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Complete the assignments below.

Earth/Space Science

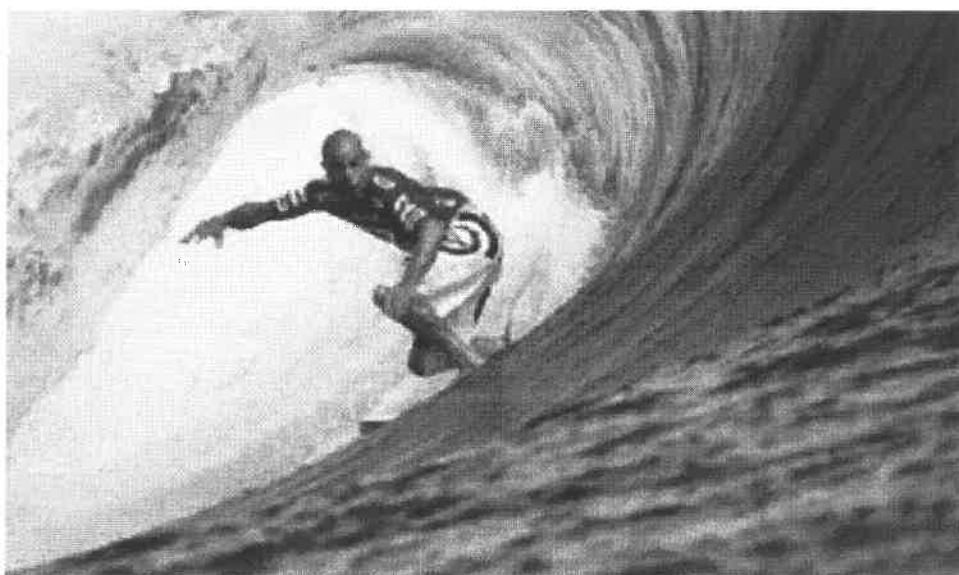
Week 1:
<input type="checkbox"/> Earth Space Science (SC.912.E.5; SC.912.E.6; SC.912.E.7)
<input type="checkbox"/> Content Area Reading: Today's surfers are leaving tradition behind and taking to the sky.
<input type="checkbox"/> Skill Activity: Scientific vocabulary and textual support (RI.1.2; RI.4.10)

Surfer's Up

by Pearl Tesler

Today's surfers are leaving tradition behind and taking to the sky.

Pro surfer Pat Gudauskas of San Clemente, Calif., has just 30 seconds to make his move-and it needs to be *big*. He's under extreme pressure at a surfing competition on an island in the Indian Ocean. Only the top two surfers in this heat will advance-and he's in third place.



Joseba Etxaburu/Reuters/Corbis

Ten-time world champion Kelly Slater caught big air at the Hurley Pro surfing competition in Southern California.

He picks his wave and paddles hard. Soon he's sweeping down the curving face of the breaking wave, zigging and zagging ahead of the chasing white water. Then, suddenly, he veers back, zooms up the face of the wave, and launches into a dizzying aerial whirl. It's part 540-degree spin and part backflip, a wild rotation in two directions at once.

Successfully landing the move, called a rodeo clown, Gudauskas scores a perfect 10. It launches him into first place as well as surfing history as the first person to pull off that trickiest of tricks in a top-level competition.

Not too long ago, a dazzling aerial display like that might have gotten Gudauskas disqualified. It certainly wouldn't have put him in first place. But the past several decades have seen a slow but accelerating transformation in the sport of surfing.



Jimmicane; Nelson Vela/Newscom

U.S. surfer Alana Blanchard (right) performed a frontside grab (above) in the Philippines.

U.S. surfer Alana Blanchard performed a frontside grab in the Philippines.

Gone are the days when the most radical moves you could pull in surfing were *floaters*-traveling atop a wave's crest-and *tube rides*-cruising inside the hollow tube of a breaking wave. Today's top surfers are doing something once unthinkable: leaving the wave altogether.

Up Or Bust

Surfers are now busting a fast-growing list of aerial moves with names such as indy, varial, Superman, melon grab, method air, and frontside air reverse. Such tricks are borrowed largely from skateboarders and freestyle snowboarders. Surfers are even moving in on a skater staple known as the kickflip. It's the trick of jumping up and kicking the board so that it rotates in midair before landing on it again and riding away.



D. Humphrey/A-Frame

Pulling aerials with a skateboard on dry land is one thing. Pulling the same moves with a 2-meter (7-foot) surfboard on a collapsing wall of water, each cubic meter of which weighs one ton, might be diagnosed as insane. But catching air is the only way up for aspiring surfers. "Nowadays, if you don't know how to do an air, it's hard to get by," pro surfer Alana Blanchard told *Current Science*. "I don't really know many pros who *don't* do airs."



