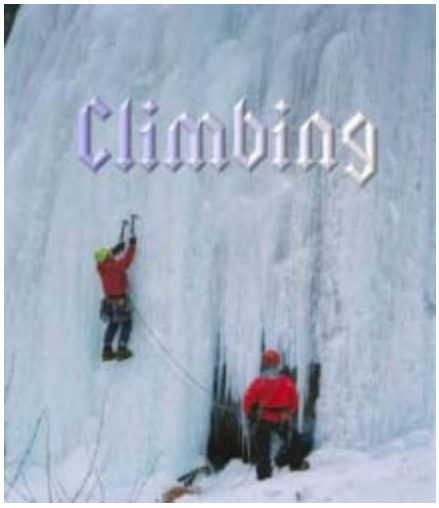
Rock Climbing



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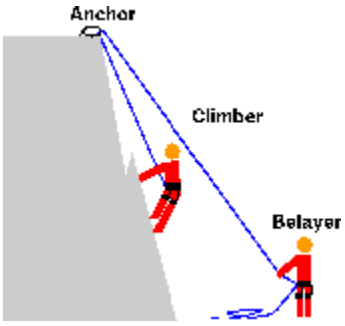
Climbing Gear Checklist

This page describes two ways of using ropes and equipment to climb safely. It also describes how to descend after climbing. Details about hand placement, foot placement, balance, and other technical climbing techniques are not described here.

Top-Roping and Belaying



In top-roping, a rope from the top of the climb always holds the climber, making most slips off the climb harmless. As shown above, the climber is attached to one end of the rope, the middle is passed through an anchor at the top of the climb, and the other end is held by the belayer.

The anchor at the top of the climb is assembled from loops of webbing connected to carabiners attached securely to the rock. The rope is passed through some of the carabiners, and the others are attached to either pieces of protection, wedged into a convenient crack, or bolts, which other climbers have drilled into the rock.

The anchor's carabiners with the rope passing through are suspended below the top of the climb to prevent the rope from rubbing. When bolts or protection are far from the top of the climb, substantial lengths of webbing are needed to place the carabiners correctly.

Not all climbs can be top-roped because of the following requirements:

1. There must be a safe way to the top to set the anchor before the climber starts. Most popular top-roped climbs have an easy way to hike to the top.
2. The climb may be no longer than half the length of the rope; when the climber starts, the rope must cross the full length of the climb twice.
3. The belayer stops the rope with a belay device attached to his harness if the climber slips. The belay device makes it easy to apply enough friction to stop a falling climber. If there is some danger of the belayer being lifted into the air, he can be anchored down.
4. The belayer must keep the slack in the rope to a minimum since when a climber slips, any slack must be taken up before the rope can stop the fall. To take up this slack, the belayer pulls the rope downward as the climber climbs. While doing this, the belayer must never release the rope fully to ensure the climber could never fall far.

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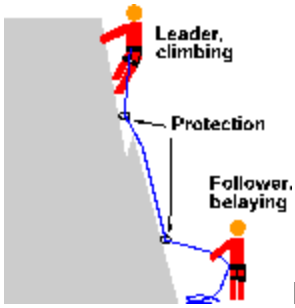
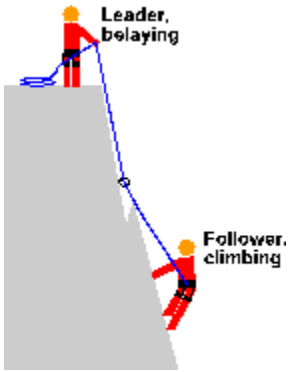
Lead Climbing



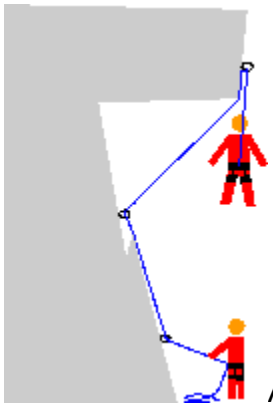
In lead climbing, two people, a leader and a follower, ascend the climb in pitches: sections of the climb shorter than the length of the rope.

