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Grade	5+	Word Count	1,912
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Learning A–Z	level Z2		

Refer to the Focus Question on page 2 of this title to guide discussion and support additional learning connected to the text.

Children and adults have been playing with remote-controlled planes, boats, cars, trucks, and helicopters for decades. What seemed like magic one hundred years ago has quickly become an important, and entertaining, part of our everyday lives. **Fun by Remote Control** explains the history, science, and future of remote-controlled vehicles. Students will enjoy detailed photographs and a text full of fun and fascinating facts about the remote-controlled world.

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Fun by Remote Control

Written by John Perritano

phenomenon *(n.)* page 16
an observable event or occurrence; someone or something that is very impressive or popular because of an unusual ability or quality

precision *(n.)* page 13
the quality of being exact or accurate

replica *(n.)* page 12
a copy or reproduction of something

semiconductors *(n.)* page 7
materials that are able to transfer some heat or electricity but not as much as a conductor, often used in electronics

throttle *(n.)* page 8
a valve used to control the supply of fuel to an engine

transistor *(n.)* page 7
a small electronic device that controls the flow o f electricity in electronic items

transmitter *(adj.)* page 6
a device that sends out electromagnetic signals, such as radio or television signals

turbine-powered *(adj.)* page 4
powered by a fan-shaped machine that captures the motion of water, wind, or steam to create an electric current

vintage *(adj.)* page 10
old and of good quality; classic

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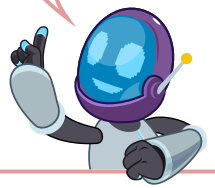
Learn More

You can learn more about RC vehicles by visiting your local hobby shop. Many cities also have RC flying clubs where you can watch pilots fly. RC drivers and pilots are usually happy to talk about their vehicles and to share tips with people new to the hobby.

Focus Question

Why are remote-controlled vehicles popular?



Words to Know

aerobatic
counterparts
drones
electromagnetic radiation
expel
filaments
fuselage
industrial
miniaturization
phenomenon
precision
replica
semiconductors
throttle
transistor
transmitter
turbine-powered
vintage

Connections

Writing and Art

Design a remote-controlled vehicle that could help with a job. Draw a diagram of your vehicle. Write the script for a commercial persuading people to buy your vehicle.

Science

Research a remote-controlled vehicle that was designed to be helpful. Create an informational pamphlet describing the vehicle and its purpose.

Glossary

aerobatic *(adj.)* page 13
of or relating to challenging or thrilling movements of an aircraft in flight

counterparts *(n.)* page 9
people or things that correspond to one another or have the same functions or jobs

drones *(n.)* page 8
unmanned aircraft or ships that are operated remotely

electromagnetic radiation *(n.)* page 5
energy in the form of electromagnetic waves

expel *(v.)* page 9
to force something out of something else

filaments *(n.)* page 7
threads or threadlike objects that conduct electricity, such as those found in light bulbs

fuselage *(n.)* page 15
the main body of an aircraft

industrial *(adj.)* page 7
having to do with the creation of goods, especially using machines, automation, and technology

miniaturization *(n.)* page 12
the act or process of designing or making something in a smaller size

In February 2014, drones were used to monitor an erupting volcano in Indonesia.

TV crews now use drones to cover almost every major athletic and entertainment event. They capture amazing footage of the events without disrupting the performances.

The Federal Aviation Administration (FAA) has created regulations for commercial and recreational drone operators to help preserve public safety. Learn more at the FAA's website before taking off.

What seemed like magic one hundred years ago is quickly becoming an important part of our everyday lives. It's still a blast to play with as well!

A father and son enjoy a remote-controlled car together.

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Some radio-controlled aircraft, like the one shown here, use jet engines.

A New Record

Niels Herbrich of Germany goes through his preflight checklist before flying his red jet airplane with the swept-back wings. This is no ordinary jet, however. It's small enough to fit inside the trunk of a car and is nearly as speedy as a full-size airliner. As for Herbrich, he's no ordinary pilot. He flies the plane without ever leaving the ground.

The plane's **turbine-powered** engine hums to life. Moments later, in an ear-splitting whine and a burst of flame, the jet skids across the grass and races into the sky.

Whoosh! The pilot uses a handheld radio remote control to maneuver the jet as it rolls and banks through the course. Eventually, the radio-

A quadcopter delivery device carries a package on a test flight.

The Future of RC Technology

RC technology isn't just a hobby. Drones flown by pilots sitting miles away use the same basic technology and can perform various scientific, industrial, and military tasks. You might have already seen remote-controlled drones flying in your neighborhood.

Some farmers use camera-carrying drones to locate crop-damaging insects instead of having to physically inspect each field. Hospitals have used drones to transport human organs from one place to another for transplant. Some companies have begun to use drones to deliver packages.

