chapter 22

Transportation Systems

Sections

What You'll Learn

- **Name** the different types of land transportation.
- **Summarize** the purpose of transportation subsystems.
- **Examine** the purpose of a transmission.
- **Tell** how oceans and inland waterways are used for transportation.
- **List** the different types of ships.
- **Define** the concept of intermodal transportation.
- **Discuss** ways in which air and space transportation are used.
- **Identify** different types of aircraft and spacecraft.
- **Explain** how an airplane is lifted into the air.

Explore the Photo

A Pleasant Trip After travelers leave a harbor or airport, they might take a bus, taxi, or commuter plane to their next destination. *A passenger tells the pilot he or she has had a nice trip. Is this part of the transportation system?*

Launch the TECHNOLOGY LAB

Build a Rubber-Band-Powered Vehicle

At the end of this chapter, you will make a simple land transportation vehicle powered by a rubber band. Get a head start by using this checklist to prepare for the Technology Lab.

PROJECT CHECKLIST

- ✓ Study the designs of different land vehicles at the library or on the Internet.
- ✓ Ask your teacher about what materials you will need for the project.
- ✓ Review your classroom's procedures and safety rules.

John Warden/SuperStock

section 22.1

Land Transportation

Reading Guide

Before You Read **Preview** What are some examples of land transportation vehicles?

Content Vocabulary

- mass transportation
- transmission
- driving wheel
- front-wheel drive
- rear-wheel drive
- four-wheel drive
- tractor-trailer
- bullet train
- maglev train

Academic Vocabulary

You will see these words in your reading and on your tests. Find their meanings at the back of this book.

- role
- interact

Graphic Organizer

Draw the section diagram. Use it to organize and write down information as you read.

Impacts of Land Transportation

	Automobiles	Mass Transportation
Positive		
Negative		

Go to **glencoe.com** to this book's OLC for a downloadable graphic organizer and more.

TECHNOLOGY STANDARDS

STL 4 Cultural, Social, Economic & Political Effects

STL 12 Use & Maintenance

STL 18 Transportation Technologies

ACADEMIC STANDARDS

Science

NSES Content Standard E Understandings about science and technology

NSES Content Standard F Science and technology in society

STL *National Standards for Technological Literacy*

NCTM *National Council of Teachers of Mathematics*

NCTE *National Council of Teachers of English*

NSES *National Science Education Standards*

NCSS *National Council for the Social Studies*

Transportation Systems

What is mass transportation?

As You Read

Connect What different kinds of subsystems do land transportation vehicles have?

A transportation system is a way of moving people or products from place to place. Transportation systems have inputs, processes, outputs, and feedback. For example, inputs to a city bus system include bus drivers and fuel. Processes include driving the bus and loading passengers. The output is arrival at scheduled stops. Feedback includes comments from satisfied customers.

Transportation systems are interrelated. Each system depends on the other systems. Buses and cars, for example, take passengers to airports and ship docks. Transportation systems are part of the larger technological, social, and environmental systems in our world.

Land Transportation

When you travel in a car, bus, or train, you are using a land transportation vehicle. Land transportation also includes travel by bicycle, motorcycle, and subway. Automobiles are an important part of our land transportation system. However, you need more than just a car to get from place to place. Roads, bridges, and service centers are just a few of the subsystems within a land transportation system that allow you to use your family car. About half of all the world's automobiles are used in the United States.

Mass Transportation

Mass transportation moves many people at one time and is available to the general public. However, it is expensive to develop mass transportation systems that can serve a large country. That is one reason why the automobile has become an important part of our land transportation system. Automobiles are for personal transportation, not mass transportation. Mass transportation is sometimes slower and less convenient. However, people who use mass transportation do not have to worry about parking their cars or paying for gas, parking tickets, or car insurance.

Reading Check **Recall** What are types of land transportation?

Mass Transportation
Tokyo, the capital of Japan, has a reliable and clean rapid transit system with trains that run above and below ground. More than 7 million people use Tokyo's trains each day. *Why is it easier to build an efficient mass transportation system in a city?*

Automobiles

What does "four-wheel drive" mean?

Modern automobiles are quite different from early models. However, your family car has at least two things in common with those early models. Both have transmissions, and nearly all have front-mounted engines.

Transmission

A car's **transmission** contains gears and other parts that transfer power from the engine to the axles and wheels. The gears work on the same principles as gears on a bicycle.

BusinessWeek Tech NEWS

Moving More People, Making Less Impact

The nonprofit Design Trust for Public Space called for the "greening" of taxicabs. In New York some 13,000 gas guzzlers jam the already congested streets. At an exhibit in 2007, several eco-friendly prototypes were introduced, including a boxy one by Vehicle Production Group. It stands six feet tall, allows for wheelchair access, and uses less gas.

Critical Thinking *List some other ways urban areas can improve their environmental footprint?*

Go to **glencoe.com** to this book's OLC to read more about this news.

When you pedal up a hill, you shift into low gear because it takes more effort to pedal up the hill. The rear wheel moves more slowly. On level ground, it takes less effort to pedal, and the rear wheel of the bicycle turns more quickly. See **Figure 22.1**. A car's engine operates best if you use a low gear while climbing a steep hill or when starting from a stop. Using a high gear is best when driving on a flat road.

Driving Wheels

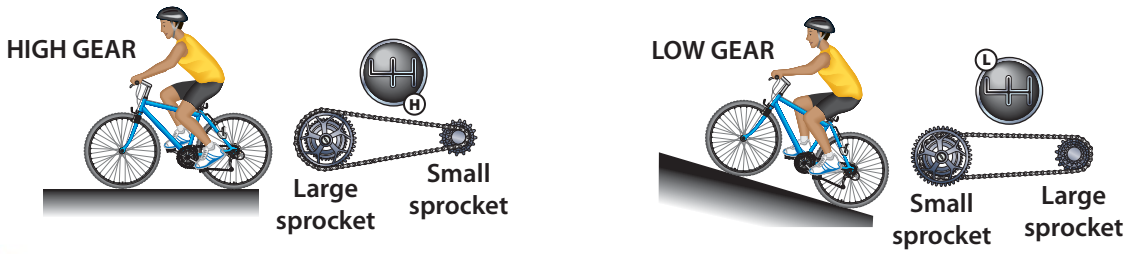
The power from your legs is transferred to your bicycle's rear wheel with a chain. The rear wheel is a bicycle's **driving wheel**. A car does not use a chain. Instead, it transfers power with one or two metal shafts called "drive shafts." Most cars transfer power to the front wheels and are known as **front-wheel drive** cars. Some cars transfer power to the rear wheels. They are **rear-wheel drive** cars. Some send power to all four wheels. These cars are **four-wheel drive**, or all-wheel drive, cars.

