What Sports Are We Talking About?

Here is a list of the winter sports that will be discussed. Some of the sports may be new to you. In the course of this section, we will explain how they are played, as well as how they work.

- Alpine Skiing
- Biathlon
- Bobsledding
- Cross-Country Skiing
- Curling
- Figure Skating
- Freestyle Skiing
- Ice Hockey
- Luge
- Ski Jumping
- Snow-Boarding
- Speed Skating

* includes downhill, slalom and giant slalom

The Hows and Whys

Rules tell us how winter sports are played. But how do winter sports work?

Why do skaters spin as they do? What lets a ski jumper hang in the air for huge distances? What controls how a hockey puck bounces? Why do bobsleds look like bullets?

The answer to these and many other questions is Science.

Yes, the stuff you study in school, with weights, beakers, charts, experiments and textbooks.

This special newspaper section will take a close look at Winter Sports Science. It will explain all the fabulous feats you see by tracing them back to the science that makes them work.

Science is about the forces of nature and the energy that sets them in motion. Forces and energy are what shape sports, too. Forces propel people along the ground or over the snow. Forces lift them into the air. Forces slow them down or bring them back to the ground.

These scientific forces combine with the energy stored in muscles to create the energy of movement.

Knowing how forces and energy work can make winter sports more fun. It will give you fun facts to share with your family and friends. And if you play these sports, it may give you tips that will actually make your performance better.

Winter Sports Science is fun science. If you like it, you may want to explore ways that School Science can be fun science, too!

What Sports Get Covered?

The sports section of the newspaper is packed with action every day. Professional, college, high school and international sports are all covered, as well as recreational sports. As a class, make a list of all the sports mentioned in today’s sports section. Have each student pick the Top 10 that interest him or her. Combine results and make a bar graph showing the Top 10 most popular sports in your class.

What sports get covered in the newspaper often depends on where the paper is located. Pretend your local paper is based in Norway instead of the United States. What sports do you think you would read less about? What sports might you read more about? Write a paragraph explaining why you think this way.
One of the most spectacular winter sports events is Ski Jumping.

In this event, skiers climb a 50-foot tower, hurl themselves 50 miles per hour down a steep ramp, launch themselves off an upturned lip and fly more than 400 feet through the air.

The goal is to see how far they can fly, without wiping out on the landing.

People who crash can be seriously injured, or even killed.

Ski jumping is not only one of the most exciting winter sports. It shows off many forces of science and nature as well.

Consider the speeding trip down the ramp. What pulls the skier? Gravity—the same thing that holds people on the surface of the Earth so they don’t float off into space.

Gravity is something every planet has. In fact, it is something every object has. It is a force that draws things toward an object. The bigger the object, the stronger its gravity. The Earth is much bigger than people. When you jump off the Earth—or off a ski jump—the Earth’s gravity pulls you back.

Everything that falls, or everything that moves from a higher position to a lower one, is affected by this gravity.

Perhaps you have run down a hill. It seems much easier than running across a flat field. You may even move faster. That’s because gravity is pulling you down the hill along with your legs.

### How Do They Fly?

Gravity is what eventually pulls ski jumpers back to the ground. But the way ski jumpers position their bodies can affect how far they fly. The leap off the upturned lip of a ski jump helps position the skier on a rising course that will increase distance.

Once off the ramp, all ski jumpers try to master the same position. The jumper seeks to balance in the air with the skis tilted upward, the tips apart in front to form a V, the body leaning forward and the hands by the side. If the ski jumper does this, air can actually pile up under the jumper and delay the landing.

The V form is fairly new for ski jumpers. Before 1988 most skiers were taught to keep the tips of their skis together while in the air. But in 1988 a Swedish jumper could not keep the tips together because of the way his legs were shaped. But this “accident” proved effective. The new form actually allowed more air to build up underneath because there was more surface to push against. This increased the length of jumps, so others quickly adopted this form. It can add up to 15 meters to a jump on Large Hill competitions.

### Increased Speed

Position is also important in getting enough speed to launch a ski jump. If you watch ski jumping on TV, you will see that once the jumpers shove off at the top of the ramp, they crouch over their skis as far as they can.

The reason they do is this is to reduce the “drag” of air against their bodies. You may not be able to see the air we breathe, but it is actually loaded with molecules and atoms of different elements. Molecules and atoms are some of the smallest bits of liquids, solids and gases.

The molecules and atoms in air may not be seen, but they have power over bigger objects. When an object moves, it pushes against the invisible molecules in the air. The molecules do not move out of the way quickly and slow down the moving object.

Ski jumpers and other athletes seeking speed try to reduce the area that air can push against. Putting their bodies in a crouch lets more air pass over them and less hold them back with “drag.”

### Test It Yourself

Here’s a way you can test the effects of “drag.”

You’ll need a bicycle, a paved hill away from traffic, a friend to help you and a stopwatch (or a watch with a second hand).

First, shove off and coast down the hill, sitting straight up on the seat. Have your friend time you from top to bottom and write down the result. Next, shove off and crouch low over the handle bars. Have your friend time you from top to bottom. Was there a difference in time? How much?
Figure skating has become one of the most popular spectator sports in the world. Turn on the TV any weekend and you will find one or more figure skating shows or competitions.

Skaters like Ashley Wagner, Jeremy Abbott, Meryl Davis and Max Aaron have become sports celebrities with their flashy and beautiful routines.

