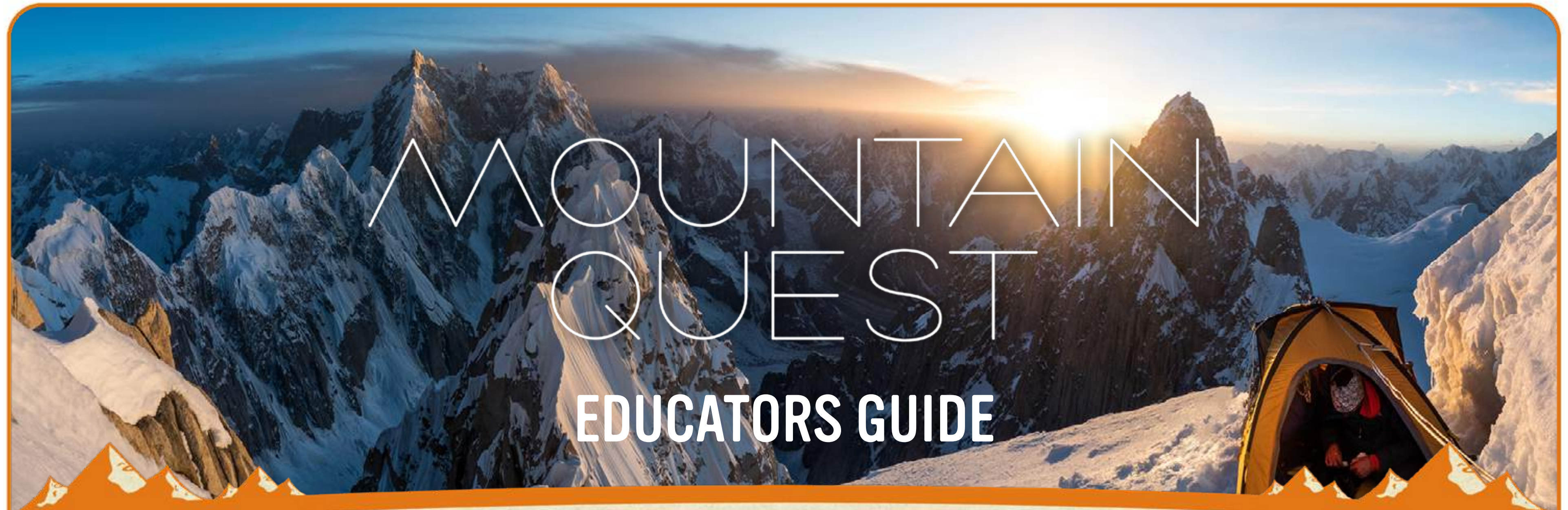
MOUNTAIN QUEST

EDUCATORS GUIDE



MOUNTAIN QUEST

EDUCATORS GUIDE

Welcome to the *MOUNTAIN QUEST* Guide for Educators!

On the following pages you will find five open-ended inquiry activities for grades four through eight, all directly related to *Mountain Quest* and exploring concepts in greater depth that the film introduces.

Here are a few important things to keep in mind as you read on:

1. Each activity is centered on a Challenge Question and includes background information regarding the science content. There are multiple ways to address these challenges – not one right answer. We want to encourage students to think independently and solve problems like scientists and engineers.
2. All activities are addressed directly to the student so that you can easily photocopy and distribute the pages to your class. The amount of supplies you will need depends on the number of students. Some activities are designed for students to work in teams. Although it might be messy to work with ice, we think it's well worth it for your students to understand its properties firsthand. We hope you'll grab a bag of ice from the grocery store and keep it in a cooler in your classroom.
3. We know there's a big difference between a fourth grader and an eighth grader. We encourage you to add more specific instructions if younger students need that, and the last step of each activity is for older students who want to find out more.
4. All activities are linked to the Next Generation Science Standards. Please see page 26 to make those connections.
5. We also have a selection of online resources on page 28 to provide more background information for you and research opportunities for your students.
6. The cameraman of *Mountain Quest* is an important part of the film's story. We encourage your students to take photos or video of their projects and share them with us at **info@k2communications.com**.

Written by: Jennifer Jovanovic

Special thanks to:
Leila Makdisi, Student Experiences,
Museum of Science and Industry, Chicago,
for her review of this guide.

An Overview of *MOUNTAIN QUEST* From the Filmmakers

Only three centuries ago, setting out to climb a mountain would have been considered close to lunacy. The idea scarcely existed that wild landscapes might hold any sort of attraction. Mountains were places of peril, not beauty. How then have mountains come to hold us spellbound, drawing us into their dominion, often at the cost of our lives? By the time Mount Everest was vanquished in the mid-twentieth century, mountaineering had become a quest for mastery rather than a search for mystery. Mountains were seen as adversaries to be overcome, places where fear could be taken to the edge – or beyond. Millions are now enchanted by the magic of mountains. And where once their remoteness protected their purity, mountains have today become theatres for recreation: managed and commodified as parks and playgrounds. But mountains are so much more than an escape, or an enemy to be overcome. Their greatest value lies in their power to inspire wonder and awe – to remind us of the limits of our schemes and ambition. Filmed by the world's leading high altitude cinematographers, with music by Chopin, Grieg, Vivaldi, Beethoven and new works by Richard Tognetti, artistic director of the Australian Chamber Orchestra, the film is directed by Jennifer Peedom, one of the co-creators of *Mountain Quest* with Richard Tognetti.

