MOUNTAIN ESSENTIALS®

WALKING on a GLACIER

This instructional manual provides a comprehensive introduction to the skills that all budding mountaineers must master in order to safely enjoy glacier walks and easy snow and ice climbs.

It covers basic techniques for tying into a rope (knots, taking in coils round the shoulder, tying-in distances between climbers, etc.), walking across glaciated terrain (crampon techniques, using an ice axe, etc.), belaying on snow and ice (with a belay plate, around the waist, stopping a slide, etc.) and getting out of crevasses.

The objective is to help mountaineers assess the situations they may have to face and make informed decisions about the best course of action to take.

- **138** clear and simple illustrations
- **155** action photos
- Step-by-step descriptions of the basic techniques all mountaineers should master
- Advice on identifying the main dangers presented by the terrain
- **15 scenarios** commonly encountered when climbing snow slopes or crossing crevasses, describing frequent mistakes and how to avoid them

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MOUNTAIN ESSENTIALS®

WALKING on a GLACIER

Sébastien CONSTANT

Éditions Constant

MOUNTAIN ESSENTIALS®

Level 1 Starting out

WALKING on a GLACIER

WARNING - DISCLAIMER

Glacier walking, mountaineering, ski mountaineering, ski touring and all related mountain sports are potentially dangerous activities that should only be undertaken by those with a full understanding of the risks involved and with the skills and experience to evaluate these risks.

The objective of this handbook is to guide users during their first steps in the mountain environment. The information and advice it provides are based on the author's experience as a mountaineer and mountain guide, and on existing manuals.

While every effort has been taken to ensure the information, references and links to other books or websites contained in this handbook are accurate, errors and omissions cannot be excluded. In addition, the author cannot accept any responsibility for the content of websites or other sources (publications, guidebooks, etc.) cited in this book.

During a trip into the mountains you may be the only person capable of making a decision. If you are not immediately sure about what to do or which route to follow, you must base your decision on a careful analysis of the terrain and the circumstances you find yourself in. This is particularly important if you feel that the methods described in this handbook are not suited to the situation you are facing.

If conditions are unfavourable (open crevasses, poor weather, etc.), or if you do not have the necessary skills and experience, do not hesitate to change your objective or call upon the services of a mountain guide. Life is worth much more than a tick in a guidebook or being able to say you climbed a certain peak.

If you cannot take full responsibility for your actions, your safety and the safety of others, do not go into the mountains and do not use this handbook.

The author does not accept liability for damage of any nature (including damage to property, personal injury or death) arising directly or indirectly from the information included in this handbook.

This handbook cannot be considered a substitute for practical training.

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INTRODUCTION

Fellow mountain lover,

The MOUNTAIN ESSENTIALS® series of handbooks provides a comprehensive introduction to the skills needed to get the most from trips into the mountains and to safely enjoy mountain days to the full. Mountaineering involves an exceptionally rich palette of skills and strategies that take time and patience to acquire. To facilitate this process, MOUNTAIN ESSENTIALS® describes the essential techniques required by each mountain activity, without swamping the reader with superfluous detail. In addition, each activity is described in two separate handbooks catering to different levels of expertise. As a result, whether you are a beginner (Level 1 Starting out) or ready to build on the skills you already have (Level 2 Advanced), you will find the information that best suits your specific needs.

A handbook can do no more than suggest techniques and solutions that can be applied in different situations. However, each solution is no more than one option among many and it is up to each individual to decide which solution is most appropriate in each set of circumstances.

This handbook is the fruit of 25 years of mountaineering experience, including 15 years as a professional mountain guide and writer for the climbing press, and several years as a member of the Savoie and Briançon mountain rescue teams.

The philosophy behind these handbooks was inspired by the new approach to risk that has been developed in the field of geography, initially in Switzerland, North America and the UK. Applied to the MOUNTAIN ESSENTIALS® handbooks, this approach can be summarised in three key words: Risk, Difficulty and Prevention.

Risk is something every mountaineer decides, more or less consciously, to accept or, sometimes, to confront. The difficulty of an itinerary depends on a number of variables (crux sections, time required, conditions in the mountains, etc.). Prevention is a way of avoiding situations whose outcome may be uncertain.