First the leader climbs the pitch, wedging pieces of protection into the rock and attaching the rope to them with carabiners.

Once the leader makes it to the top, she anchors herself to the rock and belays the follower, who climbs the pitch, removing the protection. Finally, both the leader and follower are at the top of the pitch with all their gear, ready to climb the next pitch.



The leader's job is dangerous. Unlike top-roping, where slipping off the rock usually doesn't result in a long fall, a leader can fall twice the distance from the last piece of protection before the rope can help. The figure below depicts a fairly pleasant lead fall--the leader has fallen and is dangling in midair. More often, the leader will hit the rock on the way down--a common cause of climbing injuries.


A "quickdraw"--two carabiners attached with a loop of webbing--is used to fasten the rope to a piece of protection. One carabiner is attached to the loop on the piece of protection, the rope is passed through the other. This provides some separation of protection a rope, allowing the rope to twist without dislodging the protection, pass more smoothly past the protection, and go more directly up the climb.

Ideally, so the rope is not forced to go around friction-increasing corners, the protection should be along in a straight line between belay stations. This is not always possible, so longer pieces of webbing in the quickdraw are used to make the path of the rope straighter.

Lead climbing places fewer restrictions on what can be climbed than top-roping. The two requirements are:

1. There must be places for a belayer to be secured to the rock (``belay stations'') spaced no farther than the length of the rope. Most popular lead climbs satisfy this.
2. There must be places to attach the rope to the rock. In rock with many cracks, protection, especially SLCDs, can easily be used. Occasionally on smooth rock, other climbers have drilled permanent bolts into the rock that can be used with a quickdraw to attach the rope to the rock. Getting Down There are three common ways to get down from a climb: walking, Rappelling, and lowering. Walking Often, climbers get down from the tops of climbs by walking. It is especially common to do this with top-roped climbs, since most have a way to hike to the top to set the anchor. Most multi-pitch lead climbs do not have a way to walk down from every belay station, but there is often a way to walk down from the top.

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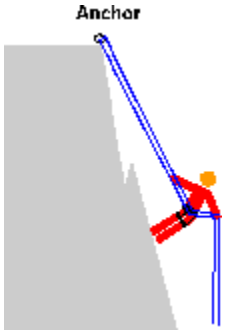
Rappelling



Rappelling is a scheme for lowering yourself with the rope. As shown above, the center of the rope is passed through an anchor at the top of the climb. The person descending wears a harness and attaches himself to the rope with a belay device, which he uses to control his descent.

Unlike climbing, it is best to be nearly horizontal while Rappelling. In this position, the body is pointing more directly at the rock, giving the feet better friction and leading to more control.

Starting a rappel is the most difficult part. It is very disconcerting to switch from standing to being supported completely by the rope. Moreover, it is necessary to get below the anchor before the rope can help. If the anchor is below the top of the climb, climbing down is necessary.

Once everybody has descended, the rope is recovered by pulling it through the anchor. The anchor cannot be recovered, but this is not usually a problem. In many cases, other climbers have placed a permanent anchor at the top, often a pair of bolts drilled into the rock connected to a ring with some chains. Another possibility is to use the base of a tree as an anchor. Since the rope is under little tension when it is pulled through the anchor, this abrades the rope and tree only slightly, and can be done occasionally.

A single rope can only be used to descend half a rope-length, but two ropes can be tied together to rappel a full rope-length. This is useful, for example, when descending a multi-pitch lead climb via the same route used for the ascent. The belay stations, usually spaced a full rope-length, can be used as rappel anchors. Three or more ropes cannot be used to rappel in this manner, since doing so would require Rappelling past a knot and pulling a knot through the anchor, which are generally impossible.

Lowering In a top-roped climb, the belayer can lower the climber. The climber places her weight on the rope, and the belayer slowly lets out the rope, using the belay device to control her rate of descent, much like Rappelling.

This is the most convenient way to descend after completing a top-roped climb. Although there is usually a way to walk down, it can be inconvenient to finish a top-roped climb because you must climb above the anchor, which is often suspended below the top of the climb.