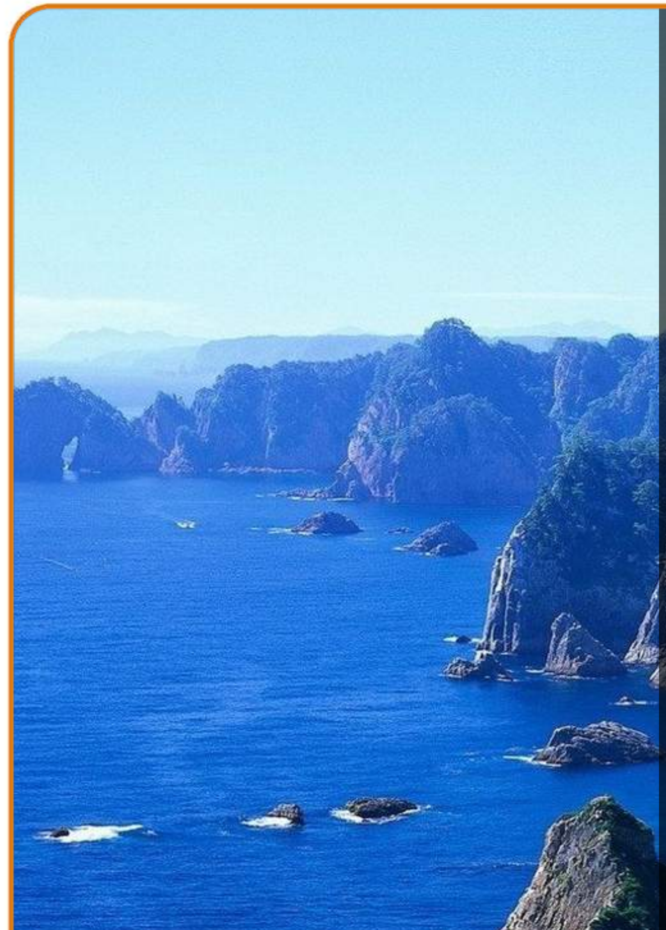
You will need for each team of two students:

- Two plastic plates
- ¼ cup brown sugar
- ¼ cup sand
- ¼ cup water
- Eyedropper or small spoon
- Magnifier

1. Create a small mountain at the edge of each plate, one of brown sugar and one of sand. Think: How will your mountains change as water flows down from the top?
2. Slowly add drops of water to the top of each mountain. How does the water change the shape of the mountains?
3. Use the magnifier to observe the liquid on your plates. How does the water affect the sugar and sand differently? What will happen to the liquid if you leave your plates out overnight?
4. Additional learning opportunity: Build a model showing the effect of weathering and erosion in forming one of the five different types of mountains – fold, block, dome, volcano, and plateau.

What is Gravity?
For both mountains and mountain climbers, gravity is a powerful force acting on them at all times. When rain falls or snow melts, gravity sends streams of water down the side of the mountain, relentlessly carving away at the rocks. Mountain climbers make use of all those cracks and crevices to hang on as they climb, but gravity is just as hard on them, constantly pulling them down to Earth, as they want to climb higher. For thousands of years we have been fascinated with gravity. You can try a very famous experiment by Galileo to determine whether the weight of an object affects the speed of its fall. If you drop a tennis ball and a basketball from the same height, which do you think will land first? The result may surprise you.

What Happened to the Sugar?
In this activity, you should see physical changes – sugar is soluble in water, so when it dissolves you no longer see the granules. If you leave the sugar water out overnight, the water evaporates and the granules reappear. The grains of sand are more noticeable too. In a chemical change, a new substance would be created. Both of these changes occur naturally in the water cycle and in the formation of mountains and rocks.

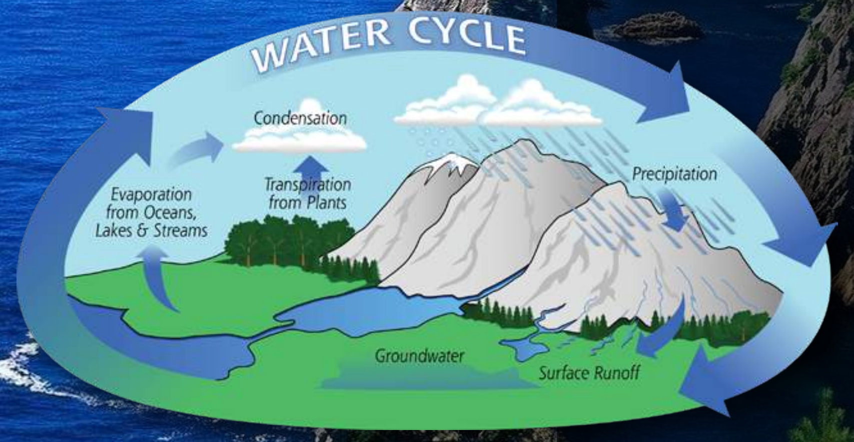


Ocean Today: The Water Cycle

You may think every drop of rain falling from the sky, or each glass of water you drink, is brand new, but it has always been here, and is a part of the water cycle. At its most basic, the water cycle is how water continuously moves from the ground to the atmosphere and back again. As it moves through this cycle, it changes forms. Water is the only substance that naturally exists in three states on Earth – solid, liquid, and gas. Over 96% of total global water is in the ocean, so let's start there. Energy from the sun causes water on the surface to evaporate into water vapor – a gas. This invisible vapor rises into the atmosphere, where the air is colder, and condenses into clouds. Air currents move these clouds all around the earth.

Water drops form in clouds, and the drops then return to the ocean or land as precipitation - let's say this time, it's snow. The snow will fall to the ground, and eventually melt back into a liquid and run off into a lake or river, which flows back into the ocean, where it starts the process again.

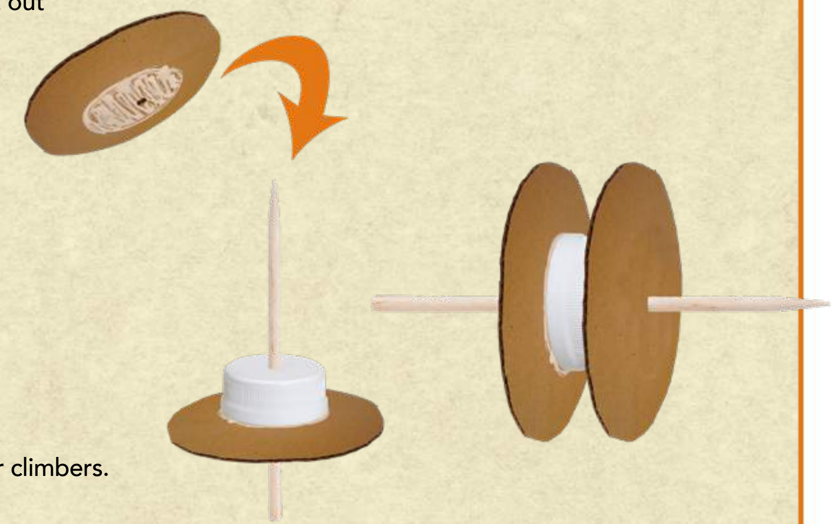
That's just one path water can take through the water cycle. Instead of snow melting and running off into a river, it can become part of a glacier and stay there for a long, long time. Or rain can seep into the ground and become groundwater, where it's taken up by plants. It can then transpirate to gas directly through the leaves and return to the atmosphere. Or, instead of being taken up by the plant, the groundwater can work its way up to a lake, river, spring, or even the ocean.