Figure skating has become popular because it combines the grace and style of dancing with the strength and speed of sports. And in pairs competition, the coordination required between partners is among the greatest of any team sport.

So how does science work in figure skating?

What forces are at work?

Water Skaters?

Did you know that ice skaters and skiers don't perform on ice and snow? They really are performing on a thin layer of water.

How can this be? The answer is friction.

Friction is a force that causes heat to build up whenever two objects rub together. You may have experienced friction rubbing your hands together on a cold day, or rubbing your hands over your skin after getting out of a cold swimming pool.

The rubbing motion creates heat by activating the molecules in the objects. The energy of the rubbing increases the energy and movement in the molecules.

Friction from the surface of skates racing over ice actually causes the ice to melt slightly. Combined with a natural effect known as surface melting, this can actually create a thin layer of water between the skate and the ice.

Maintaining a Good Balance

Balance is very important to figure skaters. It keeps them from falling over when they skate on one foot, or land from a leap, or stop a spin.

Part of figure skating, or any sport, is training and sharpening the body's sense of balance. Balance is not just for athletes. Every day our lives are a kind of balancing act.

Balance is actually controlled by your ears—and by gravity. Deep inside your ears are sacks with tiny crystals inside. The sacks are filled with jelly-like liquid and lined with microscopic hairs. Every time your body moves, gravity causes the crystals to move, pressing against the hairs. The hairs instantly send a message to your brain telling it about your change in position. Your brain then tells other parts of your body to shift position to keep your balance.
Ice hockey has always been a rough, fast game that's as fun to watch as to play. It started on frozen lakes and ponds in cold places like Canada, Michigan and New England and more recently has moved into arenas in warm climates like Tampa Bay and Miami in Florida.

When TV networks introduced the blue and red “streak graphics” to help people follow the puck, it became even more popular.

In international competition, national teams from cold weather countries like Russia, Sweden and Germany still are considered leading powers in ice hockey. But other countries are gaining. And the ice hockey in the National Hockey League is the best in the world.

The Science of Hockey

Ice hockey offers many chances to see how science works in sports. Slapshots, goals, collisions and more are all the result of scientific forces.

Hockey, in fact, could be seen as a laboratory for the science of physics (FIZ-iks). Physics deals with how objects in the world—called “matter”—interact with energy in the world.

Consider the most exciting move in hockey—the slap shot.

With a slap shot, a hockey player raises the stick as far back as he/she can, whips it toward the puck and sends the puck screaming at the goalie. Slap shots can travel upwards of 100 miles an hour with top adult players.

But what makes a slap shot so fast? Physics. More specifically the part of physics called “mechanics.” A famous scientist named Isaac Newton spent a lot of time studying how objects move some 300 years ago. He wrote out three laws of motion that still are used today.

One of these states that the rate of change in motion for an object—speeding up—is directly linked to the force applied to the object.

That is exactly why a slap shot is so much more powerful than other shots. The force of the stick has all the energy of a full swing behind it. When the stick hits the puck, it just rockets off toward the goal.

Compare that to a softer “wrist shot” or a rebound shot in front of the goal. What other sports can you think of that show this law of motion?

Check It Out!

Isaac Newton’s laws of motion also are seen anytime a hockey game gets rough. “Checking”—throwing your body into another player’s body—is a big part of hockey. Usually it occurs along the boards” that surround the hockey rink.

What happens scientifically when one player checks another?

The first part of the action is like the slap shot discussed at left. The checker applies force to another player, and sends that player flying in the direction the force is moving.

The second part of a check shows another of Newton’s laws. This law states that for every action there is an equal but opposite reaction. When a player is checked into the boards, he bounces back off. Or sometimes players collide on the ice at high speed, and bounce off each other.

The “action” in these cases is the collision. The “reaction” is the bounce. How hard you bounce is directly connected to how hard you’re hit (and how big you are).

Bounce Passes

Another way this law is seen is in how players sometimes pass or advance the puck by bouncing it off the boards. Shooting the puck at high speed against the boards will cause it to bounce off at an almost equal speed.

But there is more science at work with these passes than that. The angle you hit the puck against the boards will determine what direction it travels.

An angle is the joint that is formed when one line connects with another. When moving things bounce, their path forms an angle at the point they hit another object. If you are directly in front of the boards and shoot the puck straight in, it will bounce right back to you. If you are off to one side, though, it will bounce off in the opposite direction because of the spin that contact with the boards puts on the puck.
If you look at the athletes on the last three pages, you will quickly notice something about them. The bodies of figure skaters don't look much like the bodies of ice hockey players. And the bodies of hockey players don't look much like the bodies of ski jumpers. There's truth in what you see: Certain sports offer an advantage to people of a certain size and shape.

Three Types of Bodies

There are three basic body types among humans. **Endomorphs** (EN-doe-morfs) are solid, round and powerful. **Mesomorphs** (MESS-o-morfs) are muscular yet agile. **Ectomorphs** (EK-toe-morfs) are lean and long.

Few people are purely one body type, though. Most people are a mixture of all three. If you look at yourself or an athlete, you would see that. You might say a person is a lot of endomorph, almost as much mesomorph, and a little bit ectomorph.

When scientists describe human body types they do just that. They assign a rating from 1 to 7 for the amount of each type in the body mix. In this rating, 1 is the lowest amount and 7 the highest.

