff

9. The Water cycle includes _____.
   A photosynthesis, evaporation and condensation
   B rain, precipitation and condensation
   C evaporation, the gulf stream and the jet stream
   D evaporation, condensation and precipitation

10. What is transpiration?
    A the change of a substance from a gas to a liquid
    B the change of a substance from a liquid to a gas
    C the evaporation of water through openings in leaves
    D the water being transferred from the ground to the ocean

11. A/an _____ is composed of all living and nonliving things in a community.
    A abiotic
    B ecosystem
    C population
    D community

12. What percentage of the Earth's surface is covered by fresh water?
    A 5
    B 3
    C 50
    D 75

13. What is ***not*** a type of flowing-water ecosystem?
    A pond
    B stream
    C creek
    D river

14. What is an ecosystem in which water either covers the soil or is present at or near the surface for at least part of the year?
    A lake
    B pond
    C estuary
    D wetland

15. Which ocean zone is always covered by water?
    A open ocean
    B coastal ocean
    C intertidal
    D rocky intertidal

16. Magma is released from beneath the Earth's crust when _____.
    A there is an earthquake
    B two plates push together
    C two plates pull apart
    D there is a fault in the Earth's crust

17. What is the Mid-Atlantic Ridge?
    A a series of deep, narrow valleys
    B a series of underwater mountains
    C a soft slope made of rocks, pebbles, and sand
    D great plains

18. The continental slope is _____.
    A a gently sloping rock platform that lines the continent
    B a soft, upward slope made of rocks, pebbles, and sand
    C a sharp drop of 3,800 meters
    D a sharp drop in the middle of the ocean

19. Barrier islands protect the mainland during a hurricane by _____.
    A flooding due to high tides
    B taking the major force of the wind and water
    C eroding in areas with no seaboats
    D causing dunes to erode

20. Ice will float in liquid water because _____.
    A ice is denser than liquid water
    B temperature affects the ice
    C warm water has lower density than cold water
    D the molecules are spaced farther apart than in liquid water

21. What quality of water causes water to have a meniscus in a graduated cylinder?
    A adhesion
    B cohesion
    C polarity
    D hydrophobic

22. "Oil and water don't mix" is an example of water's _____.
    A solvent
    B cohesion
    C polarity
    D adhesion

23. The greater the volume and density of the fluid, the ***more*** _____ the object.
    A constant
    B buoyant
    C displaced
    D dense

24. Which of following solutions would be acidic?
    A pH = 13
    B pH = 2
    C pH = 10
    D pH = 7

25. Chemosynthetic bacteria carry out primary production using sulfur compounds near _____.
    A hydrothermal vents
    B trenches
    C the continental rise
    D the crust

26. High concentrations of nutrients produced when organisms die and decay at great depths are brought from the cold deep water to replace surface water in a process known as _____.
    A tides
    B turbidity
    C upwelling
    D condensation

27. When rivers deposit great amounts of minerals onto the continental shelf from land, _____ are formed.
    A natural gases
    B coral reefs
    C placer deposits
    D gemstones

28. Which of the following is at the bottom of the ocean food chain?
    A shark
    B zooplankton
    C phytoplankton
    D whale

29. In areas where the land meets the sea in coastal areas, _____ are common.
    A salt marshes
    B freshwater ponds
    C mud
    D rivers

30. A body of water shallow enough to allow plant roots to reach the bottom is called a/an _____.
    A pond
    B lake
    C river
    D ocean

31. A pond and a lake are different because _____.
    A a pond is bigger and more shallow
    B a pond is smaller and deeper
    C a lake is larger and deeper
    D a lake is smaller and deeper

32. Organisms that make their own energy are called _____.
    A producers
    B consumers
    C filter feeders
    D omnivores

33. One of the major functions of wetlands is _____.
    A to flood and water the crops
    B provide moisture to farmlands
    C to filter and purify the water that runs through them
    D give the fish a place to live

34. Because of the downward-sloping nature of North Carolina, a great deal of pollution ends up in the Neuse River Basin. Which of the following ideas could ***help*** preserve the Basin?
    A Plant trees at the outer edge of the Basin.
    B Increase upstate farming.
    C Use crop rotation techniques.
    D all of the above

35. Which of these makes up the abiotic factors in an ecosystem?
    A bacteria, fungi, mosses
    B trees, flowers, grasses
    C mice, raccoons, vultures
    D rocks, minerals, rainfall

36. What percentage of the Earth's surface water is saltwater?
    A 5
    B 3
    C 50
    D 97

37. Which ocean zone is always covered by water, is shallow enough for photosynthesis to take place, and can contain kelp forests?
    A open ocean
    B coastal ocean
    C intertidal
    D rocky intertidal

38. Which of the following would be found in an estuary?
    A waterfowl
    B starfish
    C sharks
    D plankton