As you can see, the water cycle can be a very complicated process. And all its paths through Earth's ecosystems are complex and not completely understood. Water is essential to life on Earth, and fresh water is a limited resource for a growing world population. Changes in the water cycle can impact everyone through the economy, energy production and use, health, recreation, transportation, agriculture, and drinking water. And that's why understanding of the water cycle has become one of NOAA's Grand Science Challenges. NOAA studies all aspects of the water cycle – ocean, weather, precipitation, climate, ecosystems – and our impacts on it.

– National Oceanic and Atmospheric Administration; https://oceantoday.noaa.gov/watercycle/

Teacher Preparation: Use a pen to poke a hole in the center of each water bottle cap. Cut out two cardboard circles per student (or if there is time in class, they can do that themselves).



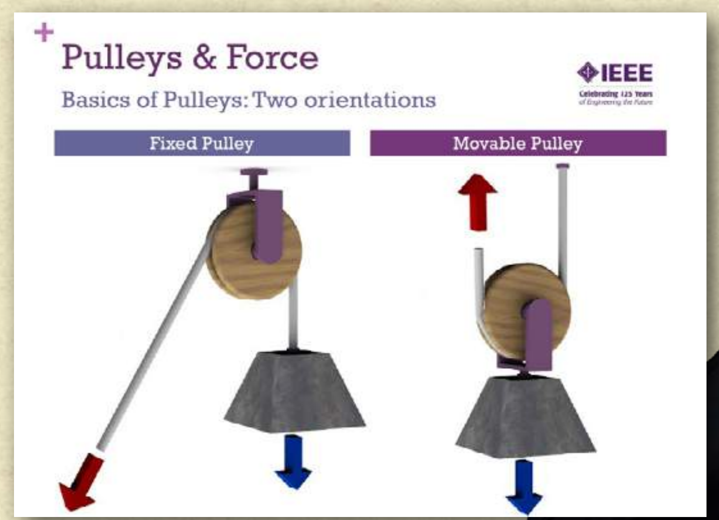
You will need:

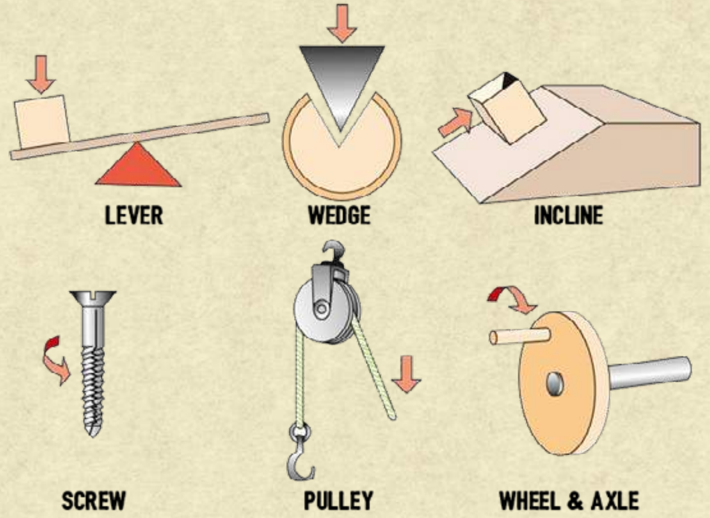
- Two cardboard circles, about an inch larger in diameter than the bottle cap
- Wooden skewer
- Plastic water bottle cap with hole in the center
- Glue
- Cotton string
- Fishing line
- Action figure
- Rocks that are about the same size as the action figure
- Packing tape

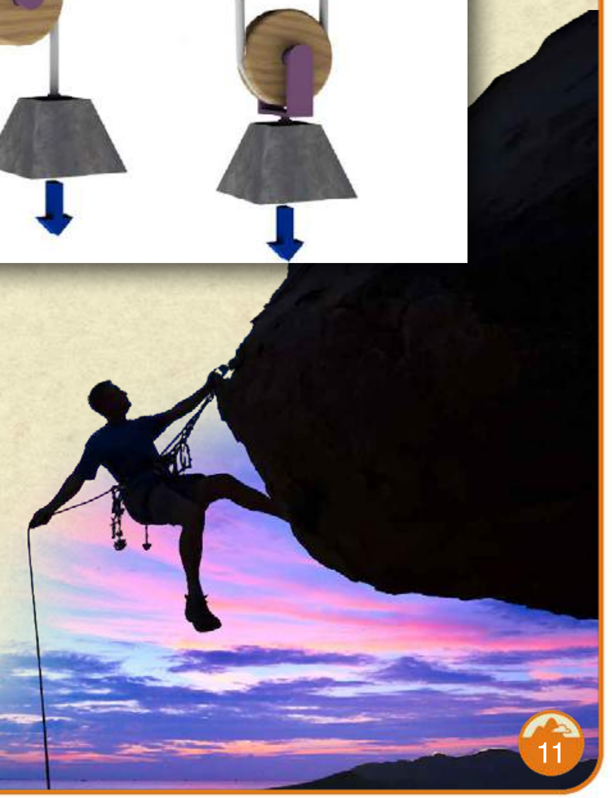
1. A pulley, an ancient simple machine, has been modernized to become indispensible for climbers. To understand why, try making your own.
2. Use the skewer to poke a hole in the center of the circles. Put the skewer through one circle and through the bottle cap.
3. Glue the bottle cap to the circle, as seen in the illustration. Glue the second cardboard circle to the other side of the bottle cap.
4. Set up your pulley on the skewer between two chairs, so that you have room to experiment. The top of the chairs represents the top of the mountain.
5. Wrap the string around the pulley and create a system for pulling the action figure (aka mountain climber) up the mountain.
6. Simulate an accident where the climber starts to fall, with or without the pulley. How can you stabilize him with the pulley system?
7. Additional learning opportunity: Try this again with the fishing line instead of the string. Which rope would you rather use if you were climbing? Why? Design an experiment to test the strength of each of the ropes.

