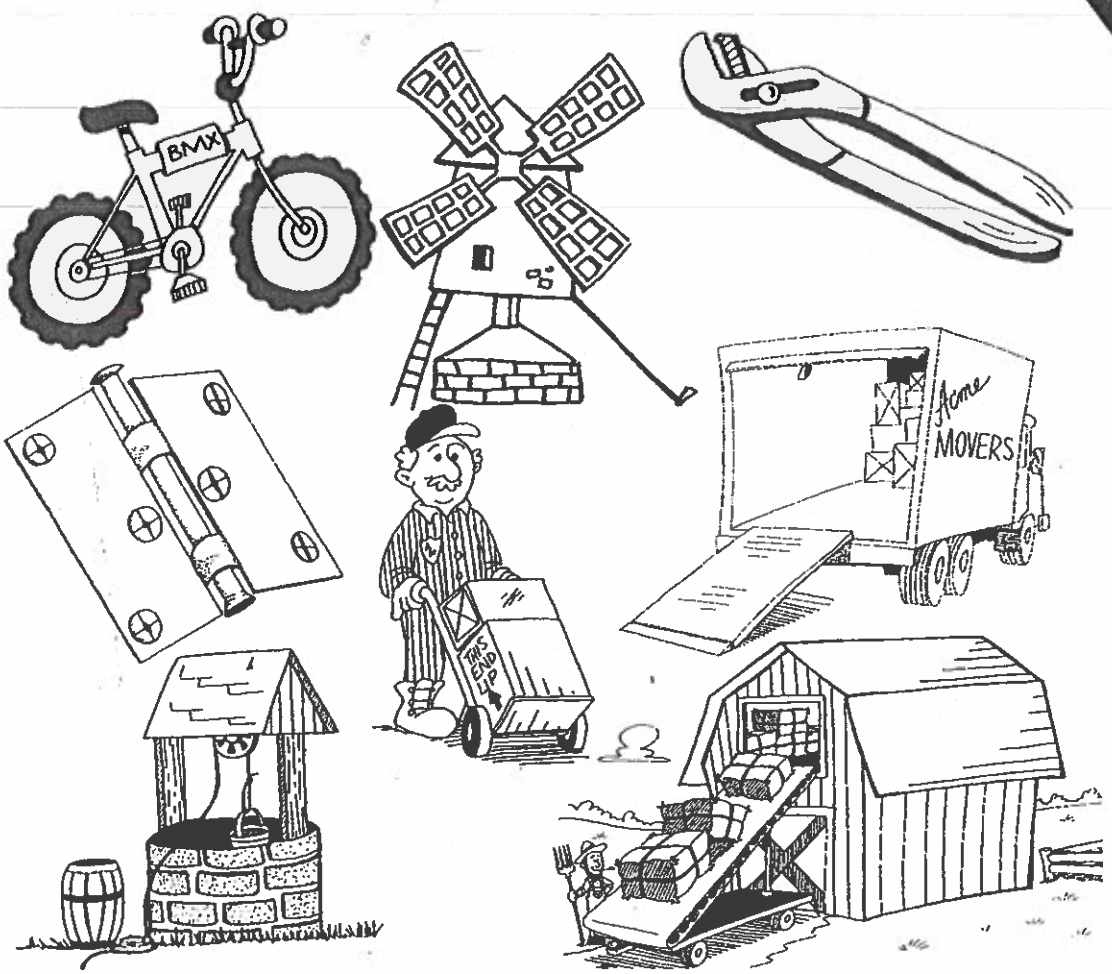
Simple Machines

Physical Science Series

STRUCTURES, Mechanisms, & Motion

Reading Resource

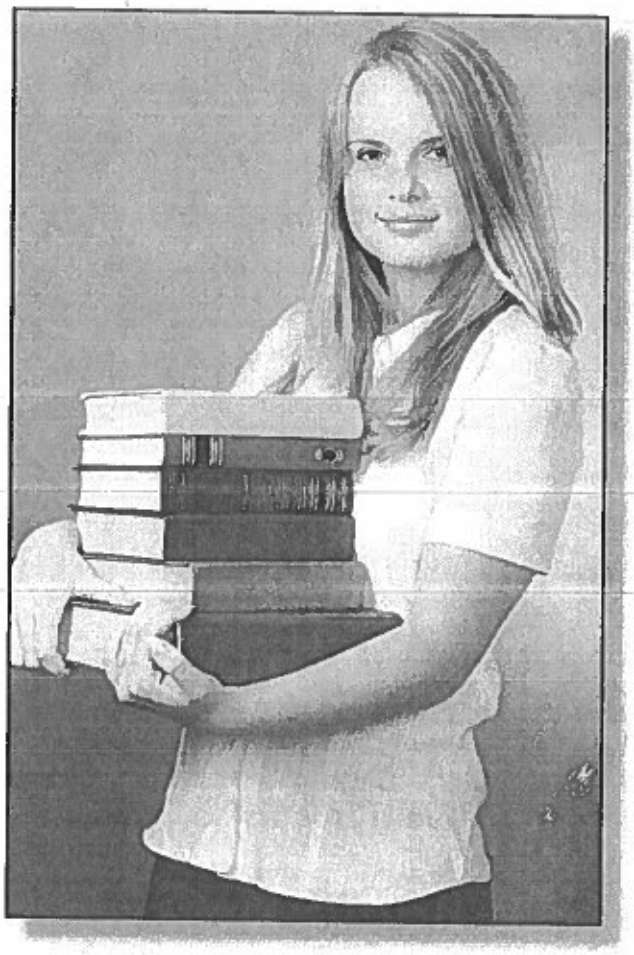


Experiments • Magnets • Pulleys • Lifecycle • Osmosis • Energy • Rocks & Soils • Lifecycle • Mammals • Osmosis • Sound • Space • Structures • Environment • Simple Machines • Energy • Tissues • The Body

Reading Passage NAME: _____

What Are Force, Motion, and Work?

Carrying a 50-pound rock around on your shoulder all day sounds like hard **work**. If you think so, you are half right. It would be hard, but it wouldn't be work—at least not the way the word work is used in science.



To understand what work is we first have to understand **force** and **motion**. You may remember that a force is a push or a pull. You can **exert** a force on something by pushing or pulling with your hands. **Gravity** and **friction** are also common forces.

We can see motion, so we already have a feeling for what it is. When something moves from one place to another, that is motion.

When a force acts on something, it sometimes makes the thing move. If the thing moves *in the direction* that the force is acting, *that* is work. Carrying the rock wasn't work because the force on it was pushing up, and the rock was moving sideways.

Lifting the rock onto your shoulder *is* work. The force is the same as the weight of the rock and the direction of motion is up. Throwing a ball is also work because the ball moves in the direction of the force exerted by your hand.

NAME: _____

Reading Passage

What Are Force, Motion, and Work?

There is a way to measure the amount of work done:

Work equals force times distance (W = F X d)

The force is the force that makes something move, and the distance is the total distance the thing moves. Work is measured in foot-pounds. One foot-pound is the work done by exerting one pound of force on something while moving it one foot. If your shoulder is 4 feet high, you do 200 foot-pounds of work when lifting a 50-pound rock to your shoulder (4 X 50 = 200).

STOP

Tell what causes the force of gravity and in which direction it acts.

_____

_____

When you do work on something, you can increase its **energy**. Raising something to a greater height increases its **potential energy**. Making something move faster increases its **kinetic energy**.

In the **metric system**, distance is measured in **meters**, force is measured in **newtons**, and work is measured in **joules**. A meter is about three feet, a newton is about a quarter pound, and a joule is about three-quarters of a foot-pound.

Sometimes you get paid for doing work. When life is fair, your pay depends on how much work you do *and* on how fast you do it. The speed at which work is done is called **power**. Power is measured in joules per second. One joule per second is one **watt**. When you pay your bill to the electric company, you pay for the number of watts of electricity you used.

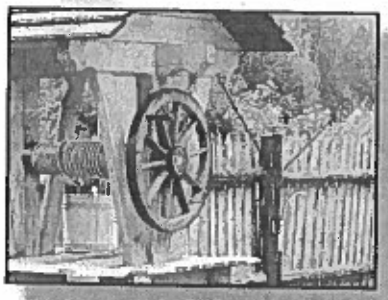
To find power, divide work by time (P = W ÷ t).

NAME: _____

Reading Passage

What Are Simple Machines?

A **machine** is something that makes work easier by changing the force you apply to do work. A machine can change the amount of force you apply, and it can also change the direction of the force. A **simple machine** is a machine with only one kind of movement.



Wheel and Axle

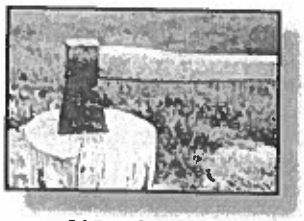
There are six kinds of simple machines: **lever, wheel and axle, pulley, inclined plane, wedge,** and **screw.** Look at the pictures of the six simple machines. It's easy to see how most of these work and how they change the force. We will look at each of these machines later in this book.

Inclined Place

Pulley

It is important to understand that simple machines make work easier, but they don't change the *amount* of work you have to do. (That's the bad news.) What machines change is the **effort** you have to put out. (That's the good news.)

For example, you can use a kind of lever to pull a nail out of a board. You could never pull a nail out with your fingers. You might have to push the lever down ten inches to pull the nail up one inch. The nail comes right out because the pull on the nail is ten times the force of your push on the lever.



Wedge

Screw

Lever

STOP

How does a bottle opener change the force you apply to the handle of the opener?

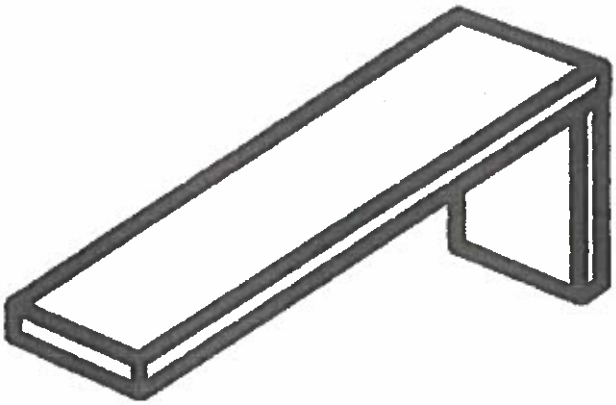
_____

_____

Later, we will learn more about what you lose and what you gain when you use a simple machine.

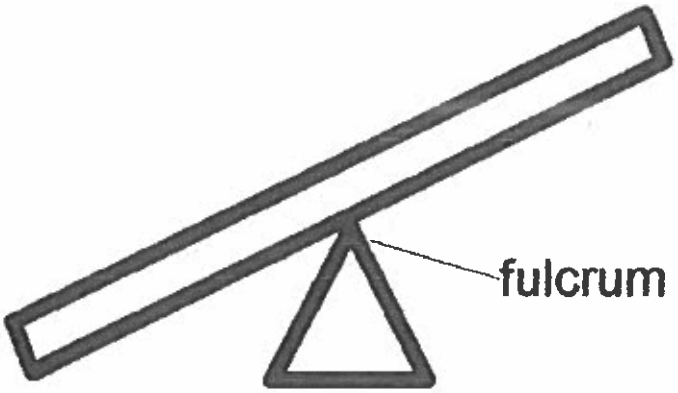
Simple Machines

incline plane



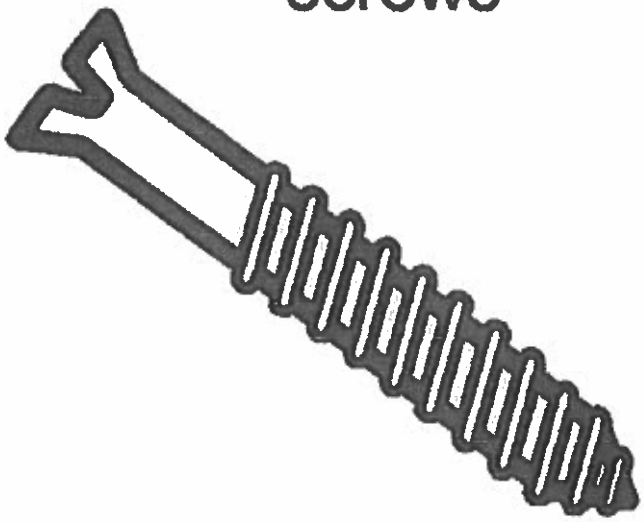
An inclined plane is a straight slanted surface.
It has no movable parts.

lever



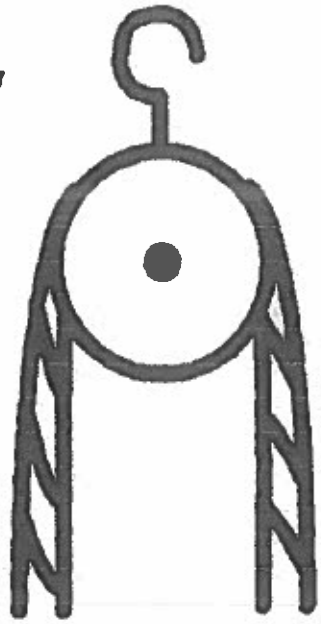
The lever is a simple machine made with a bar that is free to move about a fixed point called a fulcrum.

screws



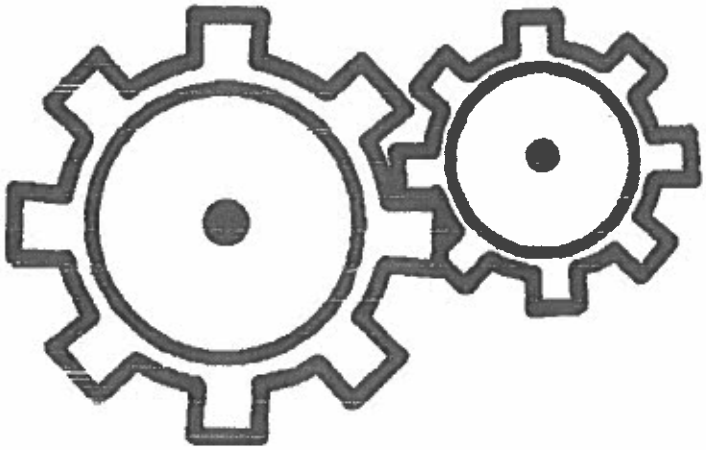
A screw is a simple machine that is like an inclined plane. It is an inclined plane that wraps around a shaft.

pulley



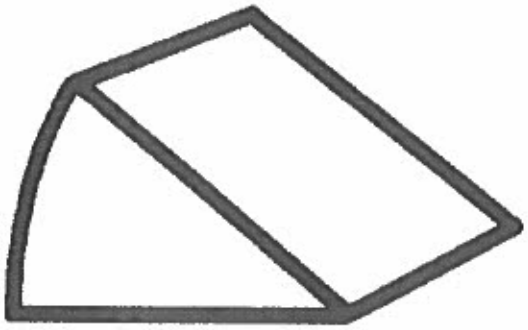
A pulley is a simple machine made with a rope, belt, or chain wrapped around a grooved wheel.

gears



A gear is a toothed wheel. Two gears can create motion.

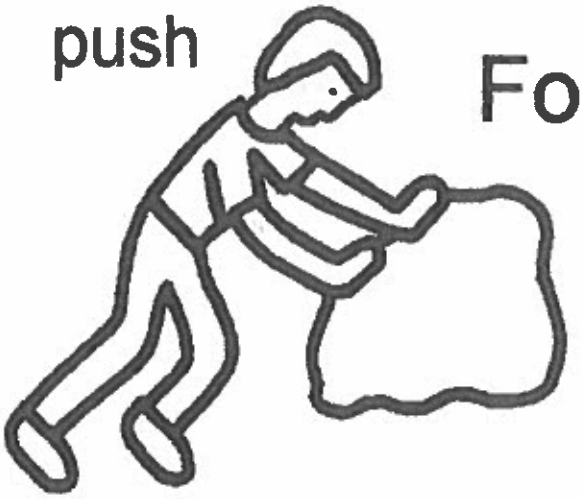
wedge



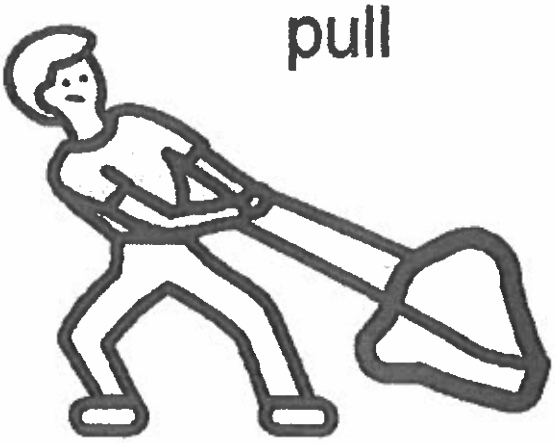
A wedge is a type of incline plane. It can move.

Force

push

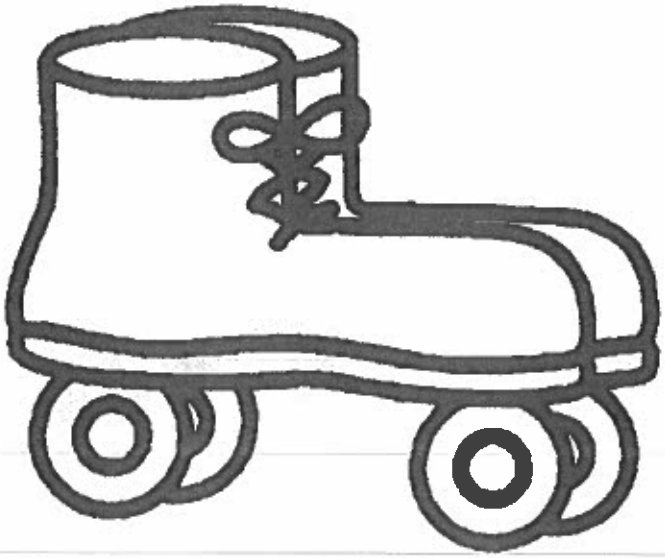


pull



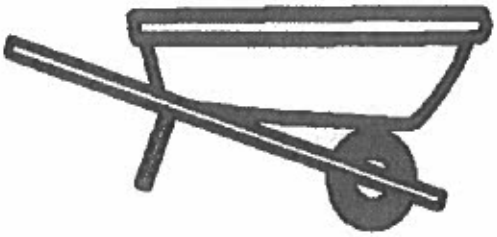
People use force to operate a simple machine. A simple machine needs energy to do work. By pushing or pulling, a person provide the energy for the machine to work.

Roller skates are an example of a wheel and axle.



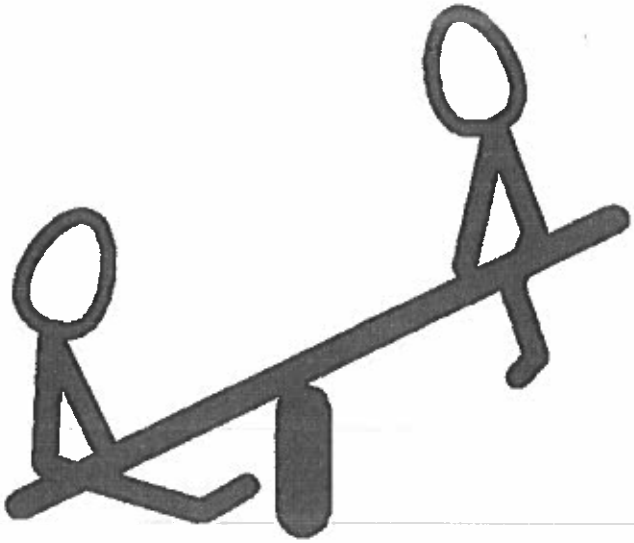
doorknob

wheelbarrow

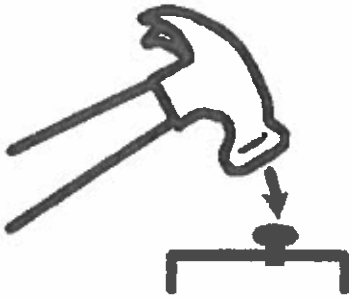


ramp

A teeter- totter is an example of a lever.

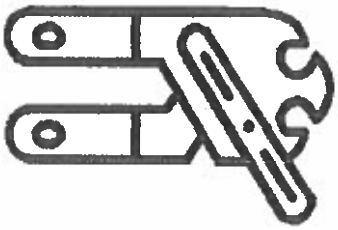


hammer



screwdriver

can opener



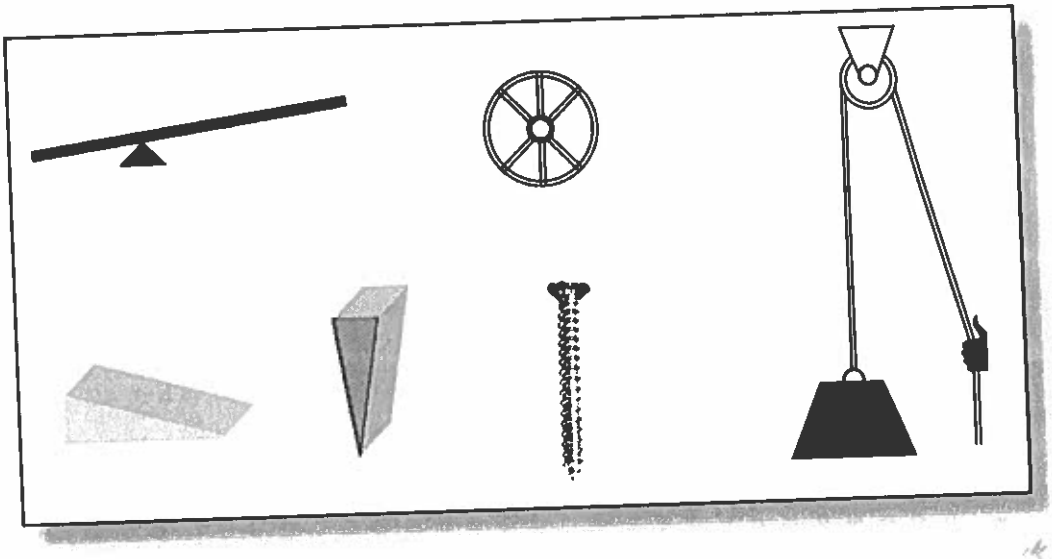
NAME: _____

Reading Passage

Gains and Losses with Simple Machines

We have studied all six simple machines: lever, wheel and axle, pulley, inclined plane, wedge, and screw.