They write this out as a formula: 5-6-2, for example. That rating would mean an athlete was a 5 on the endomorph scale, a 6 on the mesomorph scale and only a 2 on the ectomorph scale.

Muscle Twitching

There is another difference between muscles besides looks. The "dark-meat" muscles are called slow-twitch muscles, which means they contract and move more slowly. The "white meat" muscles are called fast-twitch muscles, which means they contract very quickly and yield a short burst of energy.

Everyone has a mix of fast and slow-twitch fibers in their muscles. You may have 70 percent slow twitch and 30 percent fast twitch. Your friend might have 40 percent slow twitch and 60 percent fast twitch. That would help decide what kind of athlete you are. Endurance sports like cross-country skiing or a marathon are slow-twitch events. Speed-sports like a 100 yard dash or figure skating would be fast-twitch events.

Muscles

Body type is just one factor in determining what kind of athlete a person is. Another is the kind of muscles. Men and women are not the same when it comes to muscles. Scientists have found that for the same height and weight, a man will have more muscle content and a woman will have more fat. That means men are more suited for sports that emphasize strength, and women do better at sports that require endurance.

There are more than 600 muscles in the human body, doing everything from curling your lips in a smile to raising the hair on your neck when you're scared.

Muscles go to work when they get signals sent from the brain through your nervous system. Nerves send the signal through motor neurons, triggering chemicals inside muscles to make them contract, flex, or tense up. That is when they start working for you.

Get Pumped

Some muscles are richly supplied by blood pumped from your heart. Others receive less blood from the heart.

You have probably observed this at holiday dinners. If you eat turkey, you know that some of the meat is dark meat and some is white meat. The dark meat is the muscle rich in blood. The white meat is the muscle that gets less blood. The same is true for people.

Rate Yourself

Here's a way to rate your own body.

Lay sheets of newspaper on the floor and tape them together. Lie down on the sheets. Have a friend trace around you with a marker or crayon. Cut your shape out. Then rate your body with the three-number formula at the right. The first number should be endomorph, the second mesomorph and the third ectomorph.

How does your body fit into the range of body types?  
—Adapted from "Sportworks," Ontario Science Centre, Addison-Wesley Publishing Co., 1989

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**Endomorph**  
**Mesomorph**  
**Ectomorph**
Bobsledding began as a sport in the 1800s in the Swiss Alps. The first sleds were wooden but today's models are made of fiberglass and steel. They almost look like rockets, and they certainly are rocket-fast. They can go faster than 90 miles per hour on their downhill tracks called “bobruns.” Racing a bobsled is like riding a roller coaster down a chute covered with ice.

Gravity is what powers the bobsled. The members of the team push off and jump in and then gravity pulls them from the start to the finish point. The sled has two steel runners and a streamlined shape. The front person steers with a wheel and the back person controls the brakes. On the straight parts of the run the crew members make the sled go faster and stay in control by leaning back and then jerking forward and leaning from side to side. This is called “bobbing.”

Gravity is the force that moves the bobsled along. On Page 3 you looked at gravity and ski jumping. As we discussed there, most people think gravity comes from the Earth’s center and that it is the pull of the Earth.

That is true, but the bigger truth is that everything that has mass has gravity. Right now this newspaper is pulling on you and you are pulling on it even if you aren’t touching it.

The reason neither of you is moving is because the force is very weak. Only when an object has a great deal of mass can you feel the pull.

**Center of Gravity**

Every object has a center of gravity through which the force of gravity seems to act. If its center of gravity is right over its base, an object is stable and will not fall over. But if the center of gravity leans too far off the base, the object may topple over.

If your base is your feet and you bend over too far, throwing off your center of gravity, you might fall on your head.

The members of the bobsled crew, when they lean one way or the other, are actually moving the center of gravity so that they won’t fall over on turns. They have to practice this a lot. If they lean too far, they could fall.

**Awesome Turns**

One of the most exciting parts of bobsled racing is the way the sleds make turns. Bobsled runs are almost like tubes in some places, and the sledders actually go up on the side as they shoot down the run.

Why don’t they fall off?

This can be explained in science by what is commonly called **centrifugal** (sen-TRIF-you-gal) force, and its companion, **centripetal** (sen-TRIP-eh-tal) force.

Centrifugal force describes the tendency of an object to continue in a straight line away from the center once it is in motion. Centripetal force is what pushes an object trying to go in a straight line back toward the center. When centripetal force is applied this way, it sends an object moving to the side in a circular motion.

You may have experienced this if you have been in a car that went around a corner fast, or if you have ridden on a spinning ride at an amusement park. You may have seen it if you have spun a jump rope around your head, or played with a Skip-It toy that attaches to your ankle and spins as you jump it.

On a bobsled run, the so-called centrifugal force is generated by the gravity and speed that sends the sled racing down the hill. When a sled hits a turn, the wall pushes back at the sled, forcing it to follow the curve. It is so great that even when the sled turns on its side, it does not fall.

**Luge**

A luge (LOOJ) is a one- or two-person toboggan that is somewhat like a sled. It races down an ice-covered track and can go as fast as 80 miles per hour.

The challenge is that racers have to lie on their backs and go feet first!