What is a Pulley?

A pulley is a wheel with a cable (or rope) running through it. You can attach a heavy object (the load) to the pulley or cable and, when you pull on the cable (the effort), pulleys make it easier to lift the load. Climbers use a combination of fixed and movable pulleys to get their equipment – and themselves – up and down the mountain. A pulley is one of six "simple machines" that also include a wedge, a lever, a wheel and axle, an inclined plane, and a screw. The strength of the cable is very important in mountain climbing. If the cable breaks, the climber can fall and be injured. Nylon cable (like the fishing line) is stretchier and less likely to break than cotton.







Mountain Climbing Equipment and How It's Made

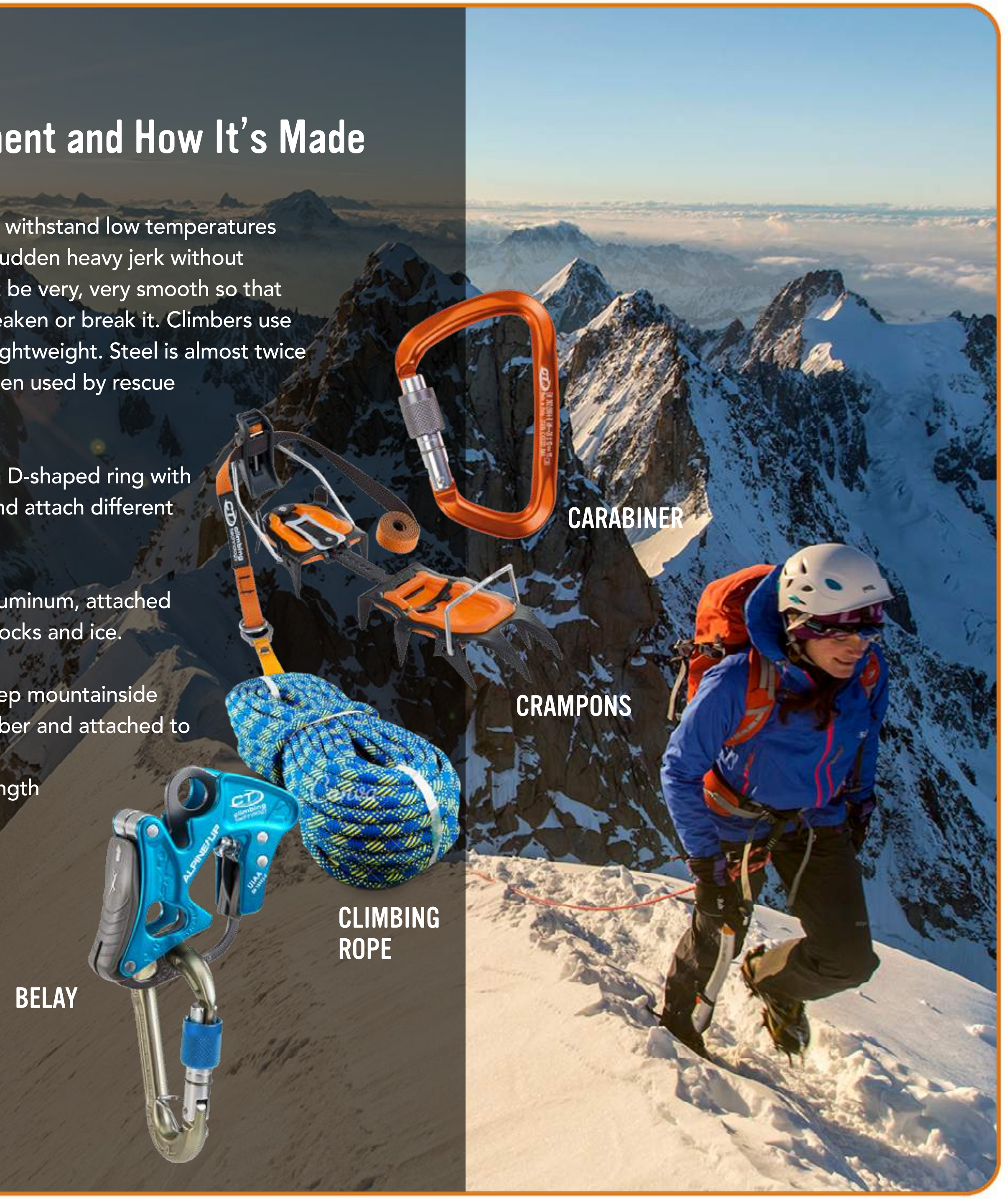
Climbing equipment must be strong enough to withstand low temperatures and, when a climber slips, be able to handle a sudden heavy jerk without breaking. The surface of metal equipment must be very, very smooth so that a rough spot doesn't rub against a rope and weaken or break it. Climbers use aluminum equipment because it is strong and lightweight. Steel is almost twice as strong as aluminum, but heavier, so more often used by rescue helicopters and firefighters.

A **Carabiner**, made from aluminum or steel, is a D-shaped ring with a safety closure, used by climbers to connect and attach different components of their equipment.

Crampons are spikes made from lightweight aluminum, attached to climbers' shoes to help prevent slipping on rocks and ice.

Rappelling is a technique for going down a steep mountainside using a doubled rope wrapped around the climber and attached to the mountain above. **Climbing rope** is made of interwoven strands of nylon, giving it both strength and flexibility.

Belaying is when one climber helps another by adjusting the tension on the other's rope, tightening it for stopping and loosening it for climbing. A **belay** device is a friction break on the rope that stops a climber from falling very far.