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Equipment

Although it is possible to climb rock without equipment, it is difficult to do so safely. All of the equipment discussed in this section is exclusively for safety, except for shoes. Climbing shoes enhance climbing ability much like running shoes enhance running ability.

The following sections discuss climbing shoes, rope, general-purpose devices for connecting things, nylon cord, harnesses for connecting climbers to things, devices for applying friction to the rope, and devices for wedging into the rock.

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Shoes

The most useful piece of climbing equipment is a pair of climbing shoes. Improvements in shoe design alone have allowed climbers to climb many things previously unclimbable. The modern climbing shoe has a stiff, smooth rubber sole that protects the foot from sharp, rough rock, and provides more friction than a bare foot. A pair costs between $100 and $150.

Climbing shoes fit tightly to prevent the foot from sliding around within. This makes them uncomfortable, but the improved friction and control they afford far outweigh the discomfort.

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Rope

A modern climbing rope, a key piece of safety equipment, is of kernmantle construction, consisting of continuous braided nylon fibers, the kern, surrounded by a continuous braided nylon outer sheath, the mantle. Such construction is superior to the more traditional laid rope (three large strands twisted together) because the outer sheath protects the inner core, where most of the strength lies, from the elements.

Climbing rope is dynamic: able to stretch a bit under tension. This is because the rope must stop falling climbers. If the rope did not stretch, a falling climber would be jerked suddenly as the rope stops him. Instead, the rope slows his fall more gently. Climbing ropes are usually ten to eleven millimeters in diameter and fifty meters (about 165 feet) long. Such ropes cost between $100 and $180.

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Carabiners

Carabiners, used constantly in climbing, are rings of solid aluminum with a spring-loaded gate that allows them to be opened. Normally, the spring holds the gate closed, but the gate can be opened to admit a rope.

Carabiners are inexpensive (between $5 and $20), strong (most are rated to hold at least 20 kN, about 2.2 tons), and versatile. Virtually every climbing technique uses carabiners.

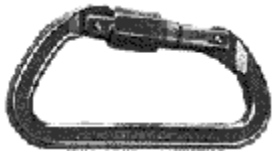
 "D" Carabiner

 Oval Carabiner

There are many variations on the basic carabiner design. The carabiner shown above is a ``D'' because the ends have an asymmetric shape that tends to push the rope against the solid side, away from the weaker gate side. An older variant , the oval, has no such asymmetry, and is not as strong. Another variant, the bent-gate , has a curved gate that makes inserting a rope easier. However, the bent gate also makes it easier for the gate to work itself open, making it less safe than other varieties.

 Bent Gate Carabiner

A carabiner is safe until its gate opens. To increase security, two carabiners can be used in tandem with their gates reversed (i.e., opening in opposite directions). It is less likely that something would cause both gates to open at once.

 Locking Carabiner

An alternative to a pair of carabiners, the locking carabiner (shown above) has an additional mechanism that makes it harder for the gate to open accidentally: a sheath that covers the gate and the outer C-shaped portion of the carabiner. This sheath either screws into place, or uses a spring to hold it in place.

Each variety is well-suited to certain applications. The ``D'' is the most versatile, although it must sometimes be used in pairs for added security. The oval is used where its symmetry is desirable, typically on longer routes. The bent-gate is excellent for rapidly securing the rope, although it is slightly less safe. Locking carabiners are best when taking the extra time to attach them is not a problem.

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Webbing

Tubular nylon webbing is used frequently in climbing. It is made of nylon woven into a flat tube an inch across. It is very strong (its tensile strength is about 18 kN, about 2 tons) and inexpensive---about $0.25 a foot.

Unlike climbing rope, it does not stretch under tension. If not expected to stop a long fall (and it is never used in a situation where it is), this is preferable.

Nylon webbing is most often used tied into a a loop. Climbing stores sell it by the foot, and it can be easily cut to any desired length. The ends are cauterized with heat to prevent fraying. Also popular is pre-sewn webbing---loops of webbing sewn (as opposed to tied) together at the factory.