Because air causes wind resistance, or drag, luge racers and bobsled racers try very hard to make their sleds “streamlined.” In bobsled, the racers duck down as they make their runs. In luge, crew members lean back until they are almost lying flat.

In all speed sports, you see athletes trying to make their equipment streamlined. Helmets are smooth and sleek, uniforms are Spandex and shiny. Bobsleds look like bullets, or rockets. The word “streamlined” comes from the effort to create a smooth “stream” of air over the object. Jet airplanes are streamlined, and so are racing cars.

Cutting down on wind resistance is vital because a whole luge run takes only about a minute and winners are sometimes separated by as little as 1/1000 of a second. Wind resistance, or drag, can separate the winners from the losers.
Alpine skiing gets its name from the Alps, the huge mountains in Switzerland, Austria, France and Germany.

This sort of skiing is skiing down mountains at high speeds. Alpine skiing includes downhill competition, slalom and giant slalom. All are timed, with the fastest time determining the winner.

Downhill is simply racing as fast as you can from the top of a mountain to the bottom. The slaloms involve racing down a mountain on a zigzag course formed by poles stuck in the snow. In giant slalom, the gates are farther apart than the poles of regular slalom courses. Both kinds of slalom test the speed and control of skiers.

Unweight a Second

When slalom skiers zoom through their gates, you will notice that they bend their knees just before making the turn. There’s a special reason they do this. They’re “unweighting” themselves so that the turn will be easier.

Unweighting? Unweighting happens any time you bend your knees quickly. When you do it, you actually reduce the push of your weight on your feet, or in the case of skiers, on their skis.

You can test this with a set of bathroom scales and a friend.

Stand on the scales and have your friend take note of how much you weigh. Lower yourself quickly by bending at the knees. What happens to the reading of your weight? When a skier unweights at a slalom turn, it takes weight off the skis and makes it easier to turn them in a new direction.

Why does this work?

When you bend your knees suddenly, you remove the support from under your upper body, and it actually falls through space for a split second. Think of what it feels like in an elevator that goes down quickly. If you are quick enough bending your knees, even the weight of your feet will be absent.

Unweighting only lasts while your body is falling through the air. When you stop bending your knees, your skis actually experience more force from your body pushing against them.

Step Lively!

Even if you’ve never skied, you probably have experienced unweighting. What happens when you go barefoot and step on a sharp rock? You probably bent your knee, dropped your hips and rushed to shift your weight to your other foot.

By doing this, you reduced the force holding your foot against the painful stone—you unweighted your foot.

Can you think of other times you have felt unweighting?

Egg-cellent Position!

Downhill skiers also shift their bodies to reduce the air drag, the same way ski jumpers do (see Page 3). They have a different position, though, than the one used by jumpers flying through the air.

As they race down the mountain—pushed along by gravity—they crouch down low to present as small an area of resistance as possible to the oncoming wind.

This position is called “the egg.” It was developed after racing skiers were put in a wind tunnel, a tube designed by scientists to test wind blasted against objects. In the tunnel, the skiers tried out a variety of positions and the scientists measured which was best for avoiding wind drag. “The egg” proved to be the best way to smoothly get wind to flow over a body.

Dress for Success

What you wear affects how successful you will be as a ski racer. When watching skiing competition on TV, you will see that the Alpine skiers all wear sleek, form-fitting clothes, and streamlined helmets.

This is how the skiers achieve speeds of more than 60 mph. The helmets and clothes smooth the passage of air over their bodies. Super speed skiers, who can hit speeds of more than 120 mph, wear helmets that extend down to their shoulders, turning the head and shoulders into one smooth rounded shape.

USE THE NEWS

1. The scientific ideas that led to “the egg” position in skiing are also at work in the design of cars and other transportation vehicles. Look through the car ads in the paper and clip out pictures of five different cars. Rank them in order of effectiveness for resisting wind drag.

2. Sports equipment is designed to protect players without slowing them down. Find a piece of sports equipment advertised in the newspaper. Write paragraph explaining all the things it does for a person, and the features that are speed oriented. Follow up by designing a piece of sports equipment for speed for a sport you like. Compare designs as a class.
Freestyle skiing is one of the most colorful, challenging and exciting winter sports. It combines the speed of downhill skiing with the style of skating or dancing and the acrobatics of gymnastics.

It is a sport in which skiers get to express their creativity and talents.

Freestyle skiing got started with skiers who were bored by going through the gates of slalom racing and the straight soaring of ski jumping. In 1929 a European named Fritz Reuel first tried spins and pole flips. In the 1950s a Norway skier named Stein Erickson added flying leaps and spins.

In the 1960s American skiers really got interested. They were daredevils on the slopes and they gave the new sport a new name: Hot-Dogging.

Later, more serious skiers renamed the sport Freestyle Skiing.

Mogul and Aerial Skiing

Freestyle skiing competition comes in two parts: Mogul skiing and Aerial skiing.

In Mogul, skiers ski down steep slopes covered with bumps of snow called moguls. From this crazy surface the skiers must do jumps and maneuvers like twists and “helicopter” spins.

Aerial skiing involves skiers launching themselves off ramps called “kickers” and performing somersaults or twists in the air. Aerial freestyle is spectacular: great skiers may do three back somersaults and four twists in a single maneuver.

In for a Landing

One of the key skills freestyle skiers must learn is how to land. And that involves science.

When an object falls, it builds up momentum from the force of gravity. That momentum will continue to build up until it is stopped by a force, or by resistance.