3. What are the different properties of ice, rocks and glaciers?

You will need:

- Plastic plate
- Two ice cubes
- Two rocks
- Sand
- Clay
- Water
- Clear plastic cup

1. Observe and test the ice and rocks separately under the following conditions: applying pressure, floating and sinking, applying heat through friction, or add a category of your own.
2. Describe the procedure for each test, for example, for pressure: "I will squeeze two ice cubes together for 60 seconds." That's just one idea. Feel free to create your own tests. There's no right or wrong answer.
3. Record your observations on the chart below. In the third column, record what you know about a glacier under the same conditions. Research glaciers at the library or online to fill in the details.
4. How can you combine the ice, clay, rock and sand on the plate to simulate the properties of a glacier?

	ICE	ROCK	GLACIER
PRESSURE			
FLOAT/SINK			
HEAT/FRICTION			
MY IDEA			

3. What are the different properties of ice, rocks and glaciers?

How Does a Glacier Move?

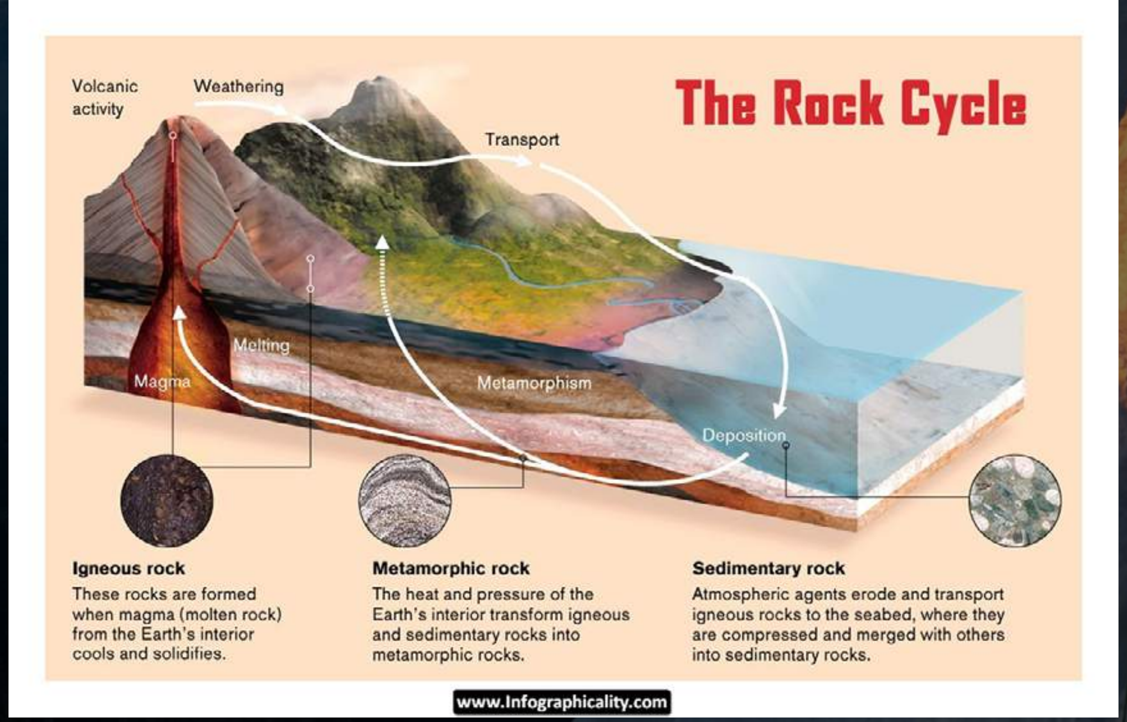
Glaciers are formed from compressed layers of snow that become ice, mixed with rocks, gravel and dirt. Glaciers move because of the pull of gravity on the ice. The pressure of glaciers changes the landscape as they move, slowly carrying rocks and soil across great distances over thousands of years.

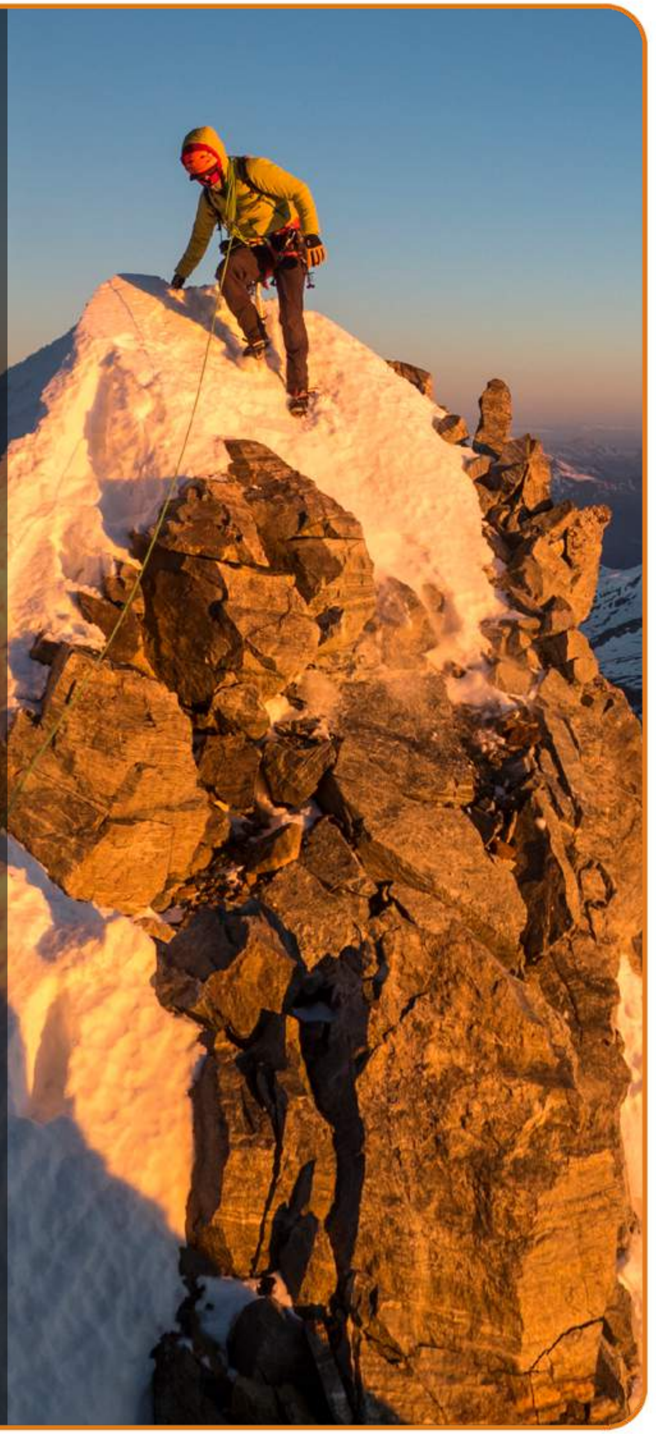
For an experiment you can eat, try simulating glacier movement with pudding and cookie crumbs. Cover a plate with cookie crumbs, angle it slightly and start the pudding sliding down from the top.