Mountaineering manuals often explain how to get out of critical situations, but very few explain how to avoid getting into such situations in the first place. It is as if a driving instructor spent the first lesson explaining how to get across a four-lane junction when the light is red – of course, the easiest thing to do is stop and wait for the light to turn green.

MOUNTAIN ESSENTIALS® handbooks have been designed to help mountaineers avoid unwelcome situations by providing simple tools that will allow decisions to be made quickly and easily.

The final part of each book describes a number of common scenarios, annotated with colour-coded pictograms (GREEN / ORANGE / RED / BLACK) that show what should and should not be done in different situations. This new approach will not always get you to your chosen summit, but it should help you get home safe and sound, ready to go back into the mountains when the conditions are better.

I hope this modern handbook will help you progress in your mountaineering career and fulfil your responsibility to look after the friends who accompany you into the mountains.

Sébastien Constant April 2011

This handbook cannot be considered a substitute for practical training.

I - TECHNICAL INFORMATION

1-1 EQUIPMENT

In such a small handbook as this it is impossible to present a comprehensive review of mountaineering equipment. There are so many manufacturers and so much specialised gear an entire book would be needed to do justice to the subject.

All technical equipment is sold with instructions. Read these instructions carefully before setting off so you know how to use each piece of gear and how to avoid accidents through misuse.

RENT OR BUY?

If you are starting out, or if you only rarely go into the mountains, renting equipment may be the best option, as this will allow you to use recent, well-maintained gear (if you rent from a reputable store). It is possible to rent boots, crampons, walking poles, ice axes, harnesses and helmets.

One drawback of renting is that you will need to go to the rental shop the evening or morning before setting off, in order to try on the gear. In many cases, gear can be booked in advance via the Internet, thereby saving time and allowing you to choose the equipment you want. However, you will still have to try gear, especially boots, before you rent it.

The following list shows the main items of clothing and equipment you will need to wear or have in your rucksack when doing a glacier climb.

PROTECTIVE CLOTHING

Use a "layering system", so you have as many different combinations as possible.

① One or two thin microfiber layers (polar fleece or wool).
② A windproof polar fleece jacket (Windstopper, Soft shell, etc.).
③ A breathable, waterproof jacket with a hood (Gore-Tex, etc.) to protect against rain or snow.
④ Mountaineering trousers made from a stretch material. The thickness will depend on the season, altitude, weather, etc.
⑤ A lightweight, insulated waistcoat or jacket that does not restrict movement (e.g., Triple Zéro Antza) and that can easily be stowed in your rucksack. This type of jacket provides excellent protection from the wind and a sudden fall in temperature.
⑥ Thermal tights, if you feel the cold.
⑦ Breathable, waterproof over-trousers, if the weather is likely to be unstable at the end of the day, etc.
⑧ A hat.
⑨ Leather DIY gloves are useful, even when the weather is good.
⑩ A rain cape, if there is a likelihood of heavy rain/storms during the walk in or walk out.

BOOTS

Use mountaineering boots with rigid soles, as they grip better on hard snow and can be used with crampons.

Leather boots are more flexible and more comfortable to walk in (especially on footpaths) than the plastic boots that were popular during the 1980s and 1990s (rigid, less precise and les comfortable for walking up to huts or on scree or footpaths).

Welt on the heel and on the toe of the boot.

Mountaineering boots have a welt on the heel ① for attaching crampons. Models designed for snow and ice climbing also have a welt at the front and can be used with all types of crampons. Models designed for rock climbing do not have a welt at the front and can only be used with strap-on crampons.

Semi-rigid trekking boots can be used for easy routes (F) and glaciers without many crevasses. This type of boot can only be used with strap-on crampons.

Welt on the heel of the boot.

Reputable rental shops should provide latest generation leather boots. Be wary if you are offered a pair of plastic boots, presented as being more suitable for what you want to do. It is probably because the shop does not have, or has run out of, leather boots.

If you decide to rent boots, it is a good idea to take enough blister pads, tape or plasters to prevent or treat blisters. Chemist shops sell squares of blister pads (10x10 cm) that can be cut to size and that are much cheaper than packs of pre-cut (oval) dressings.


Trekking boot without welt.

GAITERS

Gaiters are very useful for stopping snow getting inside your boots. In addition, they help stop the bottom of your trousers flapping about, thereby reducing the risk of your crampons snagging.