Pre-sewn webbing is more expensive, more convenient (since there is no knot), and may be safer, but custom-tied loops are cheaper and adjustable.

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Harnesses

To attach herself to a rope, a climber uses a sewn harness. A typical one has a wide nylon belt for the waist and a pair of leg loops for the thighs. When a climber is supported by such a harness, most of her weight is placed on her legs, rather than her waist, making it fairly comfortable to hang in.

Many variations are available. More expensive harnesses have more padding. Adjustable-diameter leg loops are another option. Sewn harnesses cost between $30 and $80. A climber ``ties in'' to the rope by putting a loop of rope through the loops on his harness, as shown above. The traditional knot for this is the Figure Eight Follow-through. C. Leubben's Knots for Climbers (Chockstone Press, Evergreen, Colorado, 1993) describes this knot along with many others used in climbing.

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Belay Devices

A belayer's job is to hold the rope to stop a falling climber, which is difficult without the aid of a belay device---an object capable of stopping the rope or passing it through smoothly. There are many such belay devices, and are all easy to use, making them very safe.

One common belay device is the figure-eight: two metal rings about an inch in diameter joined in the shape of an 8. A loop of rope is passed through one of the rings, then around and under the other. The ring without the rope is clipped to the belayer's harness with a locking carabiner. When pulled tight, the rope is bent into four ninety degree angles in the space of a few inches, making it very difficult to move. A figure-eight costs between $15 and $20.

A disadvantage of the figure-eight is its tendency to twist the rope as it passes through. Another style of belay device, typified by the ATC (Air Traffic Controller) depicted at left, avoids this problem by twisting the rope less. These devices typically have two holes just large enough to pass a loop of rope through. The loop of rope is attached to a carabiner such that when one end of the rope is pulled, the belay device approaches the carabiner and pinches the rope. This provides highly variable rope friction, ranging from very little to enough to support a falling climber.

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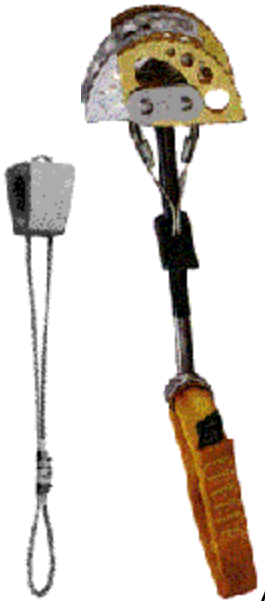
Protection (Monolithic Protection and SLCDs)

There are two common types of monolithic protection: tapered wedges and hexes. Both are made specifically for climbing from lightweight aluminum. In use, both are wedged into cracks in the rock so that they are difficult to remove in one direction (usually down) and easy to remove in another (usually up).


A tapered wedge, shown above, is a trapezoidal piece of aluminum (one to three centimeters across) attached to a loop of steel cable.

A hex is a hexagonal tube of aluminum with a diameter roughly equal to its length, between one and six centimeters. A strong piece of cord is threaded through two pairs of little holes on opposite sides of the hex and tied into a loop.

A spring-loaded camming device (SLCD) consists of a stem with an axle at one end holding four spiral-shaped spring-loaded cams. When placing an SLCD, the climber pulls a mechanism to retract the cams places it in a crack with the stem pointing down, and relases the mechanism, allowing the cams to spring back against the rock. When the SLCD is pulled downward (say, because of a fall), the spiral-shaped cams are forced harder against the rock, making it more secure.

SLCDs are much easier to use than monolithic protection. They can adapt to the rock and hold themselves in place, making them usable in more situations. They have allowed climbers to climb many routes that were too dangerous to climb using other types of protection.

The main disadvantage to SLCDs is cost: $50 to $100 each is typical. However, since each SLCD can adapt to a wider range of crack sizes than their monolithic counterparts, so only four or five sizes are needed.

SLCDs also have the dangerous ability to ``walk.'' If not under tension, a SLCD can easily move in one direction, usually farther into a crack. This can make it difficult to remove, or more dangerously, move it to where it no longer holds. Monolithic protection usually doesn't do this, since it is usually firmly wedged into the rock.