Other Subsystems

An automobile has many subsystems. Besides the transmission and driving wheels, some subsystems include those that provide structure and support (frame), propulsion (engine), and guidance (steering wheel). Others are safety related (air bags). Some cars have mapping computers that connect to GPS satellites.

Many of these subsystems are manufactured by outside suppliers. The anti-lock braking system (ABS), for example, is not usually made by the same company that makes the car. The CD player, tires, and windshield may also be manufactured by a different company.

Figure 22.1 Transmission



Shifting Gears A car's transmission works just like the gears in a bicycle. High gear combines the larger crank sprocket with the smallest sprocket at the rear wheel. *What combination of sprockets does low gear use?*

Reading Check **Summarize** What is the transmission in an automobile?

Buses

How did school buses help promote better schools?

Buses usually carry 30 or more passengers and are used for mass transportation between cities. This is called "intercity transportation." Buses are also used for transportation within cities and for school transportation. School systems in the United States alone use over 400,000 buses.

School Buses

School buses were being used as early as 1920. They made it possible to gather students together from small rural schools into one larger school with improved facilities. Millions of students ride safe and sturdy buses to school each day. Buses are made from strong steel to meet federal manufacturing requirements. Seats and other support systems are specially designed for safety. Many use diesel fuel, which would not burn as easily as gasoline if an unexpected leak should occur.

Intercity Buses

Intercity buses are also powered by diesel engines. These types of buses carry up to 64 seated passengers. They are generally less expensive for passengers to ride than trains or airplanes. They also make stops at smaller communities that are not served by trains and airplanes.

Ethics in Action

The Black Box

Many cars today have data recorders, or "black boxes," as part of their control systems. The black box monitors the release of safety air bags in an accident. It also records the driving actions of the driver.

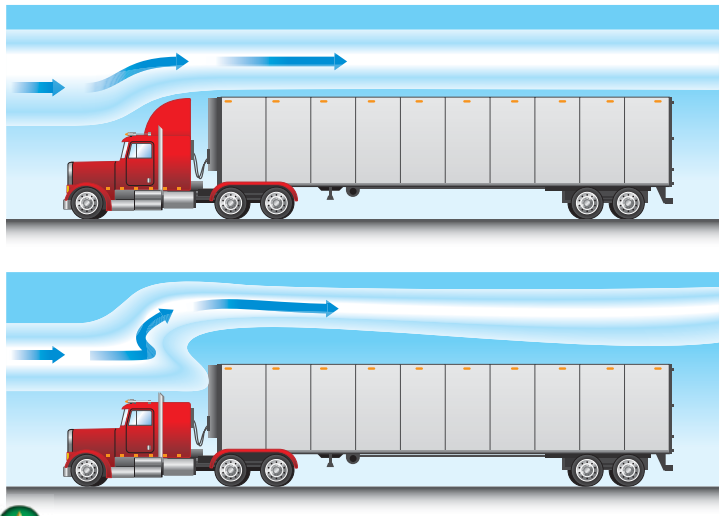
Caught in the Act If an accident happens, the police and insurance companies can use the black box to see what the driver was doing. If the driver was speeding or doing anything wrong, the accident could be considered his or her fault.

English Language Arts/Writing

Big Brother Is Watching People might be more likely to obey traffic laws if they know their actions are being recorded. But is this an invasion of privacy?

1. George Orwell, the author of the novel *1984*, once said, "Men are only so good as their technical developments allow them to be." What did he mean?
2. Do you agree with the quote? Write a one paragraph response.

Figure 22.2 **Wind Deflectors**



Air Resistance A wind deflector on top of the truck cab can save fuel costs each year. *Why?*

Urban Buses

Urban buses can carry more people than intercity buses because they allow some passengers to stand. Use of urban buses eases traffic congestion and saves fuel. They use about one-third as much fuel per passenger as do automobiles. However, urban buses account for only 15 percent of all passenger miles traveled in the United States.

Reading Check **Summarize** Why are school buses safe?

Trucks

What is the purpose of a truck's wind deflector?

American cities rely on trucks to supply them with food, fuel, furniture, and other products. Trucks play an important role in transportation. They go directly from the supply location to the customer. Most trains, airplanes, and ships do not do that.

Types of Trucks

We use hundreds of different kinds of trucks. Most are diesel powered, but gasoline engines are also used. Some commercial trucks are as small as pickup trucks. Others are as large as the 18-wheel semi-trailer trucks that carry cargo on interstate highways. These large trucks are also called **tractor-trailers**.

There is no such thing as a standard truck, but there are three general types: light duty, medium duty, and heavy duty. Panel and pickup trucks are examples of light-duty trucks. Medium-duty trucks are used locally and include sanitation trucks, soft drink delivery trucks, and heating oil trucks. Heavy-duty trucks carry large loads, and an 18-wheel tractor-trailer is one type.

Wind Deflectors

The flat front and square shape of many trucks present a large surface that the air can press against. This means that the trucks waste fuel. Some manufacturers place a wind deflector on the tractor's roof. A deflector directs the air around the truck, which reduces resistance and saves fuel. See **Figure 22.2**.

Reading Check **Identify** What are the truck types?

China Images/Alamy

Locomotives

What kind of engines replaced steam engines in locomotives?

Railroads earn most of their money by hauling freight. They deliver bulky items like coal and iron ore. They also carry things such as automobiles and television sets. About 10,000 freight trains roll over the tracks each day. Some are over 200 cars long.

Trains also carry passengers, and the busiest lines are on the East Coast. These are operated by AMTRAK, the intercity passenger railroad system. Travel between the terminals at Washington, D.C., and Boston, Massachusetts, including cities along the way, is quite popular. The distances are fairly short, and the trains travel directly from downtown to downtown. However, trains carry less than 1 percent of all U.S. intercity passengers. That is a very low number. In some countries, trains carry up to 50 percent of intercity travelers.

Commuter and subway trains transport workers, tourists, students, shoppers, and others to their daily destinations. They are also part of the mass transportation network.

High-Speed Trains

The newest all-electric locomotives, called **bullet trains**, travel at high speeds. The speed and the pointed shape of the locomotive's nose inspired its name. Japan's *Shinkansen* was the first bullet train in 1964.