We saw that the wheel and axle works much like a lever. A wheel and axle is sort of a spinning lever. We also saw that inclined planes, wedges, and screws are a lot alike. A wedge is a double inclined plane that moves and forces things apart. A screw is a long inclined plane wrapped round and round.



Simple machines can do three things to the force we apply when doing work. They can change the direction of force, they can make the force greater, and they can make the force less. Machines can also change the direction of motion and make it faster or slower. We use simple machines because we want one of these changes. We always pay for it with one of the other changes we don't want, but we decide it is a good trade for what we get.

Remember, simple machines don't change the amount of work; they just make it easier. We can raise a 200-pound rock by pushing down on a lever with a force of only 50 pounds. We pay for that gain by having to push down 4 feet to raise the rock 1 foot. Remember, work equals force times distance. The work we put in (4 X 50 = 200 foot-pounds) is the same as the work that gets done (1 X 200 = 200 foot-pounds). Still you win. Most people can't lift a 200-pound rock. So the lever gives you a way to do something you couldn't do without it.

STOP

How many foot-pounds of work do you do when you lift ten 5-pound bricks up three feet into the back of a truck?

_____

_____

Reading Passage NAME: _____

Gains and Losses with Simple Machines

Many kinds of levers are used to increase the speed of something by exerting a lot of force. When someone swings an axe to chop a log, they are using a lot of force at one end of a lever to increase the speed of the axe head at the other end. The axe head can hit a log so hard it splits in half.

With most simple machines the trade is like this:

This is what you gain: You put out a little force and something moves. The force you exert is less than the force it would take to move the thing without the machine.

This is what you lose: You have to exert the force for a longer time and over a longer distance.

So you exchange hard and quick for easy and slow.

You turn a wheel easily for a long distance, and the axle exerts a lot of force.

You give a long, easy pull on a rope and a set of pulleys raises a heavy weight.

You take a long easy stroll up an incline and move a few feet higher.

You pound an 8-inch wedge into a log, and a 1-inch crack appears in the log.

You twist a screwdriver handle many times, and a screw goes down into a board one inch.

You can do things with simple machines you couldn't do without them. It just takes a while.

NAME: _____

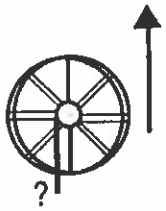
After You Read

Direction of Motion in Simple Machines

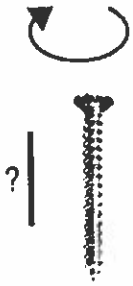
First-Class Lever

Second-Class Lever

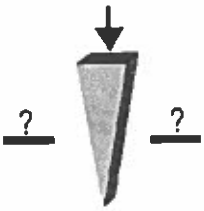
Third-Class Lever



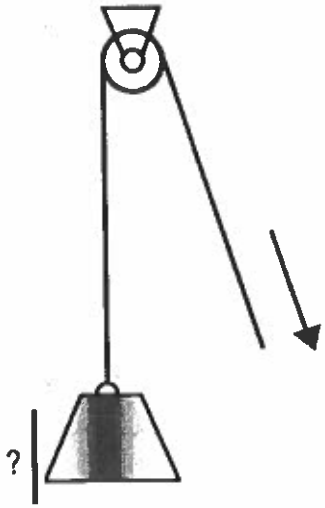
Wheel



Screw



Wedge



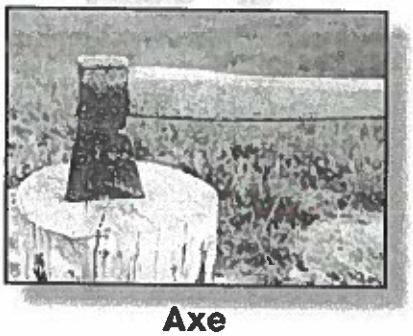
Pulley

NAME: _____

Reading Passage

Compound Machines

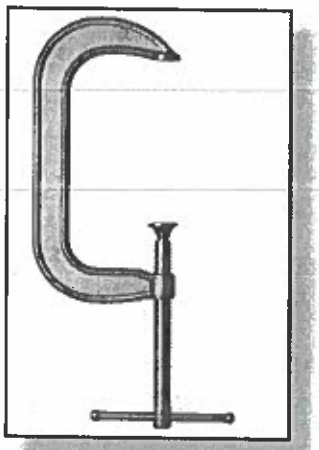
A compound machine is a machine that combines two or more simple machines to do one job. The things we usually call machines, like cars, have many simple machines working together in complicated ways. A bicycle is simpler than a car, but it is also made up of simple machines. The moving parts include several wheel and axles, levers, and pulleys.



Axe

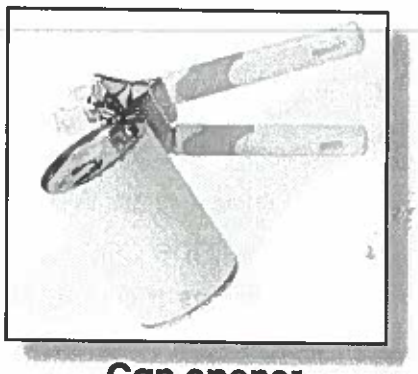
An axe is a compound machine.
The handle is a lever, and the head is a wedge.

Wire cutter



C-clamp

The wire cutter is a compound machine.
The handles are levers and the cutting edges are wedges.
The C-clamp is a combination of a lever and a screw.
The can opener combines three simple machines.
A wedge cuts into the can, the handles are levers that force the cutter down, and a wheel and axle moves the cutter around the edge of the can.



Can opener

The posthole digger shown below is a compound machine.

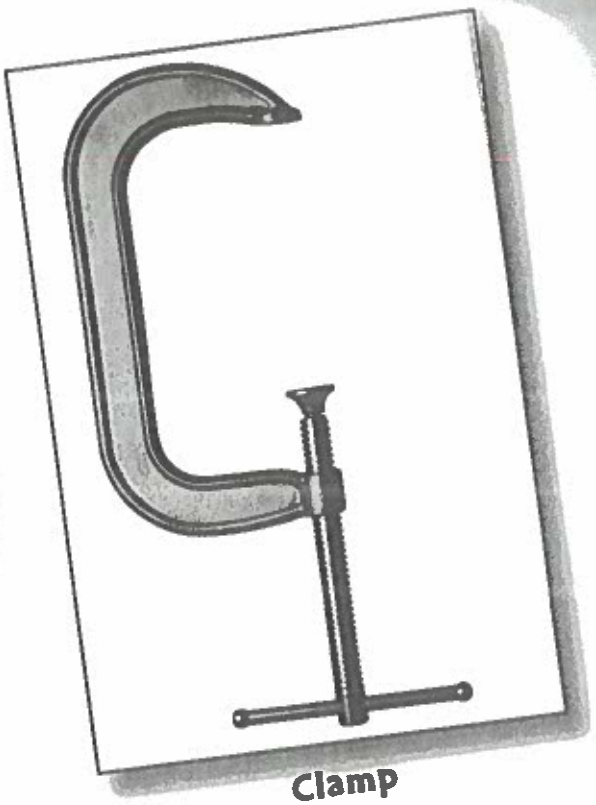
To dig a hole, you first push the blades into the ground. Then you pull the handles apart to grip the soil between the blades and pull up to get the soil out of the hole. Which two simple machines are parts of the posthole digger?

_____

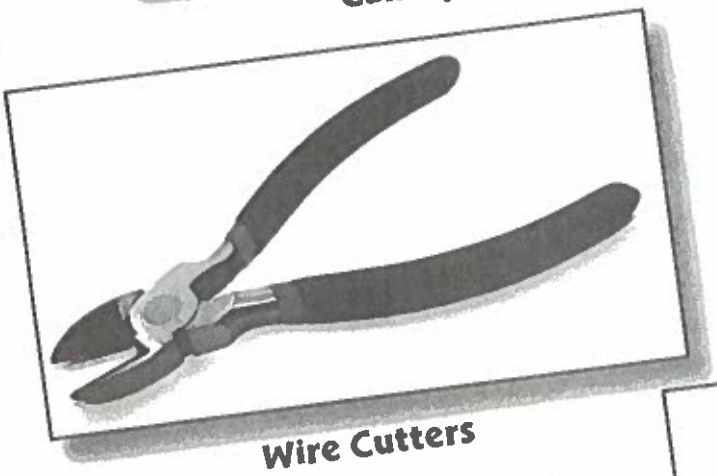
_____

Compound Machines

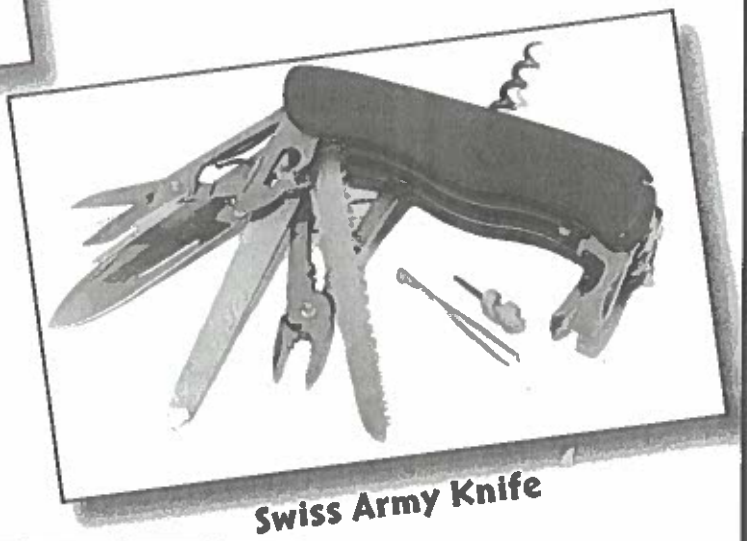
Can Opener



Clamp



Wire Cutters



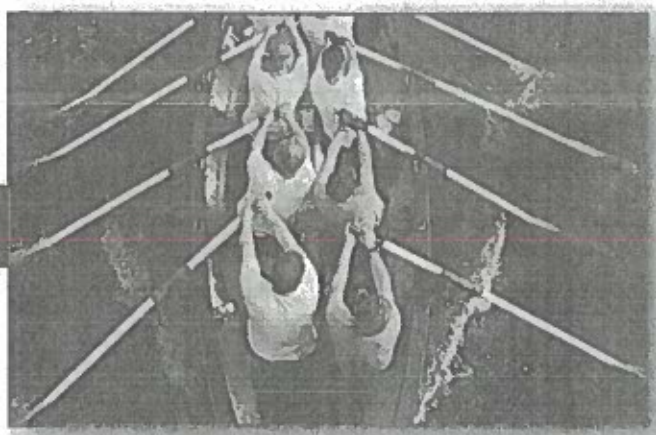
Swiss Army Knife

Bicycle - A Compound Machine

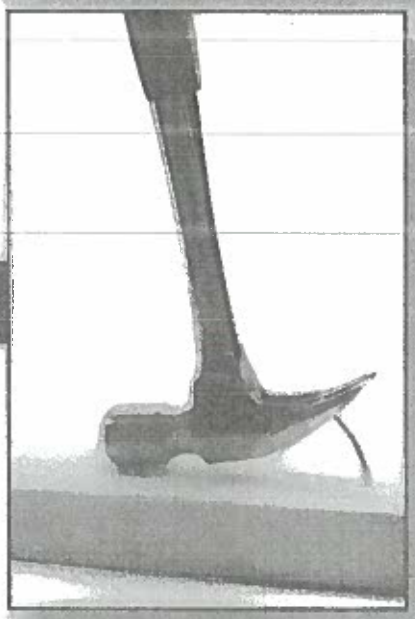
Mountain Bike

Levers

First-class lever



Second-class lever



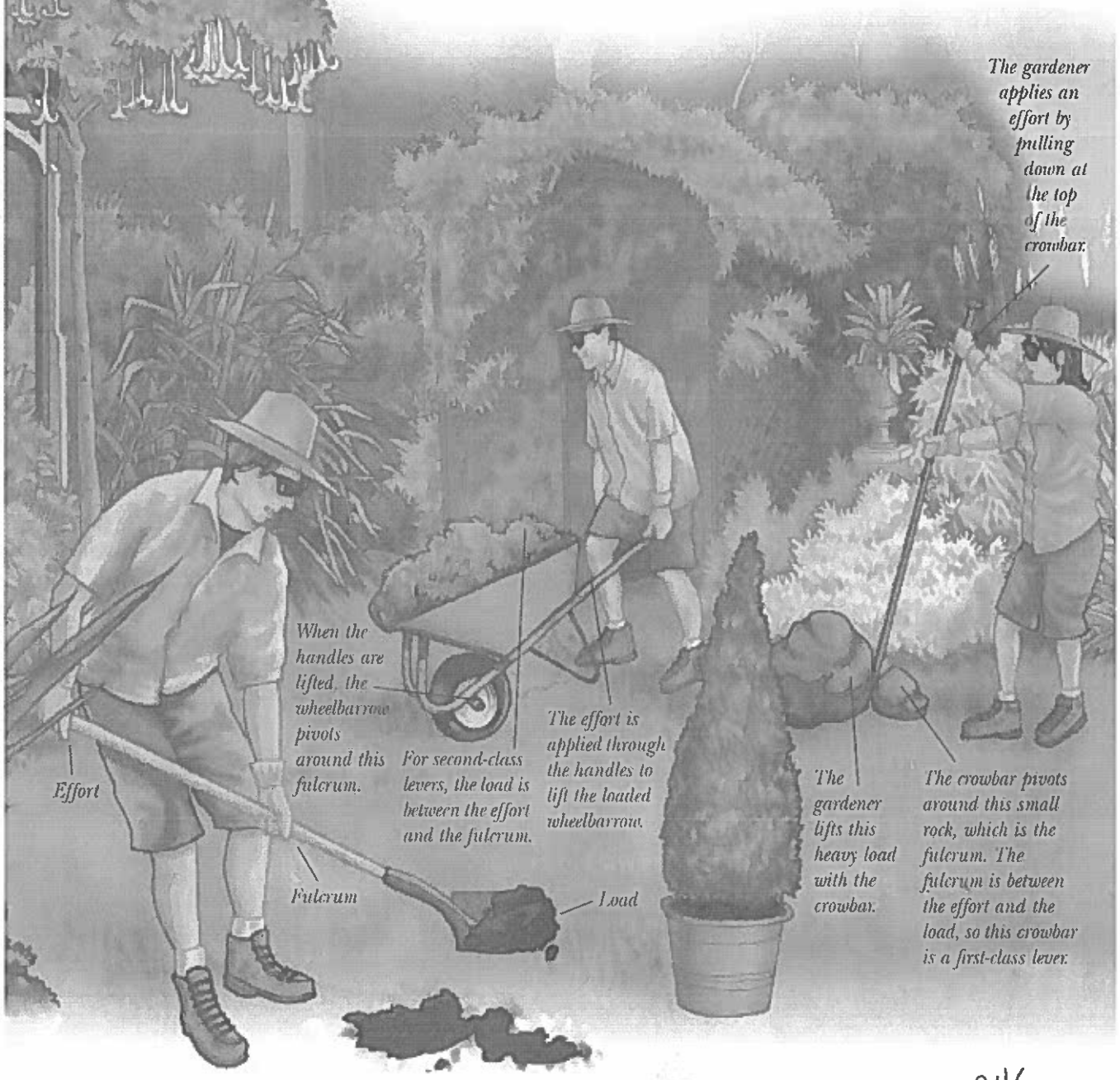
Third-class lever

In the garden

It would be difficult to move a pile of rocks from one end of the garden to the other by hand. It takes much less **effort** using a wheelbarrow. The effort you use is actually a **force**.

Sometimes, even your biggest effort isn't enough to move some very heavy objects. Moving objects can be made easier with simple machines. Simple machines can multiply your effort, change the direction of your effort or make things go faster.

One type of simple machine is the **lever**.



Using levers

A lever is usually a long, rigid object that moves around a turning point called a **fulcrum**. You need to put in an effort to make the lever move a **load**. Levers are named according to where the fulcrum, load and effort are positioned along the lever.

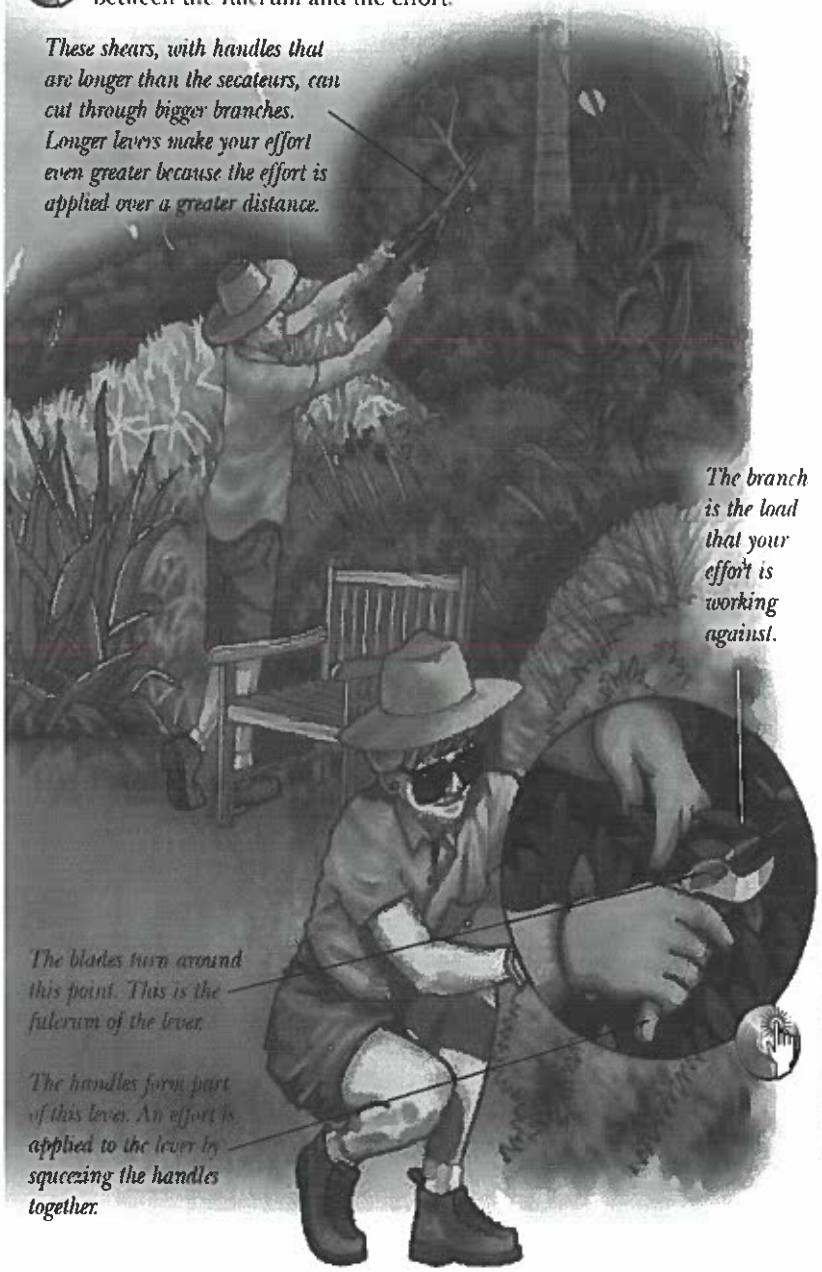
First-class levers

First-class levers, such as the shovel, secateurs and shears below, turn around a fulcrum that is between the effort and the load. All first-class levers are **force multipliers**. They magnify your effort. This means that you may be able to move loads that you couldn't move without the lever.

Second-class levers

Second-class levers are also force multipliers. They turn around a fulcrum that is at the end of the lever. For second-class levers, the load is always between the effort and the fulcrum.

The wheelbarrow is a second-class lever. It is used to move objects that would otherwise be too heavy to carry. The *load* in a wheelbarrow is between the fulcrum and the effort.



Activities

REMEMBER

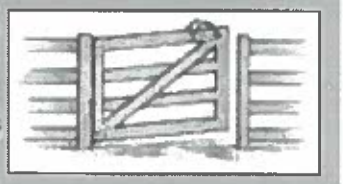
1. What do you call the force you apply to a lever to move an object?
2. Explain how a first-class lever is different from a second-class lever.
3. Why are first- and second-class levers called force multipliers?

THINK

4. Two wheelbarrows are identical, except for the length of their handles. Which would you prefer to use? Why?
5. Sketch and label the effort, fulcrum and load in each of the following diagrams. State whether each is a first- or second-class lever.

(a)

(b)



(c)

✓ checklist

I can:

- ☐ compare first- and second-class levers
- ☐ identify the effort, fulcrum and load in a lever system.

Living levers

The long bones in our arms and legs act as **levers**.

Our joints form fulcrums and our muscles apply a **force** to the bones to make them work. Many of the levers in our bodies are **third-class levers**.

Third-class levers are those in which the effort is between the fulcrum and the load. All third-class levers are **speed multipliers**. A big effort needs to be applied, but the load moves over a greater distance, at a higher speed.