CRAMPONS

Use steel crampons with anti-balling plates (reduce the accumulation of snow on the bottom of crampons). Aluminium crampons are more suited to ski touring. There are several types of crampon binding: straps, metal toe bar + strap, plastic toe piece + strap, step-in, etc.

Depending on the brand, most new crampons have very sharp points. This can be dangerous, as the crampon can slip if you step on a rock and there is a risk of cutting your leg if you snag a crampon on your trousers. A good tip is to wear the points down a bit by walking on rock or roads.

Conversely, crampons that are too blunt will not bite into hard ice. Crampons can be sharpened with a file or an angle grinder.

If you use a high-speed grinder, take care not to overheat the metal (weaken the metal). The easiest way to do this is to frequently dip the crampon in water to cool it down – taking care not to get the grinder wet and electrocute yourself in the process!

Once a crampon has been adjusted to the size and shape of the boot, it should not move. The boot must not be longer than the crampon, especially at the heel (danger of the crampon falling off).

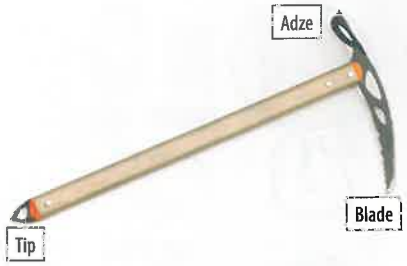
CAUTION Badly adjusted crampons.

WALKING POLES

It is a good idea to use poles for walking up to huts or over gently inclined snowfields, as they help with balance and reduce wear and tear on the knees. Telescopic poles have become much cheaper in recent years and most now come fitted with small baskets.

ICE AXES

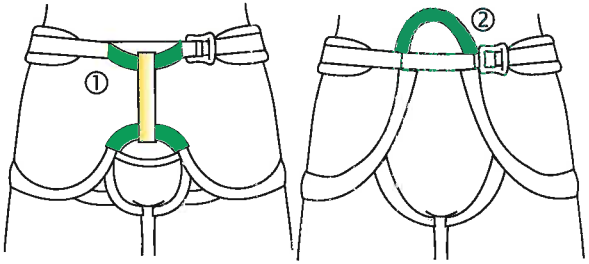
For easy routes (snow and ice slopes of less than 35°), a classic "walking axe" is sufficient. The length of the axe will depend on your height. For example, 55 or 60 cm would be a suitable length for someone who is 170-cm tall. Wrist straps have gone out of fashion in recent years, for two reasons. 1) With a wrist strap it takes more time to swap the axe from one hand to the other when changing direction. 2) Not being able to let go of your ice axe increases the risk of being stabbed by it (most notably in the face) if you fall.



HARNESSES

If you are a rock climber, you can use the same harness. The current trend is for very lightweight harnesses (150 to 350 g). I tend to use a lightweight climbing harness (300 g), with 2 tie-in points ① linked together by a belay loop (short sling that connects the 2 points).

Most rental harnesses have a single tie-in point ② (therefore no belay loop).



HELMETS

The latest helmets have an expanded-polystyrene inner shell ① that is very effective at absorbing impacts. They are a little less robust than traditional polyethylene helmets but they offer better protection. Most rental helmets are polyethylene.

RUCKSACKS

A lightweight 30-litre ② rucksack is sufficient for most trips. If you use a larger rucksack, you are much more likely to take things that are not indispensable. Carrying a heavy rucksack is a real handicap, as an extra 1 or 2 kg on your back can cost you 2 hours over a day in the mountains. Carrying too much weight is a sort of time bomb that will explode when you most need to move fast.

FOOD AND DRINK

Take 1.5 or 2 litres of water (e.g., in a hydration pack ③) for a day in the mountains. To aid the assimilation of melt water (which contains very few minerals), I generally add fructose (30 to 60 g/litre of water) to my water bottle. Take enough food (energy bars and picnic) to ensure you can keep going all day.

Possible ways of carrying ice axes and walking poles.

SAFETY AND NAVIGATION EQUIPMENT

- A compact, new-generation, LED head torch (batteries last much longer than for a filament-bulb head torch).
- Sunglasses (category 3 or 4) + sun cream + sun hat or baseball cap.
- A small first-aid kit (containing at least a survival blanket, a whistle, disinfectant, bandages, adhesive tape and painkillers) + knife.
- Map of the area, photocopies of route descriptions.
- Compass, altimeter (often integrated into mountaineering watches). A GPS can be useful for navigating over large, crevassed glaciers when visibility is poor (but that requires a certain amount of mountaineering experience).