The bullet train in the United States is the *Acela Express*, for acceleration and excellence. Several all-electric stainless steel trains entered service in the year 2000. Each six-coach train can carry over 300 passengers at speeds up to 150 mph.

Magnetism The Shanghai Maglev Train carries passengers 22 miles in seven minutes using electromagnetic force. *Since maglev trains float in the air, how do they slow down and then stop?*

Maglev Trains

Another new kind of train does not roll on wheels. It does not even touch the ground. The train is called a **maglev train**. Maglev stands for "magnetic levitation." The forces of magnetic attraction and repulsion allow the train to float, or levitate, less than one inch above its guideway, or path. The same forces **interact** to move the trains.

Academic Connections
Language Arts

The Language Barrier
Large tractor-trailer trucks, which are called "18-wheelers" in the United States, are known as *articulated lorries* in Britain. A "dual-carriage way" in Britain is a *divided highway* in the United States. High-speed, limited-access roads or interstate highways are called "motorways" in Britain.

Apply Use a dictionary to look up the words *tram*, *omnibus*, *caravan*, and *the underground*. What terms are used in the United States?

Maglevs are very quiet and produce almost no vibration. However, they are expensive to construct. Only a few experimental ones have been built in the United States. The first maglev to enter commercial service runs on a 22-mile line to the Shanghai airport in China. The train's highest speed during the trip is normally about 260 miles per hour. It was built in Germany and began passenger service in 2004.

Reading Check **Explain** What does the word *maglev* mean?

Pipelines

How is cargo transported through pipelines?

When you turn on a faucet to get a drink of water, you are using a transportation system. Some cargo, like water, oil, and natural gas, travels long distances through pipelines. Pipes may be as small as two inches in diameter or as large as 15 feet in diameter. Most pipelines are buried in the ground.

Pipelines require service facilities such as pumping and control stations. The stations are located along the pipeline and keep the cargo moving. When the cargo is made of particles, such as gravel, it is mixed with liquids to form a "slurry." The pumps then force the material through the pipeline.

section 22.1 assessment

After You Read **Self-Check**

1. Identify the purpose of a transmission.
2. Describe how an intercity bus is used. Explain how this is different from the use of an urban bus.
3. Explain what causes a maglev to "float" above its guideway.

Think

4. Some people think that high-speed trains instead of airplanes should be used for distances less than 200 miles, especially in highly populated areas. Discuss why you think this might be desirable.

Practice Academic Skills

Social Studies

5. Use the Internet to learn about bullet trains used in Japan, England, France, Germany, and Spain. Report your findings to the class.

STEM **Mathematics**

6. A tractor-trailer is hauling 32 television sets. Each TV weighs 112 pounds. What is the total weight of the cargo after eight of the TVs are delivered?

Math Concept **Two-Step Problems** Problems that require two calculations to solve take some extra concentration.

1. The first step is to determine the number of TVs that are left in the truck.
2. After you determine the number of TVs, use multiplication to determine the total weight.

For help, go to **glencoe.com** to this book's OLC and find the Math Handbook.

section 22.2

Water Transportation

Reading Guide

Before You Read **Connect** What are the different types of water transportation?

Content Vocabulary

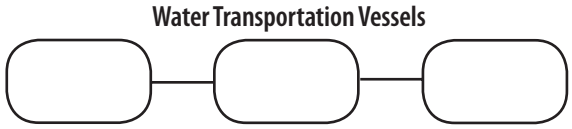
- navigable waterway
- displacement
- supertanker
- intermodal transportation
- containership

Academic Vocabulary

- overseas
- via

Graphic Organizer

Draw the section diagram. Use it to organize and write down information as you read.



Go to **glencoe.com** to this book's OLC for a downloadable graphic organizer and more.

TECHNOLOGY STANDARDS

STL 3 Relationships & Connections

STL 4 Cultural, Social, Economic & Political Effects

STL 18 Transportation Technologies

ACADEMIC STANDARDS

Social Studies

NCSS Content Standard 2 Time, continuity, and change

Science

NSES Content Standard F Science and technology in society

STL *National Standards for Technological Literacy*

NCTM *National Council of Teachers of Mathematics*

NCTE *National Council of Teachers of English*

NSES *National Science Education Standards*

NCSS *National Council for the Social Studies*

Waterways

What is a navigable waterway?

Water has provided transportation routes for centuries. Oceans, rivers, lakes, and other navigable waterways have made natural routes between cities, states, countries, and continents. A **navigable waterway** is a lake or river that is deep and wide enough to allow ships and boats to pass. The five Great Lakes are navigable waterways, as are many rivers, such as the Mississippi and Ohio.

Engineers can also construct canals through which boats and ships can pass. The Suez Canal in Egypt connects the Mediterranean Sea with the Red Sea, allowing ships to carry cargo back and forth between Europe and Asia.

As You Read

Predict How does intermodal transportation help move people and cargo?

It usually costs less to transport goods by water than by rail, highway, or air. Whenever possible, people try to save as much money as they can by transporting products the cheapest way.

Reading Check **Explain** How are navigable waterways used for transportation?

Boats and Ships

What is the difference between a boat and a ship?

A small, open vessel is called a "boat." A large, deep-water vessel is called a ship. There are about 24,000 ships in the world.

There are three general types of water transportation vessels. Passenger vessels that carry people are one type. Cargo ships are another type. They transport oil, grain, iron ore, automobiles, and many other products. Specialty craft include every other type, such as river barges used for transporting coal and other goods, tugboats for pulling large ships into dock, and icebreakers.

Overseas Cargo

Ships deliver most of the **overseas** cargo leaving or arriving in the United States. To transport by ship, we need docks with special loading and unloading equipment. We need properly trained people to operate the ship. We also need good communications for weather data and other information. They are all necessary for the entire system to operate efficiently.

Heavy Ships

For many centuries, people used sailing ships to haul cargo and passengers. The ships of the 1800s had displacements of about 1,200 tons. **Displacement** is a measure of how much water a ship and its cargo push aside as the ship floats. It is an indication of the ship's size. Today an average cargo ship might have a displacement of 21,000 tons.

A heavy ship is difficult to move, so today's ships are pushed by powerful engines. Ocean liners and cargo ships often use gas turbine or diesel engines.

Luxury Ships Large luxury ships like the *Navigator of the Sea* are used as vacation cruise liners. *How do such large ships maneuver into a tight dock space?*

Used with permission of Royal Caribbean Cruises Ltd.