Some sports make use of more than one type of simple machine. Woodchopping uses the arm and axe together as a third-class lever. The axe blade strikes the wood block at a high speed. The blade itself is another simple machine called a **wedge**. A wedge pushes objects apart. In this case, the axe blade splits the piece of wood into two parts.

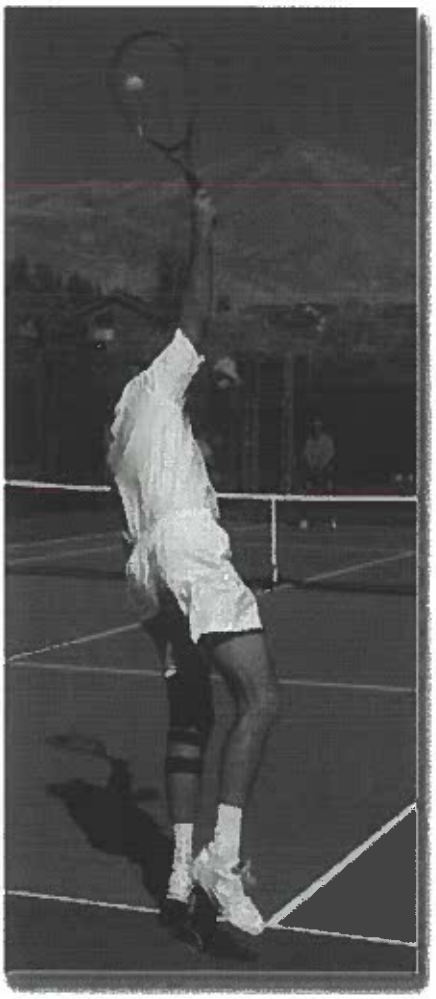
The leg below is acting as a third-class lever. The effort is between the fulcrum and the load.

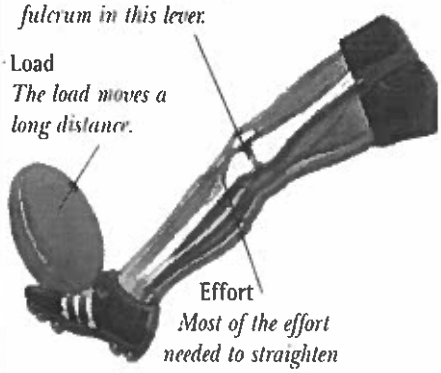
Levers in sport

In sport, levers are usually used to increase the speed of a load and the distance over which it travels. Tennis racquets, cricket bats and softball bats are all third-class levers. They are used to make objects move faster and further.

The longer the distance between the load and the effort, the faster the load will move. Tennis players reach up high when they serve. This way, the lever formed by the arm and the racquet is much longer.

A fast serve can measure over 200 km/h. Greg Rusedski has served at a speed of 239.8 km/h. Mark Philippoussis has served up to 226.9 km/h.



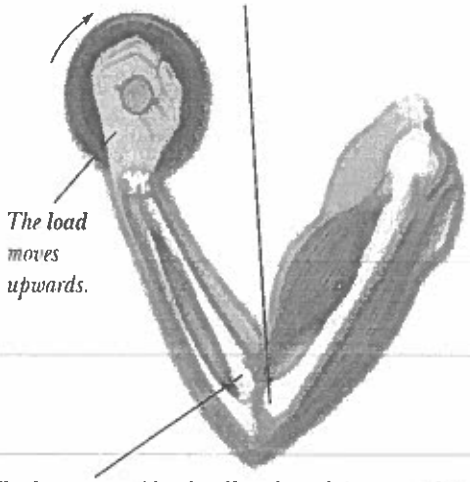


Different classes of lever in the arm

Bending and straightening the arm uses two different classes of levers.

Bending the arm

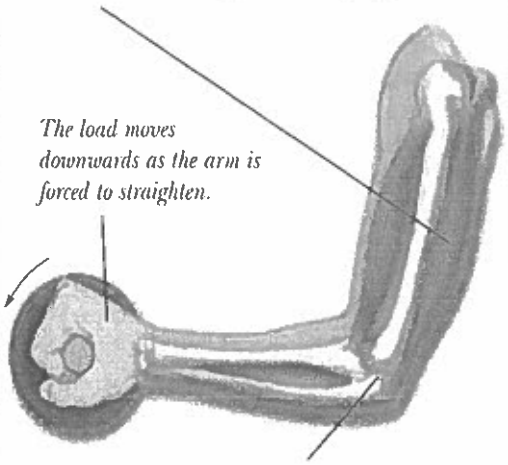
*The elbow is the **fulcrum** because it forms the pivot point for the movement of the arm.*



*The forearm provides the **effort** through its connection to the biceps muscle below the elbow. Therefore, the effort is between the fulcrum and the load, making the forearm into a third-class lever.*

Straightening the arm

This muscle is called the triceps muscle. It provides the effort used to straighten the arm. You use your triceps muscle when you push a heavy load down. The triceps are also used to shoot goals in basketball and netball.



*The triceps muscle attaches to the elbow, which is the fulcrum. The fulcrum is between the effort and the load, so your forearm acts as a **first-class lever**.*

Activities

REMEMBER

1. Explain how third-class levers are different from first- and second-class levers.
2. (a) Label the effort, fulcrum and load along the fishing rod.
   (b) What class of lever does the fishing rod act as?

THINK

Some sports, like rowing, do not rely on speed alone. It is very difficult to move through water, so a force multiplier is needed to help the rowers.

3. (a) What class of lever do these oars form?
   (b) What other sports use force-multiplying levers?
4. Do you think that humans are built for speed or for strength? Explain your answer.

INVESTIGATE

5. Choose a sport not already mentioned on this page.
   (a) Explain how levers are used in this sport.
   (b) What classes of levers are used?
   (c) Why are these types of levers used?
   (d) Draw a labelled diagram to show how the levers are used in your chosen sport.

✓ checklist

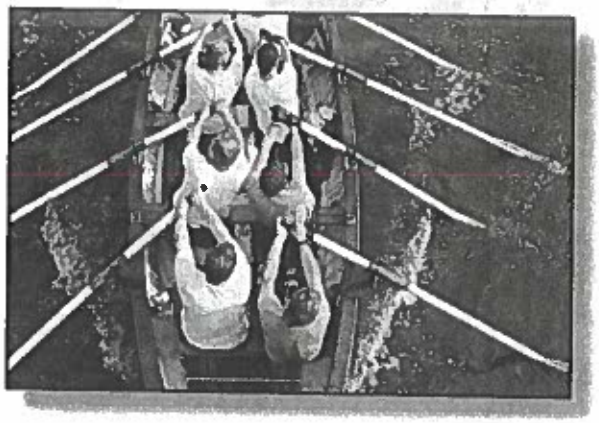
I can:
- ☐ distinguish between speed-multiplying levers and force-multiplying levers
- ☐ explain how levers are used in a variety of sports.

NAME: _____

Reading Passage

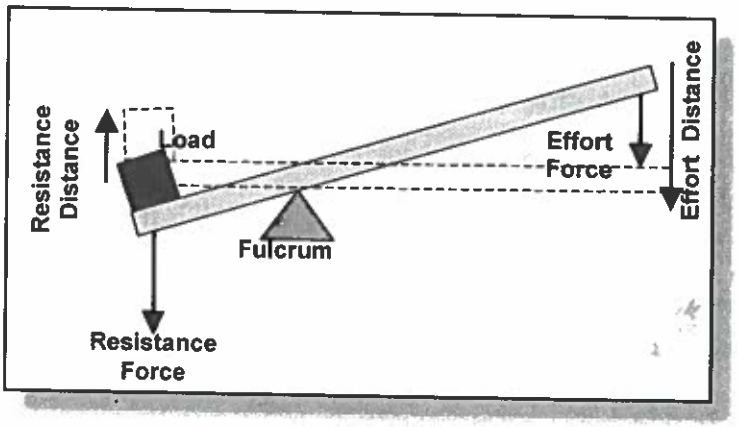
Levers

The lever was probably the first simple machine used by humans many thousands of years ago. The first person to whack something with a club was using a lever.



Oars are First-Class Levers

The picture shows the two parts of every lever. For every lever, a board or rod **pivots** on a point called a **fulcrum**. The force you apply is called the **effort force**. The lever changes the direction and amount of force and applies it to a load. The force the lever applies is called the **resistance force**. The distance you have to push or pull the lever is called the **effort distance**. The distance the load moves is called the **resistance distance**.



A First-Class Levers

For the oars shown above, the pivot at the edge of the boat (the oarlock) is the fulcrum. The effort force is applied to the oar handle. As the handle moves through the effort distance, it applies the resistance force to the end in the water. The distance the oar moves through the water is the resistance distance.

There are three kinds of levers because there are three ways to arrange the effort, fulcrum, and load. The oar is a **first-class lever,** where the arrangement is effort-fulcrum-load. Other first-class levers are pliers, scissors, and that little tab you pull to open a can of soft drink.

STOP

What are the two parts of every lever?

_____

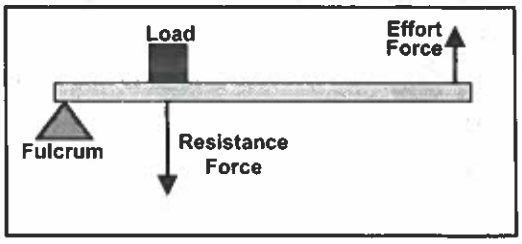
_____

Reading Passage NAME: _____

Levers

A **second-class lever** is shown below.

For a second-class lever, the arrangement is effort-load-fulcrum. Some other second-class levers are a wheel barrow and a nutcracker. The classes are just names. It doesn't mean that first-class levers are the best. The third-class lever shown below is just as classy as the others.

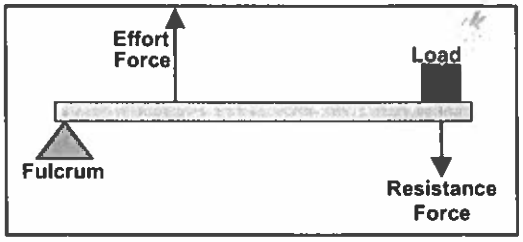


Second-Class Lever

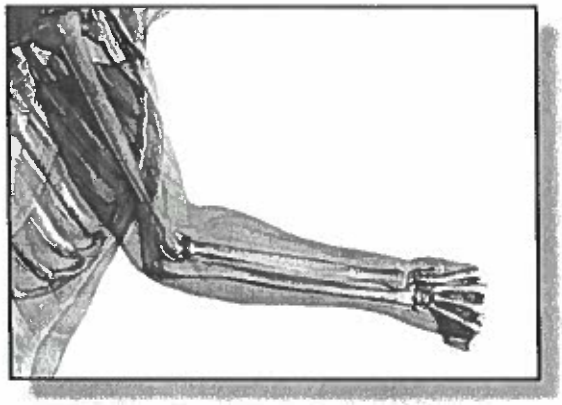
For the hammer, the resistance is at the head, and the fulcrum is the back of the hand. Many other **third-class levers** are used to make the resistance force push over a long distance at a high speed. The effort force is large and moves over a shorter distance. This is also how tennis rackets, baseball bats, and brooms work as third-class levers.

A Bottle Opener is a Second-Class Lever

Can you find another lever in the picture of the hammer? The human forearm is a lever. The elbow is the fulcrum. When the hammer comes down, the muscle behind the elbow pulls up. Then it is a first-class lever. When the hammer is lifted up, the muscle in front of the elbow pulls up. Then it is a third-class lever.



Third-Class Lever



The Forearm is a First-Class Lever and a Third-Class Lever

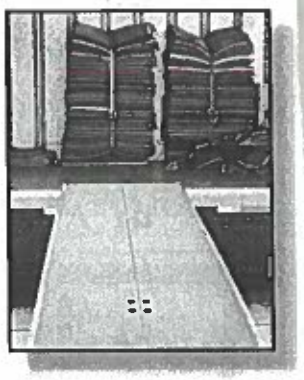
A Hammer is a Third-Class Lever

Reading Passage NAME: _____

Inclined Planes, Wedges, and Screws

Inclined Planes

An inclined plane is just a slope. It has no moving parts, but it is still called a machine. The pictures show two inclined planes.



Loading Ramp

One picture shows a loading ramp going into the back of a truck. It is easier to carry a heavy load up the slope than it is to lift it into the truck. It takes longer, but it takes less force. That's how it is with inclined planes. The more gentle the slope, the less effort it takes and the more time it takes.

The Road to Machu Picchu

The other picture shows the road to the ancient ruins of Machu Picchu. It's the slow, easy way to the top. Which would you rather do: walk for hours up the inclined plane of the road or climb straight up the hill?

Wheelchair ramps are inclined planes. Any sloping highway or sidewalk is also an inclined plane.

The Basic Wedge Shape

Wedges

A wedge is a simple machine that is a lot like an inclined plane. A wedge is just two inclined planes put together. When you use this machine, the inclined planes move past something instead of moving the thing up a slope.

On the left is the basic shape of a wedge, which is (guess what...) wedge-shaped. Other common wedges are axes, knives, and the point of a nail.

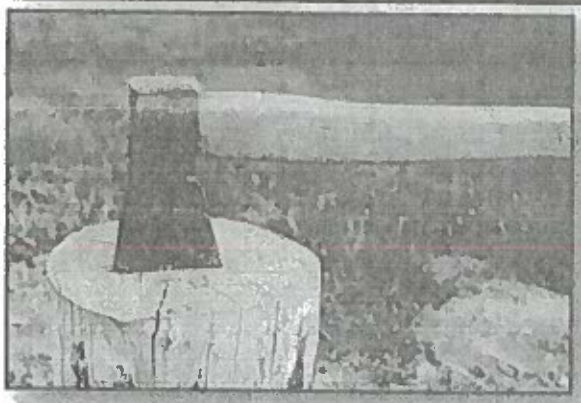
STOP

How would you use an inclined plane to increase speed?

_____

_____

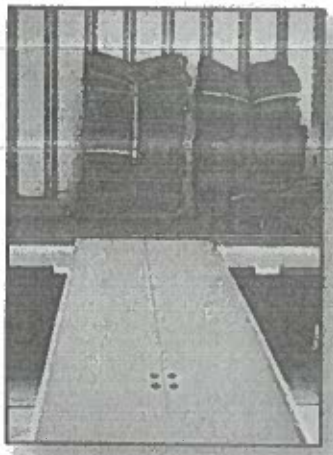
Inclined Planes & Wedges



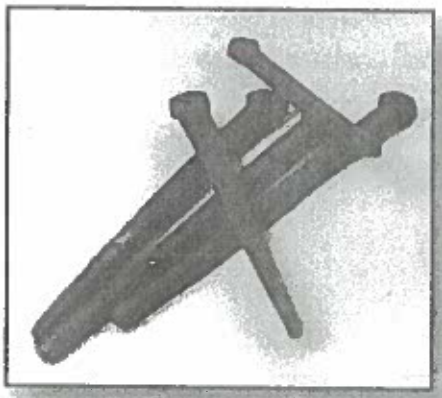
Axe - Wedge

Ramp - Incline Plane

Knife - Wedge



Inclined Plane



Spike - Wedge

Road - Incline Plane

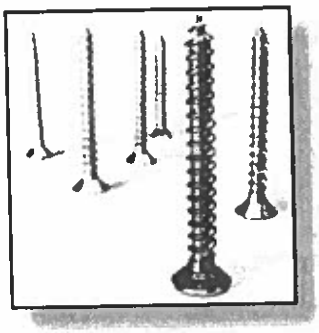
NAME: _____

Reading Passage

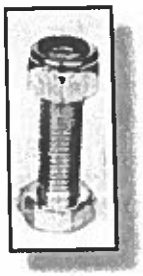
Inclined Planes, Wedges, and Screws

Screws

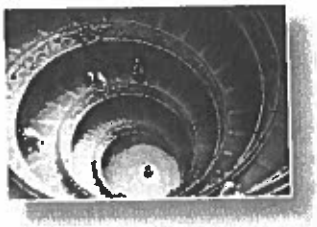
A screw is also a kind of inclined plane. Several kinds of screws are shown below.



Wood Screw



Bolt and Nut



Spiral Staircase

Three Kinds of Screws

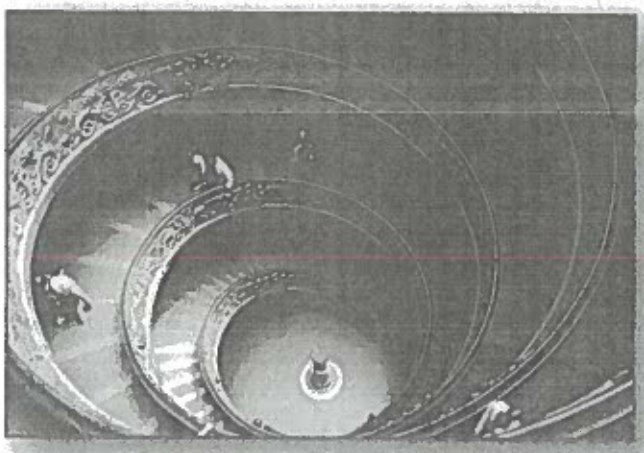
A screw has a groove wound around it the way stripes are wound around a candy cane. The groove is called a **thread.** If you follow one of the grooves, you will find it is one long groove moving from one end to the other. If you could unwind that groove and straighten it out, you would see that it is really one long inclined plane. It's just that this incline has been wrapped around something.

Screws and bolts have this kind of groove. Metal nuts have the same groove on the inside. You couldn't push a screw into wood. With the help of a screwdriver, the thread pulls the screw into the wood as you twist it.

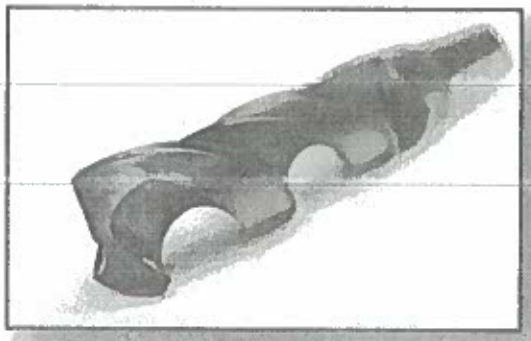
The spiral staircase shown above is also a screw. In this case, it's easy to see that a screw is really an inclined plane going up and around in circles. With a wood screw, the screw moves when you use it. With a spiral staircase, the screw sits still, and you move.

