MERIT BADGE SERIES

PIONEERING

Scouting America

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PIONEERING

"Enhancing our youths' competitive edge through merit badges"

Scouting America

Note to the Counselor

This edition of the *Pioneering* merit badge pamphlet takes an activity-based approach — Scouts will spend most of their time applying the pioneering skills they acquire. The prerequisite for this kind of approach is having all the necessary materials available, in the quantity needed, well organized, and ready to use. Therefore, counselors should be thoroughly acquainted with requirements 3 and 9 and the materials and procedures necessary for their completion. They should be prepared to provide the grounds for Scouts to have the kind of fun that comes through experiencing a well-run presentation of pioneering.

As such, those conducting this merit badge must have the knowledge and skills put forth in the pamphlet's contents. The pamphlet is organized so the information presented follows the requirements in their given order.

The objective of this merit badge is to have Scouts experience how the required skills are put into action, so they can rely upon them to successfully build things with ropes and poles. This merit badge will give Scouts the wherewithal to use what they gain throughout their lives as well as share with their units what they learned and experienced.

As with any good Scouting program, the three "Ps" of good Scout pioneering are **Planning**, **Preparation**, and **Presentation**

35931
ISBN 978-0-8395-3377-1

2024 Printing

Note to the Scout

Pioneering is about using what you know and what you have to make life outdoors easier and to get things done. It has played a major role in Scouting for over 100 years. Lord Baden-Powell, Scouting's founder, said, "Pioneering is practical and character-building: the two essential ingredients of any program material for Scouts." The main reason Scouts do pioneering: It is a lot of fun.

Pioneering is knowing how to use simple materials to build structures, sometimes referred to as "backwoods engineering." Throughout history, people have used ropes, spars, and simple hardware to build bridges, towers, and shelters. In the early days of our country, pioneering was used in mining and transportation, to clear the wilderness, and to build roads and bridges. The same skills can be used by Scouts to build pioneering projects ranging from a simple camp gadget to an elaborate gateway or bridge.

Another quote by Baden-Powell: "Pioneering develops initiative and resourcefulness. Additionally it gives practice in team work and discipline." You also get to use or play with what you've built.

In all Scouting activities, safety must come first. It follows that the first requirement for the merit badge includes reviewing safety tips.

Pioneering legend John Thurman said, "There's only one activity where it pays to start at the top, and that's swimming." That means before you can build sturdy bridges, dependable rafts, ingenious camp gadgets, and impressive gateways, you need to start at the bottom. You must become well acquainted with effective, time-tested ways to use your materials. As you take each step toward the completion of this merit badge, you'll put what you learn into action so your skills can be applied to completing projects that are safe and that work the way they're intended.

Pioneering skills are more than just knots and lashings. You must also learn how to plan and use teamwork. Principles of physics, geometry, and math come into play to build pioneering structures.

This pamphlet is geared for a practical, hands-on application. Pioneering provides the joy of accomplishment that comes when you've built something for yourself or others, whether it's for a practical purpose or just something fun to play with.

The projects shown in this pamphlet can be constructed with materials available during summer camp, at district or council camping events, and during special sessions with your counselor.

In addition to being a merit badge reference, this pamphlet is designed to serve as a field guide. It's filled with how-tos and suggestions. But when building your pioneering projects, do not rely solely on this pamphlet. Pioneering is also about relying on one's resourcefulness, creativity and ingenuity, along with a healthy dose of good sense. **Happy pioneering!**

Requirements

Always check www.scouting.org for the latest requirements.

1. Do the following:

   (a) Explain to your counselor the most likely hazards you might encounter while participating in pioneering activities and what you should do to anticipate, help prevent, mitigate, and respond to these hazards.

   (b) Discuss the prevention of, and first-aid treatment for, injuries and conditions that could occur while working on pioneering projects, including rope splinters, rope burns, cuts, scratches, insect bites and stings, hypothermia, dehydration, heat exhaustion, heatstroke, sunburn, and falls.

2. Do the following:

   (a) Demonstrate the West Country method of whipping a rope.

   (b) Demonstrate how to tie a rope tackle and the following knots: clove hitch formed as two half hitches, clove hitch on a bight, butterfly knot, roundturn with two half hitches, and rolling hitch.

   (c) Demonstrate and explain when to use the following lashings: square, diagonal, round, shear, tripod, and floor lashing.

3. Do the following:

   (a) Using square and tripod lashings from requirement 2c, build a tripod wash station (or with your counselor's permission, another camp gadget of your own design).

   (b) Using rolling hitches or roundturns with two half hitches, and round lashings from requirements 2b and 2c, build a 15-foot Scout stave flagpole (or with your counselor's permission, another camp gadget of your own design).

   (c) Using shear, square, and floor lashings, clove hitches on a bight, and rope tackles from requirements 2b and 2c, build a simple camp table (or with your counselor's permission, another camp gadget of your own design).

4. Explain the differences between synthetic ropes and natural-fiber ropes. Discuss which types of rope are suitable for pioneering work and why. Include the following in your discussion: breaking strength, safe working loads, and the care and storage of rope.
5. Explain the uses for the back splice, eye splice, and short splice. View a demonstration on forming each splice.
6. Using a rope-making device or machine, make a rope at least 6 feet long consisting of three strands, each having three yarns. Whip the ends.
7. Explain the importance of effectively anchoring a pioneering project. Describe to your counselor the 3-2–1 anchoring system and the log-and-stake anchoring system.
8. Describe the lashings that are used when building a trestle, how the poles are positioned, and how X-braces contribute to the overall structural integrity of a pioneering project.

Unless appropriate measures have been taken, materials should be brought to the building site, and as always while engaged in pioneering activities, Scouts should practice the **Leave No Trace Seven Principles** and **the Outdoor Code**.

9. Working in a group, (or individually with the help of your counselor) build a full-size pioneering structure, using one of the following designs in the merit badge pamphlet:
   - Double A-Frame Monkey Bridge
   - Single A-Frame Bridge
   - Single Trestle Bridge
   - Single Lock Bridge
   - 4x4 Square Climbing Tower
   - Four Flag Gateway Tower
   - Double Tripod Chippewa Kitchen
   - Another type of structure approved in advance by your counselor

   Carefully plan the project, assembling and organizing all the materials, referring to the points under Safe Pioneering, and complying with the height restrictions in the *Guide to Safe Scouting*.

Contents

Safe Pioneering

With the challenges, fun, and rewards of pioneering, there can be no substitute for smart behavior and common sense. As you begin your pioneering activities, safety must be your first consideration.

Always keep in mind the following safety points:

- Before and after each use, check all equipment, ropes, poles, tools, and hardware to ensure they are in good working condition.
- All equipment should be treated with respect and used appropriately for its intended purpose.
- Appoint a safety officer who, along with the rest of the group, should constantly check the work site to keep it clean of debris. Equipment should be kept in an organized fashion before, during, and after its use. Use flagging tape to mark all guy lines.
- During the construction of a project, only one person should give instructions and signals.
- There should always be plenty of room between the person carrying spars and people around them.
- Do not work during rainy or wet conditions. Rope and spars become slippery; you could lose your footing; and knots can slip and become unsafe.
- Wear clothing to fit the season and wear work gloves when necessary. Work smart and do not lift more than you can handle.

In accordance with the National Camp Accreditation Program (NCAP), if a pioneering project will have participants more than 6 feet above the ground, it first must be reviewed by the council enterprise risk management committee. Any project where a Scout's feet are over 6 feet above the ground must be top-rope belayed.

- Do not stand on spars resting on the ground. They can unexpectedly roll and cause injuries.
- When lifting a spar to facilitate the frapping of a tripod or shear lashing, always ensure the person working the rope doesn't injure their fingers.
- Take regular breaks to discuss the work in progress and ensure everyone understands what is required of them.
- Use extra care when using heavy mallets to pound in pioneering stakes.
- For safety, heel in the legs of a structure by setting them in holes approximately 4 to 6 inches deep.
- If the design calls for a certain size and type of rope or spar, do not substitute anything of lesser strength.
- Before allowing general use, run a complete test to see everything is working correctly.
- Continually check all anchors on a pioneering project as strain is applied during use.
- The number of people using a platform should be strictly limited to the maximum number established beforehand and announced by the safety officer.
- There should only be one person on a monkey bridge at a time.
- Jumping or playing around while on a structure is unacceptable. Scouts should only climb on board their project after all lashings are tight, and the structure has been completely inspected.
- While crossing a monkey bridge, no one should bounce or purposely swing or sway on the ropes, nor should anyone race across.
- Those waiting their turn to cross a monkey bridge must stay off the ropes between the anchors and the bridge framework.
- Everyone must stay completely off a monkey bridge whenever the foot and hand ropes are being tightened or the spanner ropes are being adjusted.
- When the day's work is complete, untie all knots, coil all ropes, check all hardware, and store everything in its proper place.

Managing risk includes being prepared to handle emergencies that might occur during pioneering.

Prevention goes hand in hand with mitigation, which means "to lessen in force or intensity" and "to make less severe." By taking precautions to manage risk and the possibility of injury, you can be prepared to anticipate, help prevent, mitigate, and respond to just about any incident that might happen while working on pioneering projects.

Whippings

Whipping the ends of all your lashing ropes will give your ropes good service in the field. Trying to tie knots in ropes with frayed ends is not only a bother but a waste of time. Because of the hard usage that ropes get during pioneering activities, all ropes should be whipped with either a West Country whipping or a Sailmaker's whipping.

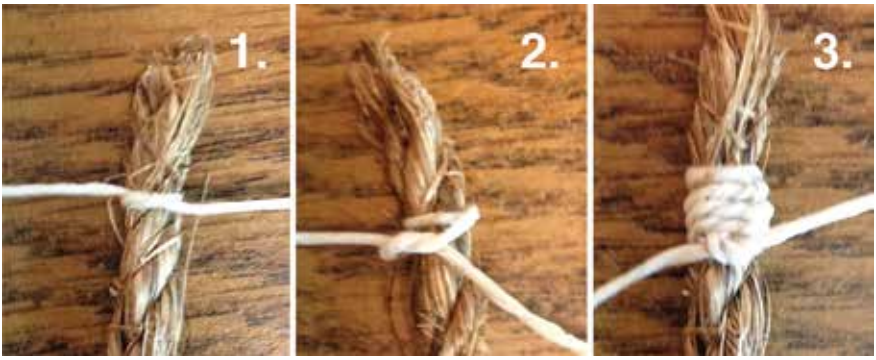
The type of whipping cord that you use is most important. Flax cord that is waxed and made of six strands is the best for pioneering work. It's available in 600-yard spools, is not that expensive, wears very well, and is strong, easy to use, and doesn't stretch.

Half Knot (West Country) Whipping

The West Country whipping works equally well on any type of rope, twisted or braided, or rope made from natural fibers or plastic filament. (All plastic ropes should have the end melted back first.) The success of this whipping depends on the tightness of the knots formed by the cord and the interlocking action of the half knots.

TO MAKE A HALF KNOT (WEST COUNTRY) WHIPPING:

1. On a quarter-inch diameter rope, start with a 14-inch length of waxed flax cord. Wrap the cord about half to three-quarters of an inch from the end, and tie a half knot (see photo 1, next page). If the rope is badly frayed, pull it together with a clove hitch or constrictor knot to begin the whipping.



2. Continue by taking the two ends of the whipping cord around the back of the rope (away from you), and tie another half knot identical to the first (see photo 2).
3. Keep repeating the half knots, front and back, pulling each one tight, until the whipping has been formed. The West Country whipping is finished with a square knot and the excess cord is trimmed.

Tie each half knot either right over left or left over right so that the knots lay neatly together and snug against the previous knot to form a smooth finished whipping.

A good practice when making any kind of whipping: Make the whipping as long as the diameter of the rope.

Sailmaker's Whipping

Just the thought of sails and ropes flapping in a strong wind when a sailing ship is under way makes you realize that the ends of the ropes aboard a ship have to be whipped to keep them from unraveling under the strain. Sailmaker's knew that a little extra effort spent whipping the ends of the ropes would make their work much easier in the long haul. The reason this whipping holds up better than any other is that the whipping cord is actually intertwined with the strands.

TO MAKE A SAILMAKER'S WHIPPING:

1. Unlay the strands about 1 inch and form a bight with the whipping cord.
2. Slip the bight over one strand and then lay the two running ends of the cord between the remaining two strands of the rope as shown in the first photo above.

Keep one end of the whipping cord long, and the other short.

3. Re-lay the strands of the rope to form the original twist.
4. Wrap the long end of the whipping cord tightly around the rope clockwise, moving toward the end of the rope.
5. Keep each wrap tight against the previous one and neatly together as shown in the middle photo above.
6. To complete the whipping, bring the original bight up over the same strand it was originally looped over. Then pull the short end of the whipping cord until the bight is pulled tight on top of the wrappings.
7. Place the long end of the whipping cord (the one that did the wrapping) between the next two strands, to the left of the first strand, and bring the short end up, between the same two strands.
8. Join the ends of the whipping cord with a square knot, pulling it down tight between the next two strands of the rope and snug on top of the wraps.
9. Cut off any excess from the ends of the whipping cord.

Sailmaker's whipping on ¾-inch, ⅜-inch, and ¼-inch manila ropes

Rope Tackle

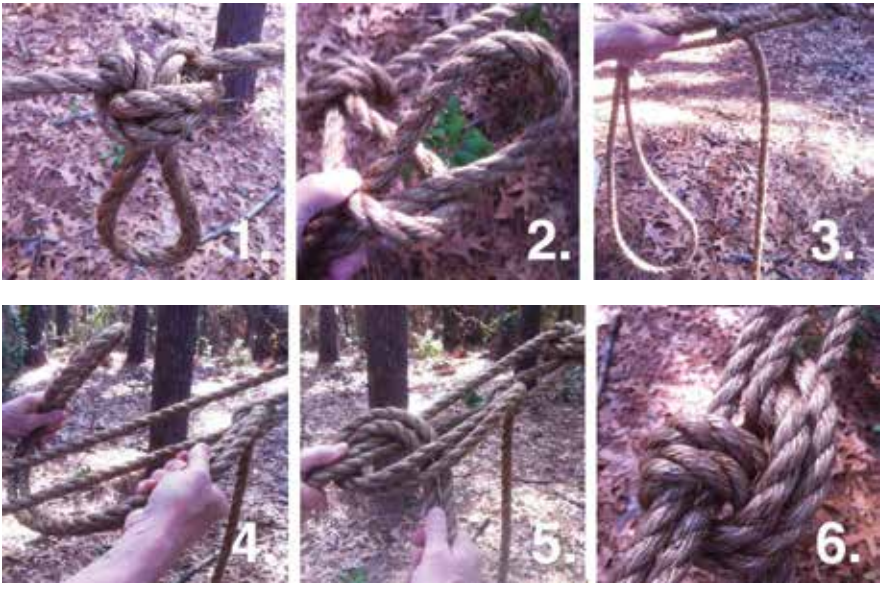
A rope tackle is applied where the guy lines meet the anchors for a wide range of pioneering projects. A rope tackle is effective when you want to pull more than your own strength will permit. The idea behind a rope tackle is similar to that of a tackle using blocks and pulleys. In a rope tackle, one end of the rope has to be anchored around a spar or tied through a ring or other piece of hardware that doesn't move. Then a loop knot is tied along the standing part of the rope forming a fixed loop that acts as the wheel in a block. A butterfly knot is often the knot of choice for this job. It can be tied in the standing part of the rope and is both easy to tie and fairly easy to untie even after being put under a strain.