Thinkstock Images/Jupiter Images

Tech Stars

Ivan Getting

Inventor of GPS

Ivan Getting, who was born in New York City in 1912, was a physicist and electrical engineer. His early contributions to the world of technology included research on the use of radar, ballistic missiles, and microwave tracking systems during World War II. In 1960, he founded the Aerospace Corporation.

Getting is best known for his original ideas about the Global Positioning System (GPS). In the 1970s, Bradford Parkinson of the U.S. Air Force was appointed to run the GPS program for the U.S. Department of Defense using Getting's ideas. By 1978, the NAVSTAR GPS was functional and accurate within three meters.

Map to Reward GPS uses satellites orbiting above the earth for mapping and navigation. In 2003, the year Getting died, he and Parkinson were honored with the Charles Stark Draper prize of $500,000 for their invention.

English Language Arts/Writing Describe in a short essay the importance of Getting's GPS invention to the 21st Century.

Go to **glencoe.com** to this book's OLC to learn about young innovators in technology.

It is not unusual for a large modern ship to displace 100,000 tons. That means it is about 80 times bigger than a ship of the 1800s. Very large ships called **supertankers** transport oil across oceans in storage tanks. Their displacements are as high as 500,000 tons. Does this tell you why they are called *super*tankers?

Reading Check **Recall** What are the different kinds of water transportation vessels?

Intermodal Transportation

Can modes of transportation be linked to carry people or products?

Can you think of a time when you used more than one mode (form) of transportation in a single journey? When two or more modes of transportation are used together to move people or cargo more efficiently, it is called **intermodal transportation**.

Reading Check **Predict** What is intermodal transportation?

Moving People

To understand how intermodal transportation helps move people, imagine that you are going to take a cruise. To get to the city where you will board ship, you need to take an airplane.

EcoTech

Ecotourism

Tourism can result in gaudy hotels, create overpriced restaurants, and generate trash. It can displace and inconvenience local people. Ecotourism includes tourism practices that try to preserve the environment and improve the well-being of the locals.

Try This Next time you travel, consider the effect you have on the places you visit.

In order to reach the airport, you might take a bus to a subway station, and then travel to the airport via subway train. You might also drive your own car or take an airport shuttle.

Different systems have been organized to work together to help you. There is a bus stop near the subway station, a subway stop at the airport, and a taxi to take you from the airport in the coastal city to the cruise ship.

Moving Cargo

Cargo is moved most efficiently when it is packed into large containers. When a product travels overseas, the containers are loaded on ships called containerships. Loading and unloading is easy because the containers are usually the same size and the same shape.

Containers can then be loaded onto a train. The products do not have to be unpacked and then repacked. Some containers are designed as truck semi-trailers. They ride on trains to a terminal, where they are then attached to truck tractors. They continue their journey on the highway. Because intermodal transportation is so efficient, it saves time and money.

section 22.2 assessment

After You Read Self-Check

1. Identify the difference between a boat and a ship.
2. Name the three general types of water transportation vessels.
3. Explain why intermodal transportation is so efficient.

Think

4. Describe how you think engine-powered ships affected society when they were first introduced.

Practice Academic Skills

Social Studies

5. Look up information and write a short report on how a particular transportation system is a part of the technological, social, and environmental systems that make up our world.

STEM Mathematics

6. Xavier is going to take his boat across a lake that is four miles wide. A bandstand is directly across the lake. Three miles to the bandstand's right is a dock for boats with a playground. If Xavier decides to go on his boat to the playground, what distance will he have to travel across the lake?

Math Concept **Pythagorean Theorem** The Pythagorean theorem states that the sum of the squares of the lengths of the two shorter sides of a right triangle equals the square of the length of the third side, called the "hypotenuse." This formula allows you to determine the unknown length of a side if you know the other two lengths.

1. Draw a diagram of the possible paths he could take. Label the distances that are given.
2. Use the Pythagorean theorem to determine the distance to the playground.

For help, go to **glencoe.com** to this book's OLC and find the Math Handbook.

section 22.3

Air and Space Transportation

Reading Guide

Before You Read **Connect** What are the main types of air transportation vehicles?

Content Vocabulary

- lift
- commercial airplane
- jumbo jet
- helicopter
- lighter-than-air craft
- payload

Academic Vocabulary

- complex
- approach

Graphic Organizer

Draw the section diagram. Use it to organize and write down information as you read.

Air and Space Transportation

K	W	L

Go to **glencoe.com** to this book's OLC for a downloadable graphic organizer and more.

TECHNOLOGY STANDARDS

STL 3 Relationships & Connections

STL 4 Cultural, Social, Economic & Political Effects

STL 12 Use & Maintenance

ACADEMIC STANDARDS

Science

NSES Content Standard E Understandings about science and technology

NSES Content Standard D Earth in the solar system

STL *National Standards for Technological Literacy*

NCTM *National Council of Teachers of Mathematics*

NCTE *National Council of Teachers of English*

NSES *National Science Education Standards*

NCSS *National Council for the Social Studies*

Air Transportation

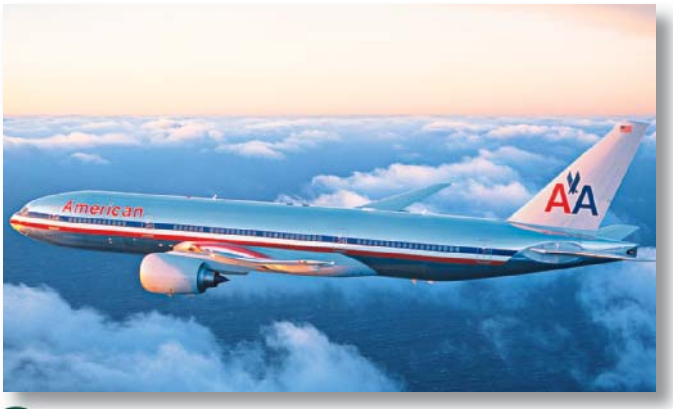
What is a jumbo jet?

Transportation by air takes place in airplanes, helicopters, and lighter-than-air craft. Hang gliders and sailplanes are used for recreation. Military airplanes are used for defense. Can you think of other vehicles for air transportation?

Airplanes are the most important part of our air transportation system. However, many other components are necessary for safe air travel. For example, we need airports, training programs, and radar. Many airplanes are in the air at the same time. This is why air travel is our most complex transportation system and is regulated by the government.