Since 2013, international search and rescue organizations have used quadrocopters with cameras in their training missions.

Quadrocopters, also known as quadcopters, have four spinning blades, usually at the corners of the vehicle, and can fly in all directions. Autogyros look like a cross between a plane and a helicopter. A propeller at the front or back moves the aircraft forward, which causes the unpowered blades on top to spin and keep the autogyro airborne. It's a **phenomenon** called *autorotation*. One advantage of all the copters is that they don't need a runway to take off or land.

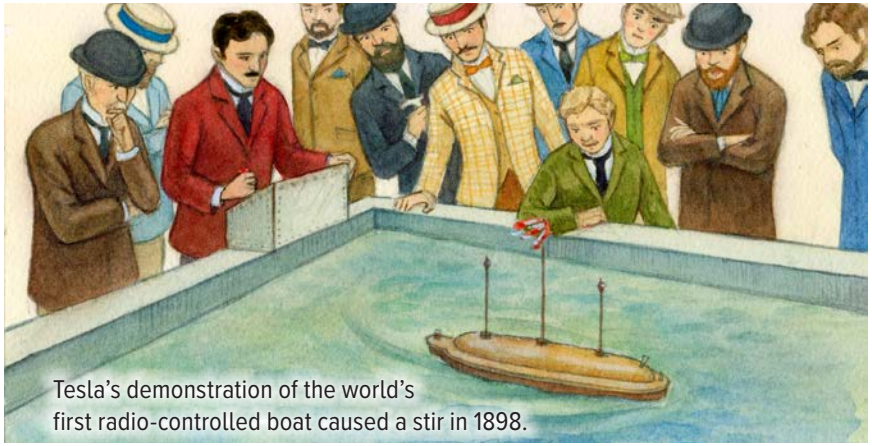
controlled (RC) jet hits a peak speed of 440 miles per hour (708 kph). Herbrich has just set a new speed record for Guinness World Records.

Children and adults have been playing with RC planes, boats, cars, trucks, and helicopters for decades. Most RC machines aren't nearly as fast as Herbrich's jet plane, but they are every bit as fun.

The Birth of Radio Control

We can thank Nikola Tesla for conceiving the idea for the first radio-controlled machine. He was born during a lightning storm on July 10, 1856, in what is now Smiljan (SMEEL-yawn), Croatia. Tesla became an inventor whose experiments in electricity would inspire others to invent radios, radar, and robots.

As a young man, Tesla had the idea to use radio waves—invisible airborne ripples of **electromagnetic radiation**—to control a boat. His "Tesla coil" laid the foundation for wireless technologies, including radio-controlled machinery. Tesla's experiments eventually led the scientist to New York City in 1898 for Madison Square Garden's first Electrical Exhibition. It was there that Tesla first demonstrated a radio-controlled boat that shocked and delighted attendees years before most people had even heard of radio technology.



Tesla's demonstration of the world's first radio-controlled boat caused a stir in 1898.

Using a homemade **transmitter**, Tesla sent a series of radio signals to the 4-foot (1.2 m) craft as it floated in a large tank of water built for the demonstration. The small boat moved gracefully around the tank in response to Tesla's silent commands. It even answered math questions from members of the audience by blinking its lights. The crowd was stunned. Some accused Tesla of using his mind to control the boat. Others said it must be magic or that perhaps a trained monkey was hidden inside. In actuality, the boat worked because of a series of levers, gears, springs, and motors controlled by a coherer, a radio-activated switch. The demonstration was front-page news. Tesla called his invention the *teleautomaton*.

Tesla did not invent the boat as a toy. He had grander plans. Tesla hoped the U.S. Navy would buy his radio-controlled device to guide torpedoes through the water, but that never happened.

A boy flies his RC mini helicopter through an obstacle course as part of a competition in China in 2013.

Today, pilots can buy Almost-Ready-to-Fly (ARTF) planes. "Instead of two hundred hours building a plane, you can do it in about twenty," Motta says. "In that time, you'll have a plane that is respectable and good looking." The ARTF planes come in fewer pieces, which saves on assembly time, but they can be heavier and harder to repair.

While planes are challenging to fly, helicopters with a single rotor on the top of the **fuselage** can be even more complicated to handle. More than half of the first-time fliers crash their helicopters in the first minute if they aren't careful and don't educate themselves before flying. Some types, such as mini helicopters, make learning to fly easier, especially indoors, but they still require practice. Although these RC copters are small, they can teach pilots many of the skills necessary to fly bigger helicopters.

Warbirds, such as this German triplane from World War I, are popular among RC hobbyists.

Many RC pilots love to fly replicas of airplanes that flew in World War I and World War II. Known as "warbirds," they come in kits or ready-to-fly (RTF) models and always get lots of attention on the flight line.