You can also simulate glacier movement with cornstarch, water, a sheet of waxed paper and some sand. First, make a cornstarch and water mixture that's not too watery, but still flows slowly. Position a small amount at the top of the wax paper. Add more and more and watch it start to move. Add sand around the edges and below the path of the glacier and see what happens.

What are the Three Different Types of Rocks?

Depending on where you live, the rock you used in this activity may be different. The three kinds of rocks (pictured below) are igneous, metamorphic, and sedimentary. Igneous rocks are formed from solidification of molten rock material. Metamorphic rocks come from deep inside the earth, modified by heat, pressure and chemical processes. Sedimentary rocks are a combination of other debris and particles. What kind of rock did you find?





4. How does the human body react to cold and altitude in the mountain-climbing environment?

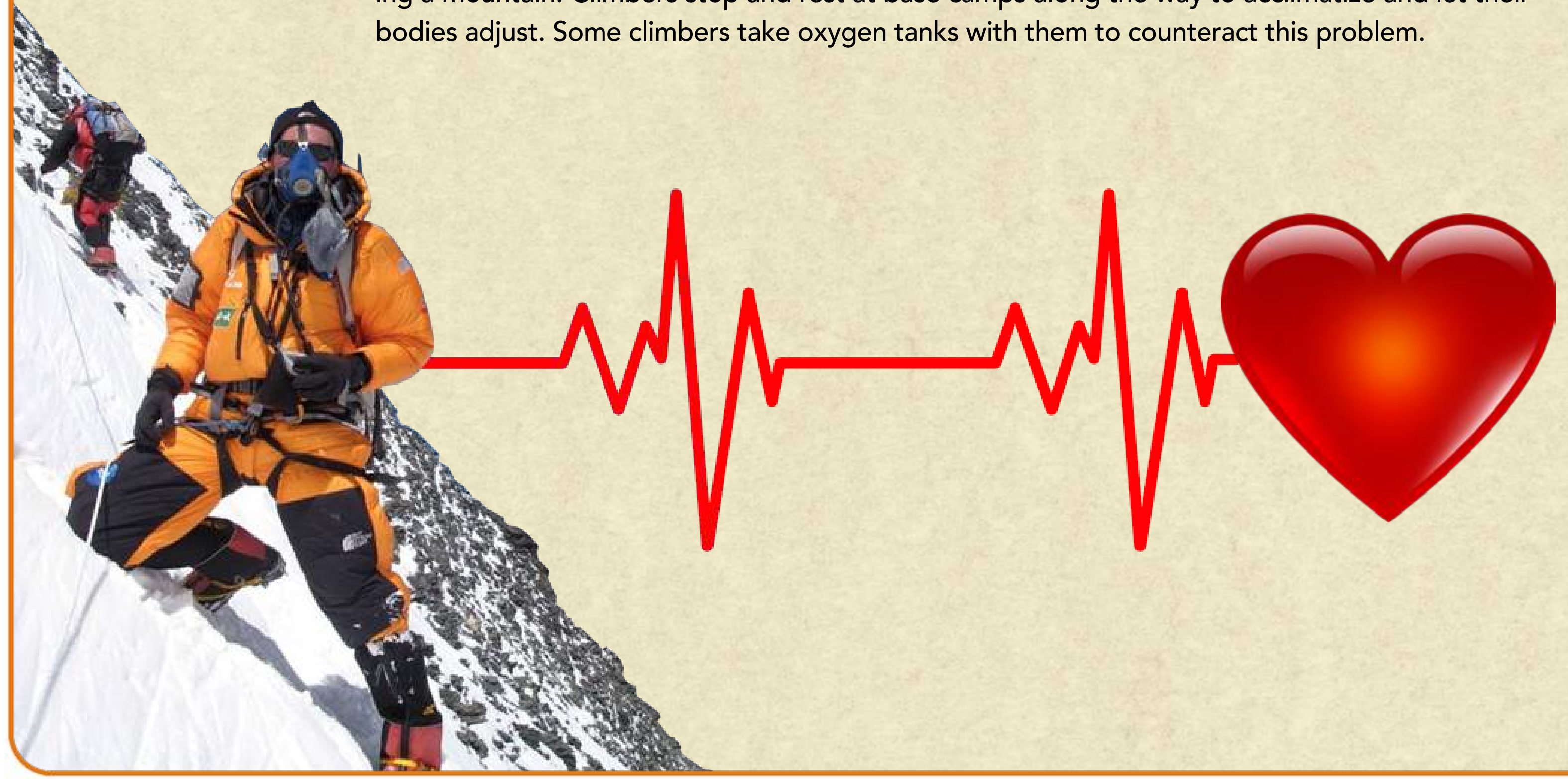
You will need for each team of two students:

- Timer or watch that measures seconds
- Squishy rubber ball that fits in your hand
- Backpack with something very heavy inside