As You Read

Compare What are some of the uses for air and space transportation?



Welcome Aboard
This Boeing 777 aircraft can carry up to 500 passengers from San Francisco to Tokyo at speeds up to .84 Mach. *What components are necessary for safe air travel?*

Airplanes

Did you ever wonder how something as heavy as an airplane could get off the ground? The secret is in the shape of the airplane's wing. As the airplane approaches the runway, it gathers speed and air rushes over the wing.

The shape of the wing causes the air to travel faster over its upper surface. See **Figure 22.3**. This reduces air pressure above the wing. It also helps increase the pressure on the wing's lower surface, pushing it upward and creating **lift**. Almost like magic, the airplane rises.

Commercial Airplanes

Many important airplanes were built and flown after the Wright brothers' first flight in 1903. One of the most important airplanes was the 1935 DC-3, which had two gasoline engines. It was the first **commercial airplane** as it made a profit by carrying just passengers.

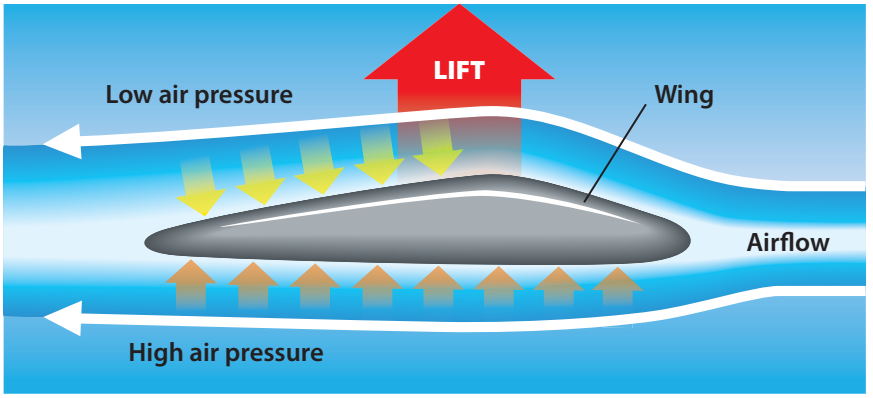
The Boeing 707 came out in 1958 and carried 179 passengers, a huge number at the time. In following years the number of airline passengers increased so much that manufacturers decided to build **jumbo jets**, very large jet airplanes that can carry about 500 passengers. The first was the Boeing 747.

Because jumbo jets have such powerful engines, they can lift more weight than other airplanes. This allows them to carry a lot of fuel. As a result, they can stay up in the air for a long time. Jumbo jets can fly non-stop from Cincinnati to London and from Detroit to Tokyo.

Smaller Jets

Smaller jet aircraft, like the two-engine Canadair RJ-200, are used on shorter flights between smaller cities. They use less fuel and do not need a long runway to take off.

Figure 22.3 Lift



The Secret of Flight
The lower air pressure above the wing helps create lift. *What happens to the air pressure if the plane starts to slow down?*

Bill Howe/Alamy

Cargo Planes

Some airplanes carry only cargo. However, even the biggest airplane can carry only a fraction of what a ship or train can haul. A Boeing 747 can carry 100 tons of cargo. Transport by air can be very expensive. Therefore only lightweight items, such as mail and electronics, are usually shipped by air.

Helicopters

A **helicopter** is an aircraft with one or two rotors that allow it to lift straight up. The twirling blades of the rotor create lift. Some helicopters also have small tail rotors to keep them from spinning out of control.

Helicopters can be as small as a one-person machine or as large as a cargo-carrying helicopter capable of lifting ten tons. Passenger-carrying helicopters connect some large cities with major airports. Some helicopters deliver parts to construction sites. Others are used to check on traffic or to transport people to hospitals.

Lighter-than-Air Craft

Lighter-than-air craft include aircraft such as dirigibles, blimps, and airships. Helium lifts them into the air, and gasoline engines turn propellers to move them forward. The engines are located in gondolas, or cars, that are suspended from the craft. The passenger compartment is located in a separate gondola.

A hot-air balloon is also a lighter-than-air craft. It uses large torches to heat the air inside a huge nylon bag. Hot air weighs less than cooler air, so the balloon rises. The pilot controls the balloon by ascending or descending into wind currents.

Reading Check **Explain** How is an airplane able to lift up into the air?

Space Vehicles

What does NASA do?

The National Aeronautics and Space Administration (NASA) is responsible for regulating and directing the entire U.S. space program. This includes the space shuttles and vehicles for exploration.

Reading Check **Identify** What do the letters NASA stand for?

Work Space This space shuttle is in orbit 115 miles above the earth. *What usually happens during a typical space shuttle mission?*

Imagine This...

Back to the Moon

Imagine flying to the moon in a space shuttle. NASA is preparing to return to the moon with a project called *Constellation*. To get there, they are working on designing a new type of rocket that combines the best features of the space shuttle and the *Saturn V*, which first took astronauts to the moon. The rocket is named *Ares 1*. Engineers hope to have it flying by 2014. *What do you think are some of the criteria and constraints for designing the Ares I?*

Go to **glencoe.com** to this book's OLC for answers and to learn more about the *Ares 1*.

Space Shuttles

The first space shuttle that went into orbit was the *Columbia* in 1981. On a typical mission, a space shuttle with four astronauts orbits 115 miles above the earth. Each flight carries cargo, called a payload, in the large cargo bay. The payload can weigh up to 65,000 pounds.

Shuttle speed is about 17,000 miles per hour. Once in orbit, an astronaut opens the cargo bay doors, which may contain a communications satellite. The astronaut controls a 50-foot mechanical arm that grabs the satellite and releases it a safe distance from the shuttle. The arm can also grab satellites already in orbit.

Shuttle Missions

The space shuttle can also carry a complete scientific laboratory in the cargo bay. However, many laboratory experiments are now done on the International Space Station (ISS). A shuttle mission can also include carrying supplies to the ISS.

To return to earth, the astronauts fire small rockets to slow down the space shuttle. It re-enters the atmosphere and glides toward a landing strip. Space shuttle astronauts have a very dangerous job, and several have been lost during in-flight failures. For example, seven astronauts on the *Challenger* in 1986 and another seven on the *Columbia* in 2003 perished during their missions.