1. Start with a butterfly knot in the desired position along the standing part of the rope.
2. When there is lots of line, make a bight in the running end and feed it through the butterfly knot's fixed loop.
3. To tighten the line, grab a hold of the bight and pull it toward the anchor.
4. When the desired tension is put on the line, with one hand, keep the line taut, and holding the bight in the other hand, use the bight to form a half hitch around both tight lines.

For safety reasons, taut-line hitches should never be used in any pioneering work. If they slip, a pioneering structure can become unstable.

5. As the half hitch is secured, maintain the tension on the line by pinching the standing part, making sure it doesn't slip.
6. Still maintaining the tension on the tightened lines in the standing part, cinch the half hitch up close to the fixed loop of the butterfly knot.

As an added measure, tie another half hitch around the tightened lines. All excess rope should be coiled under the knots.



PIONEERING USES

- To adjust the strain on the guy lines of a pioneering project
- To adjust the tension on the foot and hand ropes of a monkey bridge
- To tie down and secure equipment on a trailer or truck
- To hoist or lower equipment
- To tighten hold-down ropes on large tents and flies

Pioneering Knots

Pioneering knots are called upon because of their ability to perform specific tasks related to building a reliable and safe project. All basic camping knots and pioneering knots can be divided into three categories:

Bend: a knot used to join two lengths of rope. In pioneering, you might encounter situations where there's a need to join ropes that are wet, slick, or thick.
Hitch: a knot that attaches a rope to some object, often a ring, rail, spar, or post.
Loop Knot: a knot used to form a loop that doesn't slip, either at the end or in the middle of a line.

The best knots are easy to tie, place a minimum of strain on a rope's fibers, and are easy to untie.

Clove Hitch and Half Hitches

"The first and everlasting thing to remember about the clove hitch is that it is composed of two half hitches."
—John Thurman, Gilwell Camp Chief

When tied in this manner, the clove hitch is simple and easy. All you do is tie two similar half hitches, bring them together, and you have a clove hitch. If this concept is applied

when completing a common round, shear, tripod, traditional diagonal, or a version of a square lashing, you'll find tying a clove hitch tight against the wraps or fraps is a snap. As the photos on the previous page show, take the first half hitch and pull it snug against the fraps, then take the second half hitch and pull it snug against the first. You have a clove hitch!

Here's another demo. When proceeding from the right and moving to the left, the running end can be carried over the top of the spar, brought down behind the standing part, and then carried over the standing part. That's the first half hitch.

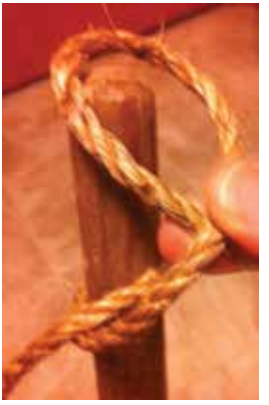
For the second half hitch, simply repeat the process next to and to the left of the first half hitch, tucking the running end under itself. That's a clove hitch. An extra half hitch can be added, and a fourth half hitch can be added, etc.

When proceeding from the left and moving to the right, just reverse the process.

Clove Hitch on a Bight

A clove hitch on a bight, (tying a clove hitch over an open-ended pole) is useful in a variety of circumstances. When preceding from the left, all that needs to be done is:

1. Form a right underhand loop and place it over the pole.
2. Form another right underhand loop and place it over the pole (on top of the pervious one).
3. Voila! Clove hitch!



When preceding from the right, instead of right underhand loops, form left underhand loops. Without being informed, one can just look at two of these half hitches and see they look exactly like a clove hitch. Of course, that's because these two half hitches are a clove hitch. Placing two half hitches over the open end of a vertical pole is the hands down, quickest way for tying a clove hitch. After you've done it for awhile, it takes about a second. This is exactly what the doctor ordered when you need to tie a clove hitch over the end of a pole.

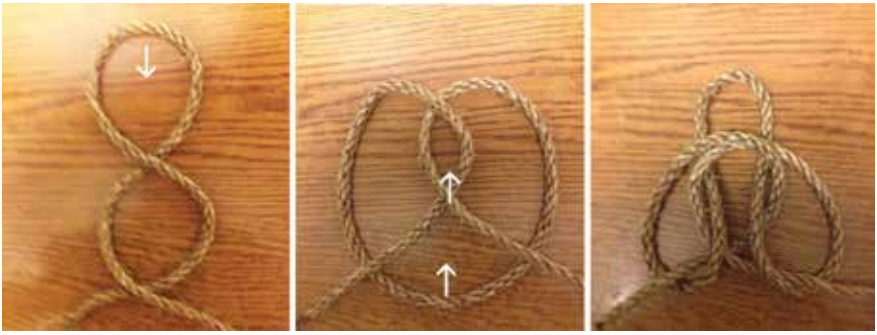
It's also the only way to tie a clove hitch in the middle of a long line, like when securing a hand rope on the top of an A-frame during the construction of a Double A-frame Monkey Bridge (unless you want to pull foot after foot of rope through the hitches because you're working with the end of the rope, or… you just don't know any better). It's also very handy when you've got a series of poles driven into the ground and you want to rope off an area, or, you want to secure a line to an upright pole at the edge of a tarp.

Butterfly Knot

A butterfly knot is a fixed loop tied in the middle of a rope. There are a number of other knots that do the same thing, but the butterfly knot tends to work better because it doesn't jam when strained and it's easy to untie.

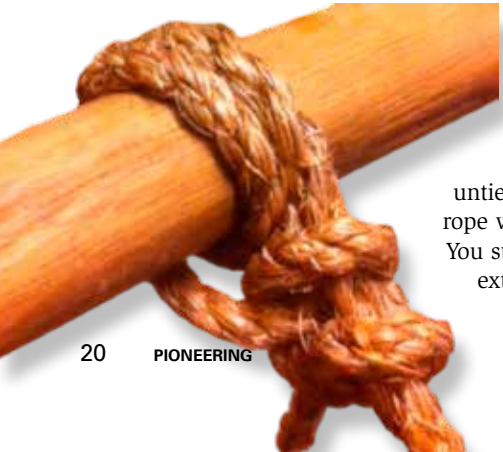
Since it's tied in a symmetrical fashion, strain can be put on it from any direction. Though this knot is usually tied in the middle of the rope, you can also tie it at the end of the line if you need a fixed loop that is easily untied.

1. Start with an overhand loop. Then twist the rope to form a second overhand loop. Next drop the upper loop down in back.
2. When the upper loop is dropped down, pull it under the two crossed standing parts of the rope. Then pull it up through the top loops to complete the knot.
3. To pull the knot tight, pull the upper loop while holding the standing parts of the rope at the bottom.



PIONEERING USES

- When using a rope to pull a heavy object (such as a log), tie a series of butterfly knots to form loops for each person's hand or shoulder.
- To provide a fixed loop to use with a toggle.
- When making a rope tackle, the loop in the butterfly knot serves as the pulley.



Roundturn With Two Half Hitches

This is one of the basic knots that is very reliable for a number of uses in pioneering work. It is easy to tie and untie and does not reduce the strength of the rope when under a hard pull due to sharp turns. You start by making a roundturn. This provides extra surface around the spar when chafing

or slipping might be a problem. Once you've made the roundturn, the rope has a grip on whatever it's around. The strain on the rope can then be adjusted before finishing off with two half hitches. The knot is well suited for both ends of a guy line.

When it is used in a place where you will not have easy access, as at the top of a tower, after the two half hitches are tied, secure the running end with a piece of light cord.
To tie the knot, make a roundturn around a pole. Next, make a half hitch around the standing part of the rope (as shown on the left in the photos). Then make another half hitch (as shown in the middle). When both half hitches are made, pull them tight (as shown on the right).

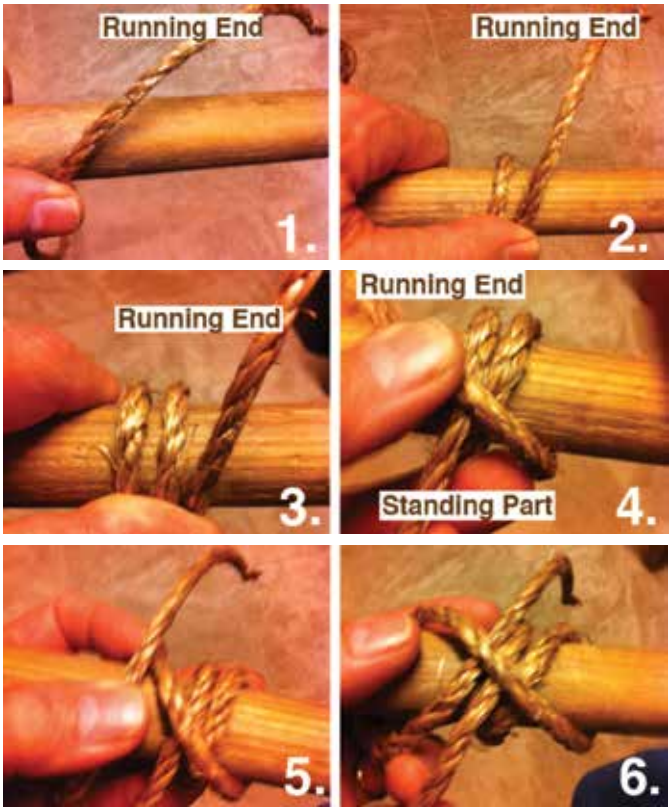
PIONEERING USES

- When wear is a factor when tied to an iron ring.
- To attach a guy line to a pole
- For connecting guy lines to the anchor stakes, because it does not jam and is easy to untie when adjustments are needed.

Rolling Hitch

As you become more involved in pioneering activities, you will find that there are many uses for the rolling hitch. After the roundturn is made, it supplies enough grip for you to complete the knot with ease, even when the line is under strain. Further adjustment can be made without completely untying the knot, by loosening the knot slightly, pulling the rope tight, and tightening the knot again.

When the rolling hitch is tied to a spar, pull can be exerted either perpendicular to or along the length of the spar. After exerting heavy pressure, it will untie easily. When you need



extra gripping power, just add extra turns. It works well with slippery or wet rope.

1. Start by laying the running end over the spar.
2. Next, take a turn around the spar.
3. Complete a roundturn and hold the running end up
4. Now cross the running end over the standing part.
5. Take another turn around the spar on the other side.
6. Tuck the running end under the turn and pull it tight.

PIONEERING USES

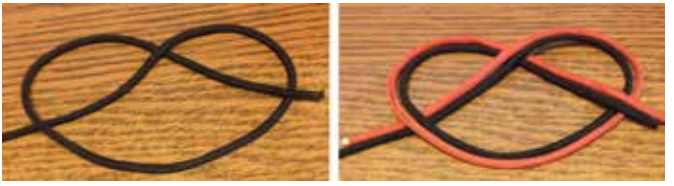
- When you want to tie a rope to a stake or a spar, the rolling hitch can be loosened easily to take up slack, and then retightened
- To attach a light tackle, double the rope over to form a bight, and tie a rolling hitch with a loop for the tackle.

- To form a hand or shoulder loop to pull a spar, tie two rolling hitches, one at each end of a short rope.

When securing a guy line to a horizontal spar, you can use a rolling hitch instead of a roundturn with two half hitches. Strain is applied in the direction of the roundturn.

Water Knot

What could be more simple than tying two overhand knots to form a water knot? Its use goes back to fisherman who needed to tie the ends of two wet fishing lines together. To tie two ropes together of man-made fiber, it's a simple knot with little bulk, and it will not fail. In pioneering, whenever you're using ropes made of man-made fibers that are braided and slick and don't hold knots well, think of the water knot.



Begin the water knot by tying a loose overhand knot in the end of one rope, then bring the end of the other rope over and under the first knot, following the same path in reverse.

PIONEERING USES

- To tie together the ends of two wet or slippery ropes.
- To make a grommet (loop) using all types of rope (braided or twisted). Keep in mind that once strain is put on the knot, it will be hard to untie.
- To tie together the ends of halyards.
- To tie the ends of flat nylon webbing to make a grommet (loop) or sling.

Carrick Bend

When the ends of each line are pulled tight, the carrick bend takes on this collapsed form.

When you have to tie together the ends of two large ropes (half inch in diameter or larger), there is no better knot to use than the carrick bend. While many other knots reduce the strength of the rope considerably, a carrick bend reduces its strength only slightly. You'll find that once a carrick bend is put under a heavy strain, it's not all that hard to untie. The knot will tighten under the strain of the ropes, but won't slip and works well with wet or slippery ropes.

The carrick bend looks very symmetrical when it's first tied. But, as soon as it's pulled tight, it looks quite different and is often hard to identify.

Start by making an underhand loop at the end of one rope and lay the end of the other rope under the loop (left hand photo). Then weave the end of the other rope over and under as you go (as shown in the middle and right hand photos).

When joining large diameter lines that will be put under a heavy strain, to assure the carrick bend can be easily untied, the knot can be left in its initial symmetrical form with both running ends seized securely to their standing parts.

PIONEERING USE

- Joining the ends of two large diameter lines.

A carrick bend with both ends seized.

Draw Hitch

This quick-release knot can hold a considerable strain. It's ideal for reliably securing a boat to a mooring or a horse to a hitching post. You can easily release the knot with a simple tug and quickly be on your way. And all you need is one hand to do it.

In addition to securing the end of a line to a fixed point, the draw hitch can be tied in the middle of the line. This results in two ends of the rope hanging down equally; use it to retrieve a long rope used as a hauling line to help hoist a tall structure.

1. Place a large bight in the desired part of the line, behind the spar (left photo below).
2. Form a small bight on the left side, under the spar, and carry it over the front (middle photo below).
3. Pass this left side bight through the top of the large bight, and tighten this by pulling up on the left side bight and down on the right side (right photo below).

4. Next, form a small bight on the right side, under the spar, and carry it over the front (left photo above).
5. Pass this right side bight through the left side bight (middle photo above).
6. Tighten this by pulling up on the right side bight and down on the left side (right photo above). Apply strain by pulling on the left. Release the knot by pulling on the right.


PIONEERING USES

- When hoisting a large structure that is not intended for climbing, e.g. a tall gateway, and the lines you're using for lifting and preventing over pulling are not guy lines, tie the middle of the hoisting ropes to the structure with draw hitches. Then, when the structure is standing, these lines can be easily removed with a simple tug on the free end.
- Great for bundling coils of lashing ropes.