Screws

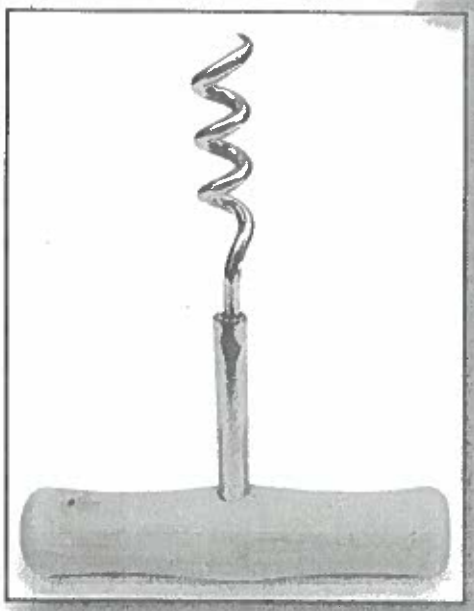
Bolt



Spiral Staircase



Drill Bit

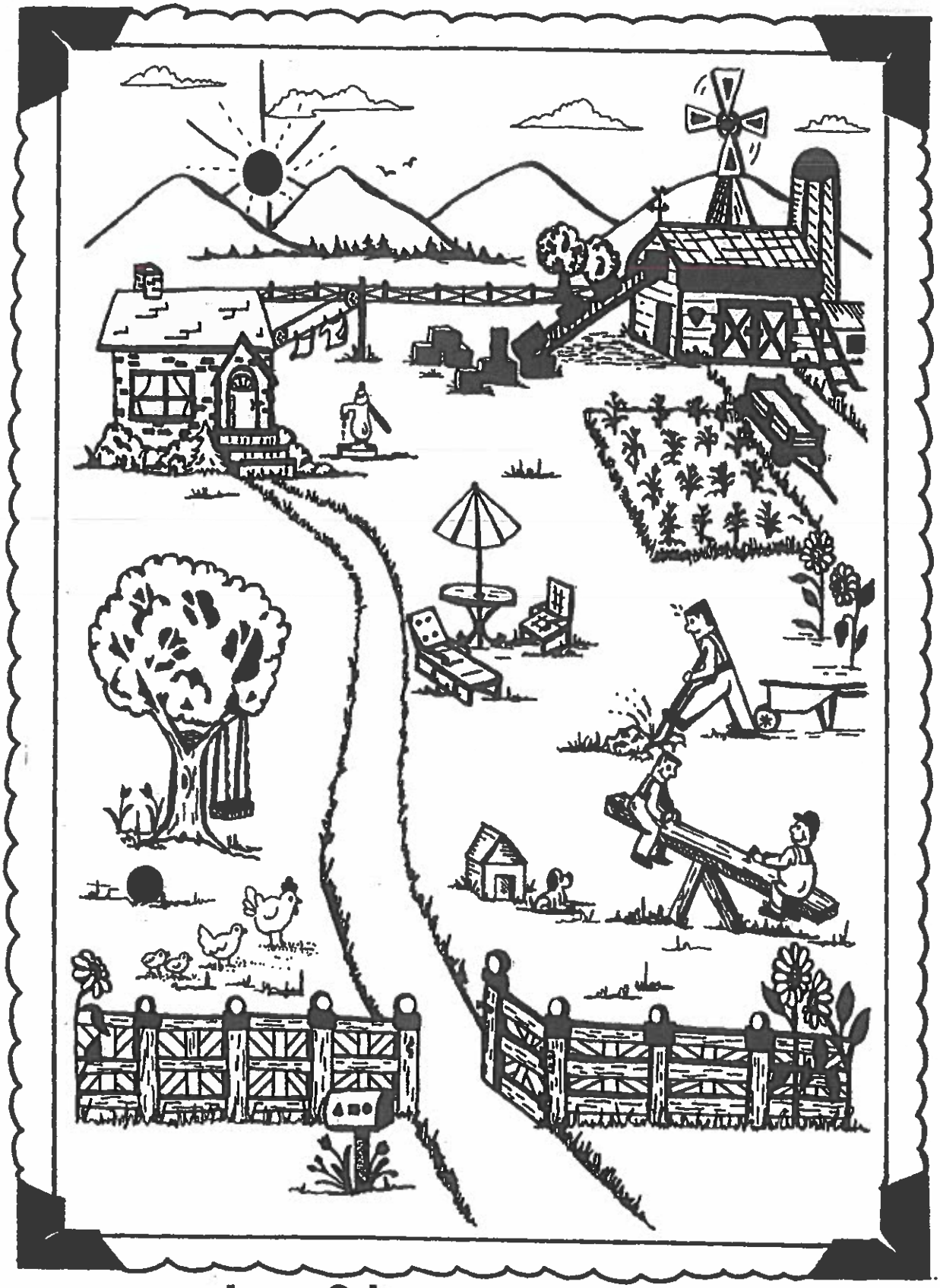


Cork screw

Screw

Science and Technology Dictionary

Structures, Mechanisms and Motion

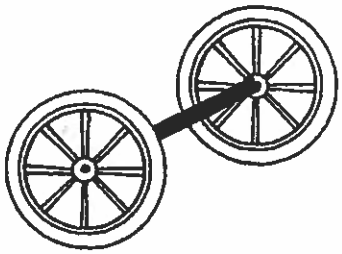


Structures, Mechanisms and Motion

in Shapeville

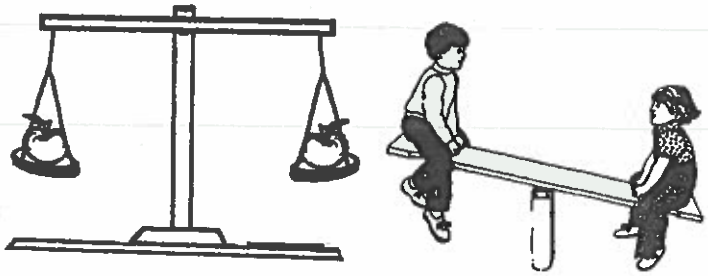
Science and Technology Dictionary

axle - a bar or rod on which or with which a wheel turns



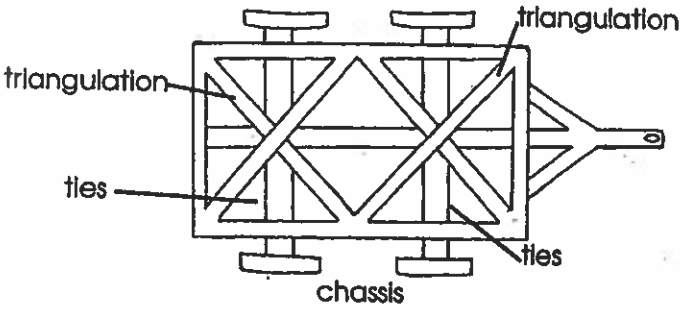
The back axle on Mr. Shape's wagon broke.

balance - to be equal in mass, effort, force, etc., - to make or keep steady



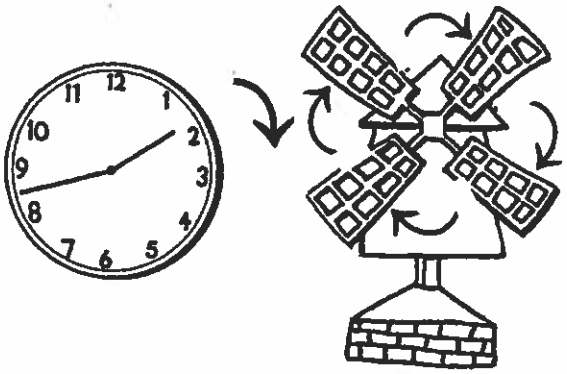
"Balance the teeter-totter," said Little Shape.

chassis - the frame and wheels of a vehicle such as a wagon, but not the box or body



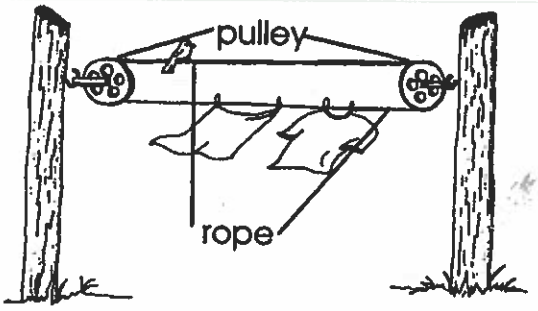
The Shape's wagon has a strong chassis.

clockwise - to rotate or turn in the same direction as the hands on a clock



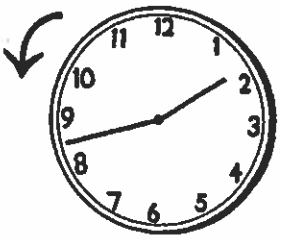
The windmill is turning clockwise.

components - parts
- a machine has different components



The pulley has two components: a grooved wheel and a hub.

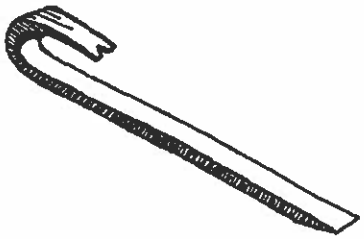
counter-clockwise - to rotate or turn in the opposite direction to the hands of the clock



The wheel on the wheelbarrow turns in a counter-clockwise direction when it is moved backwards

Science and Technology Dictionary

crowbar- a bar made of iron or steel that is used as a lever

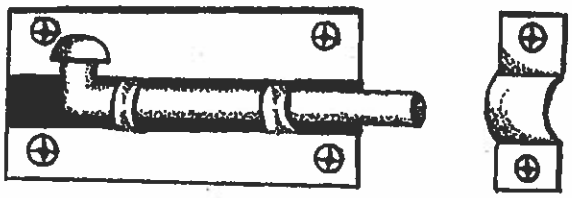


"This crowbar is a good lever to move the rock," said Father Shape.
A lever is a simple machine.

effort - to use strength or energy to do something

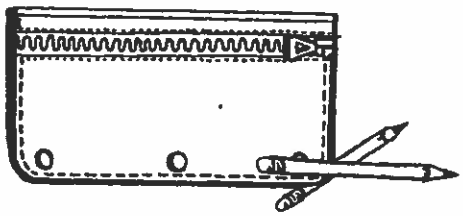
"It takes effort to pull in a line of clothes," said Little Shape.
"The pulleys make it easier," said mother.

fastener - a device such as a latch, button or zipper to fasten, hook etc.,



"I'll latch the gate," said Little Shape.

I use buttons to fasten my coat.

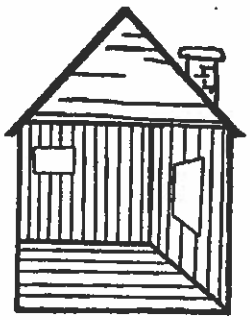


There is a zipper on my pencil case to fasten it.

force - power or strength or energy that causes change

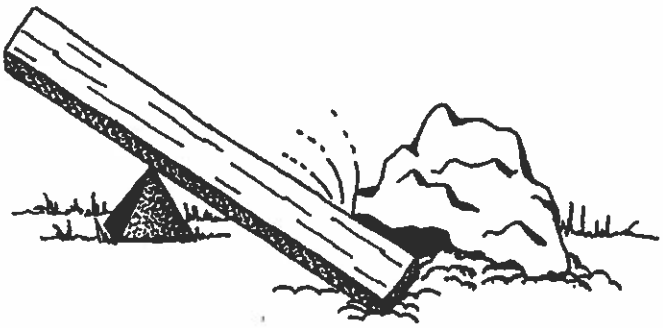
The force of the wind blew down the tree.
It takes less force to lift a rock with a crowbar because the crowbar is a lever.

frame - a support or structure over which something is built



The frame will support the building.

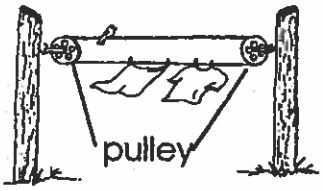
fulcrum - a support on which a lever turns or rests



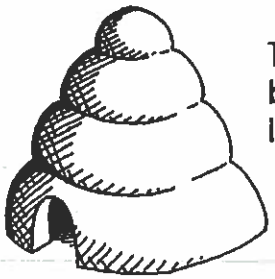
"The bar is coming off the fulcrum," shouted Mr. Shape.

Science and Technology Dictionary

function - the use or work of something such as a structure or machine - the work something does



What is the function of the pulley?

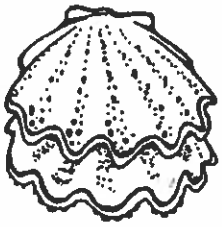


The beehive is the bees' home. That is its function.

handsaw - a small saw which can be used with one hand

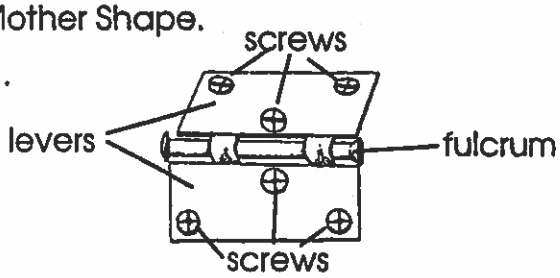
Use the handsaw to cut the board for the fence.

hinge - a mechanism on which a gate, door, lid etc., swings

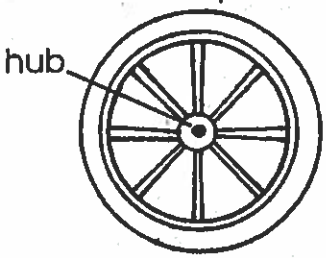


There are natural hinges on mussels and clams.

"The hinge on the door is broken," said Mother Shape.



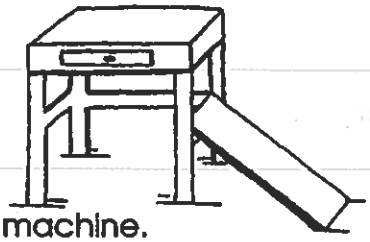
hub - the centre part of a wheel



He put grease on the hub so the wheel would run smoothly.

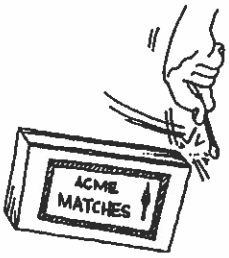
inclined plane - a flat level surface that helps to move large and heavy loads.
Example: ramps, roads, a dolly

I used the ramp to help make it easier to move the lumber fro the wagon.



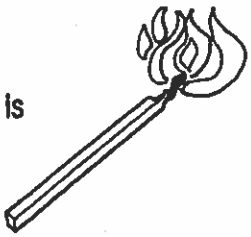
An inclined plane is a lever and is a simple machine.

input - an action to set a system working



The input is when you scratch a match to light it.

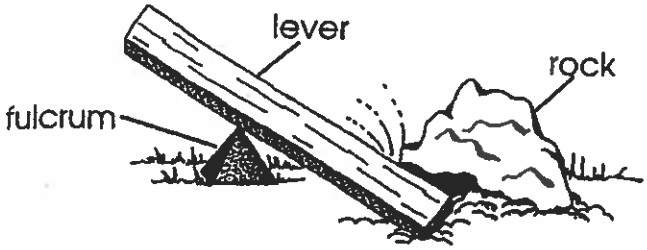
The output or result is the flame.



investigate - to search, to look for, to examine, to ask reasons for something

The Shape children are investigating how a pulley works.

lever - a bar that is used to lift or move weight - it rests or turns on a fulcrum - it is pushed down at one end to raise or move a weight at the other end



Little Shape saw her father move a rock with a lever.

load - weight that is moved or supported by a person, structure or machine

The Shape family put a load of small rocks into the wheelbarrow.

machine - a structure made of fixed parts and/or parts that move
- each part has a job

Levers and wheels and axles are simple machines.

machinist - a person who fixes or repairs or runs a machine

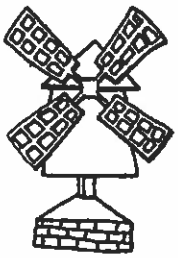
The Shape family needed a machinist to fix the axle holder.

mechanism - a mechanism is made up of simple machines that work together to cause movement

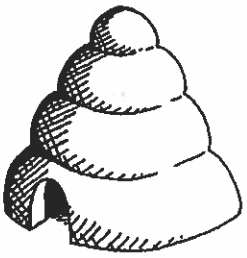
The hinge on the gate is a mechanism.

motion - moving

The windmill at the Shapes is in motion.



natural (natural structures) - not made by people - found in nature



"I did not make the bird's nest and beehive," said Mr. Shape

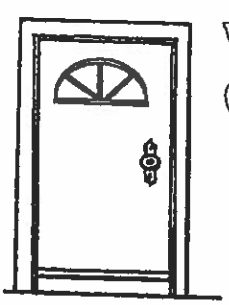
observation - to watch, to look for a special reason

Mrs. Shape's observation helped her to explain how a lever works.

output - a response which is caused by input

- input or action sets a system to work and a single output is the response of that action

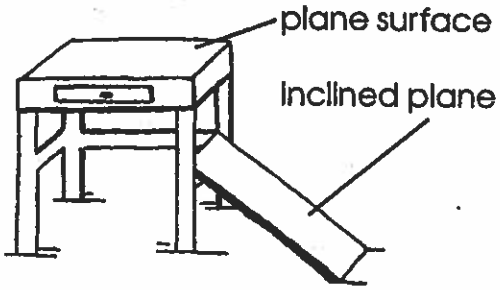
A match is lit (input). The flame is the output.



A doorbell is pushed to set the system in operation. The bells ring and that is the output or response.

Science and Technology Dictionary

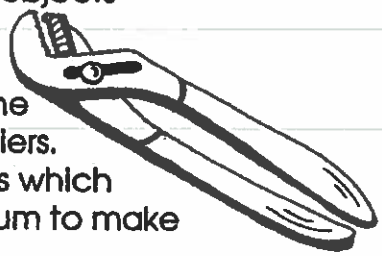
plane - a flat level surface



The top of the table is a plane surface.

A ramp is an inclined plane.

pliers - pincers which are small, used for bending such things as wire or for gripping small objects

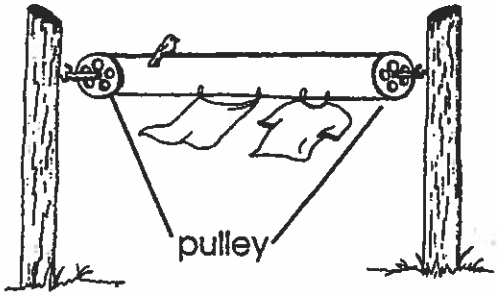


. I will remove the nail with the pliers. Pliers are levers which turn on a fulcrum to make work easier.

predict - to tell or see or believe what will happen before it takes place

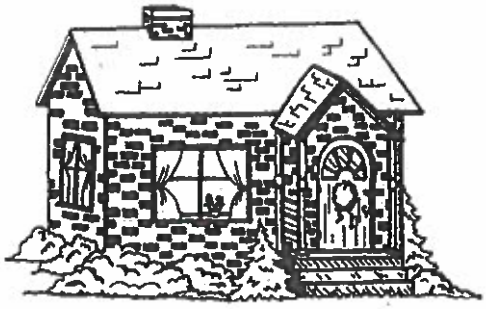
"I predict that the wheel will break because the load is too heavy," said Mr. Shape.

pulley - a small wheel which has a grooved rim and a hub
- a rope, wire, belt, string, etc., runs on the groove to move or raise a weight



A pulley is a circular lever that is a simple machine.

rigid - strong, stiff, firm, not bending

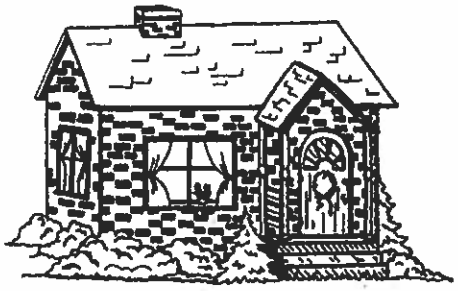


The house is a rigid structure.

shell - a structure that is rounded or dome shaped.

That tent is a shell structure.

solid - very firm and strong



Our house is solid.

solution - to solve a problem

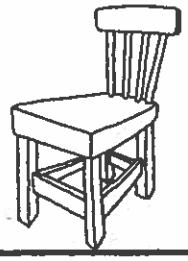
Little Shape found a solution to the problem.

solve - to find the answer to a problem

"This rod will fix the wheel and solve the problem," said Mrs. Shape.

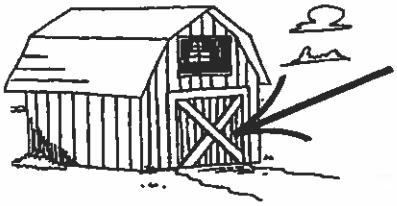
Science and Technology Dictionary

stable - that which is steady, strong, firm, etc.,



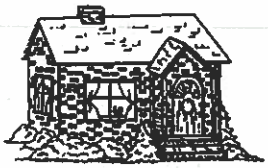
Mr. Shape made stable furniture.

stabilize - to make stable



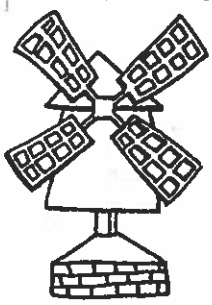
Triangulation will stabilize the door.

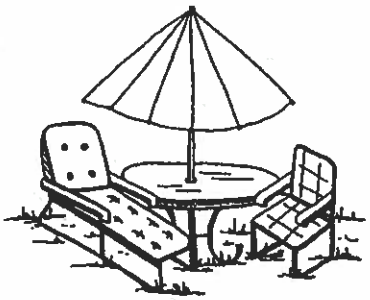
stationary - not moveable



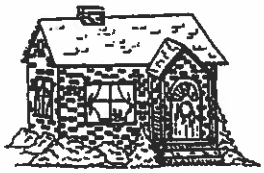
The house is a stationary structure.

structure - anything that is made of parts that are put together to make a whole





The windmill and chairs are structures which were made by the Shape family.

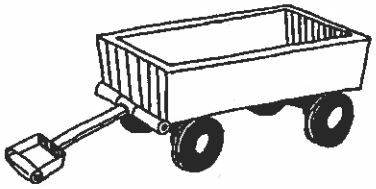


The house, bird's nest and beehive are also structures.

utensils - containers such as pots, pans and kettles which are used for cooking and baking

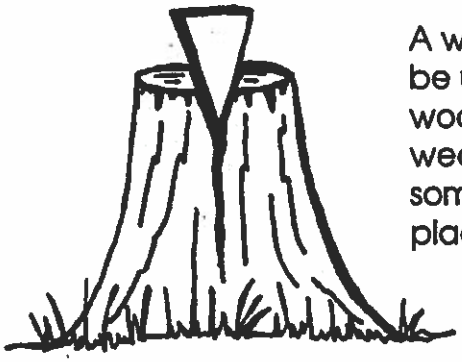
We need to get utensils for baking.

vehicles - a structure such as a wagon, car, buggy, wheelbarrow or sled which is used for carrying people or things



That wagon is a useful vehicle. It makes it easier to move a load.

wedge - a piece of wood or metal which has a tapered or thin edge

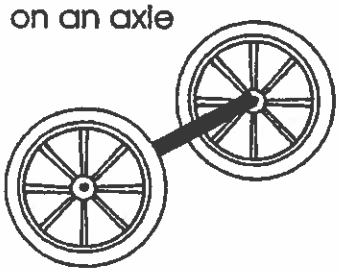


A wedge can be used to split wood or to wedge something in place.

A wedge is a simple machine.

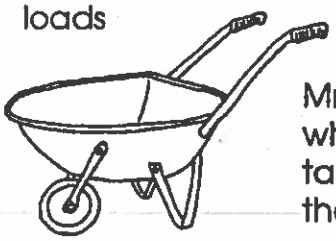
Science and Technology Dictionary

wheel - a circular shaped frame which turns on an axle



The set of wheels and axle is a simple machine.

wheelbarrow - an open box or frame with a wheel at one end and two handles at the other end - used for carrying light loads



Mr. Shape used the wheelbarrow to take the potatoes to the barn.