Spacecraft can also travel without astronauts. These ships consist of hollow containers mounted on booster rockets. The hollow containers usually carry satellites for communication or scientific research. Once a spacecraft is in orbit, its container opens, and the satellite is put into position. The satellite then begins orbiting on its own.

section 22.3 assessment

After You Read — Self-Check

1. Name the type of jet that carries the most passengers.
2. List several jobs that helicopters perform.
3. Explain the letters *NASA*.

Think

4. Explain the value you think the space program has for the development of technology for use on Earth.

Practice Academic Skills

English Language Arts/Writing

5. Do research on new rockets designed to take people to the moon and the types of missions planned for them. Imagine you are chosen to be an astronaut on one of these missions. Write a short story describing your experience going to the moon.

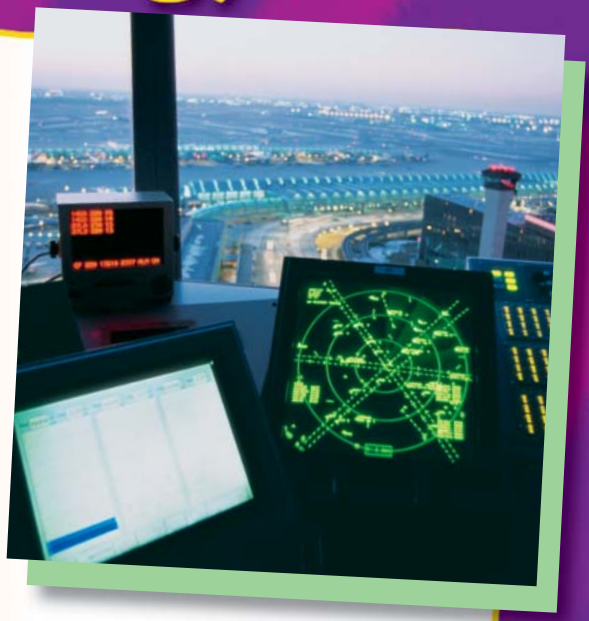
Science

6. The space shuttle is the first reusable spacecraft that NASA has used. Some feel that the space shuttle program is dated and becoming obsolete. Research new space shuttle designs. Write a few paragraphs about the designs you find and explain their advantages over the current space shuttle design.

Exploring Careers in Technology

Ronnie Coursey

AIR-TRAFFIC CONTROLLER



Q: *What is a typical day like at your job?*
A: The typical day begins with information briefings on air-space conditions, weather, traffic flow control, and equipment status. Then I receive a position-specific briefing before assuming control of a sector. A controller ensures that all aircraft are separated and controlled in a safe, orderly, and expeditious manner. Air-traffic controllers are limited to two hours at a time on each position. We rotate control positions often and receive a new briefing each time.

Q: *What kind of training and education did you need to obtain your job?*
A: I received most of my basic air-traffic training in the U.S. Army. Also, the math and science courses I took in high school were essential.

Q: *What do you like most about your job?*
A: No two days are alike. Air traffic is very dynamic, because the number and types of aircraft, weather, turbulence, and destinations are always changing. This job never gets boring!

Q: *How did you get interested in your job?*
A: I joined the Army because I wanted to have the opportunity to train for a good career and receive educational benefits while serving my country. I looked for a career that was fun, challenging, and offered good pay in a civilian life, and I found it.

English Language Arts/Writing

On-the-Job Communication In order to succeed in most careers, it is important to have good communication skills.

1. Interview three adults. You can interview anyone who works full-time, including an air-traffic controller.
2. Ask him or her to explain how they use communication skills on the job, and to give you some examples.
3. Summarize your findings in a one-page report.

Go to **glencoe.com** to this book's OLC to learn more about this career.

Real-World Skills
Speaking, listening, organization, problem-solving

Academics and Education
Science, mathematics, English language arts, social studies

Career Outlook
Growth as fast as average for the next ten years
Source: *Occupational Outlook Handbook*

chapter 22 Review and Assessment

Chapter Summary

Section 22.1 About half of all the world's automobiles are used in the United States. The car's transmission contains gears for transferring power. Buses are an important part of mass transportation. Some larger trucks use deflectors to reduce air resistance. A train that floats over a guideway is called a "maglev."

Section 22.2 There are about 24,000 large deep-water vessels in the world. Displacement is the measure of how much water a vessel moves aside as it floats. Intermodal transportation combines several different kinds. Cargo is often placed in containers for efficiency.

Section 22.3 Jet airplanes servicing smaller airports do not need a long runway and use less fuel. Helicopters can carry cargo, and some can easily lift ten tons. The force that allows a plane to rise in the air is called "lift." During missions, space shuttles orbit about 115 miles above the earth.

Review Content Vocabulary and Academic Vocabulary

1. On a sheet of paper, use each of these terms and words in a written sentence.

Content Vocabulary

- mass transportation
- transmission
- driving wheel
- front-wheel drive
- rear-wheel drive
- four-wheel drive
- tractor-trailer
- bullet train
- maglev train
- navigable waterway
- displacement
- supertanker
- intermodal transportation
- containership
- lift
- commercial airplane
- jumbo jet
- helicopter
- lighter-than-air craft
- payload

Academic Vocabulary

- role
- interact
- overseas
- via
- complex
- approach

Review Key Concepts

2. **Describe** the different types of land transportation.
3. **Explain** the purpose of transportation subsystems.
4. **Explain** the purpose of a transmission.
5. **Describe** how oceans and inland waterways are used for transportation.
6. **Identify** the different types of ships.
7. **Explain** the concept of intermodal transportation.
8. **Discuss** ways in which air and space transportation are used.
9. **Identify** types of aircraft and spacecraft.
10. **Explain** how a plane is lifted into the air.

Real-World Skills

11. Driving Wheels A car's driving wheels can be in the front or in the rear. Other cars have all four wheels as driving wheels. Research what configuration your family's car has. Write a few paragraphs describing the car, and the advantages and disadvantages of the different types of driving wheels.

STEM Technology Skill

12. Lighter than Air Aircraft that fly because they are lighter than air include blimps, zeppelins, dirigibles, and more.

a. Obtain a helium-filled balloon and see how much weight it will lift by attaching weights to its string.

b. Based on what you determine in step one, figure out how many balloons it would take to lift you. If you are not sure of your weight, weigh yourself.

Academic Skills

Social Studies

13. When deciding how to transport goods, people base their decision on price, safety, and speed. Research different shipping methods. Write a few paragraphs comparing the different ways goods can be shipped. Include a discussion about why some modes are preferred.