Constrictor Knot

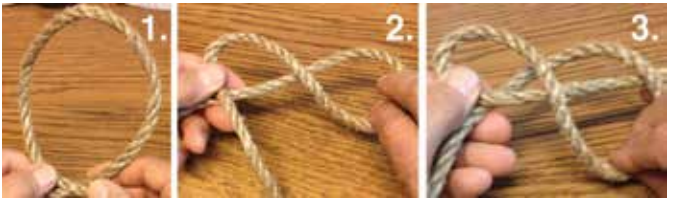
In the days when black powder was used for blasting in mining operations, this was the knot that was tied around the top of the bag containing the black powder to hold the fuse in securely—hence, its other common name, the bag knot.

The constrictor is based on the clove hitch, except after the first half hitch, the running end forms an overhand knot with the standing part. It's this extra half-knot that provides additional hold when the hitch is pulled tight.

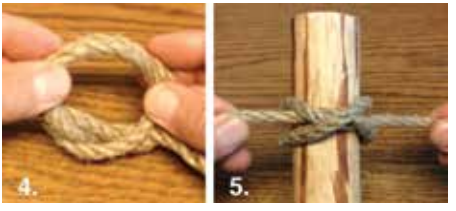
1. Make a turn around the spar with the running end, then cross over the standing part of the rope.
2. Bring the running end under the spar.
3. Cross the running end on the outside of and over the standing part.
4. Form an overhand knot by passing it underneath the half hitch.

To tie a Constrictor Knot in the standing part of the rope over an open spar:

1. Make a right overhand loop.
2. While holding the left side of the loop, twist down on the right side counter clockwise making a right underhand loop.
3. Place this second loop behind the standing part and pass it under the first loop.



4. Grab hold of both loops and place then over the spar.
5. Pull tight.



PIONEERING USES

- To use interchangeably with a clove hitch, except once the constrictor knot is pulled tight, it is quite hard to untie.
- To start a lashing. When it's tied to a vertical spar, the crossing spar can rest on it while the lashing is being made.
- To make a good temporary whipping at the cut end of a rope, or to start the West Country whipping.
- To start a splice, use it to stop off the unlaid strands of the rope so they won't unravel further as you're working the splice.

The square lashings supporting the roller bar for this camp seesaw were started using constrictor knots.

Lashings

Learning the needed skills and becoming familiar with how things are done is often referred to as *knowing the ropes*, necessary before the real fun can begin! We use lashings to bind two or more poles together to make a structure. Most lashings commonly consist of a recommended number of "wraps" around the poles, and then a recommended number of "fraps" between the poles and around the "wraps." Depending upon geographic location and personal preferences, individuals might use different versions of lashings to get the job done.

Square Lashing

The most common and frequently used lashing is the square lashing, which gets its name from the fact the wraps are "square" to the poles. Square lashings bind poles that are in contact and cross each other at any angle from 45 degrees to 90 degrees. There are various types of square lashings, and when tied tightly and correctly, they all do the job.

Most commonly used in the pioneering area at National Jamborees is the Mark II square lashing (aka Japanese Mark II square lashing, Japanese lashing, square knot square lashing), which has been widely adopted for simplicity, speed, and efficiency. It's easy and quick to tie, working both ends of the rope at the same time and tying off the fraps with a square knot.

1. Place the poles in the desired position. Fold your lashing rope in half. Place the midpoint of the rope around the vertical pole and just under the crossing pole.
2. Now work both ends of the rope at the same time to make three wraps around the poles.
3. After completing the three wraps, bring the two ends down between the poles in opposite directions to make two frapping turns around the wraps.

4. Pull the frapping turns tight, and complete the lashing by tying the two ends with a square knot. It's that simple.

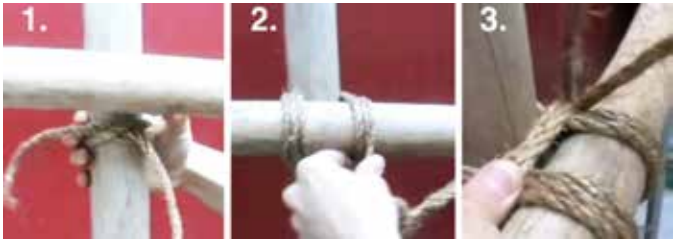
Straightforward approach for lashing two poles together

Clove Hitch Square Lashing

This long-standing approach works one end of the rope to wrap and frap—invaluable in those circumstances when only one hand is available.

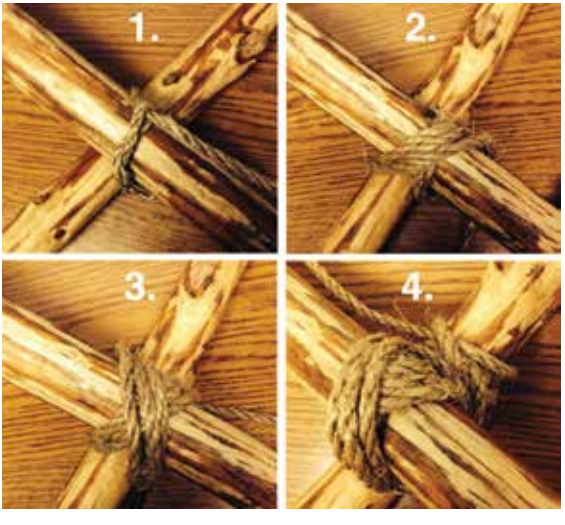
1. To join the poles, start with a clove hitch tied on the vertical pole just below where you want to join the crossing pole. After the clove hitch is tied, secure it by wrapping the excess short end of the rope around the running end.

2. Make three wraps around the poles, pulling each wrap tight to join the poles together. Don't overlap the rope.
3. Take two frapping turns around the wraps (between the poles) to pull the wraps tight. Finish with another clove hitch on the horizontal pole.



Diagonal Lashing

When putting crossed braces on a structure to keep it from racking (as used when making a trestle), the most important lashing is the diagonal lashing. A diagonal lashing is used when you need to close a gap between two poles where they cross each other but do not touch. The "traditional" diagonal lashing is tied as follows:



1. Cinch the poles together by tying a timber hitch where they cross.
2. Make three wrapping turns on the opposite diagonal to the timber hitch. Keep the wraps parallel to one another and pull them tight. (Some prefer to take these first wrapping turns along the same diagonal as the timber hitch.)
3. Make three more tight wraps across the first three, again keeping them parallel.
4. Take two frapping turns between the poles, tightly around both sets of wraps and complete the lashing with a clove hitch around one of the poles.

Round Lashing

The most commonly used lashing for extending the length of a pole is the round lashing. Tie this lashing with a clove hitch around both poles followed by eight to 10 tight wraps that are flush together, and end with another clove hitch around both poles.

There are no frapping turns. The manner in which this lashing needs to be applied results in the poles being in a position where they are already tightly touching. Taking frapping turns between the parallel poles would only weaken the connection.

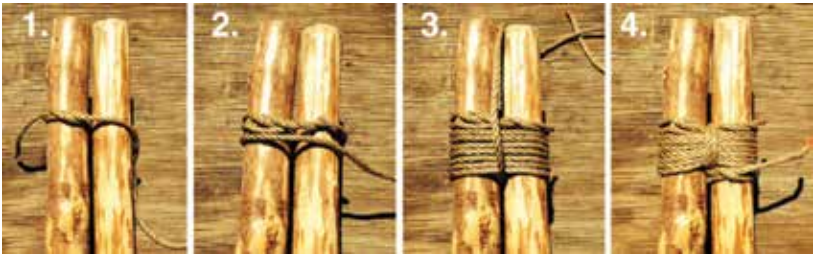
The objective is to combine the poles together to make a longer length that is as rigid as possible. So, connecting two poles in this fashion definitely requires a good overlap between them. It also requires two lashings, each tied tightly well near the ends of each pole where they overlap.

Shear Lashing

Use a shear lashing when two parallel poles are to be opened out like scissors to make a pair of shear legs. What are shear legs? Simply put, they're two upright poles, lashed together at the tips with the butt ends (bottoms) spread apart to support some kind of weight. In Scout Pioneering we frequently use shear legs to form an A-frame.

The fastest and easiest form of this lashing is with "plain turns" and is tied as follows:

1. Start with a clove hitch around one pole. (Wrapping the short end (tail) around the running end will secure the clove hitch.)
2. Make five to ten wrapping turns around the poles. (The more wraps you make, the stiffer the lashing will be.)
3. Take two tight fraps around the wraps between the poles.
4. Finish with a clove hitch on the opposite pole, and then spread the legs as needed.

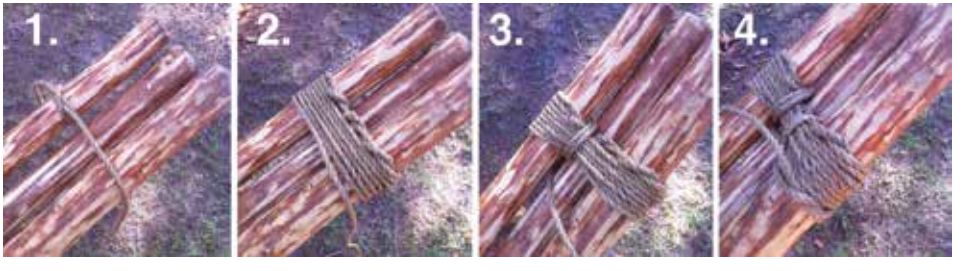


When the shear lashing will be applied to a structure that is to be used for a longer period of time, forming the wraps using racking turns (figure of eight) provides more contact between the poles and the rope.

Tripod Lashing

The tripod is the most simple self-standing pioneering structure. It's frequently used in the building of camp gadgets. In larger projects, two tripods can support a crossbar or support two parallel spars for a platform.

- The tripod lashing with "plain turns" is a simple and quick way to lash together three poles into a tripod.
- Lay the three poles alongside each other, making sure the butt ends are lined up evenly, and tie a clove hitch to one of the outside poles.
- Wrap the rope around the poles six to eight times, laying the turns of rope neatly alongside one another. (How stiff the tripod legs will be when they're separated depends on the number and tightness of these wrapping turns.)
- Make two tight fraps on either side of the center pole. End with a clove hitch around an outside pole. Spread the legs of the tripod into position, crossing the outside poles under the middle pole.



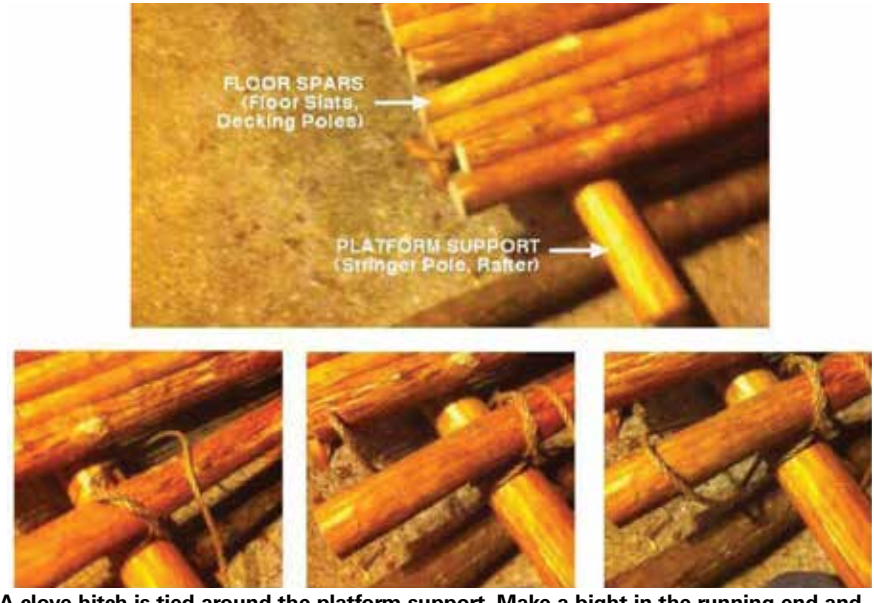
When a tripod lashing is used to build a tripod that will support excessive weight for a longer duration, forming the wraps using racking turns (figure of eight) provides more contact between the poles and the rope.

Floor Lashing

With the double floor lashing, the floor poles (floor spars, decking poles) are attached to each platform support (stringer) on both sides. When pulled tight, this lashing makes the floor or platform more secure.

Start by tying a clove hitch around the platform support and wrap the tail around the long part of the rope. Next, make a bight in the running end and pass it over the first floor pole on the inside of the platform support. Now, grab this bight from below and pass it underneath the platform support and loop it over the first floor pole on the outside of the platform support. Tighten both loops around the first floor pole by pulling the running end, which is extending out from the top of the platform floor between the first and second floor poles.

Repeat the process for each floor pole until you reach the other end. When you do, tie off the rope to the platform support with a series of tight half hitches.



A clove hitch is tied around the platform support. Make a bight in the running end and pass it over the first floor spar on the inside of the platform support. Grab this bight and pass it underneath the platform support. Now loop it over the first floor spar on the outside of the platform support.

Before applying the half hitches when lashing a floor, tighten the whole configuration by taking a frapping turn around the wraps, between the poles.



Tighten both loops around the first floor spar by pulling the running end extending between the first and second floor spars on top of the platform floor. Repeat this process for each floor spar until you reach the other end. Secure the running end of the rope to the other platform support with a tight clove hitch.



Grabbing bight from underneath **Looping bight over floor spar** **Pulling running end to tighten the loops**



Making next bight in running end **Working it between two floor spars** **Passing it under platform support**

Rope Information

KNOT-TYING TERMINOLOGY

Before you begin learning new knots, you need to know some of the basic terms used in knot tying. Become familiar with these terms and use them as you learn how to tie the various knots.

Running End and Standing Part: These are two of the most common terms used in knot tying. The running end is the end of the rope that is used to tie the knot. This end is sometimes referred to as the working end. The rest of the rope is the standing part.

Overhand Loop: An overhand loop is formed when a loop is made so that the running end of the rope is on top of the standing part. It can be formed anywhere along the standing part of the rope.

Underhand Loop: An underhand loop is formed when the running end of the rope is placed under the standing part.

Bight: A bight is formed by doubling back a length of the rope against itself to form a U. This can be done near the end or anywhere along the standing part. Bights can vary from a few inches to a few feet in length. A bight doesn't have to have a sharp bend. It can be "open". In this case, the running end of the rope is alongside the standing part of the rope, but is not crossed over or under (which would form an overhand loop or an underhand loop).

Take a Turn: The term take a turn means to wrap a rope around a spar or stake so it continues off in the opposite direction. The friction this creates will give you a grip on the stake or spar that will help you hold the strain on the line. It also gives better control in taking up or letting out a line.

Roundturn: To make a roundturn, wrap the rope completely around a pole and bring the running end back along the standing part of the rope. A roundturn gives you even more grip in holding the strain on a line, and is the basis for tying several knots, as when making a roundturn with two half hitches.

TYPES OF ROPES AND CORDS

The three most important factors to consider when selecting rope for pioneering use are **strength**, how much or little it **stretches**, and how easily it **handles**. Other considerations are how well it resists mildew, its ability to stand up to repeated wetting and drying, and whether or not it retains kinks from knots after having been under a hard strain, making it difficult to use a second time. Depending upon the application for which they're used, natural fiber ropes made from materials found in nature, and synthetic ropes produced from man-made fibers, each have their own advantages.