RC pilots can even build, paint, and customize their own planes. Motta remembers spending hundreds of hours putting a plane together. When one crashes, he picks up the pieces that are not damaged and keeps them as spares for other planes.

The technology did see some use during World War I (1914–1918) and World War II (1939–1945) but would not come into significant use until the Space Age began in 1957.

In the early twentieth century, most radio-control technology was best suited for large machines. The equipment and batteries needed to power electric motors were huge. That all changed in 1947 with the invention of the **transistor** by Bell Labs in Murray Hill, New Jersey.

Transistors are much smaller, safer, and more reliable than the vacuum tubes they replaced in electronics. Transistors use metals and **semiconductors**, rather than **filaments** in a vacuum, to amplify electric currents. Remote-control technology moved beyond narrow military and **industrial** applications into broad, everyday use. Engineers began to use transistors to shrink the size of electric motors. Some even began putting transistors into radio-controlled toys. A new hobby was born.

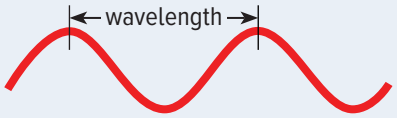
Word Wise

RC (or "R/C") stands for either "remote-controlled" or "radio-controlled." Remote-controlled vehicles include vehicles connected to a controller by a wire. However, most modern remote-controlled vehicles communicate wirelessly over radio frequencies.

Basics of RC

People have created hundreds of different types of radio-controlled vehicles, from robots to boats to aerial **drones**. While the mechanics of how they work differ, all use the same basic technology in a three-part system. A transmitter, or remote control, sends radio signals, including steering and **throttle** commands, over a specific frequency. A receiver inside the vehicle is constantly looking for signals from the transmitter. The receiver decodes the signals, sending electric currents to mechanical motors called *servos*, which move and guide the vehicle. The transmitter and receiver are both powered by batteries.

What Is Radio?



Radio is a type of electromagnetic energy—the same energy that we see as visible light. Radio energy travels in invisible waves through the air and can go through most walls. Electromagnetic energy comes in many forms, depending on the size of the waves and their frequency (number of waves per second). Radio waves range from longer than a football field to about the length of a bicycle and have a frequency of 1 million to 100 million waves per second. Light, microwaves, and X-rays are also types of electromagnetic energy, but they have much shorter wavelengths and much higher frequencies than radio.

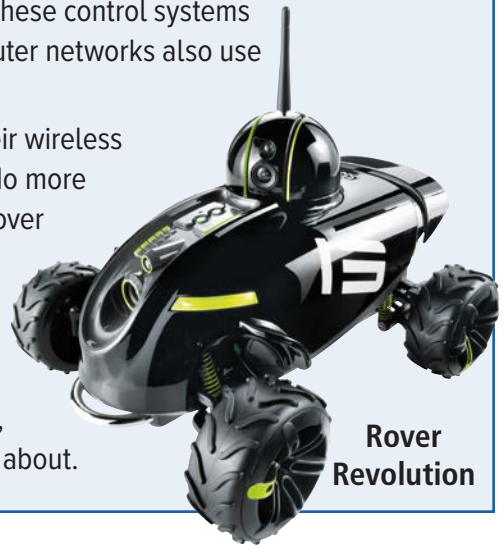
Once pilots master the trainer, they often graduate to sport planes, which can perform complicated **aerobatic** maneuvers. They are generally more forgiving than planes designed for the **precision** maneuvers associated with aerobatic flying. Sport planes often have a special wing design that makes it easier for new pilots to fly the planes upside down.

"I've had 747 [jumbo jet] pilots tell me that model airplanes are more of a challenge to fly than real planes," Motta said. "You have to stand on the ground and use all of your senses because what comes up must come down."

Computerized RC

Some RC cars now use computer networking technology for communication. Drivers control vehicles using a wireless connection and a smartphone or tablet. These control systems work because wireless computer networks also use radio waves to communicate.

Some RC vehicles use their wireless connection to a computer to do more interesting things. One, the Rover Revolution, looks like a robot on four wheels. It's equipped with two cameras, a microphone, and a speaker. The driver can see video, talk, and listen as the rover moves about.



Rover Revolution

RC Flying

Bob Motta of Danbury, Connecticut, remembers when the RC flying bug bit him. It was in the 1960s, and Motta took to the air in his first RC plane—an F4 Corsair, a **replica** of a plane that was used in World War II and the Korean War by the U.S. Navy and Marine Corps.

These days, Motta pilots mainly World War I models such as his Nieuport 28, which is a replica of a French biplane fighter. He's amazed by how advanced the planes have become. "After the **miniaturization** of the electronics, things really took off," he says.