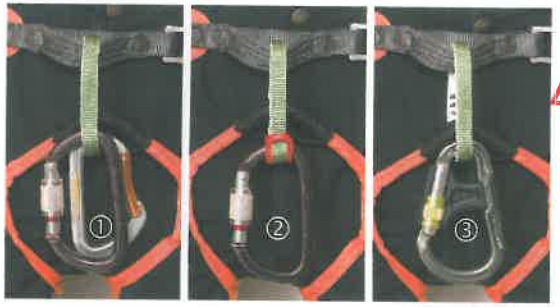
TECHNICAL RACK

A technical rack includes all the equipment needed to safely negotiate difficult terrain: karabiners, slings, ice screws, etc.

The use and placement of nuts ①, cams ② and pegs ③ will be covered in *Mountain Essentials® - Rock Climbing* (in preparation).

Using a directional safety karabiner on the belay loop of your harness facilitates rope handling. A safety karabiner is a karabiner whose gate can be locked shut by a screw, Twistlock or similar device. This karabiner is combined with either another snap gate karabiner ① (placed so the gate faces the opposite direction) or a system (sometimes made of rubber) to prevent the karabiner turning on the belay loop, thereby ensuring that it is always stressed along the correct (long) axis.

Combining two karabiners is the easiest solution ①. If you prefer a rubber band, it is possible to use a piece of bicycle inner tube or to buy specially made rubber clamps ② (e.g. the Pinch, made by Beal). DMM produces a specific directional karabiner (Belay Master) ③.



WARNING! It is still important to ensure that the karabiner is sitting correctly (in case it is suddenly subject to an unexpected shock load).

For each rope team:

In general, each team should have a 40-m to 60-m rope. On glaciers with no crevasses, a 30-m rope may suffice for a two-person team, as long as there are no long abseils to do.

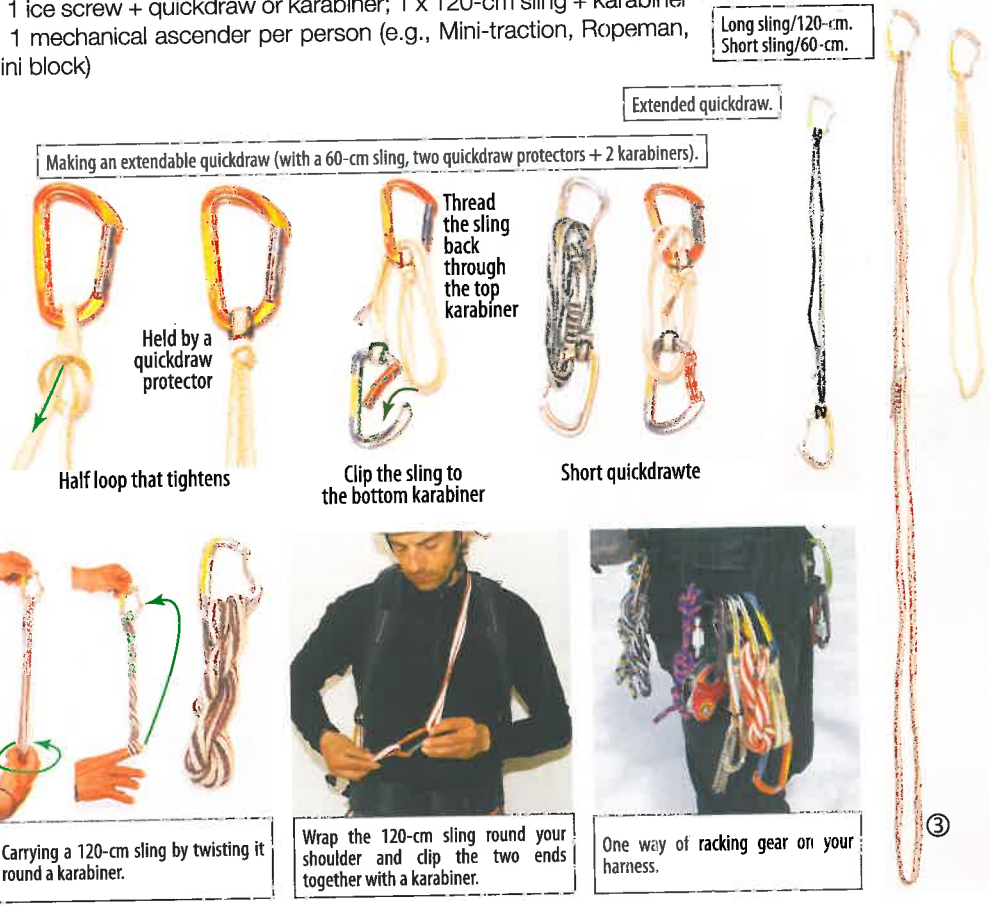
① 8.1 mm rope for snow and glacier climbs.
② 8.9 mm rope for rock and mixed climbs.