Manila: Manila rope should provide the bulk of the rope needed for your troop's pioneering kit. (Its cost is mid-range.) Properly cared for it will give good service for quite a few years. Pure manila rope is by far the best all-around rope. It's easy to handle, has good strength-to-size ratio, and does not have an objectionable stretch factor. It handles well in three important pioneering areas: knot tying, lashing, and in using a block and tackle. Manila rope can be spliced easily and withstands repeated wetting and drying cycles. Manila rope in quarter-inch diameter comes in a standard 1200-foot coil, while larger diameters come in 600-foot coils. Most other types of rope come in 600-foot spools as a standard package. Shorter lengths are available from retail suppliers.

Sisal: Sisal rope has much the same appearance as manila rope, but it's quite inferior in strength and does not handle well when used for lashing or knot tying. When sisal rope, tied into a knot gets wet and then dries, it becomes useless because of the kinks that remain. Even though it costs less. it is not cost effective because it breaks down quickly during use, so the cost is high when compared to other types of rope that can be used again and again.

Polypropylene: Rope made of this man-made plastic fiber should be considered for pioneering activities because it is lightweight and its strength-to-size ratio is good. Size for size it is twice as strong as manila rope, but has a little higher stretch factor. Its strength makes it suitable for anchor strops and for any application involving heavy strain. Though it stretches under a hard pull, this should not pose a problem if taken into consideration beforehand. It is easy to splice in a twisted three-strand form. Because it is somewhat slippery, four tucks should be made instead of the usual three tucks. Cut ends should be both melted back and whipped with a good flax cord. A disadvantage of polypropylene is that long exposure to sunlight has a weakening effect on the fibers. But, all things considered it is worth including in your pioneering supplies.

Nylon: The most prevalent disadvantage of nylon rope is that it has a 20 percent stretch factor. But, in cases where the stretch factor can be taken up with adjustment to the strain on the line, its strength can be an advantage. Nylon rope also has a tendency to slip when a hard pull is put on some knots. Because of these two factors, it is almost useless as a lashing rope.

Parachute Cord: This popular cordage is very strong for its size. It's abrasion and mildew resistant, easy to use, and available in different colors. But, it's also designed to stretch. This makes it fine to use in building most camp gadgets, but not advisable to use when building pioneering structures that need to bear lots of weight and withstand plenty of strain.

Polyester: This man-made fiber rope is usually seen in the braided form. It handles well, is strong, and its stretch factor is less than nylon. It costs more than manila or nylon, but some sizes and lengths could be used in pioneering activities on a selected basis. A 6-foot length of quarter-inch diameter polyester rope makes an excellent rope for practicing knot tying.

Polyethylene: This is the cheapest of man-made fiber ropes. It is most often seen in braided form and has a distinctive shine. Don't let the low cost lure you into buying any quantity of polyethylene for pioneering or camp use. It is not suited for either knot tying or lashing because it holds kinks after being under a strain.

Cotton: Cotton rope in both twisted and braided forms is outclassed in strength by other types and today there is little use for it in pioneering and camping.

Binder Twine: Binder twine is made from loosely twisted jute fibers that are treated with oil during manufacturing. Its principle use today is for tying bales of hay as the baling machine compresses the hay. Binder twine is readily available in varying quantities at hardware and farm supply stores. Its low cost makes it a throwaway item after use. But don't be too quick to toss it in the trash—a balled up handful of discarded twine makes a good fire starter in camp. Here are some uses:

- When pioneering projects call for the use of poles less than 2 inches in diameter, it can be used for lashing. (Do not use binder twine as a replacement for quarter-inch rope in general pioneering use or lashings.)
- Use it to make a simple strop lashing with six or eight wraps and a square knot.
- Two strands of binder twine quickly twisted together will equal a light cord.
- Use it for the back stays of anchor stakes.
- Use it for the construction of light camp gadgets.

BREAKING STRENGTH VS. SAFE WORKING LOAD

It's important to note that the breaking strength of a rope is not the measure for gauging how much strain the rope can withstand during use. Instead, use the safe working load as the measure, which takes into account the conditions and variables that exist during performance.

PREPARING MANILA LASHING ROPES

1. Obtain the quantity of pure quarter-inch manila rope that will provide enough lashing ropes to complete the project(s) you want to build.
2. New rope needs to be stretched before it is fit for use. Tie each end of a long length securely to a fixed object like a post or tree. Grab the mid point with both hands and pull back. Take up the slack and repeat the process one time.

3. Cut lengths of rope in the size(s) needed for the projects you will be building. Many camp gadgets can be completed using 6 and 10-foot lengths of quarter-inch manila. Generally speaking, depending on the diameter of the spars, 15-foot lashing ropes will be the most commonly used length for most Scout pioneering projects.
4. Whip both ends of each lashing rope. (For pioneering, the West Country or Sailmaker's whipping will prove to be the most dependable.)
5. Color code each rope by size, by dipping the ends with a dab of paint. A widely used system is in the chart below.
6. Bundle groups of the same-length lashing ropes in coils and tie them together with a 3-foot cord.

Color Coding Coils

Use this common coding system to make it easy to grab the proper length of rope. Just dip the ends of the rope with a little paint.

	Green	**6 feet**
	White	**10 feet**
	Red	**15 feet**
	Blue	**20 feet**
	Black	**30 feet**
	Silver	**40 feet**
	Yellow	**50 feet**

CARE OF ROPE

Always dry out any wet rope before putting it away. Store it in a dry place. Never hank natural fiber rope as this will cause kinks. Make large coils and bind them together with either a clove hitch or draw hitch. Color-coded coils of the same size lashing ropes can be combined and bound together for easier storage and access. Before using ropes for any project that will bear weight, separate the strands along the length of the rope and check the fibers for wear and rot. Replace any worn out lines.

COILING AND THROWING A ROPE

You might never be called upon to throw a line to someone in distress; however, it's always good to be prepared. In addition, many pioneering activities call for coiling and throwing a line to get it across a creek or ditch, or up and over a high tree branch. How you make the coil is very important. To learn how to coil and throw a length of rope. select a 40-foot length of one-quarter- to three-eighths-inch manila rope. Make sure both ends are whipped.

Coiling the Rope: If you are right-handed, coil the line into your left hand. If you are left-handed, coil the line in your right hand. As you loop the rope over your hand, make each successive coil a little smaller than the one before. This is important to keep the coils from fouling as they pay out when thrown.

Preparing to Throw the Rope: To coil the rope, first secure one end of the line to your belt or loosely around your wrist. Now transfer approximately two-thirds of the coils from your non-throwing hand to your throwing hand. Next, drop one of the loops from your non-throwing hand to allow enough rope for a free swing between your hands. Hold your non-throwing hand out so that those coils will peel off smoothly.

If for any reason you may need to get rid of the end of the rope without becoming entangled in it, before coiling, tie the end to a fixed object or have a partner hold on to it.

Throwing the Rope: To throw the rope, swing the coils in your throwing hand in an arc, much like you pitch a softball. After making two or three "warm-up" swings, release the rope. A little practice will help you determine where your release point should be to get the most distance. As the rope is released, the weight of the rope will pull the coils from your non-throwing hand until the entire rope extends out in a straight line from where you're standing.

Applying a weight to the end of a light line will make it easier to throw. A sock or small stuff sack filled with sand and attached with a clove hitch works well.

Lashing ropes, stored safely and conveniently. Note the color-coded tips representing each rope's length.

Making Rope

For ages man has twisted natural fibers from plants to form cordage. Making rope out of plant fibers is still done today in remote parts of the world. In many cases people make their own rope because money is in short supply and the native plants that have the needed fibers are in great abundance. As early as 1200 A.D. the Papago Indians of the American Southwest made rope from cactus fibers using a twirling stick. The technique can still be used today.

Throughout history, a variety of rope making devices and machines have been used to make rope. One such device is the Indian Rope Spinner. The internet is filled with information about this and other rope making machines.

The basic process of making rope consists of twisting fibers to form yarns. Then yarns are twisted together to form strands. Finally, several strands are twisted to form the rope. For example, to make quarter-inch diameter rope, binder twine can serve as the yarns. Three of these binder twine yarns are twisted to form a single strand. Then three strands are twisted to form rope approximately quarter inch in diameter.

You can make your own length of quarter inch diameter rope using simple binder twine. The twine itself is made up of

separate fibers that have been twisted together and will serve as the yarns. These yarns can be twisted into strands, and the strands into rope. Here's how you can very simply make a rope about 6 feet long:

- Cut a 60-foot length of binder twine and divide it into three 20-foot lengths.
- Attach each to a stick or connect to a rope-making device and twist these three 20-foot lengths together, clockwise, to form a strand.
- Take the long strand you made and fold it into three parts to make three shorter strands each about 7 feet long.
- Now twist these three strands together, counter clockwise. Whip both ends to keep it from unraveling

Making rope using a well-designed rope spinner at the National Jamboree.

A mock cell tower built at the National Jamboree using bamboo.

Splicing Rope

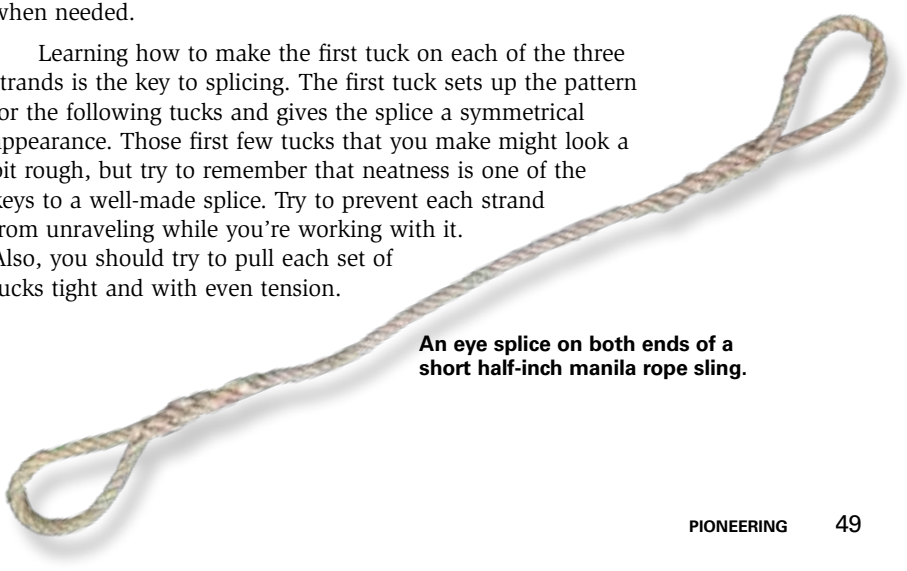
Making the proper splices in the proper places on your ropes is the benchmark of a skilled craftsman. Very often, the ability to do a neat job of splicing is placed on the top of the skills list of ropework. Making splices is not really all that hard to do.

There are three basic types of splices that are typically made on three-strand twisted rope: an **eye splice**, a **back splice**, and a **short splice**. The process in all three splices is to unlay the strands at the end of the rope, then weave them over and under back into the rope to form the splice.

In some cases the right knot could do the same job as each of these three splices: a bowline might be used instead of an eye splice; a sheet bend or carrick bend instead of a short splice, and whipping could replace the back splice.

Knots are more bulky than an eye splice or short splice. Splices are neater and smaller and not likely to come untied in use. Splices in ropes make the rope secure and ready to go when needed.

Learning how to make the first tuck on each of the three strands is the key to splicing. The first tuck sets up the pattern for the following tucks and gives the splice a symmetrical appearance. Those first few tucks that you make might look a bit rough, but try to remember that neatness is one of the keys to a well-made splice. Try to prevent each strand from unraveling while you're working with it. Also, you should try to pull each set of tucks tight and with even tension.



An eye splice on both ends of a short half-inch manila rope sling.

The rope should maintain approximately 80 percent of its strength if the splice is made with a series of three tucks on each of the three strands. If after making the first three tucks on all three strands, you reduce each strand to half of its fibers and make a fourth tuck, the splice will have a nice tapered look.

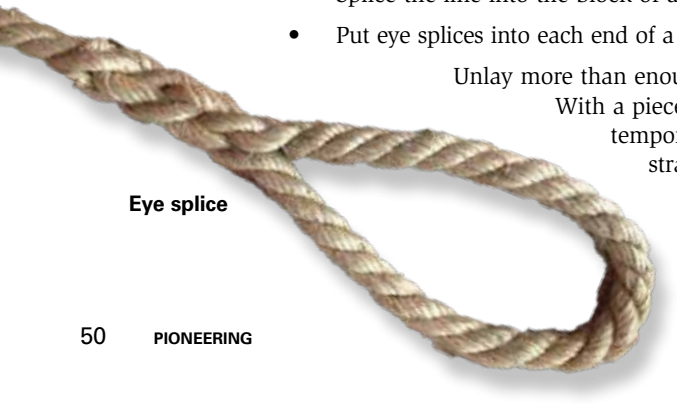
To learn the technique of splicing, it's best to practice with a short piece of quarter-inch three-strand manila rope. Avoid sisal and plastic rope until you have mastered splicing with manila rope.

Even the best photos of steps for making a splice can look confusing. The best way to learn how to splice is to sit down one-on-one with someone who is familiar with the techniques and go over each step a few times until you get used to how the strands are woven together. Splicing is not one of those skills that you can do once and then never forget how to do it. It takes a lot of practice.

EYE SPLICE

The eye splice creates a fixed loop at the end of the rope. These are some of the uses for an eye splice:

- Splice a fixed loop onto the end of a guy line.
- Splice a fixed loop with a thimble in a 10-foot rope to form a strop.
- Splice a rope into an eyebolt at the bow of a canoe.
- Splice a rope into a tent or fly grommet.
- Splice the throwing line into a ring buoy at the waterfront.
- Splice the line into the block of a block and tackle.
- Put eye splices into each end of a rope to be used as a sling.



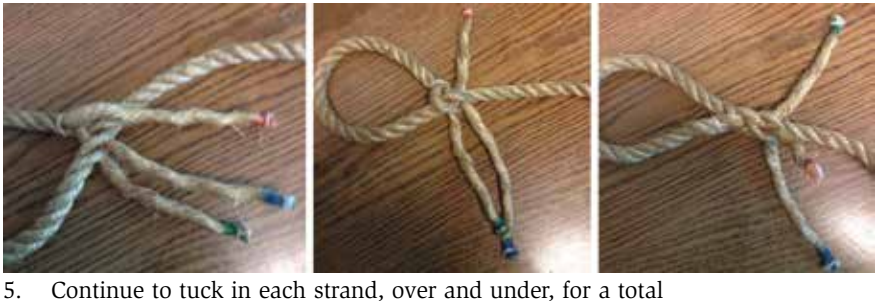
Eye splice

Unlay more than enough strands for tucking. With a piece of string or some tape, temporarily whip the ends of the strands and the part of the rope where they were separated. (See the constrictor knot on page 26.)