1. First, let's see how hard your heart works at sea level (most people live at about sea level already, unless you live in Denver) when you're nice and comfortable.
2. Decide who will be the Timer, and who will have the ball. After you try this once, you can switch.
3. While the Timer watches the clock for 60 seconds, the other partner squeezes the ball as many times as possible, counting as you go.
4. Now switch roles and do the activity again. Discuss how this felt. You just simulated for one minute what your heart muscle does 24 hours a day! But you don't have to take our word for it; you can listen to your own heart beat.
5. Put two fingers (not your thumb) between the bone and tendon on the inside of your wrist and find the quiet thumping feeling of your pulse. You can also feel your pulse with two fingers on the side of your neck.
6. Choose someone to be Timer again. When the Timer says, "go," count how many thumps you feel for 20 seconds, when the Timer should say, "stop." Multiply that number by three and you will get your number of heartbeats per minute.
7. What do you think will change if you run in place for three minutes and take your pulse again? Challenge yourself by trying it with a heavy backpack, like a climber might carry. At 14,000 feet, your heart rate can increase as much as 50% higher than at sea level. How many beats per minute would that be for you?

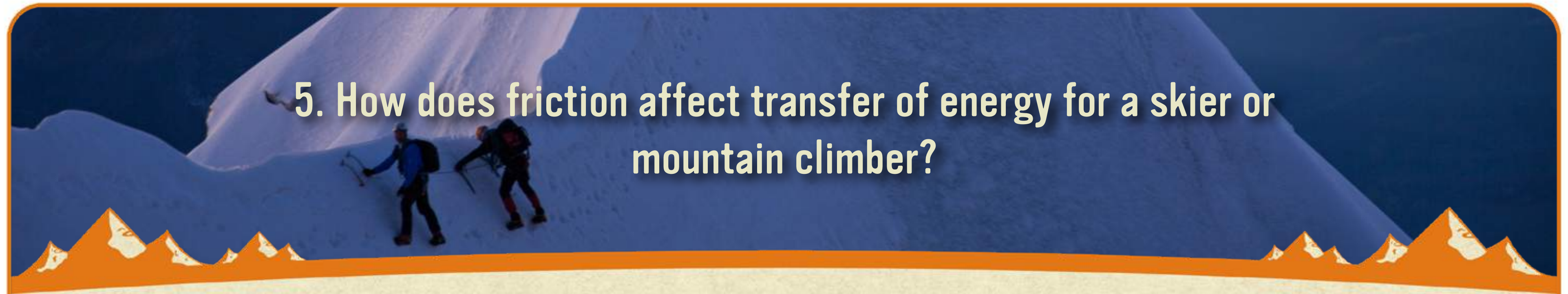
4. How does the human body react to cold and altitude in the mountain-climbing environment?

Why Does A Climber's Heart Have to Beat So Fast?
An average resting heartbeat at sea level is about 80 beats per minute. Being at high altitude makes your heart work harder because there is less oxygen available and your heart must beat faster to get that limited oxygen to the cells of your body. We all need oxygen to stay alive. The very low oxygen level at high altitude can cause confusion, headaches, shortness of breath and lack of coordination – all very bad things to happen anytime, but especially when you're climbing a mountain. Climbers stop and rest at base camps along the way to acclimatize and let their bodies adjust. Some climbers take oxygen tanks with them to counteract this problem.



How Do People Stay Warm?

Cold weather makes your heart beat faster, speeding up your circulation to keep your body warm. You also shiver – your muscles move and that generates heat. It's harder to breathe in cold air because the cold tightens up your airways. Mountain climbers wear scarves across their mouths so that their body heat helps warm the air before it goes into their lungs. You don't have to climb a mountain to figure this out. When it's cold outside, breathe in the air with a scarf around your mouth and again without it. Can you feel the difference? Mountain climbers wear clothing with layers of insulation that keep their body heat close. You can simulate an insulated boot by putting on a sock, then a plastic bag, and then another sock over that. How does that foot feel compared to the other one?



5. How does friction affect transfer of energy for a skier or mountain climber?

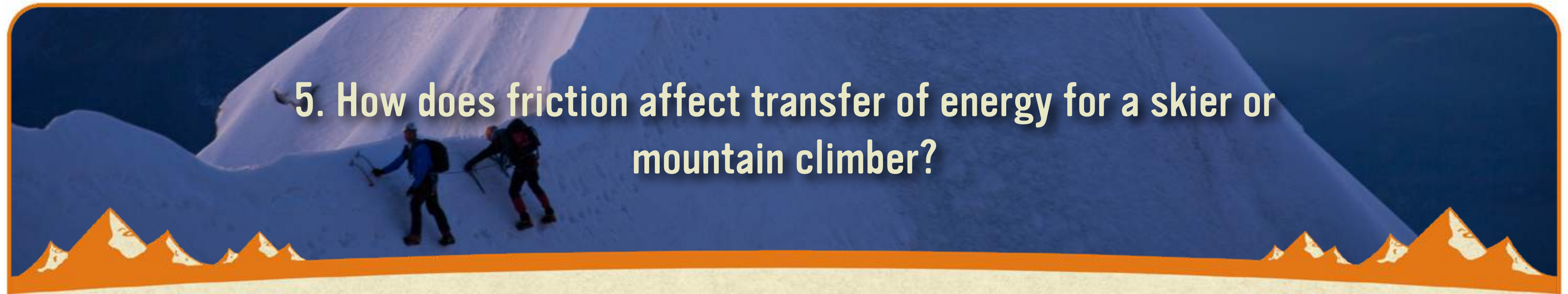
*Teacher Preparation**: Pour a layer of water over enough plates for every 2 students in your class. Freeze overnight. Bring the plates to school in a cooler and store in a freezer.

First, you will need to make some fake snow. Students will love helping with this. One disposable diaper will make enough for the whole class!

- Cut the diaper in half and carefully shake out the white particles into a clear plastic container, separating them from the cotton. The particles are sodium polyacrylate, a super-absorbent polymer that can absorb several hundred times its mass in water. It looks like salt and a small diaper will have about a tablespoon.
- Have the students take turns gradually adding water to the container and watch what happens. Discuss how the fake snow is different from real snow.