For each person:

① 1 directional screwgate karabiner
② 1 belay device (mechanical break, such as a Reverso, belay plate, figure-of-eight) + screwgate karabiner
③ 2 x 120-cm sling + screwgate karabiner
④ threading hook
⑤ 1 ice screw + quickdraw or karabiner
⑥ 2 x 60-cm prusik loops + karabiners
⑦ At least one mechanical ascender for each rope team (e.g., Mini-traction, Ropeman, Mini block) + karabiner
⑧ accessory cord

In chaotic glacial terrain (high risk of falling into a crevasse), each person should add:

⑨ 1 ice screw + quickdraw or karabiner; 1 x 120-cm sling + karabiner
⑩ 1 mechanical ascender per person (e.g., Mini-traction, Ropeman, Mini block)



Carrying a 120-cm sling by twisting it round a karabiner.

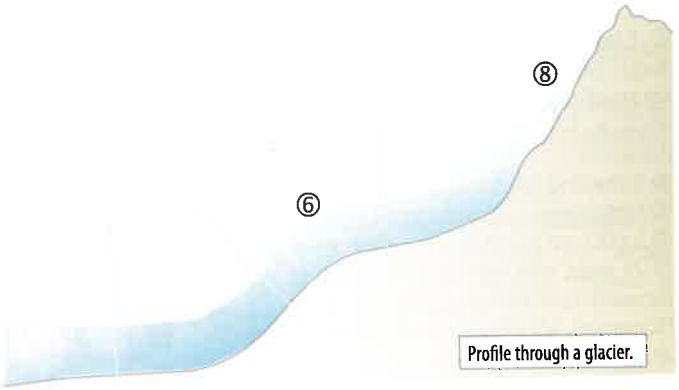
Wrap the 120-cm sling round your shoulder and clip the two ends together with a karabiner.

One way of racking gear on your harness.

1-2 GLACIERS AND SNOW

Choosing the best route and the most appropriate techniques are important aspects of moving safely over glaciers.

With this in mind, the following pages provide a brief overview of how glaciers work and the obstacles that occur on glaciers.



Profile through a glacier.

HOW GLACIERS WORK

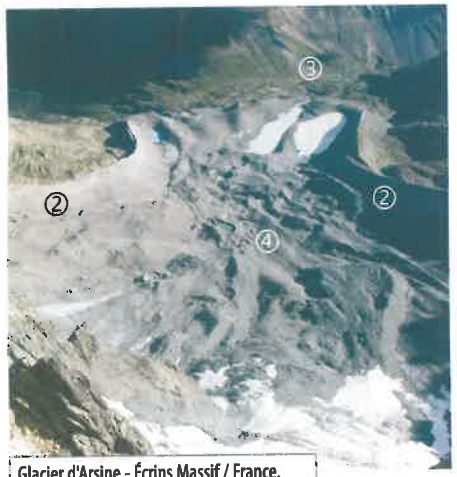
Glaciers flow slowly downhill under gravity, melting as they advance. Geographers divide glaciers into several zones:

Tongue of the Glacier Blanc - Écrins Massif / France.

① Glacier tongue: the lowest section of a glacier.

② Lateral moraine: ridge of debris deposited along the side of a glacier. The debris consists of material that fell on the surface of the glacier or that was scoured by the glacier from the underlying rock.

③ Terminal moraine: ridge of debris deposited at the snout of the glacier. The debris consists of material that fell on the surface of the glacier or that was scoured by the glacier from the underlying rock.