How To Create an Eye Splice

1. Lay the strands out so there's one on the left, one in the middle and one on the right.
2. Take the middle strand and tuck it under a strand at the proper distance to form the size eye you want.

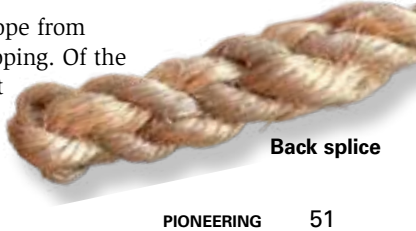
3. With the strand on the left, go over the strand you just went under, and under the strand behind it.
4. Turn the splice over and tuck in the last strand so that it exits where the middle strand entered. All strands should be coming out evenly at the same position around the rope.



5. Continue to tuck in each strand, over and under, for a total of three times for natural fiber rope, and four times for synthetic rope.

BACK SPLICE

The back splice is made to prevent the end of the rope from unraveling. It can be used instead of making a whipping. Of the three splices shown here, the back splice is the least used because its bulk at the working end of the rope makes tying some knots more difficult.



Back splice



How To Create a Back Splice

1. Unlay more than sufficient to make the splice and spread the strands evenly. With pieces of string or some tape, temporarily whip the ends of each strand.
2. Make a crown knot by bending each end over its neighbor in turn, going the same way round as the lay of the rope.
3. Pull the crown knot into shape.
4. Tighten it on top of the rope.
5. Tuck each end in turn over the adjoining main strand and under the next. Draw tight close up to the crown knot.
6. Continue over and under one in turn at least three times.



7. Draw tight after each round of tucks.

SHORT SPLICE

A short splice can be used in place of a knot to join two ropes or the ends of the same rope together. If two ropes are being joined with a short splice, they should be the same type of rope and have the same diameter. Some uses for a short splice:

- Splice the ends of a long line that has been cut, or when a frayed or unsafe portion needs to be cut out.
- Splice the ends of a short length of rope to form a rope grommet.

How To Create a Short Splice

Short splice on a rope grommet

1. Unlay the ropes, intertwine the strands, and tie a temporary whipping to hold the ropes together. With pieces of string or some tape, temporarily whip the ends of each strand to keep them from unraveling, (See the constrictor knot on page 26.)
2. Starting with one strand (blue) of the left rope, take it over one of the strands on the right rope, and tuck it under the next strand on the right.
3. Roll the rope toward you and take the next strand (white). Carry it over the strand on the right rope, and tuck it under the next strand.

4. Roll the rope toward you again and take the third strand (green). Carry it over the next strand on the right rope, and under the one after.

5. At this point, three strands of the left rope should be tucked under three strands on the right rope. Continue by making another tuck with each strand.
6. Continue the process until three tucks have been made with each strand. Remove the temporary whipping and splice the other ends in the same way.

Bamboo grows very thickly in a variety of locations across the United States.

Poles For Pioneering

Wooden poles are the main ingredients in building a pioneering structure. Everyone knows what a pole is. Depending on the project at hand, we use them in all different lengths and diameters.

Scout staves

What Is a Spar?

Simply stated, in pioneering, a spar is a thick, strong pole. Obviously, a pioneering project has to be able to withstand the strain and stress that will occur while performing its intended function. We cannot build a structure out of spindly sticks tied together with string and expect it to work. We use spars lashed together with good, natural fiber rope! Here's what you should know:

- The best spars for pioneering are straight with a minimum of taper.
- The diameter of a spar is measured at the butt end, not the tip. Depending on what's being built, the butt ends of spars are generally between two and four inches thick.
- Spars can be any length, depending on what is being built. In Scout Pioneering, the most common sizes are 6, 8, 10, and 12 feet, and sometimes 14 feet, 16 feet and even longer.

- For pioneering projects, spars should be skinned. If the bark moves when the project is under strain, lashings can slip. Also, skinned spars last longer, and the projects look nicer.
- Spars should be stored out of the weather and regularly inspected for soundness.

Is a Scout Stave a Spar?

No. By themselves, they're too skinny. Scout staves (hiking staffs) are great for instruction and small projects, but a 5-foot Scout stave is a strong stick, not a spar. Many camp gadgets can be built using these short, smaller diameter poles.

About Scout Staves

The Scout staff (plural "staves") hails back from the days of Baden Powell when it was even considered part of the Scout uniform. There are many uses for the Scout staff, and these are in addition to its use in making camp gadgets. With Scout staves, we can combine the Leave No Trace Seven Principles and the Outdoor Code with a timeless Scouting tradition. Carry them on outings and put them to good use to improve your campsite!

What About Bamboo?

Depending on its condition, large diameter bamboo is very strong. However it should be born in mind, bamboo can withstand vertical stress much better than horizontal stress. It's fine for a variety of pioneering uses because it grows so straight, and for its size it's very lightweight. Due to its slick surface, lashing bamboo poles together can often present additional challenges.

Where To Get Poles

Stands of trees with the right characteristics grow in numerous locations. Get permission from the land owners and perform a conservation project! Under most conditions, thinning out the land encourages a healthier tree population. But, get permission and be prudent. Each spar is a prize and with the proper care will last for several years of repeated use.

A “spar barn”

Anchors

Any pioneering project that cannot safely stand by itself needs to be anchored. Sometimes nature will provide a tree or rock in just the right location, or you might be able to shift the project's placement to take advantage of a natural anchor. At all other times, anchors need to be built to assure the structure's stability.

Stakes

Anchors can be built using strong pioneering stakes. The common size of stakes for most Scout pioneering projects is 2½ inches in diameter and about 24 to 30 inches long. After cutting the stake to this size, cut a point on one end. It's good to bevel the top edge to minimize mushrooming or splitting when the stake is driven into the ground. Long-lasting pioneering stakes are made of hardwood, such as oak or hickory.

Drive the stakes into the ground at about a 20-degree angle. Soil conditions can vary and will dictate how large and long a stake you need. The main thing is to make sure all stakes are deep enough so they don't wobble or budge at all.

Tent pegs should **never** be used for pioneering stakes. They're neither long enough nor strong enough to make a safe anchor.

Mallet

When driving stakes into the ground, it's best to use a wooden mallet. Using a metal sledge hammer can more easily damage the stake. To make a mallet, cut a 4-inch diameter piece of hardwood, such as hickory, elm, or sycamore, to about 11 inches in length. It should weigh about four pounds. Drill a $1\frac{1}{8}$ inch diameter hole to mount the handle. The handle can be made from a 24 inch length of hardwood (similar to making a stake). Use a knife or ax to round the end of the handle to fit the hole in the mallet head. Secure the handle in place with a wedge placed crosswise to the length of the head.

Guy Lines

When attaching a guy line, make sure its contact with the stake is as low to the ground as possible. If the guy line is placed or slips higher on the stake, there will probably be enough leverage to pull the stake loose. Guy lines should be secured to the structure about three-quarters of the way up. To determine how long a guy line should be, measure the height at the point where its attached and double that distance. That's how far away the anchor should be from the pole. For example, if the guy line is attached 10 feet up the pole, the anchor should be a minimum of 20 feet from the base.

3-2-1 anchor

3-2-1 Anchor

A 3-2-1 anchor is made by driving stakes in a series: three stakes, then two stakes, and then one stake to form the anchor. First drive in the set of three stakes. Next drive in the set of two stakes about 24 inches away from the first set. Finally, drive a single stake in the ground about 12 inches from the two-stake set.

Connect the stakes by tying a rope from the top of the three-stake set to the bottom of the two-stake set, and from the top of the two-stake set to the bottom of the single stake. Use at least two loops of quarter-inch manila rope, or six to eight loops of binder twine. Twist the rope tight using a small stick as a lever. After the rope is tight, push the end of the stick in the ground to keep it from unwinding.

Depending on the strain the anchors need to withstand, you can use other configurations, such as 2-1-1, or 1-1-1, or even 1-1 for a light strain.

Log-and-Stake Anchor

This type of anchor is easy to make and can hold a considerable amount of pull. You can tie the line directly to the log, or you can use a ring with a rope grommet as shown in the photo below. To make the log-and-stake anchor, place a log 4 to 6 inches in diameter perpendicular to the pull of the line. Then drive in four large stakes in front of the log. Next, slip the rope grommet through the ring and then slip the ends of the grommet around the log. Drive a second row of stakes 24 inches behind the front stakes. Then anchor the front stakes to the rear stakes with a tourniquet made of binder twine or rope.

Log-and-stake anchor

Rope Grommets

Rope grommets are useful when attaching a long line to an anchor of stakes. A large grommet can be made by splicing together the ends of a 10-foot length of half-inch polypropylene or manila rope. If you don't have a spliced grommet in your pioneering kit, tie the ends of the rope with a carrick bend. Be sure to secure the ends. The grommet you use must be made of a rope with a higher safe working load than the lines they're connecting, to avoid creating a weak link in the chain between the structure and the anchor.

Strops

When attaching lines to a natural anchor such as a tree or large rock, a strop can be used very effectively. Splice a thimble with a large ring to a 10-15-foot length of half-inch diameter manila or polypropylene rope. A piece of canvas or burlap should be used to protect the rope from sharp edges of a rock or to protect the bark of the tree from rope burns.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Smaller Projects

Scouting's founder Lord Baden-Powell said, "My ideal camp is where everyone is cheery and busy, where the patrols are kept intact under all circumstances, and where every patrol leader and Scout takes a genuine pride in his camp and his gadgets."

Camp gadgets are smaller pioneering projects that serve a useful purpose around camp. They normally improve the campsite by adding convenience, and generally make a campsite feel more like a home away from home. There are numerous designs and ideas, several of which are featured on the Scout Pioneering website (scoutpioneering.com) containing links to suggested materials, procedures, and photo illustrations.

The projects listed in requirement 3 were selected because they provide a practical opportunity to put into practice the knots and lashings presented in this merit badge program. Each one also has practical uses during troop outings.

Dishwashing rack

Clothes-drying rack

Tripod Hand Wash Station

This wash station is sturdy, portable, and very useful when camping away from washroom facilities. Its design is a sound example of Scout engineering. Each of the three legs making up the tripod gets a lashed on support piece, and the wash station's stability stems from the fact the design contains three triangles.

WHAT YOU'LL NEED

- ❑ 2 2-foot sticks (¾ inch to an inch diameter) for the leg braces
- ❑ 2 4-foot sticks (¾ inch to an inch diameter) for the back leg and crossbar
- ❑ two 5-foot sticks (¾ inch to an inch diameter) for the front legs

For the lashings, you'll need binder twine, or:

- ❑ 1 10-foot lashing rope for the tripod lashing
- ❑ 6 6-foot lashing ropes for the square lashings

You'll also need:

- ❑ bar of soap in a sock
- ❑ small to medium-sized towel
- ❑ 2 3-foot cords
- ❑ No. 10 can with a bail or 4-quart cooking pot with a bail

WHAT YOU'LL DO

Make the tripod. Using the 10-foot rope, lash the two 5-foot sticks and one 4-foot stick together with a tight tripod lashing. The 4-foot stick should be in the middle. Make sure the butt ends of all three sticks are even. Separate the legs and set the tripod up. This project's success relies on a secure, well-tied tripod lashing.

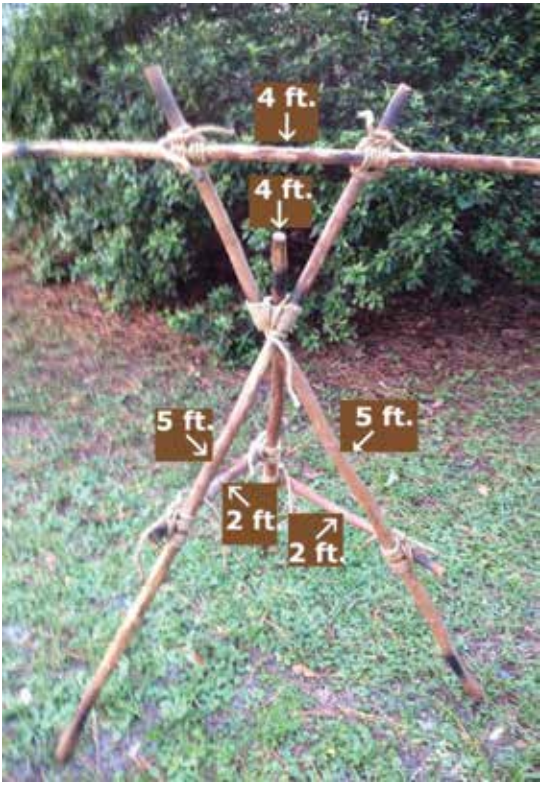
Lash on the braces. Using the 6-foot ropes lash one end of the 2-foot sticks to the 5-foot legs and the other end of the 2-foot sticks to the 4-foot leg, with four tight square lashings.

Lash on the crossbar. Using two more square lashings, tightly lash the other 4-foot stick to the top extended sections of the two 5-foot sticks to make a cross bar to hang the towel and soap-in-a-sock.

Add the soap, water, and towel. With clove hitches, tie the end of one 3-foot cord to the soap-in-a-sock and the end of the other 3-foot cord to the towel, and suspend them on either side of the 4-foot crossbar.

Hang the can filled with water to the end of the 4-foot stick extending from the front of the tripod.

During the outing, make sure the soap-in-a-sock is not left inside the can after use, and frequently change the water. One nice thing about using a metal container is that in cold weather, the can of water can be heated over a fire or on a stove.



15-Foot Scout Stave Flagpole

Flying flags high is great for Scout spirit, and making a flagpole is really easy. For a simple 15-foot flagpole, here's all you'll need:

WHAT YOU'LL NEED

- ❏ 4 5-foot Scout staves
- ❏ 6 6-foot lashing ropes
- ❏ 3 20-foot guy lines
- ❏ 3 sturdy stakes
- ❏ 1 small mallet
- ❏ 1 flag with grommets and two short cords to tie it on

WHAT YOU'LL DO

Lash the staves together. Lay out the Scout staves so they overlap one another about 10 inches. Join them with six tight round lashings.

Attach the guy lines. With either rolling hitches or roundturns with two half hitches, tie on the guy lines about three quarters of the way up to the top of the pole.

Hammer in the stakes. About seven to eight feet from where the pole will stand, hammer in each stake at a 20-degree angle, forming an equilateral triangle.

Attach the flag. Spacing it so the top and bottom edge are stretched onto the top stave, tie on the flag.

Raise and secure the flagpole. Taking turns, one Scout holds the pole up as the other attaches a guy line to each stake to hold the pole in a vertical position with a rope tackle.

Simple Camp Table

This small table is functional and provides a convenient raised surface for personal or patrol use. Its design is simple and it sets up quickly.

WHAT YOU'LL NEED

- ❑ 4 Scout staves for the A-frame legs
- ❑ 2 sturdy sticks, about 2 to 3 feet long, to join the legs and support the platform
- ❑ 6 6½-foot lashing ropes
- ❑ 1 20-foot rope to secure the table
- ❑ 2 sturdy stakes
- ❑ mallet
- ❑ 12 5-foot Scout staves or similar poles for the platform
- ❑ binder twine

WHAT YOU'LL DO

Make the A-frames. Lash the top of each pair of legs with a shear lashing, and lash on the 2½- to 3-foot cross piece with tight square lashings. Lash on each cross piece at the same place on each of the legs, about 2½ feet up from the bottom.