STEM Mathematics

14. The Mach number is the speed of something, relative to the speed of sound. The speed of sound is called Mach 1. If something is traveling at Mach 1.2, it is going 1.2 *times* the speed of sound. If the speed of sound is 735 mph, how fast is a plane traveling if its speed is Mach 1.8?

Math Concept Operations If a problem uses the word *times*, it is indicating that multiplication should be used. To determine the speed of sound based on a Mach number, simply multiply the given speed of sound by the Mach number.

TSA WINNING EVENTS

Aerospace Engineer

Situation You and your team will design and build a glider. Your teacher will determine the glider's minimum and maximum dimensions. You will launch the glider by an elastic band.

Activity Design the glider model within the given constraints and criteria. Make a series of sketches. Then make a working model of your glider and conduct flight tests. Make changes as needed. Finally, conduct a series of five final flight tests, recording the times aloft.

Evaluation Time aloft—total number of seconds of five flights

Go to **glencoe.com** to this book's OLC for information about TSA events.

Standardized Test Practice

Directions Choose the letter of the best answer. Write the letter on a separate piece of paper.

1. What is the cost of a $56.50 computer program if it is discounted 20%?

A $22.80 **C** $45.20
B $56.30 **D** $11.30

2. The lift of a wing is a result of the high pressure generated on top of the wing.

T **F**

Test-Taking Tip Learn ahead of time the kind of test you will be taking, when and where the test will be, and what materials to bring.

chapter 22

TECHNOLOGY LAB

Build a Rubber-Band-Powered Vehicle

Modern land vehicles have many basic parts that are the same as those used hundreds of years ago. Most have wheels, a body, and a way to provide power. You can learn more about land vehicles by making your own.

Tools and Materials

- ✓ One wooden block, 1 inch thick, 2 inches wide, and 6 inches long
- ✓ Two wooden ready-made wheels, about 2¼ inches in diameter
- ✓ Two wooden ready-made wheels about 1 inch in diameter
- ✓ One dowel rod, ⅜ inch in diameter and about 3 or 4 inches long
- ✓ Three heavy rubber bands, ¼ inch wide and about 2 inches in diameter
- ✓ Staples
- ✓ About 18 inches of fishing line
- ✓ Punch
- ✓ Wire cutters
- ✓ Hand drill with ⅜-inch drill bit
- ✓ Hammer
- ✓ Tape measure, 25-feet long
- ✓ Saw

Set Your Goal

For this activity, you will make a simple land vehicle powered by a rubber band. You will then experiment with the design to see if you can make the vehicle go faster or farther.

Know the Criteria and Constraints

In this lab, you will:

1. Follow the basic design in the picture for your first vehicle.
2. Keep a record of all speed and distance measurements.
3. Submit sketches of your design improvements.

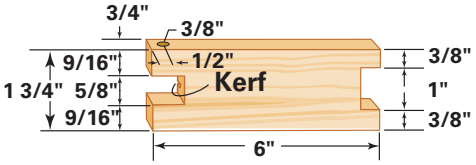
Design Your Project

Follow these steps to complete this lab.

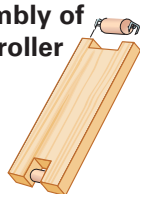
1. Look at the drawing of the completed vehicle on page 489.
2. Build the vehicle.
   - Drill a ⅜-inch hole at one end of the body, as depicted in picture 1.
   - Use the saw to cut notches at the front and rear.
   - Put the dowel rod through the hole.
   - Cut it to length and attach the two 2¼-inch wheels.

Body Detail

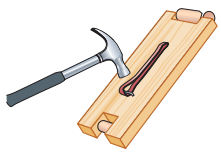
1.



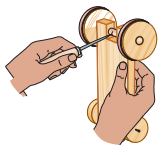
2. Assembly of front roller



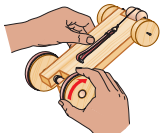
3. Attaching rubber band



4. Marking center of axle

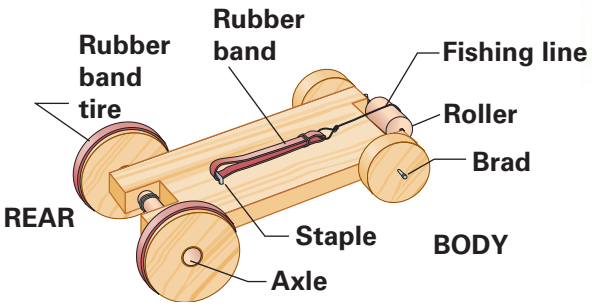


5. Winding wheels of the vehicle in preparation for operation



- Place a rubber band around the outside of each wheel. These wheels will be your car's drive wheels, providing its driving power.
- Mark the center of the dowel rod with a punch and hammer in a small nail. Leave about ¼ inch sticking out.
- Attach the front wheels with small nails. Make sure all four wheels can spin freely.
- Make the front roller from a $\frac{1}{8}$-inch-long section of the dowel rod.

Completed Vehicle



- Hammer small nails into each end and cut off the nail heads.
- Attach the roller to the body with staples, as shown in picture 2. Do not drive the staples too deep. The roller must turn easily.
- Attach a rubber band to the bottom of the body by hammering in a staple, as depicted in picture 3.
- Tie one end of the fishing line to the rubber band. Pass the line over the front roller and under the body of the vehicle.
- Tie the other end of the fishing line to the small nail on the dowel rod connecting the large wheels.
- To provide power for your car, wind the larger wheels backward, as in picture 5. Continue until all the fishing line is wound onto the axle and the rubber band is stretched over the front roller.

3. Place your vehicle on a smooth floor and let go. It will quickly accelerate and then coast to a stop.
   - Use the 25-foot tape measure to measure how far it traveled.
   - Use a stopwatch to measure its speed.
   - Repeat a few times to get averages of speed and distance.
4. Sketch several improvements for the vehicle and try them out.

SAFETY

Reminder

In this activity, you will be using tools and materials. Always follow appropriate safety procedures and rules so you and your classmates do not get hurt.

Evaluate Your Results

After you complete the lab, answer these questions on a separate piece of paper.

1. Did your vehicle travel as fast as you expected it would?
2. How did you change your vehicle to make it go faster or farther?
3. What would happen if you used bigger or smaller drive wheels?