Glacier d'Arsine - Écrins Massif / France.

④ Debris-covered glacier: glacier buried under a substantial thickness of moraine.

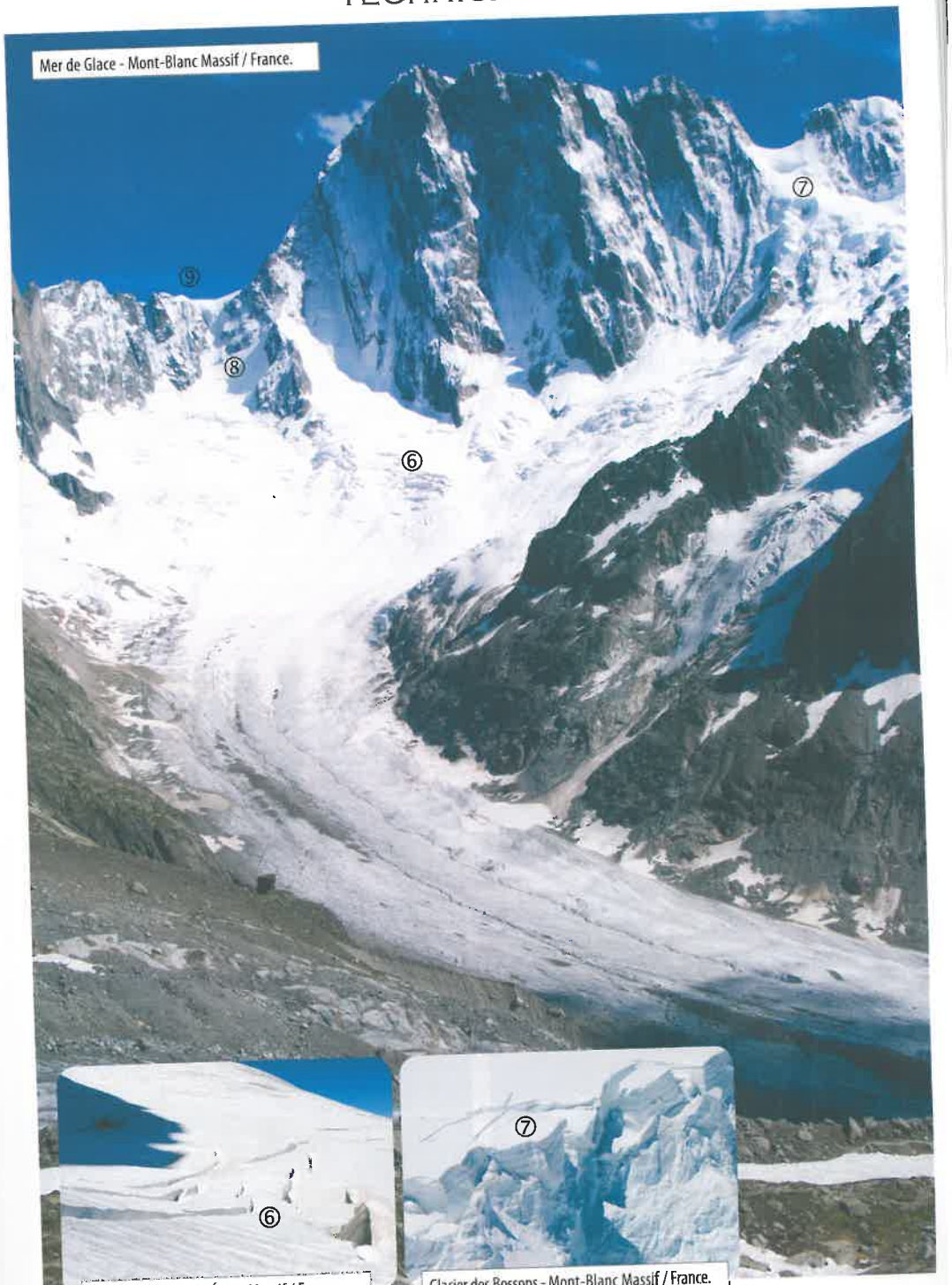
⑤ Glacial rills: grooves on the surface of a glacier formed by flowing melt water. The size of rills depends on the water flow rate. This water can collect in crevasses or percolate into the "underground" part of the glacier (inset).