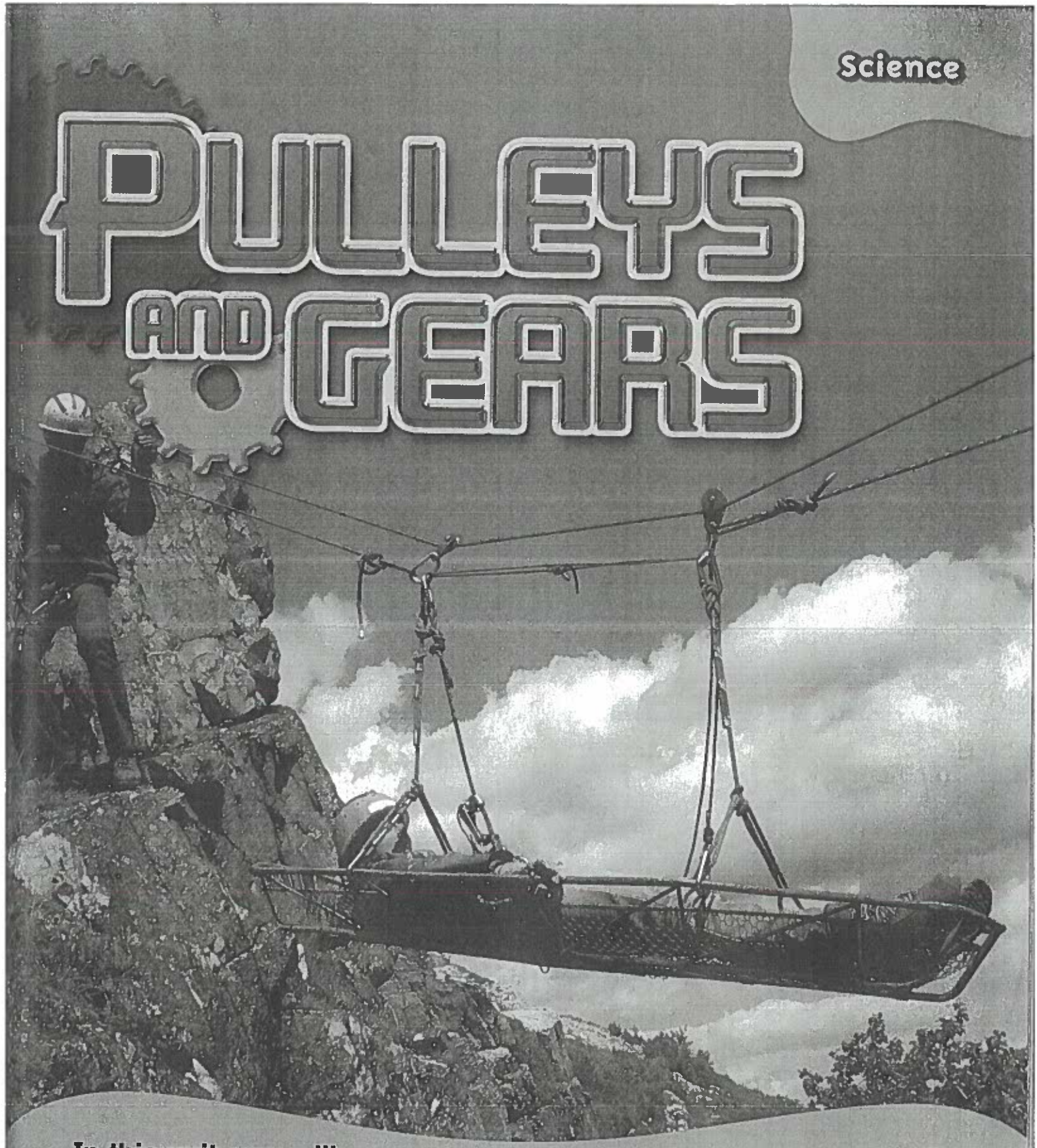
The wheel and axle on the wheelbarrow is a simple machine

zigzag - to move from one side to another with quick sharp turns

She made a zigzag pattern.

Science

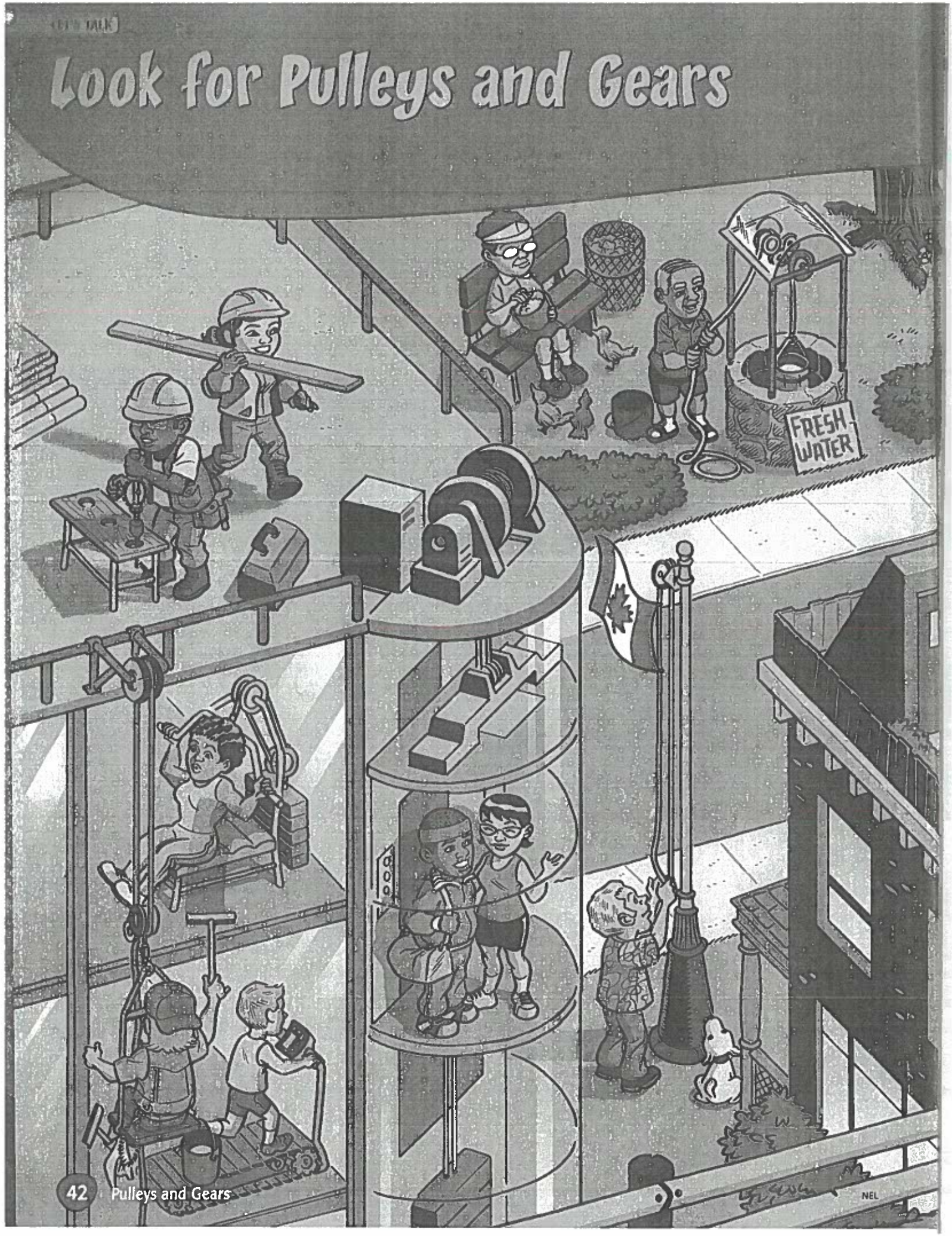
PULLEYS AND GEARS



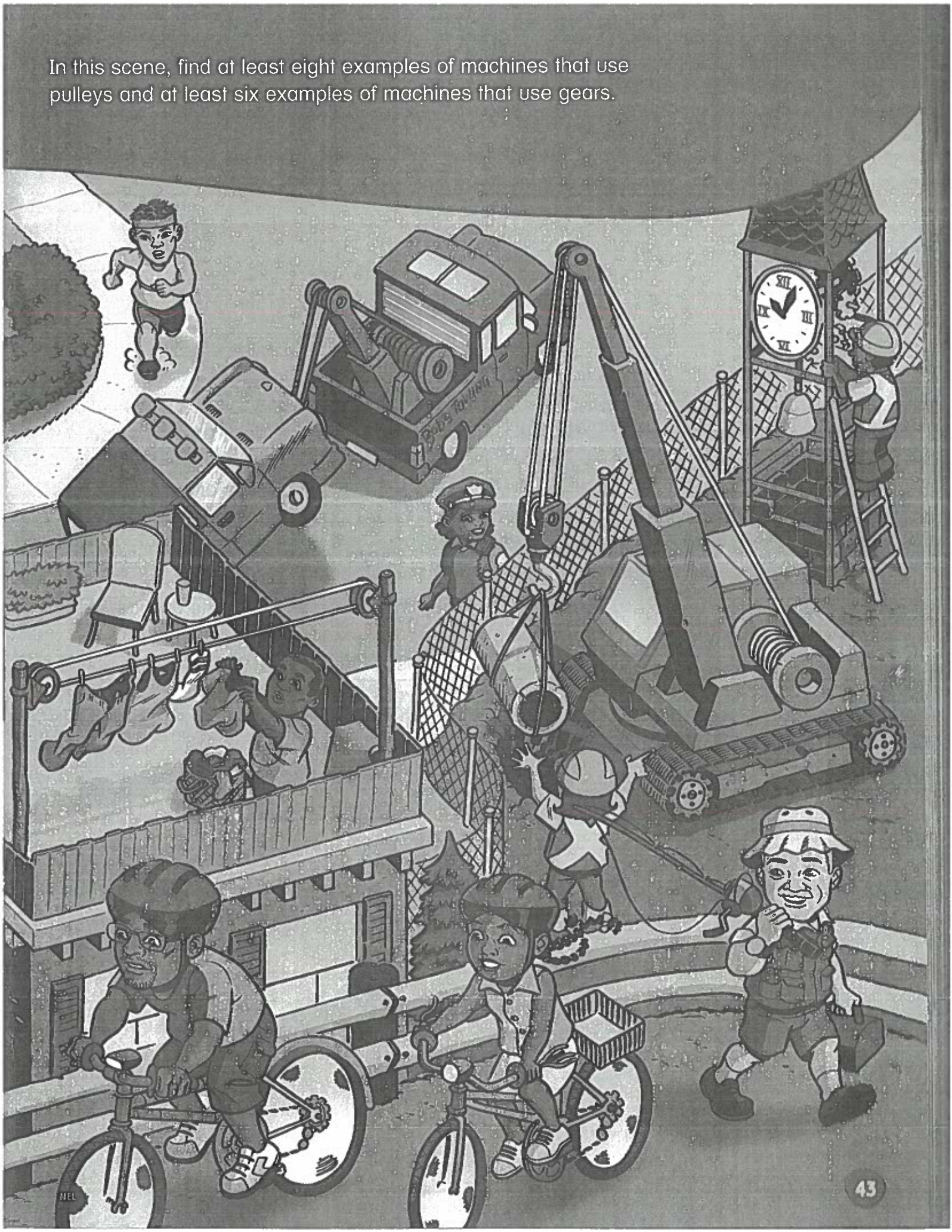
In this unit, you will

- make inferences
- read labelled diagrams
- identify conventions of photos in print media
- vary sentence beginnings in your writing
- learn about pulleys and gears

Look for Pulleys and Gears



In this scene, find at least eight examples of machines that use pulleys and at least six examples of machines that use gears.



Understanding reading strategies

Making Inferences

Making inferences helps you get more out of your reading than just the facts written on the page. When you make inferences, you draw conclusions by combining what you already know with new information and clues the writer gives you.

WHAT ARE PULLEYS AND GEARS?

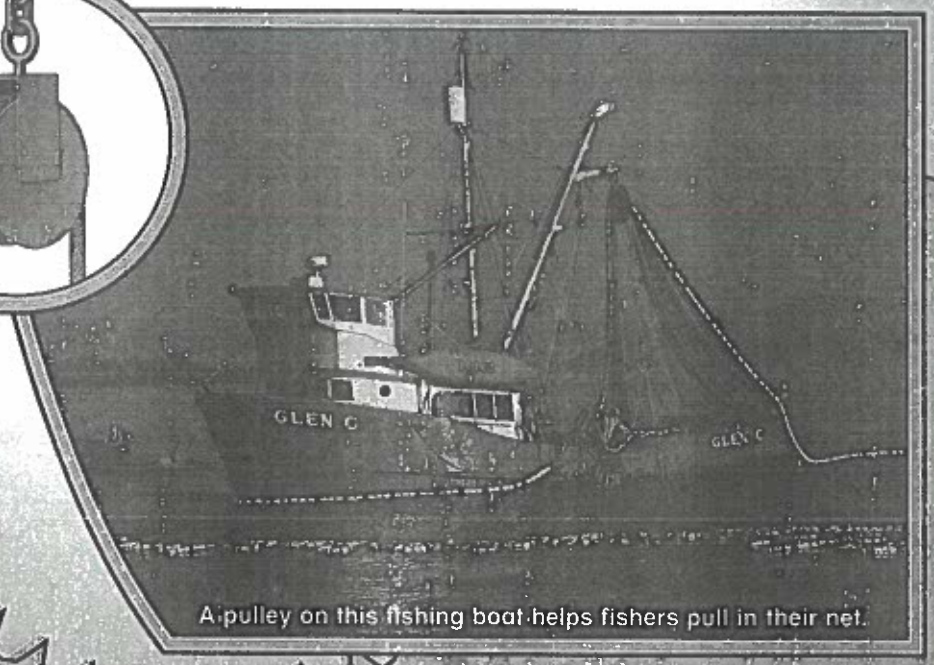
Written by Angela Royston
Illustrated by Dave Mazierski

Pulleys and gears are special kinds of wheels. A wheel is a simple machine that lets you use a small force to produce a big result. For example, wheels are often used to make it easier to move things. Pulleys and gears are wheels that make it easier to lift heavy loads.

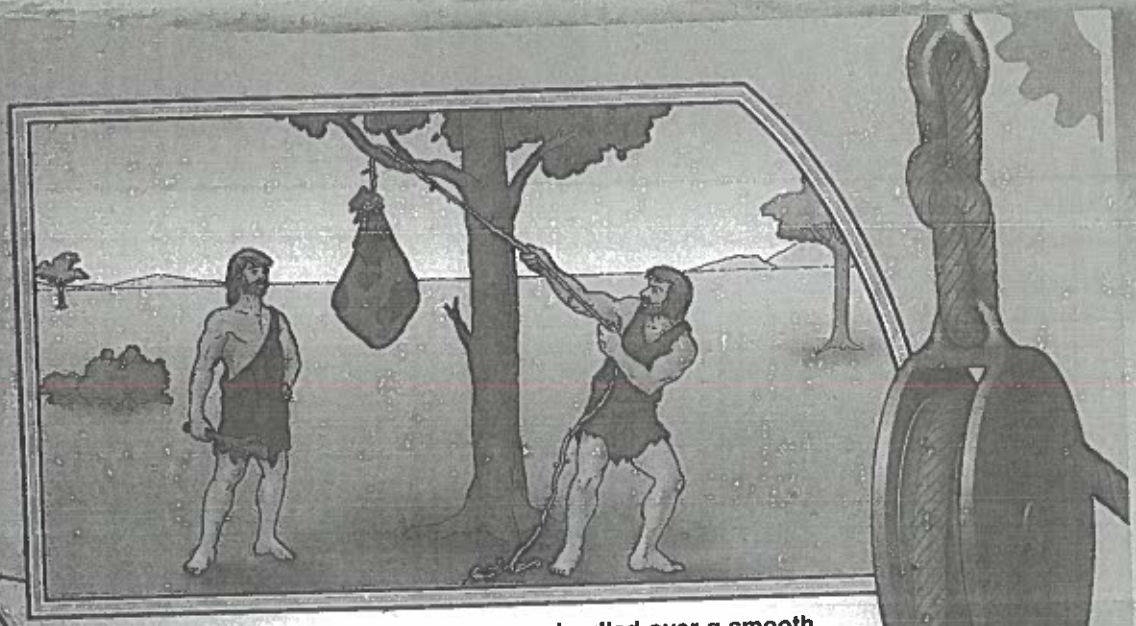
Think about what you already know and the information the writer includes. Why are wheels called "simple" machines?

PULLEYS

A pulley is a wheel with a groove around the outside for a rope or cable to fit into.



A pulley on this fishing boat helps fishers pull in their net.



The simplest kind of pulley is a rope or cord pulled over a smooth tree branch or beam.

A Simple Pulley

No one knows who invented the pulley, but the first pulley was probably just a rope thrown over a smooth branch. Someone must have discovered that a load tied to one end of the rope was easier to lift.

The rope over the tree works because it allows you to pull down in order to lift something up. Pulling down is easier than pulling up because you can use your weight to help you. A wheel at the top works better than the branch because there is less friction and the rope slides more easily.

← Ask yourself questions about what the writer has not included. What jobs could have been so difficult that early people invented pulleys to help them?

Make It Work!

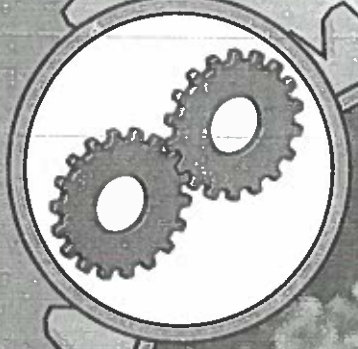
Use a simple pulley to lift a weight. Tie a piece of strong string or cord around a large, thick book. Lift the load with the string using one hand. Now, put the string over the back of a chair and pull the string down with one hand to lift the load. Which way is easier?

When you raise a flag on a flagpole, you pull down on the rope and the flag goes up.

Flagpole

A small, grooved wheel hangs from the top of the flagpole. The flag is tied to a long loop of thin rope that fits into the groove of the wheel. As you pull one side of the loop down, the other side goes up, taking the flag with it.

GEARS



A mountain bike has many toothed gears around the hub of the back wheel. The gears help the cyclist to pedal up and down steep hills.

Gear wheels have teeth around their rims. The teeth on one gear wheel fit into the teeth on another gear wheel. When one wheel turns, it turns any other wheel that is linked to it. The gears on a mountain bike allow the bike to go faster or slower while the cyclist pedals at the same speed.

Think about your personal experience and clues from the text to draw a conclusion. How would your pedalling be affected if your bike had only one gear? →

Pulley Power

Written by Terry Jennings
Illustrated by Chris Forsey

Applying Strategies

Making Inferences

As you read, remember these ways to help you make inferences and draw conclusions:

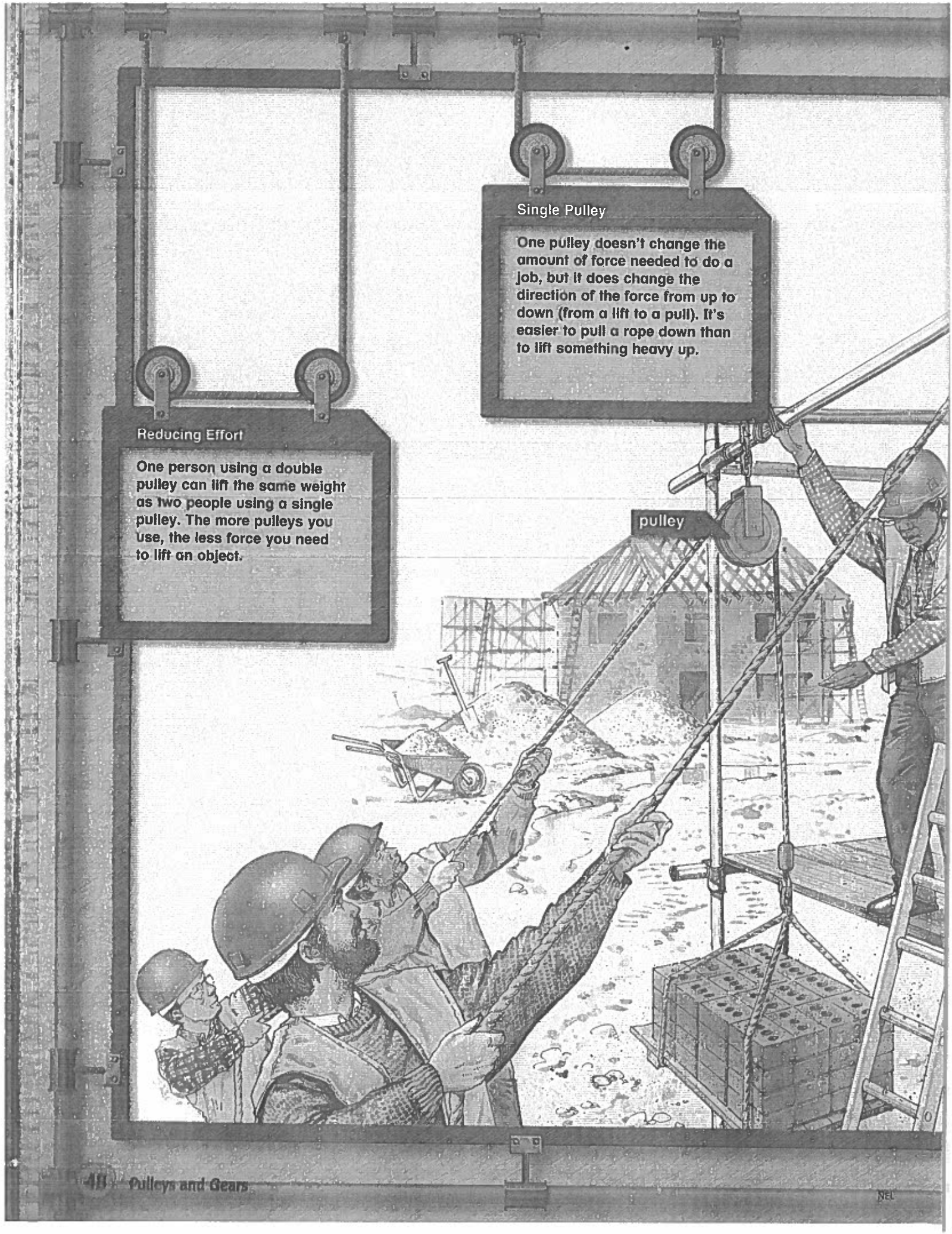
- Think about what you already know.
- Think about the information the writer has included.
- Ask yourself questions about what the writer has not included.