D. Humphrey/A-Frame

Catch The Wave

Catching a wave isn't like catching a bus. If you just sit and wait for it, it'll pass you by. And as it passes, it will send you in a complete circular orbit-back, up, forward, and down-before moving on and leaving you behind, right where you started.



D. Humphrey/A-Frame

Catching a wave is really more like trying to jump onto a moving streetcar. As it bears down from behind, you point your board toward the beach and paddle hard, digging in with both arms to

accelerate (go faster). If you can roughly match your speed to that of the wave, your surfboard will slide down the front of the wave. The ride is on.

The forces on a surfer waiting to catch a wave are simple and balanced. The downward force of *gravity* on both board and rider is balanced by the upward force of *buoyancy*, created by water pushing up on the partially submerged board. Once the wave is caught and the surfboard starts moving through the water, however, *hydrodynamic forces*-forces exerted on an object by moving water-come into play.



ASP/Getty Images; Inset: Getty Images

U.S. surfer Pat Gudauskas (left) competed at the Billabong Pro Tahiti competition in French Polynesia last September (above).

Although hydrodynamic forces are partly determined by the shape and design of the surfboard itself, a skillful surfer can control them. For example, leaning to the right on a moving board pushes the right edge of the surfboard deeper into the water. That creates extra *drag* (a backward force) on the right-hand side and makes the board turn right. With slight (and often not-so-slight) adjustments to the way you balance on the board, you can use hydrodynamic forces to carve turns up and down the face of a wave.

Launching an aerial has something in common with popping an ollie on a skateboard. You start by turning up toward the *lip* (crest) of the wave. A vertical section of the lip becomes your launching pad. As you approach it, you shove hard on your rear foot to pop the front of the surfboard up and off the wave. Once airborne, you can level out the board by applying pressure with the front foot, causing the rear of the board to rise as if it's glued to your back foot.

The exact path you take through the air is determined by your direction and your rotation at the moment you leave the wave. In the air, you become a projectile, and the only force that can act on you there is gravity. That's why the launch is so crucial.

Flying High

Speed is also crucial for surfers trying to perform aerials. The faster you move, the higher you rise above the wave. And the higher you rise, the more time you have to perform a trick, whether it be a stalefish-grabbing the back of the board while spinning-or a high-flying Superman-launching skyward with your legs dangling behind you.

Surfers get their speed from the same source that skateboarders do: gravity. Positioned at the top of a wave or a concrete slope, you have *potential* (stored) energy-in this case, energy stored as height. By letting the force of gravity pull you downhill, that potential energy becomes *kinetic* energy, the energy of motion.

Surfers have one big advantage over skateboarders: Their "hill" moves with them. All they have to do is stay on it. By turning the surfboard so that they ride across the face of the wave as it *peels*, or breaks gradually from one side of the wave to the other, they can continue to convert potential energy into kinetic energy. They gain more and more speed until they're moving much faster than the wave itself.

Air Sickness

Above the lip, only creativity limits the variety of "sick" tricks a surfer can pull. The possibilities are endless, and new tricks are arriving on the scene as relentlessly as waves on a beach.



D. Humphrey/A-Frame

Many new tricks begin as glorified accidents—a botched attempt at one trick yields an entirely new one. So it was for Australian surfer Julian Wilson, who "invented" the sushi roll, a flying barrel roll, while attempting a Superman. "The board just got away from me," Wilson says.



Zuma Press/Newscom

In an interview with *The New York Times*, Gudauskas confirmed that anything can happen-or more often, not happen-on a wave when attempting aerial tricks. "You may only stick one out of ten flips or one out of ten air reverses, or maybe not even," he says. "You could go ten straight and never stick one."



D. Humphrey/A-Frame

That unpredictability is what kept aerials out of mainstream surfing for so long. Compared with the power turns and long rides that once served as the measure of a surfer's skill, aerial tricks are riskier and more often result in total wipe-outs. Purists and judges alike saw aerials as a waste of a good wave, and for decades aerial efforts went unrewarded.

Recent changes to scoring practices at official surf competitions are encouraging the airborne revolution, however. Those changes mean surfers are no longer rewarded just for the consistency of their moves but also for their difficulty.

Most surfers, including 10-time world champion Kelly Slater, see the new rules as a long-overdue acknowledgment of the changing direction of their sport. "I think in modern-day surfing," Slater told *The New York Times*, "you shouldn't be able to get the highest score possible unless you've done something pretty crazy on a wave."

Where the Waves Are

The hidden sources of great surfing waves

When a sweet surfing wave rears up on a beach in, say, Southern California, it's the grand finale of a journey that may have started days earlier, hundreds or thousands of miles away.