Academic Skills Required to Complete Lab

Tasks	English Language Arts	Math	Science	Social Studies
Build car.	✓	✓	✓	
Test car; measure time distance.		✓	✓	
Retest car several times to obtain average distance and time.		✓	✓	
Make changes to car and retest.		✓	✓	

Technology Time Machine

As the Wheel Turns

Play the Game This time machine will travel to the past to show you how the invention of the wheel dramatically changed transportation. To operate the time machine, you must know the secret code word. To discover the code, read the clues, and then answer the questions.

Clue 1

3500 B.C.E. The earliest evidence of the wheel comes from the area between the Tigris and Euphrates Rivers in what is now known as Iraq. There, the ancient Sumerians formed wheels from three planks of wood that were bound with leather ties held in place by some copper nails. A hole in the middle held an axle.

Clue 2

2000 B.C.E. Use of the wheel for organized warfare created a demand for something that weighed less and moved faster. Spokes eliminated most of the heavy wood in the center of the wheel. Sculptures from Chinese tombs from the 13th century B.C.E. show spokes on chariot wheels.

Clue 3

1800s Heavy railroad cars required sturdy metal wheels that ran along a track. Locomotives in the United States used large driving wheels to help increase speeds to about 30 mph. Some of these wheels were more than six feet in diameter.

Clue 4

1845 The wheels on horse-drawn vehicles were covered with a solid, rubber tire. However, solid rubber was hard on roadways and did not produce a comfortable ride. In England, Robert W. Thompson patented the first pneumatic (air-filled) tire for use on carriages.

Clue 5

1888 John Dunlop of Ireland patented a pneumatic tire for bicycles and formed a company to manufacture the tires.

Clue 6

1900 At the turn of the century, the use of pneumatic tires spread to automobiles. Separate inner tubes held the air, and the outer covering was made from rubber-coated cotton cloth.

Clue 7

1954 The tubeless tire was introduced. These tires permitted higher speeds by reducing surface friction.

Clue 8

2001 Dean Kamen designed the battery-powered Segway Human Transporter. Its two wheels are made of plastic and are surrounded by air-filled tires. Each wheel is powered by its own motor and controlled by a computer. Kamen hopes it will eventually replace automobiles in crowded cities.

Crack the Code

On a piece of paper, write the answers to these questions:

1. What is another term for an air-filled tire?
2. Which part of the tire was made from rubber-coated cotton cloth?
3. Name the material from which the earliest wheel was made.
4. In which country was the first pneumatic tire patented?
5. Wheels on horse-drawn vehicles were covered with this material.

Now write down the first letter of each answer. Put them together to discover the secret code word!

Hint Engines and motors produce this to provide transportation.

Unit 7 Thematic Project

Advancing Transportation

Getting from Place to Place In Unit 7, you learned about the types of engines that make vehicles go. You also looked at transportation systems people use to move in neighborhoods, travel on water, fly through the air, and even rocket into space! The way people get from place to place affects their lives. Think about your own community. If you live in a city, do you have an easy way to get to the country? If you live in the country, do you have an easy way to get to the city? Do you live near an airport? How difficult is it to visit relatives who live in another city?

Design for the Future Think about how to improve transportation systems in your community. For example, if you live near a river that is upstream from a city, a system of hovercraft ports every few miles could reduce traffic.

This Project In this project, you will research and design a transportation system to meet the future needs of your community.

Your Project

- Choose a mode of transportation.
- Complete the following tasks:
  1. Design a new system of transportation for your community. Include time schedules, seating capacities, and safety procedures.
  2. Design it to use a sustainable fuel.
  3. Build a model of the transportation system.
- Write a report.
- Create a presentation with posters, video, or presentation software.
- Present your findings to the class.

Tools and Materials

- ✓ Computer
- ✓ Internet access
- ✓ Trade magazines
- ✓ Word-processing software
- ✓ Presentation software
- ✓ Posterboard
- ✓ Colored markers

Big Cheese Photo/Jupiter Images

The Academic Skills You'll Use

- Communicate effectively.
- Speak clearly and concisely.
- Use correct spelling and grammar when taking notes or writing presentations.
- Think about transportation technology design.

English Language Arts

NCTE 4 Use written language to communicate effectively.

NCTE 12 Use language to accomplish individual purposes.

Social Studies

NCSS 8 Science, Technology, and Society

Step 1 Choose Your Topic

You can choose any mode of transportation that interests you. Examples might include:

- Submarines
- Helicopters
- Monorails
- Escalators
- Rocketships
- Hydrofoils
- Ferries
- Aerial Trams

Tip! *Choose something you have used before!*

Step 2 Do Your Research

Research your project. Your fact-finding may include a combination of any of these ideas:

- Talk to or write to someone in the transportation industry.
- Study plans for similar systems.
- What do old and new articles in libraries and Web sites say about your topic?
- Take a ride on the transportation mode of your choice and write your observations.

Tip! *Use the library, the Internet, and magazines.*

Step 3 Explore Your Community

- Visit a power plant that generates power from hydroelectric, solar, or wind power.
- Ask local people what kind of innovations they would like to see in local transportation.

Tip! *Thank everyone who gives you information!*

Step 4 Create Your Project

Your project should include:

- 1 research project (design, blueprint, or model)
- 1 report
- 1 presentation

Project Checklist

	Objectives for Your Project
Visual	✓ Make a poster or slide presentation to illustrate your project.
Presentation	✓ Make a presentation to your class and discuss what you have learned.
	✓ Turn in research and names from your interview to your teacher.

Step 5 Evaluate Your Presentation

In your report and presentation, did you remember to:

- Demonstrate your research and preparation?
- Present an imaginative solution to a problem?
- Label your designs or test your model?
- Use facts and evidence to back your ideas?
- Engage your audience?
- Speak clearly?

Rubrics Go to **glencoe.com** to the book's OLC for a printable evaluation form and your academic assessment form.

GLOBAL TECHNOLOGY

High-Speed Rail

France has been a world leader in high-speed public transportation since the 1950s. Later the first TGV (*Train à Grande Vitesse*) was built in 1981. Passengers could ride from Paris to Lyon at 186 miles per hour! Today the railway system is so expansive and effective that some airline services have been discontinued. Double-decker cars have been added to the train to handle the many passengers.

Critical Thinking *Do you think the TGV could succeed in most U.S. regions? Why or why not?*

French

hello	bonjour
goodbye	au revoir
How are you?	Comment allez-vous?
thank you	merci?
You're welcome	de rien

Go to **glencoe.com** to the book's OLC to learn more and to find resources from **The Discovery Channel.**