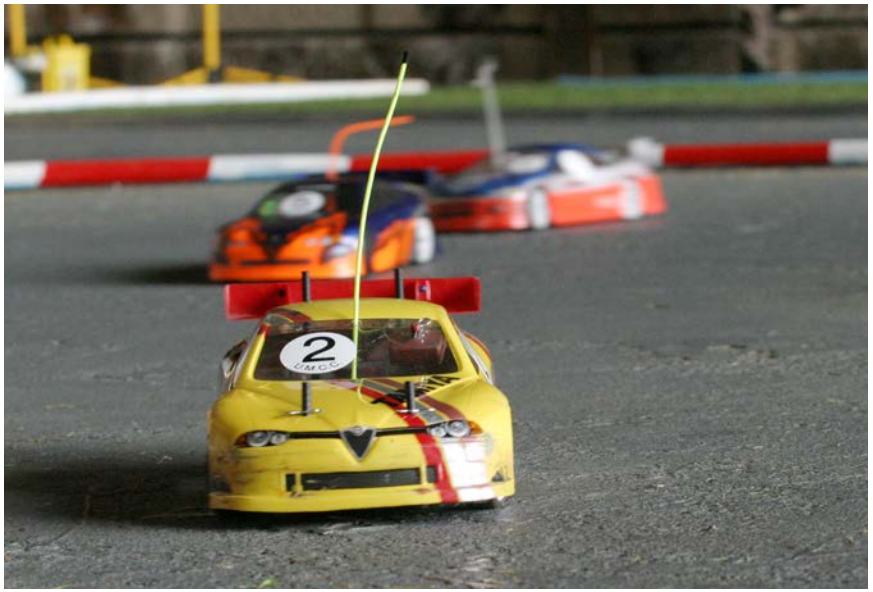
RC planes perform stunts in the air during a competition in 2009.

Whether piloting a plane, blimp, helicopter, or one of the new types of drones, many hobbyists love taking to the sky in an RC aircraft. Most RC pilots learn the basics by flying training planes, sometimes called "trainers" or "foamies." Trainers are designed to be simple and to make flying easy. They are often made from foam, which makes them lightweight and less likely to be seriously damaged in the event of a crash. These models also often come with several flight modes to provide a progressive learning experience for new pilots.

Four-Wheeled Fun

Toy makers first began to sell RC cars in the mid-1960s. Today's cars are smaller and more powerful. They are powered by gasoline, electricity, or something called *glow fuel*—a high-performance fuel mixture nicknamed "nitro." Batteries don't **expel** fumes or create significant noise, but they need to be replaced or recharged often, meaning drivers need to carry several with them for an afternoon's fun. Gasoline- or nitro-powered models run faster and longer than models that run on batteries, but drivers need to carry bottles of fuel, and they can be messy and more expensive to maintain than their battery-powered **counterparts**.

Many toy stores sell basic RC cars that are inexpensive and easy to maintain, but serious RC drivers buy "hobby-grade" cars that can cost several hundred dollars. Many people build hobby-grade RC cars from kits that come with all the parts boxed together. Drivers can replace parts, paint the body, and buy accessories such as upgraded metal gears, better shocks, and higher-quality or replacement body parts. Many drivers also modify kit cars with bigger engines or motors. Others prefer ready-to-run (RTR) cars that come already assembled.



Three nitro-powered RC cars race around a track.

Whether assembled from kits or purchased as already constructed units, RC cars come in several shapes and sizes. For example, touring cars include such models as Ford Mustangs, Chevy Camaros, and Porsche 911s. Some RC drivers choose the car based on their favorite track: asphalt, concrete, or carpet.

Off-road vehicles are popular because many of them come with large tires and heavy-duty shock absorbers. These vehicles can go just about anywhere, including uncut lawns, vacant lots, and dirt fields. Some resemble classic monster trucks. Others look like sporty pickup trucks or **vintage** buggies. Many specialty units are available for only a limited time and become collector's editions.

RC Racing

Some people love racing their RC cars. While some drivers compete with friends in vacant lots or in parks, others race in organized competitions on tracks that look like real speedways. With names such as the Serpent Cup and the East Coast ProCup Challenge, racing competitions are organized into categories by the size of the vehicle, its class, whether it is kit-built, and whether it gets its power from an electric motor, a nitro-powered engine, or a gasoline-powered engine. The racing classes include touring cars, sports cars, and off-road vehicles (both two-wheel drive and four-wheel drive).

Off-road buggies catch big air on jumps during a national RC car competition in Kingsville Township, Ohio, on August 10, 2013.

Some competitions are straight-line races that are usually held at a drag strip or airfield—places with long, open, paved areas for the vehicles. Drivers also race around closed-course oval tracks and complicated off-road courses that include hills and obstacles. Some of the coolest off-road events occur at RC truck- and tractor-pulling competitions. RC trucks pull wheeled sleds that weigh from 35 to 100 pounds (16–45 kg). That's like pulling an average-sized bulldog or a German shepherd!