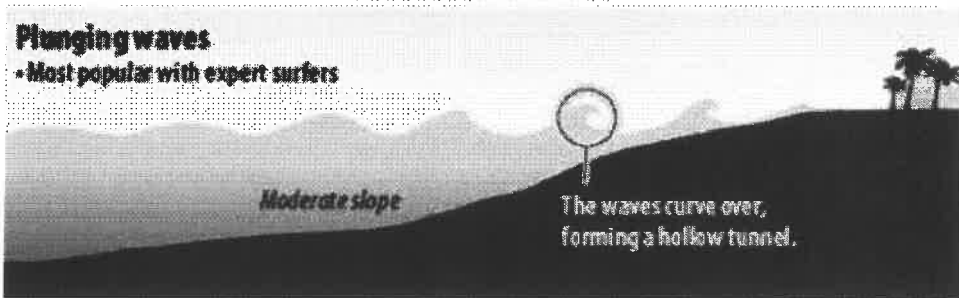
At the point of origin, somewhere in the Pacific Ocean, the strong winds of a violent storm blow across the ocean's surface, kicking up waves in much the same way you do when you blow across the surface of a bowl of soup.

Initially choppy and disorganized, the storm-whipped waves grow larger as the wind continues to blow. Traveling outward from their source, the waves separate into orderly rows of smooth, hump-shaped waves called *ocean swells* that cross vast distances of ocean before finally reaching shores.

Swells travel through the ocean as *orbital waves*, which are so called because they move water in circles known as *orbits*. When a wave approaches shore, the bottom part of each wave slows down as it encounters the seafloor. With the top of the wave now moving faster than the bottom, the wave begins to *break*, or pitch forward.

An incoming ocean swell is one necessary ingredient for great surfing. The right beach is another. What makes a beach hot (or not) for surfing has everything to do with what can't be seen—the *bathymetry* of the beach. Bathymetry is the shape and depth of the ocean floor.

Gently sloping beaches make for small, gentle *spilling waves*, which are great for beginners but useless for launching big aerials. Abrupt changes in depth, such as those caused by underwater reefs or sandbars, give rise to steep *plunging waves*. They're the kind of waves a surfer needs to launch aerial maneuvers. If the beach's bathymetry is too steep, however, or the incoming waves are too big, the result is *surgin waves* that "close out," or break all at once in an explosion of water. Those waves are generally unsurfable.



KRT/Newscom

kinetic

 ki · net · ic

Advanced Definition

adjective

1. of, concerning, or caused by motion.

Windmills are used to harness the kinetic energy of the wind.

Spanish cognate

cinético: The Spanish word *cinético* means kinetic.

These are some examples of how the word or forms of the word are used:

1. When he jumps from the plane, that energy is then converted into motion, known as **kinetic** energy.
2. When enough air is stored, valves open, releasing the air into a second set of pumps, forcing the pistons in them to move. Those pumps act like muscles, moving the beasts' legs. The compressed air's potential energy is turned into **kinetic** energy, the energy of movement.
3. By turning the surfboard so that they ride across the face of the wave as it peels, or breaks gradually from one side of the wave to the other, they can continue to convert potential energy into **kinetic** energy. They gain more and more speed until they're moving much faster than the wave itself.
4. Sports showcase countless examples every day of potential energy being converted into **kinetic** energy. Kinetic energy is the energy of movement. When an archer draws and holds her arrow, her bow is brimming with stored potential energy. When she releases the bowstring, all the potential energy is quickly converted into kinetic energy, which is transferred to the arrow that takes flight.
5. At 20,000 feet, of course, the amount of **kinetic** energy generated by a falling skydiver poses a risk to his life. A parachute, which slows the skydivers fall by creating air resistance, is required to reduce the kinetic energy the skydiver generates as he falls. Consequently, once the parachute has opened, the skydiver makes a gentle impact with the ground when he lands.

maneuver ma · neu · ver**Advanced Definition****noun**

1. a planned military movement, as of troops, ships, or tanks.

The maneuver was carried out according to plan.

2. (pl.) a series of such movements used as a military training exercise.

The army is conducting maneuvers in the area.

3. a movement or change in direction requiring skill and dexterity.

An adroit maneuver brought the boat safely past the reef.

4. a skillful or crafty procedure or manipulation.

The lawyer used a clever maneuver to force a mistrial.

transitive verb

1. to skillfully move (something) to a desired position or goal, or to manage using strategy and cleverness; manipulate.

The captain maneuvered the ship into the narrow harbor.

He maneuvered himself so that he was close to the leader and could gain his trust.

2. to make a tactical change in the placement of (troops or military vehicles).

intransitive verb

1. to change position, location, or approach for tactical advantage or as part of a plan.
2. to carry out a military maneuver or series of maneuvers.