In freestyle skiing, that force is provided by the ground, which in effect pushes against the falling object, causing it to stop.

When there is a high jump and a long fall, that can be a real collision. The bigger the object and longer the distance, the greater the momentum.

To soften the landing, skiers learn to “absorb” the force exerted by the ground.

To do that, they bend their knees as they land, and bend at the hips. This spreads out the force of the impact over a longer amount of time and makes landing easier.

Try This

Here’s a way to test the force of landing. Stand on the bottom step of a staircase. Jump off and land with your legs stiff. You should feel a jolt when your feet hit the ground.

Now leap from the bottom again. This time make contact first with your toes, then the balls of your feet, then your heels. As your feet make contact, bend your knees.

This is what cats do when they land softly on the ground—even when jumping from great heights. Doing this replaces one big force of landing with a series of little forces. And they bend their joints to soften the force.

After you have practiced this several times, give yourself a real test. See if you can jump off the first stair holding a paper cup of water. The goal is not to spill! If you get really good, jump off a small chair with your paper cup. Always wipe up spilled water between jumps.

An Egg Experiment

Here’s another way to look at making soft landings. You’ll need an egg and a bedsheet—and a place outside!

Have four students use the bedsheet to make a curved “wall,” with the bottom curled up in a kind of catch basin. Then have another student throw the egg at the sheet as hard as he/she can. Amazingly, the egg won’t crack. It will hit the sheet and drop unbroken to the catching area at the bottom. The sheet absorbs the egg’s momentum slowly so the egg doesn’t come to a full stop until about a second after it hits the sheet. But if you throw the egg against a wall, the egg stops in about a millisecond. The force of that IS strong enough to shatter the egg.

USE THE NEWS

1. Knowing how to land is not just something skiers need to know. It is something every athlete needs to know. Look through the sports covered in today’s sports section. Pick three sports and write a paragraph giving advice on how to fall and not get hurt.

2. Athletes and other workers often get hurt. And not just in one part of the body. Look through the paper for examples of people getting hurt in sports or on the job. For each injury you find, list what part of the body is affected.

3. Doctors recommend that people get exercise in order to build strength and stamina. People who are fit are less likely to get hurt. Look through the photos in the paper and make a class list of all types of exercise you can see. Stretch your thinking! At the end, rank them from the ones that offer Most Benefit to your body to those offering Least Benefit.
Cross-country skiing is just what it sounds like: skiing across the countryside, not down a mountain. That is not to say that cross-country skiing is all flat. There are still plenty of hills to go up and down. But it does not involve the steep slopes of mountains as Alpine skiing does.

That means cross-country skiers do not have the force of gravity to help push them along. They have to provide all the energy on their own most of the time. This is a lot of work and requires great endurance. It is also why cross-country skiing that people do for fun is considered such good exercise. It gets your heart pumping hard and burns a lot of calories.

Cross-country skiing is sometimes called Nordic skiing. The name comes from the Latin word *nordicus*, which means “north.” The snowy northern parts of the world were where cross-country got its start.

Cross-country skiers have a different challenge than downhill skiers. Downhill skiers are going one direction—down—so their main worry is how to make their skis go as fast as they can.

Cross-country skiers, however, are not always going downhill. They may have to travel for several miles at a time on flat ground or they may even have to ski uphill.

### Get a Grip

To move themselves, cross-country skiers have to push back against the snow with their skis and thrust themselves forward. It sounds impossible—skis that will slide when pushed in one direction, but grip the snow when pushed in the opposite direction.

Long ago, cross-country skiers solved the problem by attaching seal skin to their skis. That gave their skis the quality of a seal’s coat. Seals look smooth and shiny, but they are actually covered with short hair that lies down flat against their skin in one direction. When the skin is attached to the bottom of the skis, the hair lies flat when the skis slide forward, but it stands and catches the snow when they are pushed backward.

Today, the bottom of cross-country skis are designed to duplicate the effect of seal skin. Different waxes are also used on the bottom of some skis to increase the grip.

### Change of Approach

The grip skis get on snow is determined by friction. And in recent years the desire for more friction and stronger grip has changed the way cross-country skiers compete.

In earlier years, cross-country skiers skied in the straight tracks cut by previous skiers in the snow. That made for a smooth glide. But, after several skiers had used a track, it became slicker and offered less traction.

With the new approach, skiers reach outside the tracks with their skis, so they can place the skis in the snow at an angle. That way, the edge of the skis can grip the snow and give more push by creating more friction. International competition is usually divided into the two types. The old style is called “classical.” The new style is called “free.”

### Center of Gravity

One of the hardest things for beginners in cross-country skiing is learning how to keep yourself balanced over your skis while moving. In scientific terms, this is called using your “center of gravity.”

The center of gravity is the point in any object around which its weight is equally distributed. For example, try to take a pen and place it across your finger so that it balances perfectly. The point at which the pen stays without tipping is its center of gravity.

The same goes for the body of a skier.

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**USE THE NEWS**

1. **Balance is important to cross-country skiers.** Balance is important to other jobs as well. Look through the stories, photos and classified ads in today’s paper and make a class list of jobs that require good balance. Rank them in order, with 1 being the job needing the most balance.

2. **Men have a higher center of gravity than women.** Look again through the jobs you listed for Question 1. Which would be done best by women with a lower center of gravity? Which by men with a higher center of gravity?