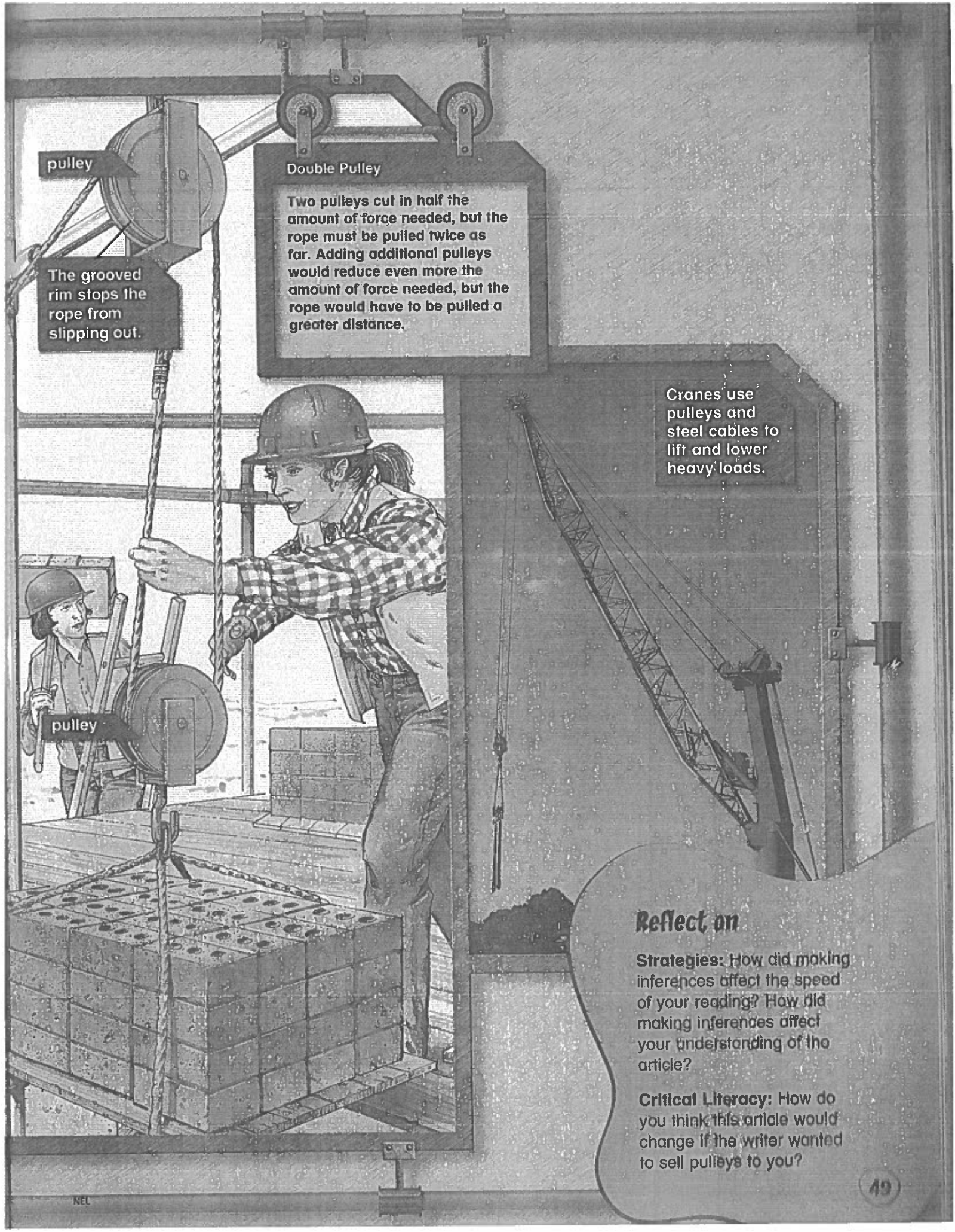
Pulleys are useful because they make it easier to lift things. A pulley is a wheel that has a groove in it and a rope running through the groove. (Sometimes a chain or steel cable is used instead of a rope.) One end of the rope is attached to a heavy object. The object is lifted by pulling down on the other end of the rope. One pulley can be used on its own, or several pulleys can be used together.

Pulleys and Work

The scientific term *work* means "using force to move an object." For example, imagine you were pushing a car. Your push is the force used to move the object, which is the car.

Some machines, such as pulleys, allow you to do work by using less force. When a machine reduces the amount of force needed to do work, we say the machine provides "mechanical advantage."


Single Pulley
One pulley doesn't change the amount of force needed to do a job, but it does change the direction of the force from up to down (from a lift to a pull). It's easier to pull a rope down than to lift something heavy up.
Reducing Effort
One person using a double pulley can lift the same weight as two people using a single pulley. The more pulleys you use, the less force you need to lift an object.
pulley



Reflect on

Strategies: How did making inferences affect the speed of your reading? How did making inferences affect your understanding of the article?

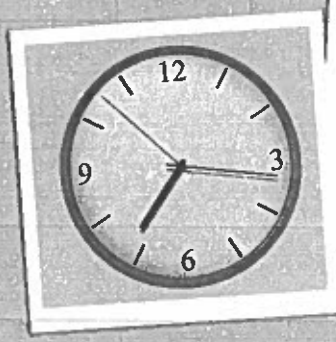
Critical Literacy: How do you think this article would change if the writer wanted to sell pulleys to you?

Understanding reading strategies

Text Features: Labelled Diagram

A labelled diagram shows how something works. When you see a labelled diagram in an article, plan to look back and forth between the diagram and the text as you read. Use the diagram to help you understand the text. Use the text to help you understand the diagram.

Gearing



What do clocks, bikes, cars, and windmills have in common? Without gears, none of these machines would work! There are many different kinds of gears. Let's take a look at just a few, and find out what gears can do when they work together.

Kinds of Gears

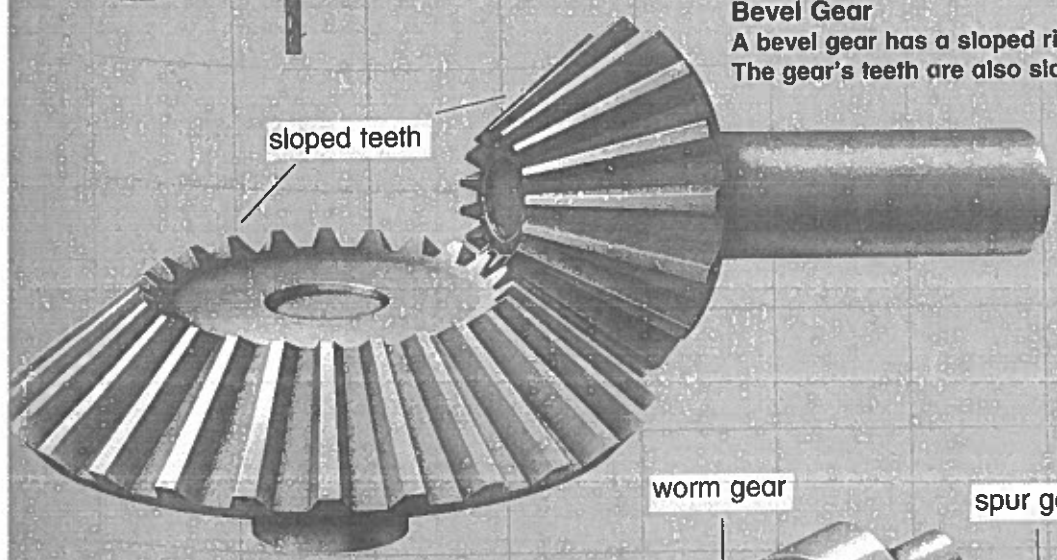
Spur Gear
Almost all gear wheels have teeth all around the rim. A spur gear has teeth that go straight up and down when the gear lies flat.

The caption title tells you what the diagram shows. What does this diagram show you? →

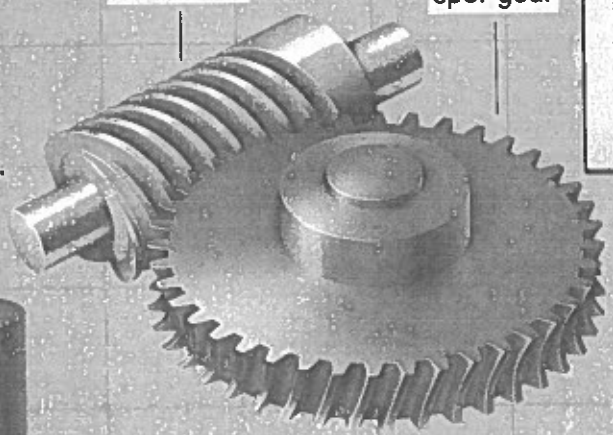
Up!

Written by Amita Markandaya
Illustrated by Allan Moon

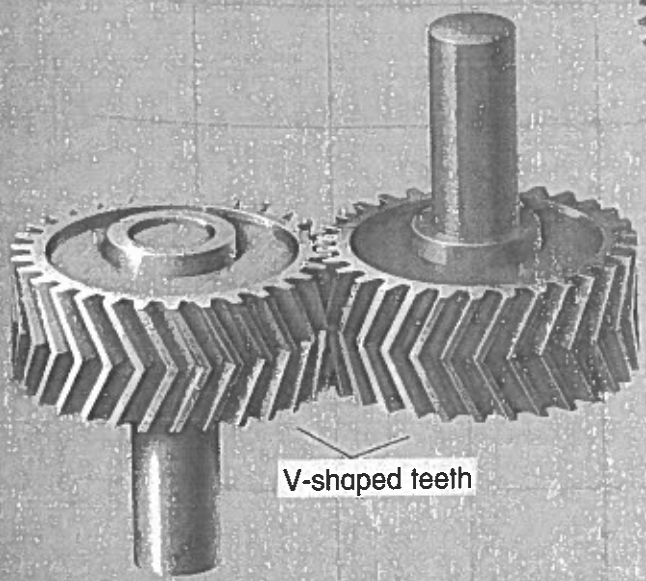
Bevel Gear
A bevel gear has a sloped rim. The gear's teeth are also sloped.



Important parts of a diagram are labelled. What labels do you find in the diagrams on this page?



Worm Gear
A worm gear looks like a screw. A worm gear can be linked to a spur gear.

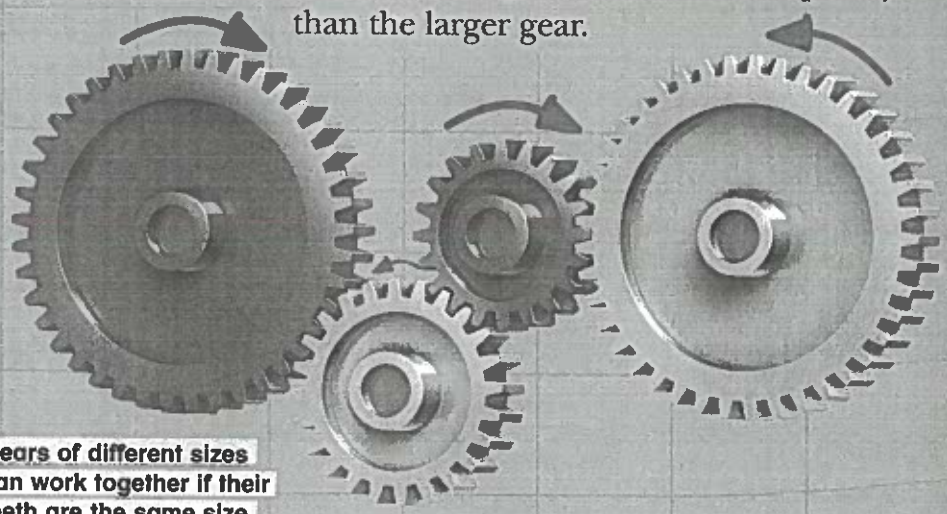


Herringbone Gear
A herringbone gear has teeth that are shaped like a V.

Gears Working Together

Gears can be linked together so that one gear makes several other gears turn. This is called a gear train. Each gear moves in the opposite direction to the ones touching it.

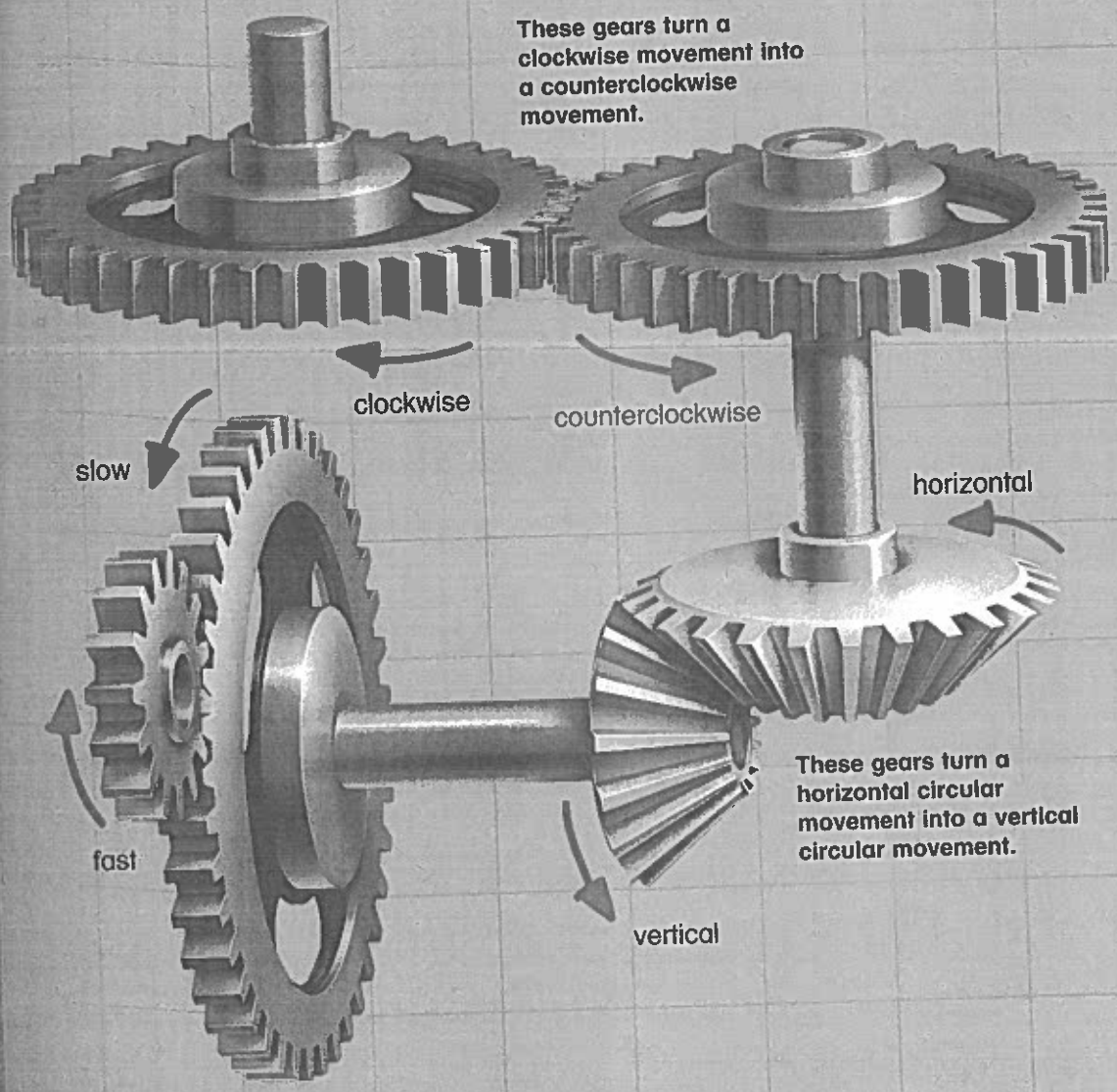
A gear train can contain gears of different sizes. Each size of gear turns at a different speed. When a larger gear makes a smaller gear turn, the smaller gear will turn more quickly than the larger gear.



Gears of different sizes can work together if their teeth are the same size.

Captions can give you additional information. What do you learn from this caption that is not explained in the text?

When one gear in a gear train turns, it makes the other gears turn. As the turning movement is passed from one gear to the next, the gears can make changes to the turning movement.



How Bicycles

Written by Amy Pinchuk
Illustrated by Allan Moon

What makes a bike such an awesome machine? It's built to ride! Check out its parts and how they work together.

Applying Strategies

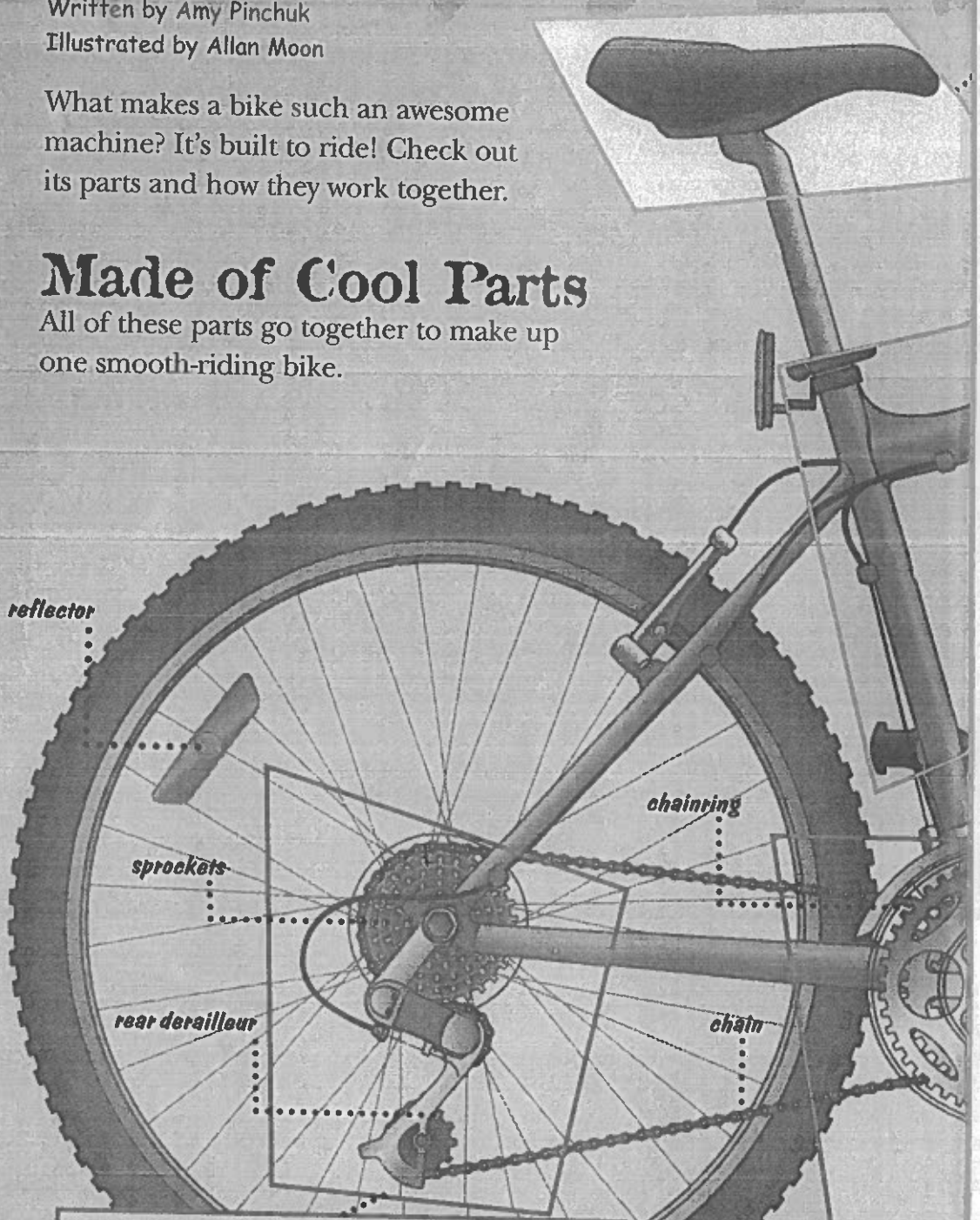
Text Features: Labelled Diagram

As you read, use what you know about labelled diagrams:

- The caption title tells you what the diagram shows.
- Important parts of a diagram are labelled.
- Captions can give you additional information.