Hammer the stakes. Lay a stave where the table will stand. On each side of the stave, about 5 feet out, hammer in a sturdy stake at a 20-degree angle, with the notch facing to the outside.

Get ready to stand up the A-frames. Halve the 20-foot rope. About 2 feet from the middle, tie a clove hitch on a bight over the top of one pole of each A-frame. (The A-frames will stand about 4 feet apart. With the staves between the A-frames, about 6 inches of the staves will extend out from each side.)

Stand up the A-frames. Attach each end of the 20-foot rope to a stake with a rope tackle, then pull each A-frame upright. The clove hitches will hold the A-frames in a tight, stable position.

Lash on the table top. Lay the 5-foot staves between the 2½- to 3-foot cross pieces and use the binder twine to attach them on each side with a floor lashing.

Scouts pose on a sturdy 4 x 4 climbing tower built using two trestles.

Trestles and Walkways

Building a Trestle

A *trestle* is the basic component for building a variety of bridges. It's used to support the walkways.

The most basic and most often-used form of a trestle consists of two legs, two ledgers, and two cross braces. When building a bridge, the top ledger is also called a transom. This is the part that supports the walkways. To make a trestle, the two ledgers are lashed near the top and bottom of the legs and the cross braces are added, lashing them to the legs.

All together, a trestle is composed of nine lashings. Eight of them are square lashings and one is a diagonal lashing, which is used to lash the two cross braces together where they cross in the center. This cross brace, or X-brace, forms four triangles contributing to the trestle's overall structural integrity.

The overall shape of the trestle is an engineered structure that is able to support quite a bit of weight with relatively small diameter spars for legs.

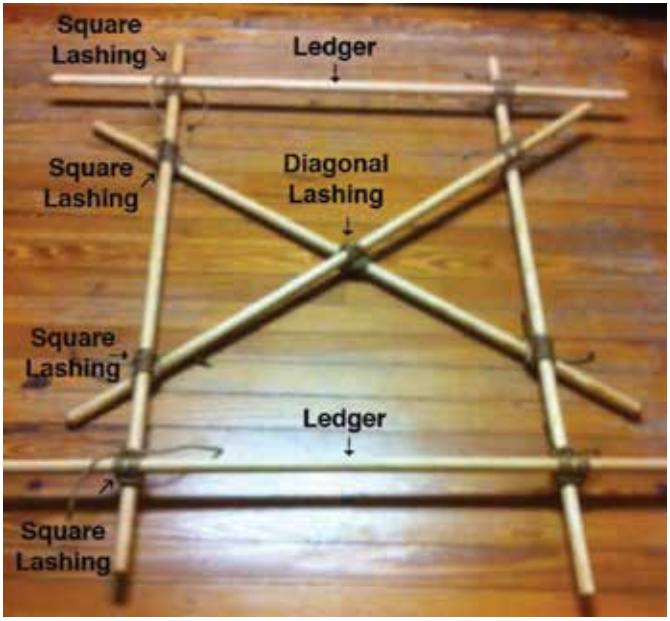
LEGS

When setting out to build the trestle, choose the two spars for legs first. These spars can be most any length, depending on the type and height of the structure you're building. Lay the two legs on the ground with the two butt ends of the spars at the same end and even with one another. Then add the ledgers.

LEDGERS

The ledgers are spars that are typically 2 inches to 2½ inches in diameter. The position of the ledgers on the legs will depend on the structure you're building. There are a couple of general rules to keep in mind:

- Always keep the butt ends of the legs even with each other.



- Except in the case where the tops of two trestles will be interlocked, always keep the legs parallel as you're lashing on the ledgers.
- All lashings should be tightly tied, and when building a bridge, make sure the larger, top ledger (transom) is tied most tightly.

CROSS BRACES

Next, the cross braces are added. The cross braces are spars that are usually 2 inches in diameter. They are lashed to the legs in a particular sequence:

1. Flip the trestle over and work on the opposite side from the ledgers.
2. Lash one cross brace to the back side of both legs.
3. Lash the bottom end of the second cross brace on the same side as both ends of the first cross brace.
4. Lash the other end on the front side—the side with the ledgers. This is done so that the cross braces are standing slightly apart. There will be a gap where they cross at the center.

After the ends of the ledgers and the cross braces are lashed to the legs, stand the trestle up on end. Adjust the trestle so the legs are parallel. Also check to see that the top ledger is parallel to the ground. If it is not, lower the trestle, untie the lashing, and adjust it.

DIAGONAL LASHING

When the legs are parallel and the top ledger is parallel to the ground, you're ready to tie the diagonal lashing to the cross braces while the trestle is standing upright. This lashing is very important to the strength of the trestle. Along with springing the two cross braces together, the diagonal lashing creates triangles that are important to stiffen the arrangement of the spars and to keep the trestle from racking.

Building Walkways and Bridges

Bridges are very popular pioneering projects. Essentially, a bridge consists of one or more trestles that support some sort of walkway. In the case of a monkey bridge, the walkway is just a rope that you walk on. But for many other bridges, you can build a walkway from spars that's easier to walk on than is a monkey bridge.

To make a 10-foot section of walkway, select two spars with a butt diameter of 3½ inches. These spars should be matched in the amount of sag they have when you stand on them with the ends supported above the ground. If one spar sags more than the other, it will make the walkway slant from side to side and hard to walk on.

CROSS SPARS

A strop lashing is easy to tie. Halve the rope, place the midpoint behind what you're lashing, wrap both ends around the spars a few times and finish with a square knot.

The cross spars for the walkway should be approximately 2 to 2½ inches in diameter and 3 feet long. You will need two additional cross spars that are 3½ feet long for each walkway section. (The longer spars go at each end of the walkway.) All of the cross spars can be lashed to the lateral spars with quarter-inch manila. Since the lashing is made only to hold the cross spars in position and not support weight, you can use a double strand of binder twine. If you use binder twine, double it over and twist it a few times before you start the lashing. Make sure you have enough to complete the full lashing with the doubled-over binder twine. Don't finish the lashing with only one strand if you run short. Instead, tie on more binder twine to complete the lashing. Each of the cross spars is lashed to the lateral spars with a square lashing, making three wraps and two fraps.

There are two ways to approach lashing on the cross spars. If you are going to add a plank over the top of the cross spars, you will need a total of eight cross spars for each walkway. That is, six 3-foot long cross spars, and two 3½-foot long cross spars.

Start by lashing one of the 3½-foot long cross spars about 6 inches from the butt end of the lateral spars. Place this spar on top of the lateral spars so that the ends of the cross spar extend 3 to 4 inches out over both sides of the lateral spars. This additional length hanging out is used to lash the cross spar to the stakes, which anchors the ends of the walkway in place.

After the first cross spar is lashed in place, add six more 3-foot cross spars every 16 to 18 inches down the length of the lateral spars. The last cross

spar should be lashed about 12 inches from the ends of the lateral spars to allow room for the "underspar."

UNDERSPAR

An important feature of this type of walkway is to lash one 3½-foot cross spar to the underside of the lateral spars, 6 inches from the end. When the two walkway sections are placed on the trestle(s) to form the bridge, these under spars should contact the transom of the trestle(s). Then the three spars [two underspars on the two walkways and the transom spar of the trestle(s)] are lashed together at three points using a strop lashing.

WALKWAY PLANK

Before lashing the walkway to the trestle, the walkway plank should be lashed in at least three places with square lashings. If you are going to walk directly on the cross spars (with no plank on top), you will need enough cross spars to make a safe walkway, one that your foot cannot slip through. Start making the walkway as described before by lashing a 3½-foot cross spar at the butt end of the lateral spars. Then lash the 3-foot cross spars about 3 inches apart, using as many cross spars as necessary to go the entire length of the walkway, ending about 1 foot from the other end. Finally, add the 3½-foot long underspar.

ANCHORING THE WALKWAY

After the walkway is assembled, the butt ends are placed on the bank of the creek or ravine. This end is anchored in place by driving stakes in the outside corners formed by the lateral spars and the first (3½-foot) cross spar. Lash this cross spar of the walkway to the stakes with a strop lashing. When the walkways are lashed to the stakes and to the trestle(s), all the walkway sections become joined to form a single unit that is very strong. While the above text describes how to make 10-foot walkways, you can make 8 or 12-foot sections the same way. If you use the longer walkways, be sure to test the strength of the lateral spars before lashing them into a walkway that could be unsafe.

Joining the underspars of the walkways to the trestle's transom

If you put together a pioneering kit, take some time to save the matched lateral spars to be used only for walkways.

Larger Projects

Double A-Frame Monkey Bridge

The traditional monkey bridge is perhaps the most familiar of all Scout pioneering projects. It's frequently featured at expos, camporees, and camps, and is often a central attraction at public gatherings where Scouting is represented.

Using a double A-frame to build a monkey bridge is a departure from the common X-frame that supports the foot rope and hand ropes, but it has two advantages: The double A-frame provides a wider base making it less likely to tip over and the positions of the A-frames can be adjusted so the span between the hand ropes can be narrowed for better balance.

WHAT YOU'LL NEED

- ❑ 8 8-foot x 4-inch A-frame legs
- ❑ 4 6-foot x 3-inch A-frame ledgers
- ❑ 24 15-foot x ¼-inch lashing ropes for square lashings
- ❑ 1 50-foot x ½-inch or ¾-inch foot rope
- ❑ 2 50-foot x ½-inch hand ropes
- ❑ 5 8-foot x ¼-inch stringer ropes
- ❑ 6 10-foot x ¼-inch lashing ropes for strop lashings
- ❑ 6 pioneering stakes for each 3-2-1 anchor **OR**
- ❑ 8 pioneering stakes and one 4-foot x 4- to 6-inch diameter spar for each log-and-stake anchor
- ❑ 2 10-foot x ½-inch polypropylene or manila ropes for rope grommets
- ❑ 2 pieces of scrap canvas or burlap for foot rope saddles
- ❑ binder twine for the back stays of anchor stakes

A strop lashing is easy to tie. Halve the rope, place the midpoint behind what you're lashing, wrap both ends around the spars a few times and finish with a square knot.

WHAT YOU'LL DO

There are many ways to build your bridge. Here's one provided by the project designer, Adolph Peschke:

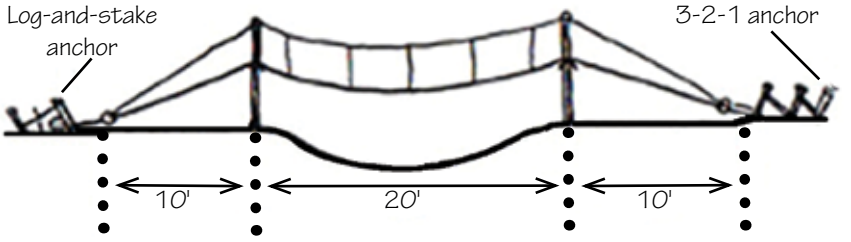
Building the A-frames: Build four identical A-frames using the 8-foot spars for the two legs and 6-foot spars for the ledger. Make sure the ledgers of each A-frame cross the legs at the same height and that the tips of the legs intersect at an equal distance from the tops. Lash each A-frame together with three tight square lashings.

Double A-frame: When you have four identical A-frames, lash two of them together. Hold the A-frames up and maneuver them into position or lay one A-frame on the ground and put another on top of it so that the bottom ledgers overlap one-half their length (about 3 feet). The first step in lashing the A-frames together is to go up where the two legs cross (the X formed by one leg from each A-frame). Then with a tight square lashing, lash the two legs together. The point where these legs are lashed together is where the foot rope will rest. Adjust the overlap of the two A-frames to adjust how high the foot rope will be off the ground. Also note where the tops of the A-frames are, because this is where the hand ropes will be.

To complete the double A-frame, stand it up so the butt ends of all four legs rest solidly on level ground. Lash the two bottom ledgers together where they overlap with three round lashings or strop lashings.

Site Preparation: Before you erect the double A-frames, prepare the site. Stretch a length of binder twine along the center line of where the monkey bridge is to stand. Working from the center, measure 10 feet toward each end to mark where the A-frames go. They should be 20 feet apart. Then mark out another 10 feet from each A-frame to where the anchors go.

Building the Anchors: The foot rope will be attached to anchors at both ends. Before erecting the double A-frames, build a 3-2-1 anchor, or a log-and-stake anchor, 10 feet from where the A-frames will be erected.



Rope Grommet: After the anchors are built, attach a rope grommet with a ring or shackle in it. (On a 3-2-1 anchor, make sure the grommet is added before the tourniquets are applied.)

Position the A-frames: Prepare to erect the bridge by moving the A-frames into position no more than 20 feet apart. Lay them on the binder twine that marks the center line of the bridge.

Hand and Foot Ropes: Prepare the hand and foot ropes. Lay the foot rope in a straight line off to the side of where the A-frames are. Then lay the two hand ropes on the ground next to each other so they're parallel to the foot rope, 42 inches away.

Stringer Ropes: Add the stringer ropes that will go from the foot rope to the hand ropes. Start by taking a turn around the foot rope with an 8-foot long stringer rope so that both ends are 4-feet long. Add two more stringer ropes on both sides of the center stringer rope (so there are five stringer ropes in all), positioning them about 4 feet apart. Tie one end of each stringer rope to one of the hand ropes with a clove hitch. Then do the same with the other ends of the stringer ropes, attaching them to the other hand rope.

Assembling the Bridge: Place a piece of burlap or heavy canvas (called a "saddle") in the V formed by both double A-frames. This will protect the foot rope and allow it to slide a little in the V without interfering with the lashing rope.

Erect the Bridge: You'll need a safety officer to watch for problems and a signal caller to tell the crew what to do. Two Scouts will lift and hold each double A-frame in place; two more will lift the foot rope into the V of the double A-frames; two more will lift the two hand ropes into place at the tops of the A-frames. Lift everything into place then, holding the A-frames steady, temporarily tie the hand and foot ropes into the rings of the grommets using a roundturn with two half hitches.

Tightening the Foot Rope: Now you can put a strain on the foot rope. It's not necessary to use block and tackle since this can put too much strain on the lashings, anchors, and the foot rope itself. Whatever strain three or four Scouts can put on the foot rope by pulling it by hand will be enough. As soon as the bridge is crossed a few times, there will be a sag in the rope. This is fine because it means you are working with reduced strain on the foot rope as a safety measure.

Tightening the Hand Ropes: Tie the hand ropes to the top ends of the A-frames. Loosen one end at a time from the anchors. Then use a clove hitch on a bight to tie the hand ropes to the top end of a leg on each side of the double A-frames. As you're tying these clove hitches, adjust the strain on the sections of the hand ropes between the double A-frames to match the sag of the foot rope. Also, adjust the length of the stringer ropes so there is even strain between the foot rope and both hand ropes. After the hand ropes are tied to the tops of the A-frames, move down and retie the ends of the hand ropes to the rings in the grommets using a roundturn with two half hitches.