Spanish cognate

maniobrar. The Spanish word *maniobrar* means maneuver.

These are some examples of how the word or forms of the word are used:

1. The barges, called trajineras, are sturdy and festive, painted brightly in yellow, blue, and red.

But they're difficult to **maneuver**, clumsy in the water.

2. Abrupt changes in depth, such as those caused by underwater reefs or sandbars, give rise to steep plunging waves. They're the kind of waves a surfer needs to launch aerial **maneuvers**.
3. She **maneuvers** the food to her mouth and tries to breathe deeply and calmly, like her doctors have taught her. But calming her face long enough to take a bite is an almost impossible task.
4. The longest drekar measured 119 feet long with a crew of 100 men and space for 72 oars. With its gigantic sail, shallow hull and so many oarsmen, the ship must have been incredibly fast and highly **maneuverable**.
5. Instead, EDL engineers designed a **maneuver** that would allow the entry capsule to turn sharply and activate powerful rockets to finish the job. Once this maneuver was complete, the capsule could attempt a vertical landing.
6. No one was allowed on the roof, but the girls of St. Hildegard's boarding school knew how to **maneuver** themselves in such a way, at a certain spot where the walls were close together, that they could clamber up and onto the roof.

submerge sub · merge

Advanced Definition

transitive verb

1. to put or plunge under water or other fluid.

He submerged his feet in the warm water.

Submerge the vegetables in boiling water to blanch them.

The crew submerged the submarine.

2. to cover completely or cause to overflow with water; flood.

The tide submerged the beach.

intransitive verb

1. to sink or plunge under, or as though under, water.

The scuba diver submerged and did not return to the surface for several minutes.

The submarine submerged rapidly.

Spanish cognate

sumergir. The Spanish word *sumergir* means submerge.

These are some examples of how the word or forms of the word are used:

1. "Done for the day?" shouted her mother, whose legs were still **submerged** in the deep blue water.
2. Only once she was **submerged** in the icy water did she stop to think: If Marie's dad couldn't battle the current in his boat, how would she be able to?
3. The downward force of gravity on both board and rider is balanced by the upward force of buoyancy, created by water pushing up on the partially **submerged** board.
4. I spend 23 hours a day in a cell, he writes, "and to keep the reality of this place in check and to maintain a bit of sanity in this dark place, I **submerge** myself in a world of books."
5. Built on a series of islands, Venice is slowly sinking into the sea, dropping about 1.57 inches a year. By the end of the century, scientists warn, the city could be completely **submerged**.
6. According to tradition, Parsis cannot cremate, bury, or **submerge** their dead in water because they believe a corpse is dirty and impure, so the corpse would taint the fire, earth, or water, which they regard as pure.
7. When an object is **submerged** in water, the surrounding water exerts a force (buoyancy force) on the object. This force increases with the depth of the water, so that for any submerged object, there is a net force upwards.

Name: _____ Date: _____

1. Which type of waves is important to have for a surfer who wants to do aerial maneuvers?

- A. plunging waves
- B. surging waves
- C. orbital waves
- D. spilling waves

2. How does the author describe *most* surfers' response to the trend of aerial maneuvers being incorporated into surfing and surfing competitions?

- A. ambivalent
- B. relieved and happy
- C. concerned
- D. annoyed and frustrated

3. Which of the following conclusions about aerial moves in surfing is supported by the passage?

- A. Aerial moves are fun to watch, but the conversation in surfing should focus more on the quality of judges and scoring process at competitions.
- B. There are only a few people in favor of the aerial moves, but they are loud and powerful.
- C. Aerial moves are risky, but the surfing community is ready to embrace the risk.
- D. Incorporating and supporting aerial moves in surfing is like asking for a lawsuit because of all the potential injuries.

4. Read the following sentences and answer the question below: "The exact path you take through the air is determined by your direction and your rotation at the moment you leave the wave. In the air, you become a projectile, and the only force that can act on you there is gravity."

The word **projectile** means

- A. something pushed forward in the air
- B. crazy, risky person
- C. complex project
- D. an impenetrable force

5. This passage is mostly about

- A. surfers who like to try new moves
- B. how to become a professional surfer
- C. conflict in the surfing community
- D. a shift away from traditional surfing

6. How are "floaters" and "tube riders" different from moves like the "rodeo clown" or "Superman"?

7. How do you think the surfing "purists" might feel about the movement towards incorporating aerial moves into surfing competitions?

8. The question below is an incomplete sentence. Choose the word that best completes the sentence.

Speed is a crucial factor for surfers attempting aerial maneuvers _____ the faster you move, the higher above the wave you rise, giving you more time to perform the trick.

- A. because
- B. however
- C. despite the fact
- D. although