3. **Cross-country skiing is not the only sport in which techniques have changed.** Look through the sports section and find others. Write a sentence stating what the change was for each. Write another sentence stating how it improved performance in each.

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**Men and Women**

Men and women are different when it comes to center of gravity. That is because there are general differences between men’s and women’s bodies.

Men usually have bigger, broader shoulders and more muscular chests and arms. Women have broader hips and more weight in the lower part of their bodies.

This gives men a higher center of gravity than women. When a man stretches forward, his high center of gravity shifts outside the zone above his knees and feet more quickly and he will fall over sooner. Because a woman’s center of gravity is lower, it remains within the balance zone longer.
Biathlon is a sport that could remind people of the James Bond movie The Spy Who Loved Me. Competitors ski over fields and hills and shoot rifles at targets.

The Biathlon not only tests the speed and endurance of the athletes, but their accuracy with weapons. It forces them to quickly shift from racing at full speed to calming their breathing and pulse so that they can shoot accurately. It requires that they be able to hit targets while standing up, and while lying down with their .22 rifles.

Biathlon had its beginnings in real hunting—when cold-climate people had to hunt for food. In winter, to speed their hunts, they used skis to travel over the snow.

Later, in northern Europe the same approach was tried by soldiers for military activities in cold climates.

**Body Control**

One of the biggest challenges for a Biathlete is learning to quickly shift from racing on skis to being so calm he/she can hit tiny targets with rifles. At peak racing, a biathlete’s pulse—the rate at which blood is pumped through the body—can jump as high as 150 beats a minute. That is about double a person’s pulse at rest. On top of that, a biathlete often arrives at the shooting sites breathing heavily.

Both high pulse and breathing are a problem. Shooting requires complete body calm. Even a twitch of an arm or hand can send a bullet off target. Misses result in penalties—in form of extra time added onto the score.

**Take Aim Scientifically**

Forces of science affect the bullet while it is in flight—and affect the aim of the shooter. Like everything else, a bullet is affected by the Earth’s gravity. The farther the bullet travels, the longer gravity pulls it down toward the ground. Eventually it will be pulled down completely.

Added to gravity is the effect of friction. The friction of the air also will slow down a bullet. As friction slows it down, it makes it easier for gravity to pull it toward the ground. Long distance shooters also have to take into account the pull of gravity and friction. To do that they have to aim just a little high for long distances.

**Under Pressure**

Science is at work in the shape of bullets. Bullets are pointed or rounded at one end, blunt on the other. Here is a way to test why.

Put a cup on the floor and place a piece of paper over it. Hold a sharpened pencil three feet above the paper. With the eraser end down, drop the pencil on the paper and note what happens. Next drop the pencil with the pointed end down.

Compare your results. You should see more damage to the paper in one of these tests. Does this help explain why bullets are shaped the way they are?

**How a Rifle Shoots**

Review the discussion of slap shots in the ice hockey section on Page 5. You’ll recall that Isaac Newton’s second law of motion stated that the rate of change in motion for an object—speeding up—is directly linked to the force applied to the object.

With a hockey slap shot, that force was applied by the swing of a hockey stick. With a bullet, it comes from an explosion.

A bullet contains several parts. One is the lead (pronounced LED) that flies out the barrel of a gun. One is the casing that holds the lead. And one is the gunpowder or explosive that is packed between the casing and the lead.

When the trigger of a rifle is squeezed, it activates a firing pin in the rifle. The pin slams into the center of the casing with such force it causes the gunpowder inside to ignite. This causes gases inside the bullet to expand or “explode.” The force of this blasts the lead out of the bullet, out the barrel of the rifle and off toward the target.

**USE THE NEWS**

1. Biathletes are judged on two distinct skills—skiing and shooting. Those skills are broken out as separate parts of competition. Look through the sports section of today’s paper. Can you find any other sports competitions that test different skills with different parts of competition? Write them out.

2. All athletes have to master different skills for sports—even if they are not judged separately as in biathlon. Look through the sports section today and pick three athletes you like. For each one, list as many skills as you can that the athlete has had to master to do well.
Curling is an unusual winter sport. But it is one that has great science. Curling is an ancient sport that got its beginnings in Scotland in the early 1500s. It is something like the game of shuffleboard that you may have played in gym class or on a playground. Like shuffleboard, you have to slide a game piece over a surface from great distance and try to place it on a target.

But curling requires much greater skill and strength. Instead of a gym floor, it is played on a sheet of ice nearly 150 feet long. And the game piece is a stone weighing 42 pounds!

Unlike shuffleboard, curlers put a spin on the stone, which can make it curve, or “curl,” as it travels over the ice.

Great curlers are so expert at this that they can actually shoot a stone around another stone on the ice and place it behind!

In competitions, curlers compete in four-person teams. Each player on the team shoots to see who can put the stone closest to the center of a 12-foot wide target, called “the house.” Points are awarded on the basis of which team has the most stones closest to the center.

Inertia

One scientific property that curlers have to overcome is inertia (in-ER-sha). This involves Isaac Newton’s first law of motion. This states that any body or thing will continue in its state of motion (or non-motion) until compelled by a force to act otherwise.

That means a thing that is moving will keep moving until something causes it to stop. It means a thing that is not moving will not move until a force compels it to.