Final Testing: With caution, one crew member can get on the bridge as all lashings, anchors, and knots are observed by the safety officer and all other crew members. Make adjustments as required. If there is too much sag, retighten the hand and foot ropes as necessary. Adjusting and maintaining the strain on the hand and foot ropes can be handled using rope tackles.

Single A-Frame Bridge

This bridge is simple to build because there are few lashings needed for the center A-frame. The A-frame is a triangular shape that resists racking and provides strength for the structure.

WHAT YOU'LL NEED

- ❑ 2 12-foot x 3-inch A-frame legs
- ❑ 1 6-foot x 2-inch bottom ledger
- ❑ 1 6-foot x 3-inch transom
- ❑ 4 10-foot x 3-inch walkway lateral spars
- ❑ 12 3-foot x 2-inch walkway cross spars
- ❑ 4 3½-foot x 2-inch walkway cross spars
- ❑ 2 10-foot x 2-inch x 10-inch walkway planks
- ❑ 6 stakes
- ❑ 2 30-foot x ¼-inch guy lines

WHAT YOU'LL DO

A-frame: Determine the depth of the creek or ravine to be spanned. Add 8 feet to that measurement to get the total height of the legs for the A-frame. For example, to span a creek 4 feet deep, the legs of the A-frame should be 12 feet or longer. This length allows for the distance from the butt ends of the A-frame legs up to the transom that supports the walkways. The transom should be about 1 foot higher than the banks of the creek. It also allows for the height from the walkways up to the tops of the legs, to permit free passage for a person along the walkways. Lay the A-frame subassembly out on the ground to check if the spars are long enough when lashed together for the two requirements mentioned above.

Walkways: Build two 10-foot walkway sections as separate subassemblies (see previous chapter).

A-frame Legs: When you've determined the length of the spars for the legs of the A-frame, lash them together at the top with a sturdy shear lashing.

Ledger and Transom: To complete the A-frame, use square lashings to lash the bottom ledger across the legs about 1 foot from the bottom of the legs. Then lash a transom spar to support the walkways at the proper height in relation to the banks of the creek.

Add Guy lines: Using rolling hitches or roundturns with two half hitches, add a light ¼-inch guy line to the top of each leg, about three-quarters of the way up. These will prevent the A-frame from tipping over. On each bank, about 20 feet from where the A-frame will be positioned, drive a stake into the ground at a 20-degree angle.

Assembly: After making the walkways and A-frame, take them to the assembly site. Place the A-frame in the center of the creek and heel in the legs about 4 to 6 inches deep. At the same time, level the transom to accept the walkways in a level position.

When the A-frame is upright and the transom is level, lash both underspars on the walkways to the transom with strop lashings at three points. Next, lash the cross spars at the ends of the walkways to stakes on the banks of the creek with strop lashings. Attach the guy lines to the stakes, driven into the ground 20 feet away on either side, with rope tackles.

Single Trestle Bridge

This simple bridge uses a single trestle and two walkways. The legs of the trestle are extended above the walkways to provide a way to attach handrails. The length of the spars listed for the walkways and trestle will be enough to build a bridge that will span a creek or ravine up to 4 feet deep and 18 feet wide.

WHAT YOU'LL NEED

- ❑ 2 8 or 10-foot x 3-inch trestle legs
- ❑ 1 4-foot x 3-inch trestle transom
- ❑ 1 4-foot x 2-inch trestle ledger
- ❑ 2 6-foot x 2-inch cross braces
- ❑ 4 10-foot x 3-inch walkway lateral spars
- ❑ 12 3-foot x 2-inch walkway cross spars
- ❑ 4 3½-foot x 2-inch walkway cross spars
- ❑ 2 10-foot x 2-inch x 10-inch walkway planks
- ❑ 4 12-foot x 2½-inch handrails
- ❑ 4 stakes

WHAT YOU'LL DO

Break up this project into four subassemblies: the trestle, the two walkways, and the handrails.

Trestle: The legs for the trestle are spars that are about 3 inches in diameter and 8 to 10 feet long. When choosing these spars, take into account the depth of the creek you're crossing. The distance from the base of the legs to the top ledger (transom) on the trestle should be about 1 foot higher than the level of the banks of the creek. This will allow the walkways to slant up.

Then allow an additional 4 feet in height on the legs from the top ledger up to the top of the legs for attaching the handrails.

The top ledger of the trestle should be about 3 inches in diameter since it also acts as the transom and carries all the weight of the walkways and the person using it. The bottom ledger can be smaller: a 2-inch diameter spar will work here.

Walkways: The two walkways are assembled as separate subassemblies (see previous chapter). Note: make sure the 3½-foot cross spars at the end of the walkway extend far enough out to attach both the stakes and the handrails without interfering with the passageway.

Assemble the Bridge: Set the trestle in the center of the creek. Heel in the bottoms of the trestle legs by setting them in holes approximately 4 to 6 inches deep. This will prevent the trestle from shifting and is also a way to level the transom spar as the trestle is set in place so the walkways are level.

Put the walkways in position from both sides and lash the walkways' underspars to the transom (top ledger) of the trestle in three places using strop lashings. Then drive stakes at the other end of the walkways. Lash the ends of the cross spars on the walkways to the stakes with strop lashings.

Handrails: Handrails help those crossing the bridge and add strength to the entire structure. Handrails form triangles with the walkway and the trestle leg. These triangles produce a strong structure that prevents the bridge from racking. Lash the handrails to the top of the trestle legs with square lashings and to the stakes with simple strop lashings.

Single Lock Bridge

This is a well established and basic design. Over the years it has stood out as a remarkable example of real Scout engineering.

WHAT YOU'LL NEED

This list of spars will build a bridge to span a creek or ravine approximately 4 feet deep and 18 feet from bank to bank.

- ❑ 4 6-foot x 3-inch trestle legs
- ❑ 4 4-foot x 2½-inch trestle ledgers
- ❑ 1 4-foot x 3-inch trestle transom spar
- ❑ 4 6-foot x 2-inch cross braces
- ❑ 4 10-foot x 3-inch walkway lateral spars
- ❑ 12 3-foot x 2-inch walkway cross spars
- ❑ 4 3½-foot x 2-inch walkway cross spars
- ❑ 2 10-foot x 2-inch x 10-inch planks
- ❑ 4 stakes

WHAT YOU'LL DO

The bridge consists of four subassemblies: two trestles and two walkways.

Trestles: If necessary, adjust the length of the spars for the trestle so that when they are placed in the creek, the tops of the ledgers will be about 1 foot above the level of the bank. This will give a comfortable slant to the walkways. When constructing the two trestles, build only one trestle first. Then as the second trestle is being built, make sure the legs are narrower at the top and fit between the legs of the first trestle.

When lashing on the top ledgers, leave enough space from the top so when the legs interlock, there's enough room to fit the transom.

Walkways: Each walkway consists of two lateral spars, six cross spars, and two longer cross spars. One of these two longer cross spars is used as an underspar at the end of the walkway that is attached to the transom. The other longer cross spar is used to anchor the walkways to the stakes.

Assembly: After building the trestles and walkways, take them to the assembly site (the creek or ravine). Place the trestles in the center of the creek so the tops of the trestles are interlocked. Lift the 3-inch diameter transom spar to fit on top of the interlocked trestle legs.

Heel in the bases of the legs in holes 4 to 6 inches deep. At the same time level the transom spar so the walkways won't slant.

Put the two walkways into position. Lash the underspars on the walkways to the transom spar with strop lashings at three points.

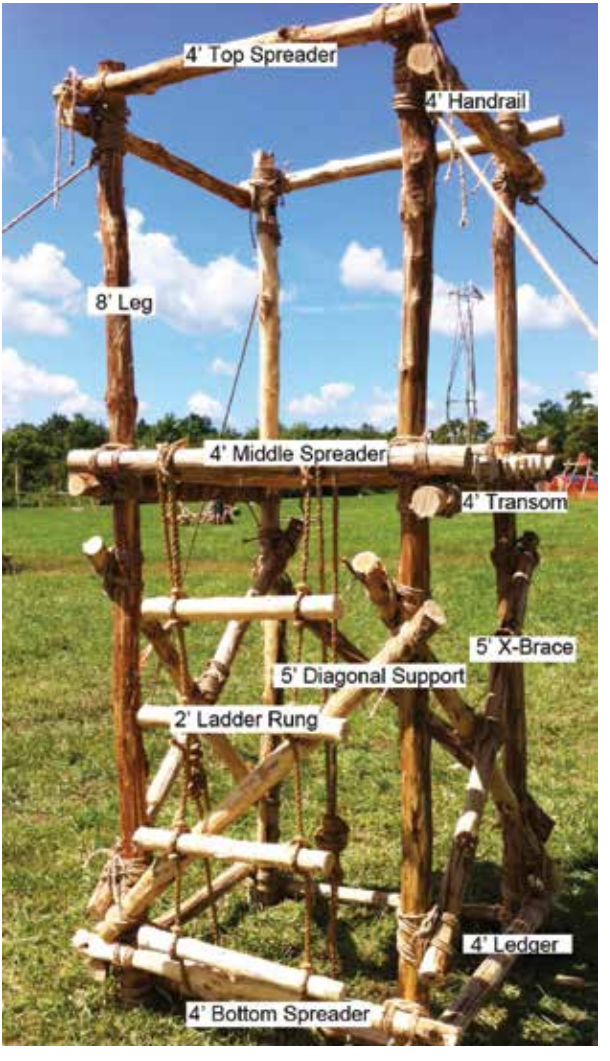
Anchoring the Walkways: Finally, to anchor the walkways, drive the stakes in the outside corners formed by the lateral walkway spars and the first (3½-foot) cross spars, and lash the ends of the walkways to the stakes. By lashing the walkways to the transom spar and lashing the ends of the walkways to the stakes, you make a complete walkway unit that will prevent movement and provide a sturdy bridge deck.

4 x 4 Climbing Tower

This sturdy tower sees plenty of action wherever it's built. Its a simple design, but very solid. It's formed by building two trestles with top handrails, and joining them on each side with three spreaders and a diagonal support. A rope ladder is used to climb up to the platform.

WHAT YOU'LL NEED

- ❑ 4 8-foot x 4-inch spars for the legs
- ❑ 12 4-foot x 3-inch spars for the spreaders
- ❑ 6 5-foot x 2- to 3-inch spars for the diagonal supports and X-braces
- ❑ 9 to 13 4-foot x 2- to 3-inch floor spars
- ❑ 4 2-foot x 2-inch ladder rungs
- ❑ 38 20-foot x ¼-inch lashing ropes
- ❑ 6 25-foot x ⅜-inch ropes for guy lines and ladders
- ❑ 2 35-foot x ¼-inch ropes for the floor lashings
- ❑ 8 pioneering stakes
- ❑ 4 sticks (for anchor back ties)
- ❑ binder twine (for anchor back ties)



WHAT YOU'LL DO

Build the Trestles: For each of two trestles, lay two 8-foot spars next to one another on the ground, making sure the butt end of each is on the bottom. With tight square lashings, connect the legs

Make an overhand loop.

Reach through underneath and grab the standing part.

Pull the standing part through the overhand loop.

about 3 inches from the bottom with a 4-foot spreader (ledger), and about 6 inches from the top with a 4-foot spreader (handrail). Select one of the stoutest 4-foot spreaders and lash it securely to the legs, so the underside of the spar is 5-feet from the bottom. This leg will serve as the trestle's transom and act as a platform support for the floor. Make sure the ends of the 4-foot spreaders extend out from the legs about 4 inches on each side.

Add the Cross Braces (X-braces): Lay one end of one of the 5-foot spars on top of one 8-foot leg, about a foot up from the bottom, and place the other end underneath the other 8-foot leg, about a foot down from the 4-foot transom. Lash this 5-foot spar in place with square lashings. Now take a second 5-foot spar, and cross it on top of the first, forming an 'X', and lash it in place. Where these cross braces intersect, spring them together with a tight diagonal lashing.

Connect the Trestles: When both trestles are complete, stand them up on their sides, parallel to one another and join them together by lashing a 4-foot (bottom) spreader tightly over each trestle's 4-foot ledger. Also lash a 4-foot top spreader just over the handrails, and a 4-foot middle spreader just over each platform support (trestle transoms).

Tightly lash on a 5-foot diagonal support from the bottom of one leg to just under the X-brace on the other leg.

With all hands on deck, carefully flip over the tower and, in the same fashion, join the trestles on the other side. (When it comes time to lash on the 5-foot diagonal support on the other side, make sure the bottoms of the diagonals are lashed on opposite trestles.) When the trestles are connected on all four sides, with the whole crew

pitching in, carefully stand up the tower and place it in position.

Anchor the Tower: tie one end of a 25-foot rope to each 8-foot leg, 2 feet from the top, using a roundturn with two half hitches. Construct a 1-1 anchor, 12 feet out at 45° from each corner. With rope tackles, secure the guy lines to the 1-1 anchors.

Lash on the Floor: Lay out the floor spars on top of the platform supports (trestle transoms) and using the 35-foot ropes, lash them securely in place with good floor lashings.

Build and Attach the Rope Ladder: Your rope ladder is made by tying marlin spike hitches to the four 2-foot ladder rungs using the two other 25-foot ropes. Start by tying one end of each rope to the middle spreader on the side of the tower you want the ladder, using a clove hitch. Leave enough tail in the rope so you can tie a bowline with a small loop in the end. Let this bowline dangle down 1 to 2 feet towards the ground.

Space the rungs about 15 inches apart. When all the rungs have been added and are evened out on each side, carry the end of each rope under the 4-foot bottom spreader and thread them through the loops of the bowlines that are dangling down. Now tighten each side of the ladder by pulling on the end of each side, using the bowlines' loops like rope tackles. Finish off with a couple of half hitches.

Insert the rung in the loop made out of the standing part.

Adjust the rung and tighten the hitch.

Rear view

Four-Flag Gateway Tower

This simple project is an impressive feat of engineering. While it's a tower that requires hoisting, it's also a campsite gateway and an elaborate flag display. It can create a spectacular effect.

WHAT YOU'LL NEED

Bamboo works great for this project.