You will need for each team of two students:

- Disposable plate covered with a layer of ice*
- Wooden craft stick
- Fake snow
- Some or all of these materials: real snow if it's available, salt, sand, dirt, rubber bands, small plastic forks, pennies, paper clips, aluminum foil, paper towels, plastic bottle caps, ice cubes
- Other materials students would like to test
- Optional: Large plastic tray covered with layer of ice

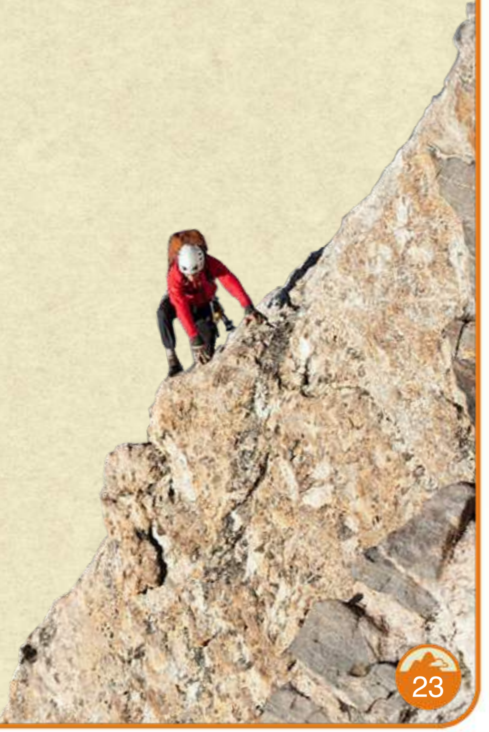


5. How does friction affect transfer of energy for a skier or mountain climber?

1. Study and observe all the materials and make your hypotheses, filling in the blanks:

	Fork	Sand	Paper Clip	Craft Stick
What material is it?				
What happened?				

2. Based on your hypotheses, choose a combination of materials to test from the group listed above.
3. Test your materials on an ice-covered plate. The first ski was just a piece of wood with a shovel on the front. We're guessing you can improve on that!
4. Consider variables that affect sliding. Surface area? Weight? Roughness? Shape? Heat conductivity?
5. Consider variables that affect the slipperiness of the ice. What do you expect to happen if you put sand, salt or fake snow on the ice? Be careful only to use these in a small section of your plate.
6. Record your data in a chart with the name of each material across the top and the way you tested it down the side of the chart.
7. Based on your observations, what materials and design would you use for a ski? Present your proposed design to your classmates.
8. Optional Finale: Test model skis by racing them down a large, ice-covered plastic tray.
9. Additional learning opportunity: Using the same materials, but with the goal of more friction rather than less, address this same challenge focusing on the design of a mountain climbing shoe.



What is Friction?

Two solid objects moving against each other create friction. Friction slows down motion, causing some of the kinetic energy to be converted into thermal energy, creating heat. Friction slows your materials down when they are sliding on the ice. Skiers want to reduce friction between their skis and the snow. Mountain climbers want to increase friction between their shoes and the snow and between their hands and the side of the mountain. Gloves need to be insulated, waterproof and flexible for gripping. When the weather is warm, sweat makes their hands slippery, so they apply chalk. You can try this yourself. Put your hand inside a plastic bag until it begins to feel damp. Now rub a piece of chalk over your hand and see what happens.

What Materials are Good Conductors of Energy?

If you experimented with the penny, paper clip or aluminum foil, you may have had a surprising result! What happened and why? Hint: Metals are excellent conductors, quickly moving heat from the air to the ice and cold from the ice back into the metal.

******If you don't have a freezer or cooler, you can substitute plastic plates, but they are not as slippery.*

Next Generation Science Standards and Related Activities for Mountain Quest

MS-ESS2-4. ***Earth's Systems.*** **Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.** [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.]

Activity #1: How do water and gravity affect the formation of mountains?

MS-PS1-3. ***Structure and Properties of Matter.*** **Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.** [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.]

Activity #2: How have developments in science and engineering improved mountain-climbing equipment and safety?

5-PS1-3. ***Structure and Properties of Matter.*** **Make observations and measurements to identify materials based on their properties.** [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.]

Activity #3: What are the different properties of ice, rocks and glaciers?

4-LS1-2. ***Structure, Function, and Information Processing.*** **Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.** [Clarification Statement: Emphasis is on systems of information transfer.]

Activity #4: How does the human body react to cold and altitude in the mountain-climbing environment?

4-PS3-3. ***Energy.*** **Ask questions and predict outcomes about the changes in energy that occur when objects collide.**

Activity #5: How does friction affect transfer of energy for a skier or mountain climber?

Resources

The Physics of Sliding on Ice
https://www.insidescience.org/news/physics-sliding-ice

Behind-the-Scenes of *Mountain Quest*: Cameraman Renan Ozturk
https://www.youtube.com/watch?v=AO7yBJQJTxo

Rocks: Igneous, Metamorphic, Sedimentary
http://geology.com/rocks/

Keeping Climbers Alive with Physics
http://physicsbuzz.physicscentral.com/2015/01/keeping-climbers-alive-with-physics.html

Keep from Slipping on the Ice
https://www.youtube.com/watch?v=qOAPZZRvbZ8

How Carabiners are Made
https://www.youtube.com/watch?v=goQRzSyNpb4

How Climbing Rope is Made
https://www.youtube.com/watch?v=EWmzdsfeeZM&t=6s

Learn This: Friction Science
https://www.climbing.com/skills/learn-this-friction-science/

An In-Depth Look at Pulley Efficiency
http://www.balancecommunity.com/slack-science/an-in-depth-look-at-pulley-efficiency/

Why Skis Slide
http://www.mechanicsofsport.com/skiing/basic_mechanics/why.html

Two Weeks in the Mountains Can Change Your Blood for Months
http://www.sciencemag.org/news/2016/10/two-weeks-mountains-can-change-your-blood-months

Types of Mountains
https://www.universetoday.com/29771/types-of-mountains/

The Water Cycle
https://pmm.nasa.gov/education/water-cycle

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https://www.globe.gov/do-globe/globe-teachers-guide