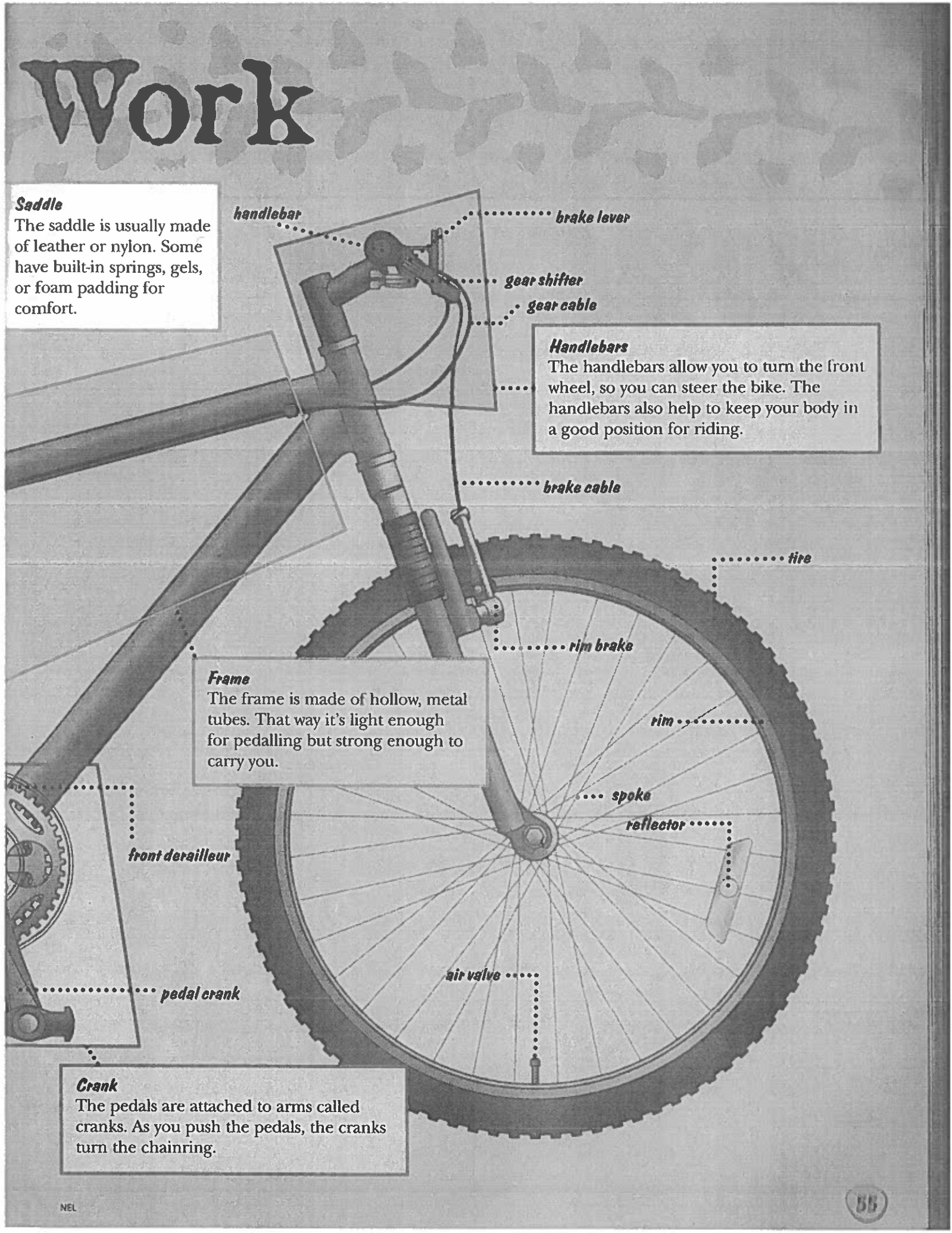
Made of Cool Parts

All of these parts go together to make up one smooth-riding bike.



Chain and Chainrings
The chain is made of steel links that loop onto teeth on the chainrings and rear-wheel sprockets. As you push the pedals, the chainring turns, pulling the chain. This turns the rear-wheel sprocket, which turns the rear wheel.

Work



Saddle
The saddle is usually made of leather or nylon. Some have built-in springs, gels, or foam padding for comfort.

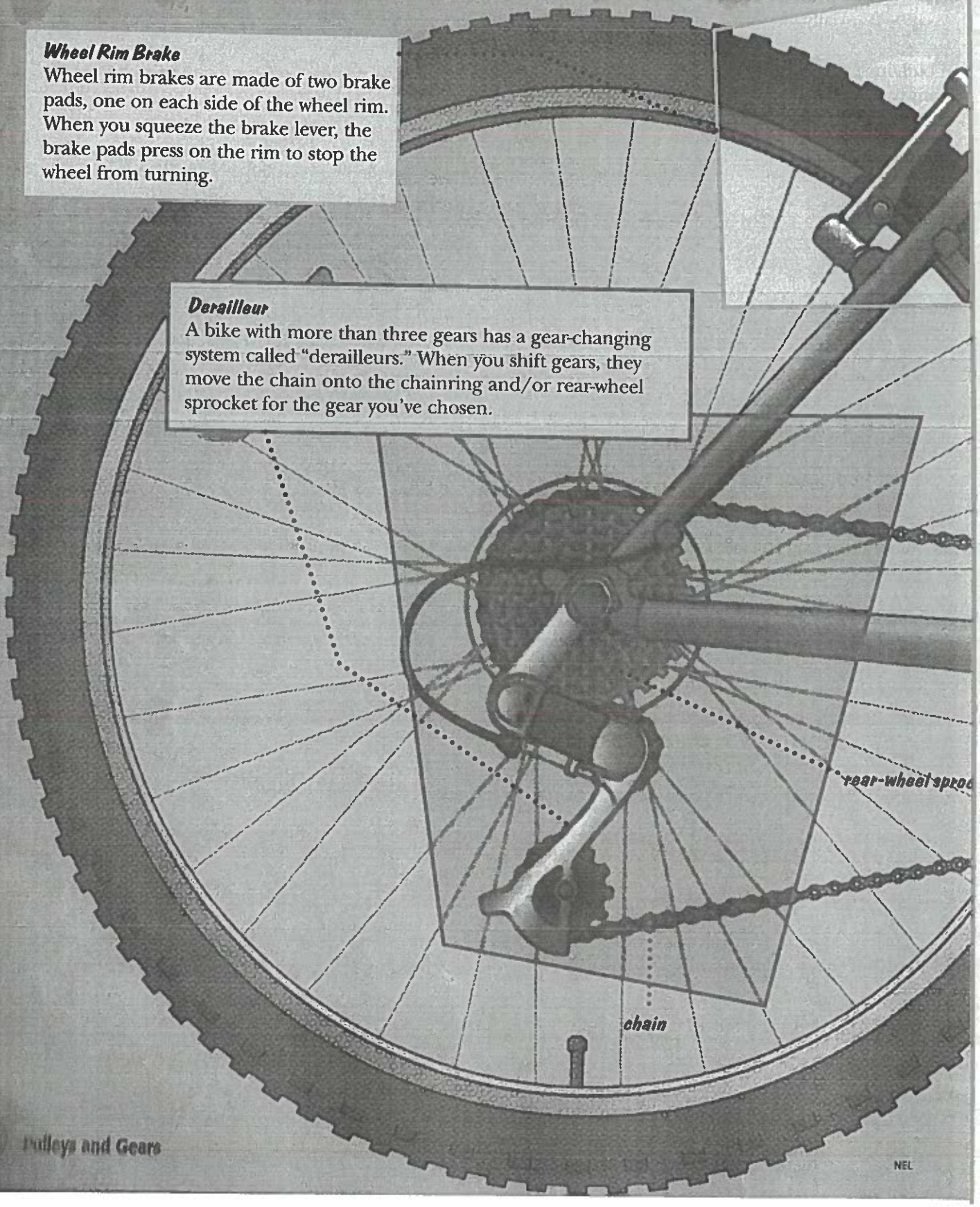
Handlebars
The handlebars allow you to turn the front wheel, so you can steer the bike. The handlebars also help to keep your body in a good position for riding.

Frame
The frame is made of hollow, metal tubes. That way it's light enough for pedalling but strong enough to carry you.

Crank
The pedals are attached to arms called cranks. As you push the pedals, the cranks turn the chainring.

The Controls

Here's the lowdown on how gears and brakes make your bike stop and go.

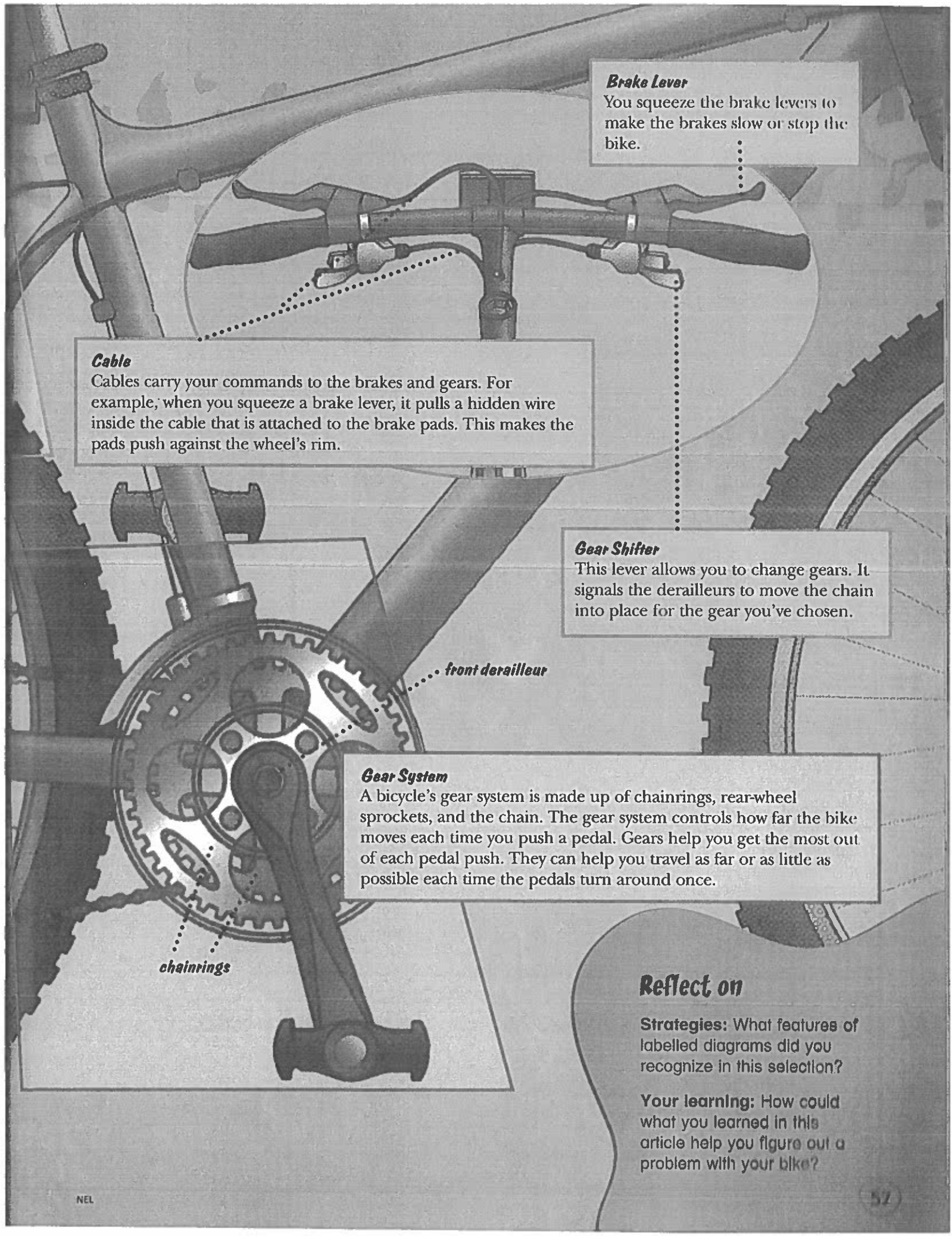


Wheel Rim Brake

Wheel rim brakes are made of two brake pads, one on each side of the wheel rim. When you squeeze the brake lever, the brake pads press on the rim to stop the wheel from turning.

Derailleur

A bike with more than three gears has a gear-changing system called "derailleurs." When you shift gears, they move the chain onto the chainring and/or rear-wheel sprocket for the gear you've chosen.



Reflect on

Strategies: What features of labelled diagrams did you recognize in this selection?

Your learning: How could what you learned in this article help you figure out a problem with your bike?

Understanding media

Gears on the Move!

Identifying Conventions of Photos in Print Media

Photographers use many skills and techniques to communicate messages, especially in print ads. As you learn about some of these techniques, think about the impact they have on you as a viewer.

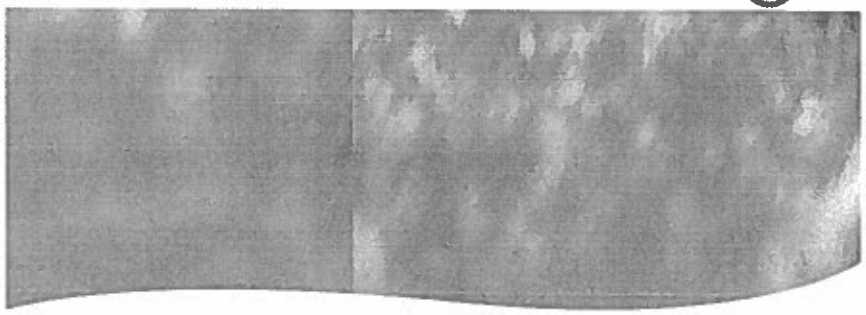
A long-distance shot shows the subject from faraway and gives you a good look at the background. What ideas does this shot give you about biking?

A middle-distance shot shows the subject and some background. What ideas does this shot give you about the bike rider?

The colours in a photo can be changed after the photo is taken. What is the impact of changing this photo's colours from natural to blue?

It's all about: Blowing through the big ring.

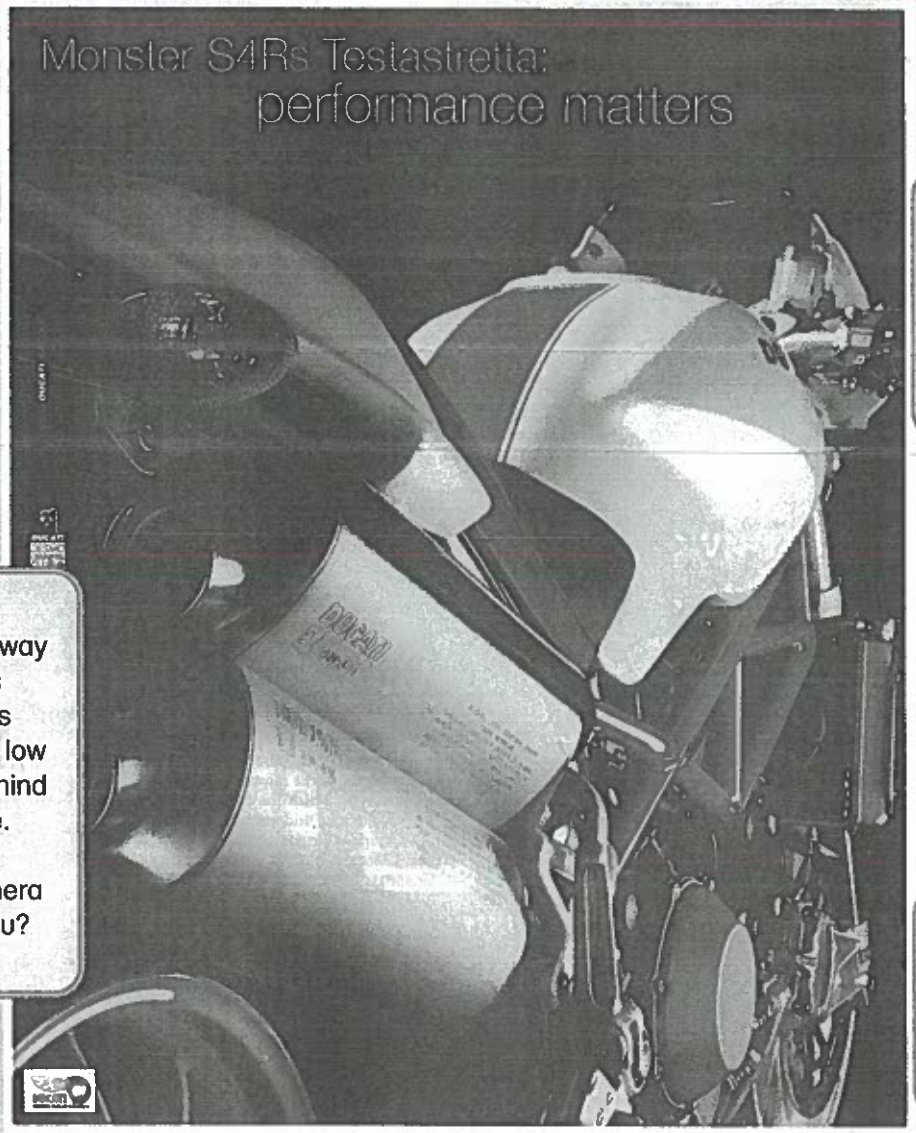
TRANCE I



MAESTRO

GIANT GO

Notice the techniques that make the photo in this magazine ad grab your attention.



Ducati Monster S4Rs Testastretta – the most powerful, highest performance Monster ever built. Now experience thrilling Testastretta Superbike power with every twist of the throttle. With the mighty stopping power of radial Brembo brakes, the confident and responsive handling of full Öhlins suspension and strikingly beautiful lightweight Marchesini wheels, the S4Rs Testastretta is the ultimate naked bike. Monster style and Testastretta engine technology – a Monster never looked or felt so good. Find your nearest Canadian Ducati dealer at www.ducatiusa.com

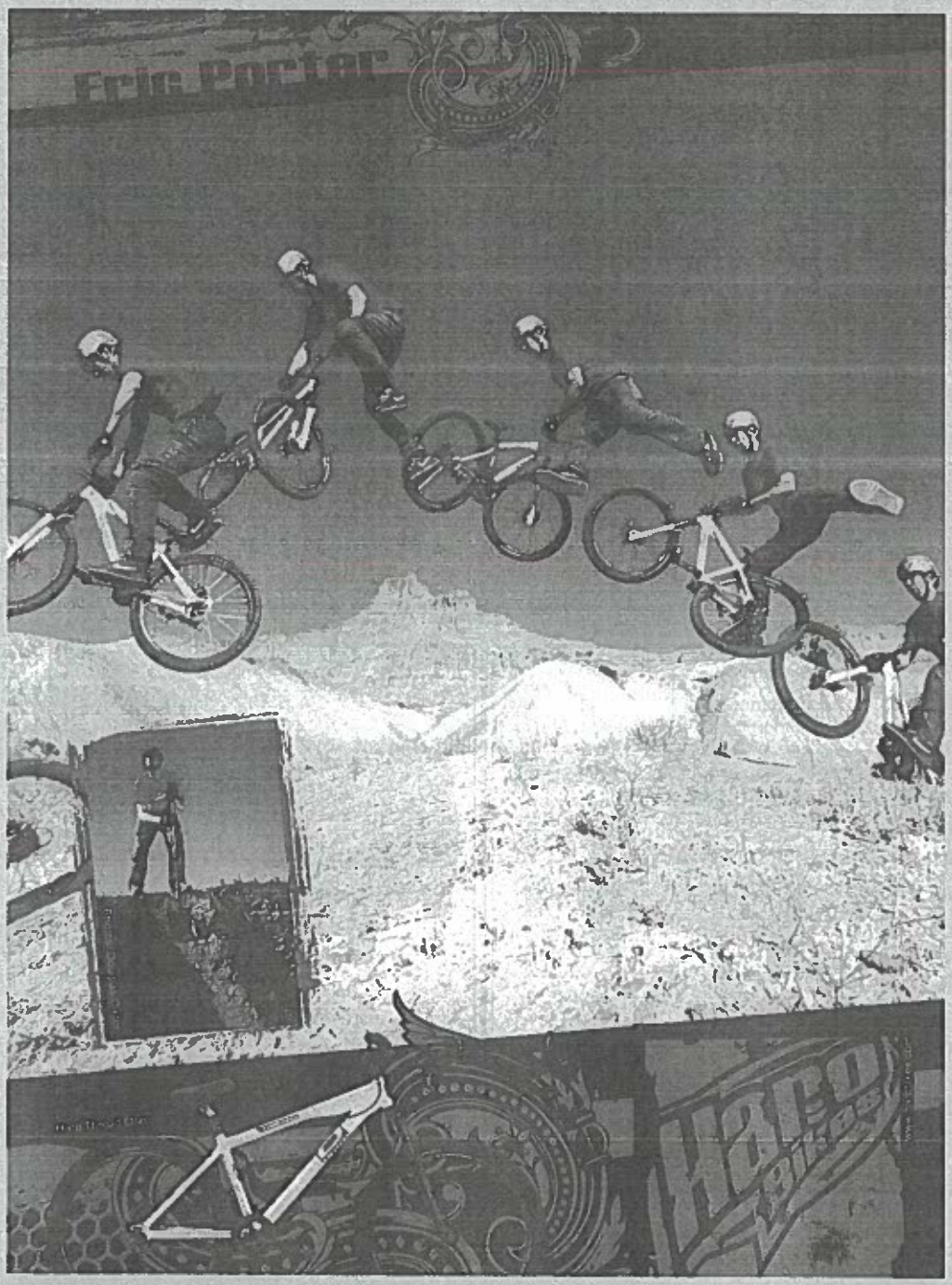
DUCATI

Close-up photos are good for showing details. What is your reaction to this close-up shot?

The camera angle, or the way the camera is looking, in this photo is from low down and behind the motorbike. What feeling does the camera angle give you?

Lighting can add interest to a photo. What stands out in this photo?

Photographers can use special effects to create a powerful photo. As you look at the main photo in this magazine ad, think about the technique the photographer used. What impact do techniques like this have on you?



Understanding Writing Strategies

Varying Sentence Beginnings

Varying your sentence beginnings makes your writing lively.

When all the sentences in a paragraph begin the same way, readers get bored. You can add energy and variety to your writing by adding some new words and changing the order of words in your sentences.

Look at the sentence beginnings for this paragraph before it was revised. Read the first two words of each sentence in the original paragraph to see why this writer needed to work on varying the sentence beginnings. Then read the revised paragraph to see how the writer changed it.

A Magical Summer

We had a magical summer. We spent every day putting on plays. We made costumes from old clothes. We had a stage curtain with pulleys that my mother made. We felt like real stage actors when that curtain went up on its silent pulleys!

A Magical Summer

This was a magical summer. Every day, we put on plays. Our costumes came from old clothes. My mother made a stage curtain with pulleys. When that curtain went up on its silent pulleys, we felt like real stage actors!

How to vary sentence beginnings:

- ☑ Read your writing out loud to find the sentences that sound too much the same.
- ☑ Try putting the time when something happened right at the beginning of a sentence.
- ☑ Rewrite some sentences to begin with different words.
- ☑ Read your writing again to make sure it's lively and clear.

Pulleys and Gears at Work

Written by Jeff Siamon
Illustrated by Tad Majewski

Putting It All Together

As you read this article, remember to use the strategies you've learned in this unit:

- Make inferences.
- Use the labelled diagrams.
- Look for a variety of sentence beginnings.