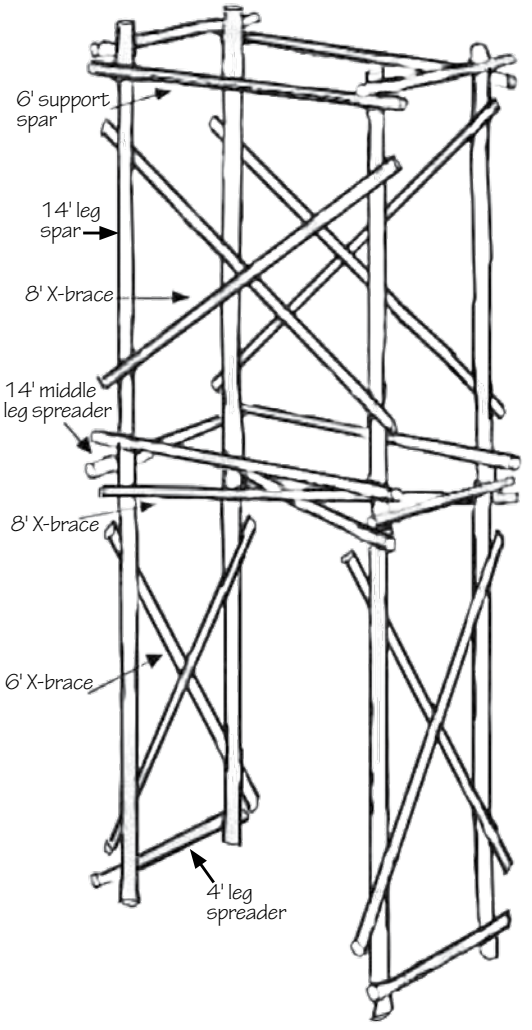
- ❑ 4 14-foot x 2½-inch leg spars
- ❑ 6 8-foot x 2-inch X-brace spars
- ❑ 4 6-foot x 2-inch X-brace spars
- ❑ 4 6-foot x 2-inch support spars
- ❑ 6 4-foot x 2-inch leg spreaders
- ❑ 45 15-foot x ¼-inch lashing ropes
- ❑ 8 6 to 10-foot x ¼-inch lashing ropes (for flags)
- ❑ 4 35-foot x ⅜-inch guy lines
- ❑ 8 24-inch pioneering stakes

WHAT YOU'LL DO

Assemble the Four-Foot Sides: Lay out two pairs of 14-foot spars for the tower legs, side by side, about 3½ feet apart. Be sure the butt ends are even at the bottom so the tower will stand up straight. With square lashings, tightly lash each pair of legs together starting with a 4-foot bottom leg spreader about 6 inches from the butt ends. Lash on a 4-foot middle leg spreader in the middle of the 14-foot legs (7 feet up), and a 4-foot top spreader about 3 inches from the top of the 14-foot legs.

When the legs of each 4-foot side are joined with the three 4-foot spreaders, lash on two 6-foot X-braces using square lashings to join the ends to the legs, and a diagonal lashing where they cross, forming a trestle in the bottom half of the legs. (Three of the ends are lashed to the inside of the legs and one on the outside, so a slight gap is created where they cross. As you start the diagonal lashing, this gap will be sprung together.)

This project consists of several sub-assemblies, and with a division of labor, can be built in good order e.g. building both of the 4-foot sides while simultaneously, laying out the position of the legs and building the anchors.



Joining One of the Four-Foot Sides: Turn both sides up horizontally, parallel to one another about 5½ feet apart. Make sure the bottoms are even. Lash on one of the 6-foot support spars directly above the 4-foot middle spreader. Lash another one of the 6-foot support spars directly under the 4-foot side spreader at the very top.

Now, lash on two of the 8-foot X-brace spars diagonally between the two 6-foot supports using square lashings to join the ends to the legs, and a diagonal lashing where they cross, forming a trestle in the top part of the wide (6-foot) side.

Join the other Side: To make the lashings to join the other side, you have to get the whole crew together to carefully lift and roll the tower over 180° so that it's laying on the X-brace, and the other side is easier to get to. Once rolled over, repeat the above process to join together the remaining Four-Foot-Side.

Lashing on the Middle X-Brace: This X-brace is what will keep the sides from racking. Lash the two remaining 8-foot X-brace spars diagonally across the legs just under the 4-foot middle leg spreader. Use square lashings to lash them to the legs and a diagonal lashing where they cross. To accomplish this, some crew members will have to hold up the top of the tower so that there is better access to all four ends of the 8-foot X-brace spars.

Lashing on the Flags: Lash the flagpoles of the four selected flags to the top of each tower leg using a couple of tight round lashings.

Anchors and Guy lines: Lay out the position of the four legs on the ground. (This can be done at anytime.) Then determine where the four anchors for the guy lines will be placed to steady the legs of the tower. Using the pioneering stakes, build four 1-1 anchors. Each should extend 16 feet, and 45° out from the leg. When all the lashings are done, move the tower to where it will be hoisted.

Note: This design is not self-standing. Therefore, allowing for the necessary guy lines, it requires a space wide and deep enough to accommodate a 16-foot x 16-foot area.

Before Hoisting the Tower: Attach the four guy lines securely to the legs, about 10 feet up, with rolling hitches or roundturns with two half hitches. Note: Since this design has no halyards, before hoisting the tower make sure the flags are unfurled. (With longer legs, halyards can be added to the tops of the legs extending three to four feet above the top leg spreader.)

Hoisting the Tower: You'll need a whole crew to do the hoisting. Get ready to hoist the tower by delegating the following:

- One signal caller who tells the crew members when and how fast to pull on the ropes;
- One safety officer who's on the look out for all safety considerations and signs of trouble during the hoisting;
- Four Scouts to serve as "lifters," to lift the top 6-foot support spar that's on the ground, whose job it is to first lift and then push the tower up;
- Two Scouts, one on each of the two guy lines attached to the legs, to make sure the tower isn't over pulled and topples over; and
- Four "pullers" who will use the two guy lines facing up as hoisting ropes to pull the tower until it is standing.

Hoisting a tower in itself is an exhilarating experience, and even more so when the tower is flying your flags!

When everyone is in position, the signal caller should direct the Scouts on the hoisting ropes (the pullers) to hoist the tower into position, while the lifters start lifting. Care should be exercised not to over pull the tower. As soon as the tower is standing, four Scouts should temporarily tie the guy lines to the anchors using a roundturn with two half hitches.

Heeling the Tower: If the tower is uneven, you can heel the butt ends of the legs 4 to 6 inches deep as needed to make it more level.

Tightening the Guy lines: As soon as the tower is in position, go to each of the anchors and untie the roundturn with two half hitches and replace it with a rope tackle. Use the rope tackles to hold the tower steady, by gradually applying strain to each of the four guy lines at the same time. Do this by tying a butterfly knot in each guy line about 6 to 8 feet from the anchor. Then wrap the running end of the guy line around the forward stake of the anchor and back through the loop in the butterfly knot. When rope tackles are tied to all four anchors, gradually tighten the lines. Apply enough strain to each of the guy lines to hold the tower firm and in a vertical position. Then tie off the rope tackles by securing the running ends with half hitches.

Double Tripod Chippewa Kitchen

The Chippewa Kitchen is the ultimate camp kitchen pioneering project, providing a huge element of convenience to a wide range of camp cooking operations. The Chippewa Kitchen provides a raised surface for food preparation, a nifty place to hang tools and utensils, a framework from which a pot can be safely suspended over a cooking fire, and primarily, a convenient, raised cooking surface for cooking over hot coals.

WHAT YOU'LL NEED

- ❑ 2 10-foot x 3-inch platform support spars (For a smaller kitchen, 8-foot spars work great.)
- ❑ 6 8-foot x 3-inch tripod leg spars
- ❑ 4 6-foot x 2½-inch tripod braces
- ❑ 2 6-foot x 2½ to 3-inch front tripod braces (to support the platform support spars)
- ❑ 20 to 40 3 to 4-foot x 2-inch floor spars (depending on the size of the cooking surface required)
- ❑ 16 15-foot x ¼-inch manila lashing ropes for square lashings
- ❑ 2 20-foot x ¼-inch manila lashing ropes for tripod lashings
- ❑ binder twine for floor lashing
- ❑ burlap, terry cloth, or canvas to cover cooking platform

WHAT YOU'LL DO

Build the Tripods: Lay three 8-foot tripod legs side by side and lash them together with a tight tripod lashing. Make sure the butt ends are at the bottom and even. Stand the tripod up by crossing the outside legs underneath the middle leg. Repeat this process for the second tripod.

Lash on the Tripod Braces: Connect the two outside legs with one of the thicker 6-foot front tripod braces. With tight square lashings, lash the brace so it is perpendicular to the ground and three feet high. Lash another 6-foot tripod brace to each outside leg and connect them to the middle leg with square lashings, about two feet and two and a half feet high respectfully.

Repeat this process for the second tripod, making sure one of the thicker front tripod braces connecting the outside legs is again, three feet high.

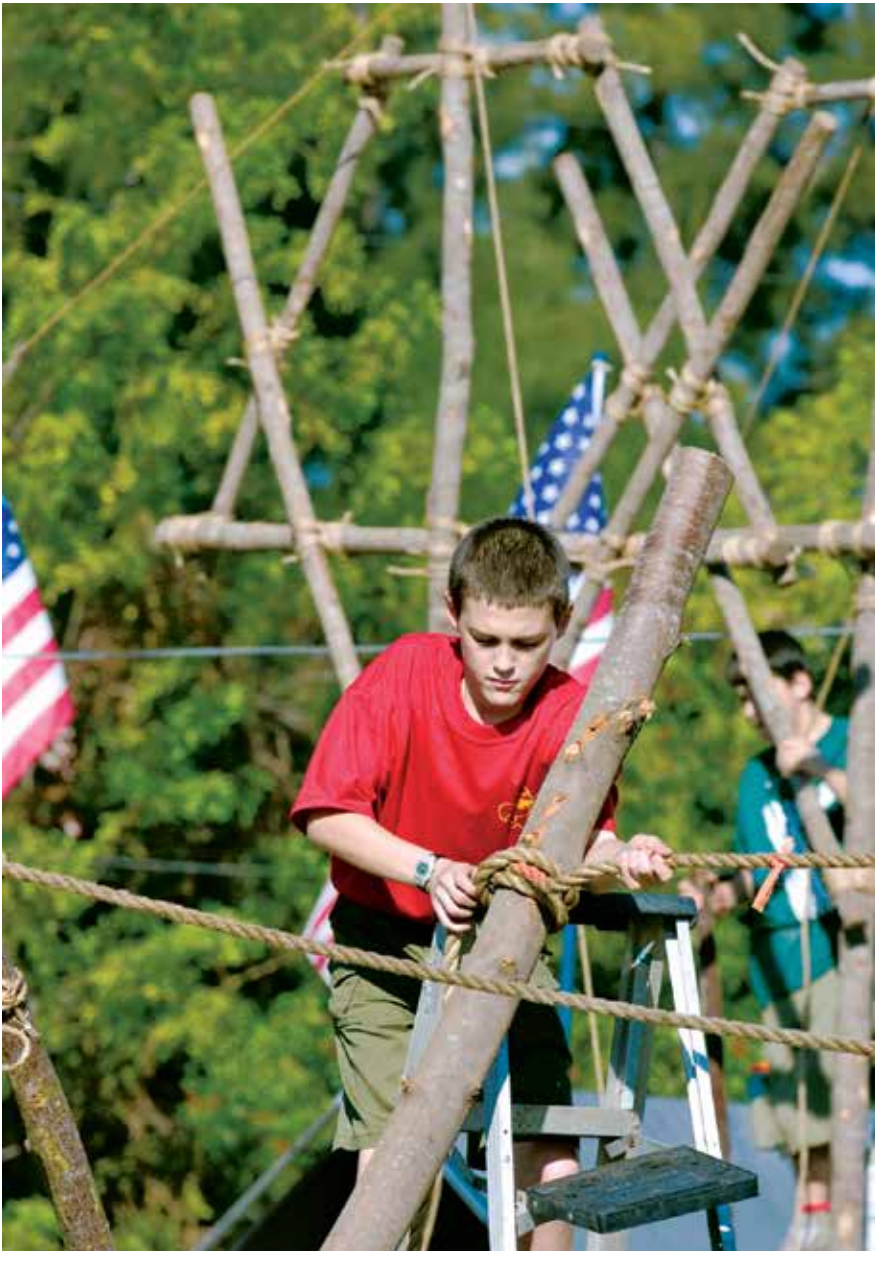
Position the Tripods: Place the tripods so the 6-foot tripod braces lashed to the outside legs (the thicker ones that are three feet off the ground) are facing each other. These braces are the ones that will hold up the long platform support spars, which in turn will support the cooking platform. The distance between the two tripods should be close enough so the long platform support spars can extend over each brace by at least six inches.

Lash on the Platform Support Spars: Place the long platform support spars parallel to each other on top of the three foot high tripod brace on each tripod. Space them apart so the shortest floor spar will extend over their edges by six inches on either side. Lash them in place with tight square lashings.

Lash on the Floor Spars: The cooking surface is made up of 3 to 4-foot x 2-inch floor spars, depending on how wide a cooking area will be required. These are lashed onto the parallel platform supports with a floor lashing using binder twine.

Prepare the Cooking Surface: Prior to adding 2 to 3 inches of mineral soil, and to keep he mineral soil from falling though spaces between the floor spars, spread pieces of burlap, terry cloth, or canvas over the platform.

Cover the platform: Use a layer of mineral soil thick enough to protect the floor spars from the intense heat that will be generated from the coals during cooking.



Pioneering Resources

Scouting Literature

Scouts BSA Handbook for Boys; Scouts BSA Handbook for Girls; Guide to Safe Scouting; Deck of First Aid; Emergency First Aid pocket guide; *Wilderness First Aid Manual; Wilderness First Aid Field Guide; Knots* pocket guide; *Deck of Knots; Knots and How to Tie Them; Camping, Climbing, First Aid, Model Design and Building, Textile,* and *Woodwork* merit badge pamphlets

With your parent's permission, visit Scouting America's official retail website, www.scoutshop.org, for a complete listing of all merit badge pamphlets and other helpful Scouting materials and supplies.

Books

Green, Larry. *Scout Pioneering Good Ol' Fashioned Outdoor Fun*, Creative Space Publishing, 2017

Findley, Gerald L. *RopeWorks Plus*, booksurge.com, 2007

Sweet, John. *Scout Pioneering*, Scouts Canada, 1974

Websites

Guide to Safe Scouting
www.scouting.org/health-and-safety/gss

Scout Pioneering
scoutpioneering.com

Troop Leader Resources
troopleader.scouting.org/program-feature-pioneering

Acknowledgments

Thanks go to Larry Green for writing this pamphlet. Thanks also go to the former National Camping Committee for their support, and to the Merit Badge Maintenance Committee and the National Scouts BSA Committee for their guidance.

For over 25 years, Scout pioneering has primarily been influenced by the late Adolph Peschke. Much of the content in this pamphlet has been taken directly or adapted from his writings. Mr. Peschke's input into the way Scout pioneering is approached and carried out has assured the success of numerous pioneering endeavors. It's because of Mr. Peschke that many of today's Scout pioneering enthusiasts are so avid in their pursuit to provide our youth with repeated opportunities to engineer and orchestrate

the construction of pioneering structures that are useful or just plain fun.

It is appropriate to also acknowledge the extraordinary jamboree staff of the pioneering area and their leaders, whose love for what they do is evidenced by their dedication, along with the obvious fun they have in the midst of all their joyfully undertaken hard work.

Acknowledgements pertaining to Scout pioneering would not be complete without a reference to the late John Thurman, longtime Gilwell Camp Chief. His wisdom, his wit, and his insight into what Scouting is all about live on through his writings and stories.

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