The object affected by inertia in curling is the stone. It sits on the ice until a player forces it out of its stillness. Getting this 42-pound object to move requires both strength and skill.

Mass and Inertia

The inertia of an object is connected to the mass of the object. The more mass something has, the more inertia it will have.

Mass is the amount of matter in an object. Mass is different from weight. Weight is determined by gravity—the more gravity the more weight. If you sent a 300 pound football player to the moon, his weight would be only 50 pounds, because the moon has less gravity than the Earth. But the player’s mass would stay the same.

A 42 pound curling stone has a lot more mass than a hockey puck. Therefore it has more inertia than a hockey puck.

Curling the Stone

Why does a stone curl, or curve, when an athlete puts a spin on it?

Any moving object has a thin layer of air around it that “sticks” to it as the object flows through air. For an object moving without spin the layer moves around the ball, then separates from it at the back to form a wake of rough, or turbulent, air.

A stone with spin on it, moves differently. The turning motion of the stone pulls the air around it to the back and then gives it an extra shove. The effect of this is to push the stone in the opposite direction.

If you put a clockwise spin on a curling stone, the effect will be to curl it to the right. A counterclockwise spin will curl it to the left.

The same sort of thing happens with a baseball. Pitchers put spin on the ball to throw curves.

Friction Again

Like skiers, skaters and bobsledders, curlers have to deal with friction. One way the friction is reduced is by the design of the stone, which curves up toward the middle on its bottom. In curling competition you sometimes see curlers rapidly sweeping the ice with a broom. Sweeping the bristles against the ice produces heat by friction of the broom against the ice. As with ice skating, this produces a thin film of water on which the curling stone slides more easily.

Put Money on It

Here’s a way to see how inertia works. Place an Index card over a drinking glass and put a penny (or other coin) on the card. Flick the card off the glass by quickly snapping its edge with your finger so the card moves to the side. What happened to the penny? The penny has more inertia than the card. This means that it has greater resistance to changes in motion. Its inertia keeps it in place until the card has cleared the glass and gravity pulls the penny in.
SNOWBOARDING

**Balanced Course**

In competition a snowboard course is laid out symmetrically (sim-MET-ri-kal-ee). That means it is shaped the same on both sides of the middle. It is balanced in its design so that snowboarders will have equal opportunity if they put their left foot out front or their right foot. It’s the same as if they were using their hands and the course were being fair to those that are left-handed as well as right-handed.

Can you find examples of five things in your classroom that are symmetrical? List them on the chalkboard. Now find five things in the newspaper that are symmetrical and list them. Then find five that are not the same on both sides, or asymmetrical (A-sim-MET-ri-kal). Draw a symmetrical and an asymmetrical shape.

**Muscle Power**

Great muscle condition is important to snowboarders. In half-pipe competition, they may do handstands or other maneuvers in which their head is lower than their boards. They may perform airborne twists in which they reach down and grab their boards before landing. They may do spins of 360, 540 or even 720 degrees.

These degrees are not about temperature, but are the way circles are measured. A complete circle contains 360 degrees, so a 360 degree spin would be a complete circle. A 720 degree spin would be two complete circles.

Can you find examples of five things in your classroom that are symmetrical? List them on the chalkboard. Now find five things in the newspaper that are symmetrical and list them. Then find five that are not the same on both sides, or asymmetrical (A-sim-MET-ri-kal). Draw a symmetrical and an asymmetrical shape.

**On Top of Things**

What keeps the snowboarder from sinking into the soft snow on a mountain? The key is how scientific rules of pressure work.

You might be better able to understand the force of pressure with this illustration:

Two people who weigh the same amount are walking on deep snow. One person is wearing regular shoes and the other is wearing snowshoes, those big, wide attachments that go on your feet. The person wearing regular shoes will sink deeper into the snow.

The reason is that while their weight is the same, the snowshoes spread the weight over a larger area. As a result, the force under the equivalent portions snowshoe is weaker than under the regular shoe.

**USE THE NEWS**

1. Snowboarding started out as a game people made up for fun. They wanted to combine the thrill of skiing with the technique of surfing. Pick another sport from today’s paper. Think about how it is played, and write a paragraph stating how you think it came about. Then look up the sport in an encyclopedia. How close were you to the real beginning of the sport?

2. Can you find an object in the newspaper that requires that weight be evenly distributed? Which of the appliances for sale in the ads involve weight and might be affected by how the items are placed in it?
Speed skating first became popular in England in the 1870s. It became an international event in 1924 for men and in 1960 for women. In some competitions the skaters race in a pack. In others, only two skaters are on the track at one time. They are racing against the clock, not really each other. The skater with the best time in a competition wins.

You might think that speed skating is all about acceleration, or speeding up. When we hear the word accelerate, we think it means to speed up and in common language, it does. But in science any object that changes speed is accelerating. Even things that are slowing down are accelerating—scientists call this “negative acceleration” (commonly called deceleration).

In sports, acceleration just measures how quickly speed is increasing. How does acceleration affect speed skating?

Mass, or the size of the skater, might affect acceleration. An object with more mass needs a greater force to change speed. That’s why cars with more mass are usually built with bigger engines so they can get up to speed as quickly as smaller cars. But they also use more gas in doing so.