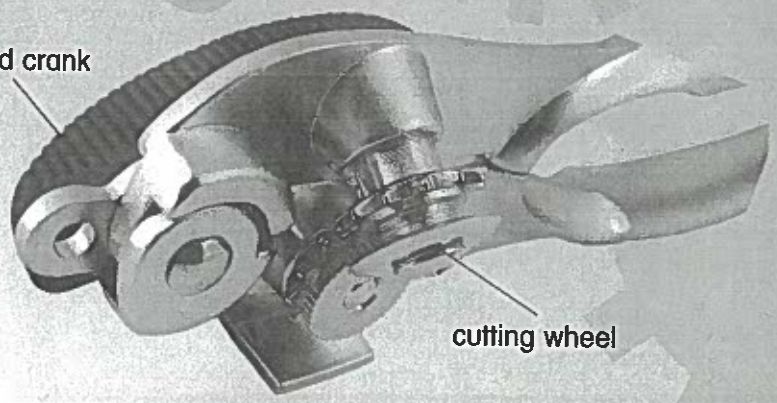
Pulleys and gears are used in machines to raise, lower, and move things. You might be surprised at how many machines use pulleys or gears—or both!

Clocks and Watches

What do *you* use to keep time? Clocks and watches use many gears to keep time. Some of these gears move the hands on the clock or watch.

Can Opener

Watch your fingers! Manual can openers usually have two sets of gears. One gear is connected to the hand crank. The other gear moves the cutting wheel.



boom

steel cable

pulleys

hook

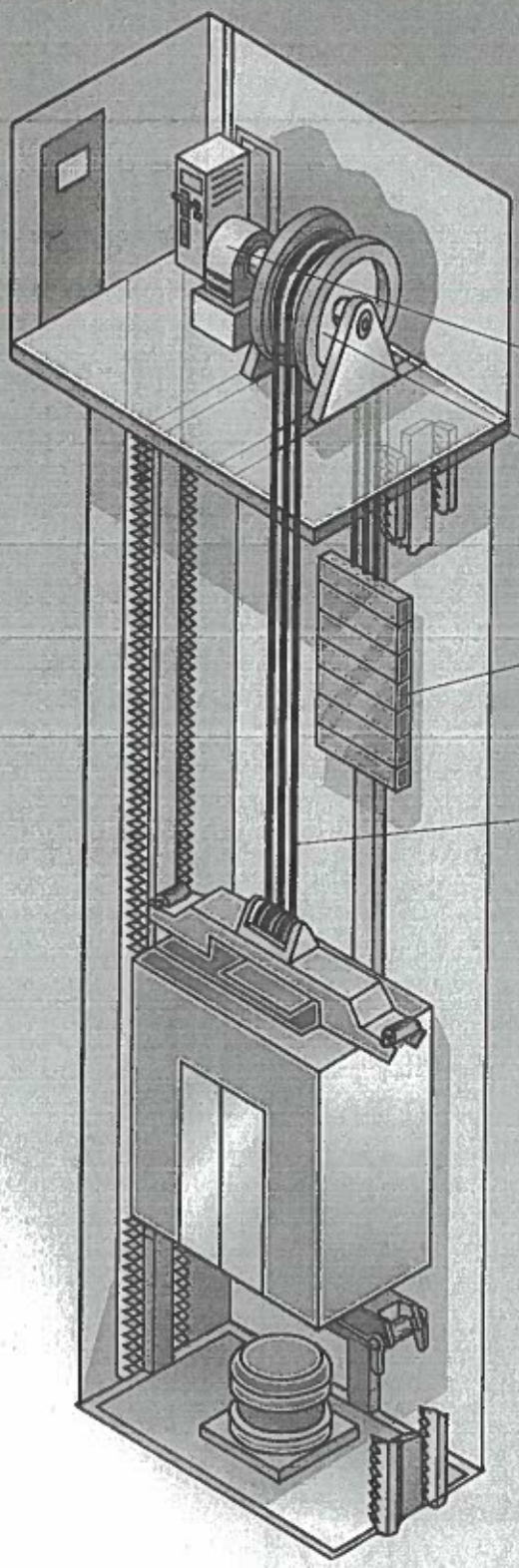
load

counterweight

Crane

These aren't the kind of cranes that can fly, but they're pretty special. These cranes are machines that lift heavy objects. Some are as tall as a multistorey building, and some fit on the back of a truck. Steel cables run through pulleys attached to the boom. If the load is heavy, a counterweight helps balance the crane.

The Canadarm is a type of crane used to lift and move things in space.



Elevator

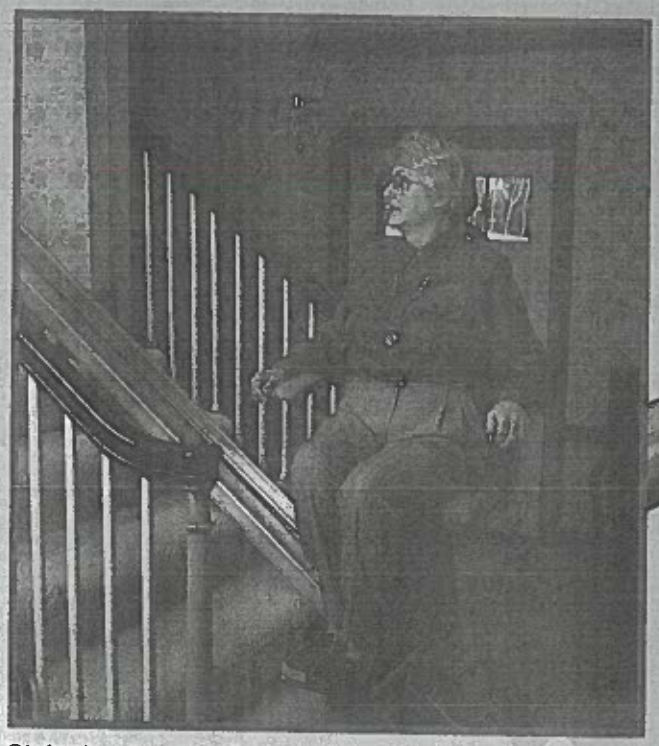
Going up? An elevator is a platform that moves people and things up and down. It uses a system of pulleys and cables that are powered by an electric motor.

Electric Motor
The motor turns the pulley.

Pulley
The pulley works with the cables to move the platform up or down.

Counterweight
The counterweight moves in the opposite direction to the platform. It makes it easier for the motor to raise and lower the platform.

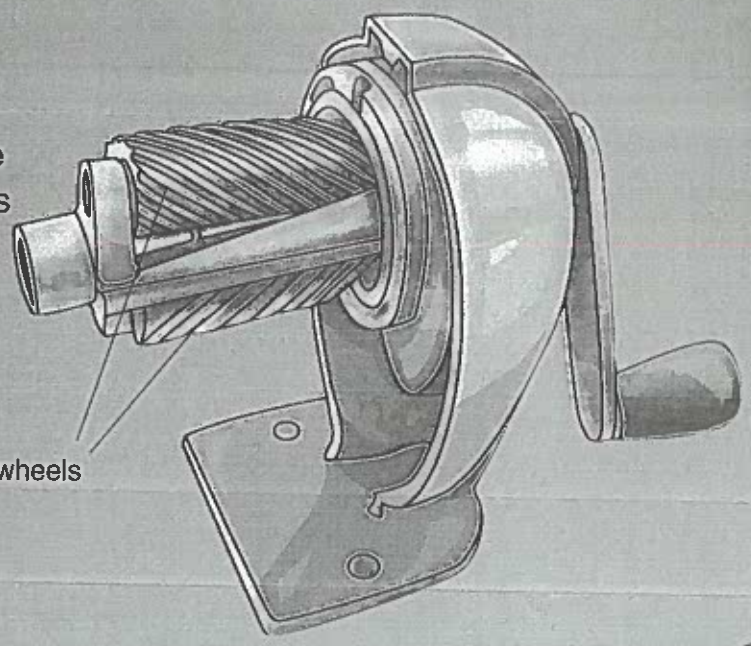
Cables



Stair elevators can be used in homes.

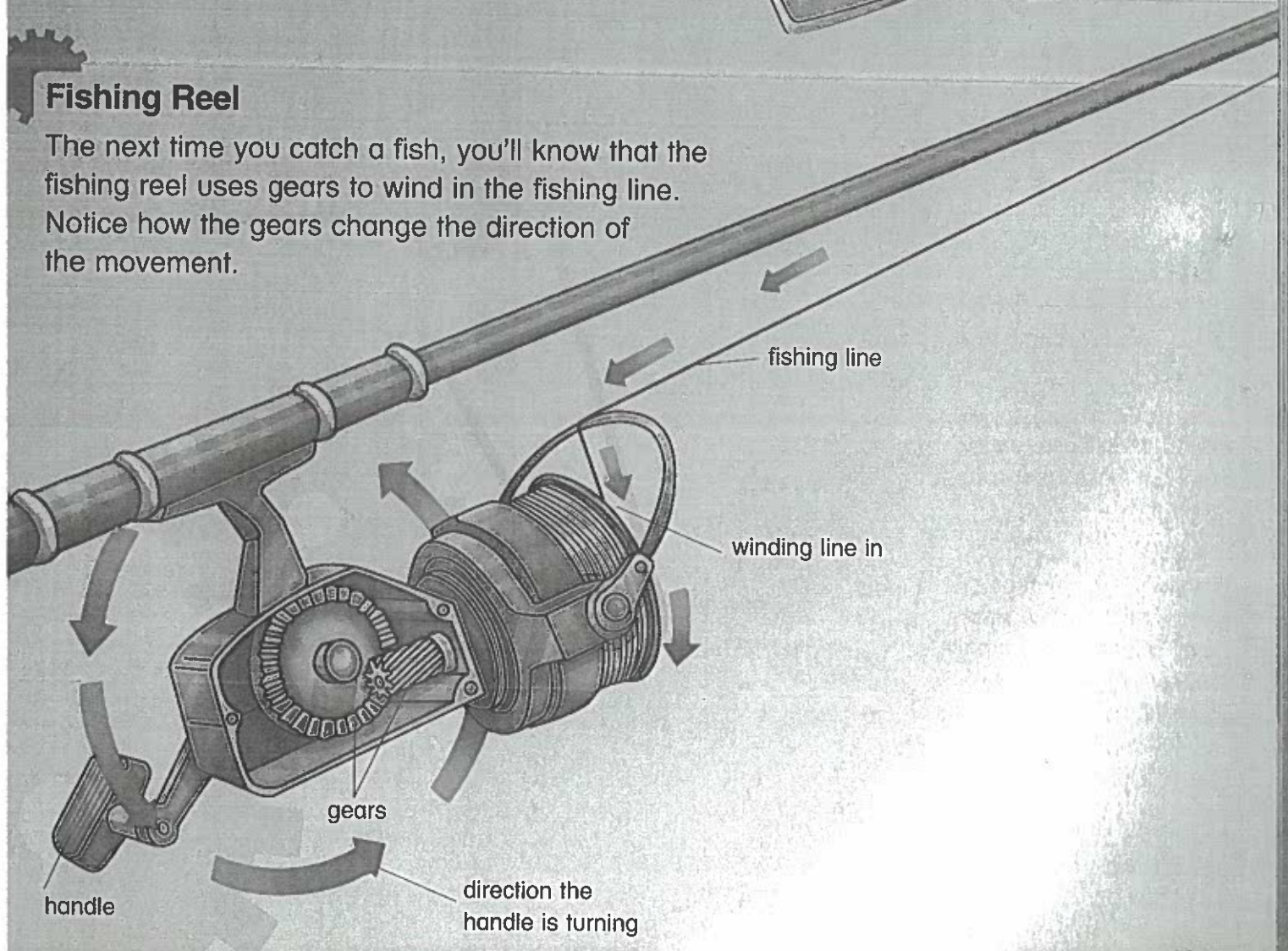
Pencil Sharpener

The handle on a pencil sharpener is connected to a gear. When you turn the handle, the gear inside turns and makes the cutting wheels turn. The cutting wheels carve away at the pencil to make a nice sharp point.



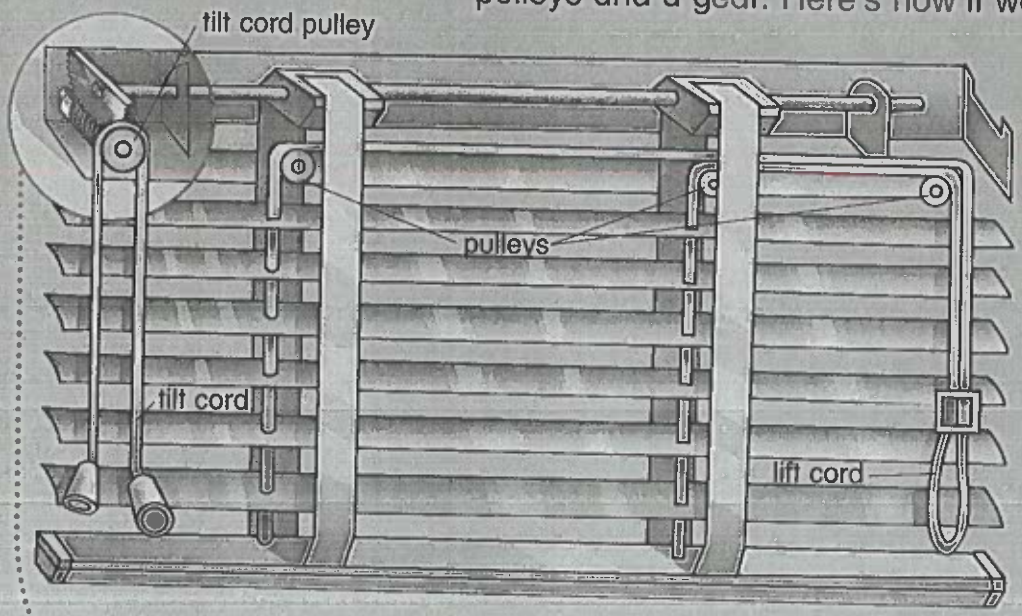
Fishing Reel

The next time you catch a fish, you'll know that the fishing reel uses gears to wind in the fishing line. Notice how the gears change the direction of the movement.



Window Blind

A window blind is an example of a machine that uses pulleys and a gear. Here's how it works:



Pulleys
These pulleys work to raise or lower the blind. When you pull down on the lift cord, the bottom of the blind moves up.

Tilt Cord Pulley
This pulley works with the tilt cord to open and shut the slats on the blind.

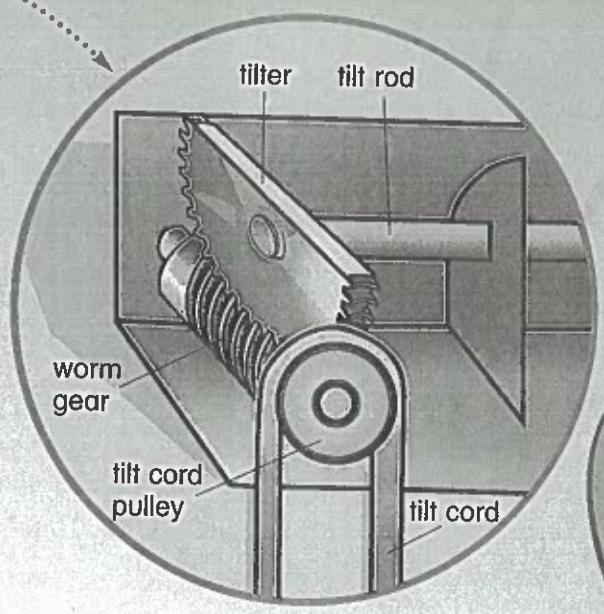
Tilt Cord
You pull one end of the cord to tilt the slats to the open position. You pull the other end of the cord to tilt the slats to a closed position.

The diagram below shows a close-up of the tilting mechanism, which opens and shuts the slats.

Tilt Cord Pulley
When you pull the tilt cord, the tilt cord pulley turns.

Worm Gear
When the tilt cord pulley turns, it makes the worm gear turn.

Tilter
When the worm gear turns, it makes the tilter turn, and this turns the tilt rod, which makes the slats tilt to the open or closed position.



Pulleys and gears are all around us. Keep your eyes open because you never know where you'll see one next!

Reflect on

Strategies: What strategies did you use to help you understand the article?

Connections: How has reading this article about pulleys and gears affected the way you will look at everyday things in your life?

Light Like a Pro

Your best bet is to use existing light. (That means shooting your video where there is already lots of light.) But, if you want to learn lighting, here's how the professionals do it.

It's called **three-point lighting**: three lights in three different places aimed at the middle, and presto!—they almost erase each other's shadows. Hard shadows are bad stuff in videos, except in monster and bad-guy stories.

no light

There are three kinds of lights in this system:

Key light—The first and brightest light, usually pointing at the subject. A work light, or a 100-watt bulb without a shade, would make a good key light.

key light

Fill light—The second light, half as bright, is placed opposite the key light on the other side of the camera. It softens most of the shadows cast by the key light. A basic work light with a 50-watt bulb, or a lamp with a shade, can do the trick.

key light + fill light

Backlight—The third light is set behind the talent (actors), to help them stand out from the background. Don't shine it directly into the camera lens. A lamp (with a shade) in the background would make a good backlight for you. You can even keep it visible in the frame.

key light + fill light + backlight

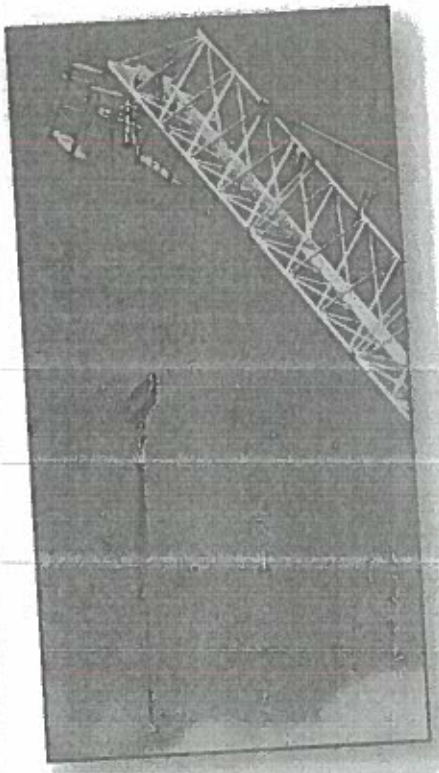
If you can't get all three lights set up, try just a key and a fill light. No? Just a key light, then. No? Use the light on your camcorder. Or the sun. Or the refrigerator light....

Reflect on

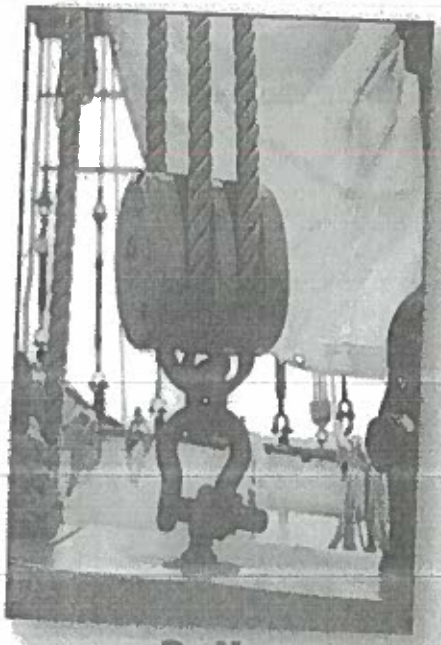
Strategies: What strategies did you use when you were reading this article? Find a place in the article where you found yourself reading in a new way.

Your Learning: Which tips do you want to remember when you make a video?

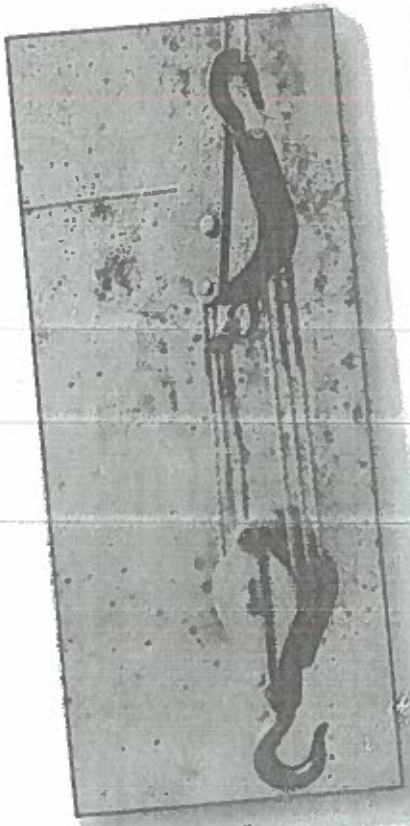
Pulleys and Wheel and Axles



Crane



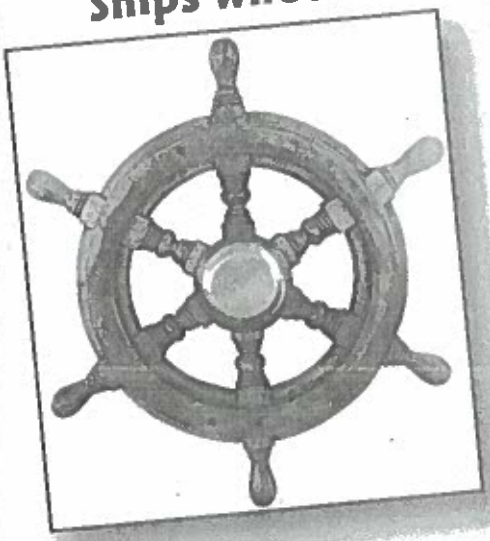
Pulley



Pulley

Steering wheel

Ships wheel



Wheel & Axle