Newton’s second law of motion says that in order to accelerate, the greater the mass is, the greater the force must be. In plain words, the bigger something is, the more force you need to move it. Since skating is just a matter of force on the ice, the powerful skater will do better because he or she just powers along. Eric Heiden, a top medalist in 1980, for example, was over six feet tall and had thighs that were 29 inches around! Being so large, and in top condition, gave him enough force to be faster than anyone else.

If you watch speed skaters, you will see that they use an unusual body position when they compete. As they speed along the ice, they keep one hand behind them, and one swinging to the side.

The reason for this position is wind resistance, or “drag.” Speed skaters have found that bending over with only their head and shoulders facing into the wind cuts down the amount of surface area hitting the air and is the best way to reduce drag. (The arm that swings back and forth does so to maintain the skater’s balance.)

**Warming Up**

Warm-up exercises are an important aspect of athletics, especially for heavily muscled athletes like speed skaters. The purpose of a warm-up is to prepare specific muscles for strenuous physical activity. Slow stretching and bending give time for the body to increase blood flow to the proper muscles. This flow warms the muscles and delivers oxygen and energy that the muscles will need in a race. As a class discuss ways you could warm up and stretch your leg muscles before a race. Try spreading your legs side to side and front to back and stretching slowly. Cross your legs and slowly try to touch your toes.

**Warming Down**

Another activity that is often overlooked is the warm-down. Athletes do not lie down and sleep after playing a sport. If they did their muscles would take longer to recover from the strain of competition. Instead of resting immediately, they walk around or do slow exercises to allow the blood to restore their tired muscles. They do this to deal with lactic acid.

Lactic acid is a chemical that is created by the muscles when you work hard. It builds up in muscles when they do not get enough oxygen through blood to meet their demand. Your muscles will not ache after the blood removes this lactic acid. Warm-down exercises remove it for you by allowing blood to clear it from the muscles. The blood carries it to the liver, where it is broken down by the body.

**Fact or Friction**

Speed skaters want to reduce the friction on the ice so they can slide along it more easily. But what about the rest of us? Most people walking, riding bikes or driving cars DON’T want to slide on ice.

What controls whether you slide? Think of a car when its tires are spinning on an icy surface. Tires lose their grip—or “traction”—if they break away from the surface and start sliding. The car can move only if the wheels move very slowly so that they stick to the ice. Traction is created by using the natural friction between the tire and the ice.
Here are some more sports science facts—and experiments to try.

**Ski Skills Test**

Downhill and slalom skiers have to have good balance. You can try this test of the balance they use called “dynamic” balance.

Put on running shoes and stand on a hard surface (not a rug). Stand on your strongest leg (the one you kick with) and press your other foot against the side of the knee of the leg you’re standing on. Put your hands on your hips. Have a friend time you with a watch with a second hand. When five seconds have gone by, make a half turn by swiveling on the ball of your foot. Keep turning every five seconds until you take your hands off your hips or your foot off your knee.

This “dynamic” balance test shows how fine-tuned the muscle receptors in your legs are. If you did well, you might make a good downhill skier—or a surfer.

For a real challenge, try to stay balanced with your eyes closed!

**Don’t Get Up!**

You can use someone’s center of gravity to keep him or her in a chair.

Get a friend to sit with feet flat on the floor and back against the back of the chair. Put a finger against your friend’s forehead, preventing the head from moving forward.

Challenge your friend to stand up. He/she won’t be able to do it because as soon as your friend starts to stand there will be no support under his/her center of gravity. Your friend will fall back.

In order to stand up we need to put our center of gravity over our feet. Your finger keeps your friend from doing this.

**Slow-Twitch Experiment**

Your class can compare slow-twitch muscles by doing an experiment. Everyone will need two school or library books, one for each hand. Try for something heavier than paperbacks.

Take hold of the books and raise your arms until they are straight out from your shoulders.

The kids who can keep their arms out straight the longest have more slow-twitch muscles than the others in the class. Those who could not hold the books out for very long would probably be better at fast-twitch activities that require strong but short bursts of energy.

**Penny Traction**

Here’s an experiment you can do to test traction by using a penny. You will need a book, a protractor and a penny. Lay the penny on the book and slowly raise one end of the book. Using the protractor, measure the angle at which the penny begins to slide off the book.

After the first time you do this, repeat the experiment. This time give the penny a slight nudge at each angle. Which test penny had the greatest traction?

Finally, wet a piece of paper and then freeze it. Place it on the book and repeat the experiment. Does this reduce the traction?

Dizzy?

So why don’t spinning figure skaters get dizzy?

The answer is: They do! But they train themselves to not fall over. Dizziness, like balance, is controlled by your ears. The fluid in the inner ear has the tiny hairs moves when you start a spin. Only it lags a little behind. When you spin and then stop, you feel dizzy because the fluid is still moving.

How do skaters not feel dizzy the way everybody else does?

They use their eyes. They train themselves to focus instantly on a non-moving object as soon as they stop. This helps the brain sort out the signals it gets from the fluid in the inner ear.

A luge racer can go as fast as 80 miles per hour on an ice-covered track.
Winter Sports Word Find

See if you can find the winter sports words below among the letters on this page. They may be written left to right, right to left, up and down, or diagonally.

ALPINE
BIATHLON
BOBSLED
CURLING
FREESTYLE
FRICITION
GRAVITY
HOCKEY
LUGE
MOTION
SKI JUMPING
SNOWBOARD