⑥ Crevasse: crack formed by the stresses and strains to which glaciers are subjected. Crevasses can be perpendicular, parallel or oblique to the glacier flow direction. Their depths range from 1 m to 40-50 m or more. They generally form at breaks in the slope.

⑦ Serac: wall of ice that rises above or overhangs the downstream part of a glacier.

⑧ Bergschrund: crevasse at the top of a glacier, between the part of a glacier that moves and the snow/ice frozen to the rock above.

⑨ Cornice: Formed by snow accumulating due to the action of the wind. Cornices form on ridges.



Mer de Glace - Mont-Blanc Massif / France.

Glacier de la Meije - Écrins Massif / France.

Glacier des Bossons - Mont-Blanc Massif / France.

FORMATION OF CREVASSES AND SNOW BRIDGES

For mountaineers, the most important features of glaciers are the obstacles they contain, most notably crevasses. These obstacles may be completely or partially hidden, thereby forming traps for the unwary mountaineer.

Annual cycle for the northern hemisphere[1]:

From autumn to spring, snowfall covers and/or fills in crevasses.

Most moderate-sized crevasses become covered by snow, but they are rarely completely filled, and the largest crevasses tend to remain open all year round.

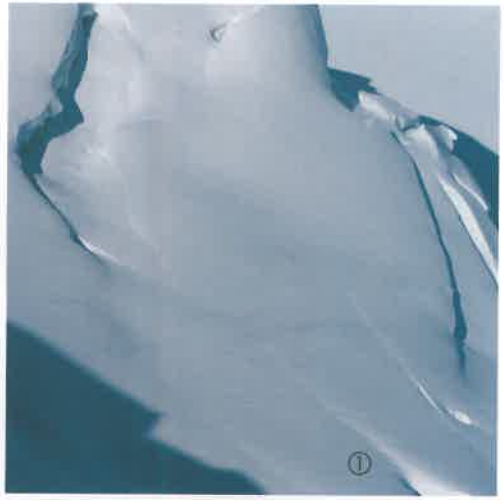
Snow bridges have not attained their maximum strength.

By the beginning of summer, most crevasses are filled in and/or covered in snow.

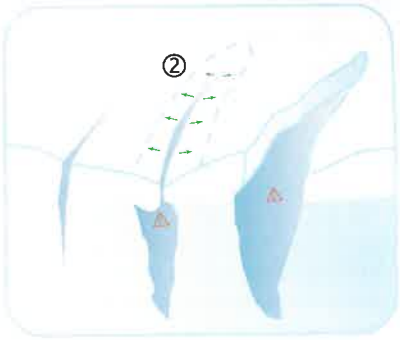
This is also the time of year when the snow bridges covering/masking crevasses are strongest.

Consequently, the best time for walking over glaciers is from the beginning of June to the middle of July.

The slight hollows ① that can sometimes be divined on the surface of a glacier indicate the presence of crevasses covered by snow bridges that have slumped slightly under gravity.



1 The standardised sequence described here will vary from one mountain range to another. It does not apply to areas close to the Equator or to the southern hemisphere.

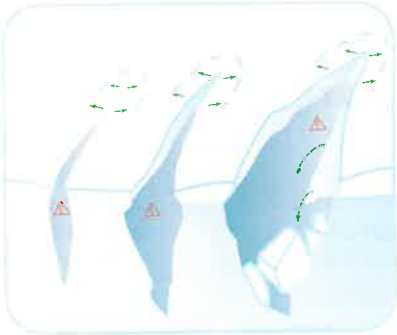


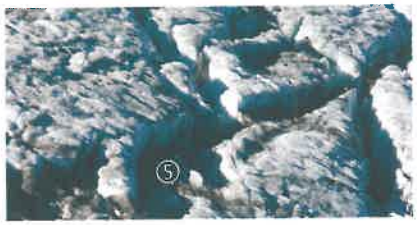
After the middle of July, snow bridges start to become less reliable. Crevasses continue to open and the bridges ② over them become thinner as the snow compacts and melts.

Bare ice begins to appear in the lowest parts of glacial basins, making it easier to see where obstacles are.

As summer progresses, the snow continues to melt and open crevasses become wider. Some snow bridges collapse.

Walls of snow and ice on the edges of large crevasses ③ may fall into the crevasse as the glacier advances.





At the end of the summer, much larger areas of bare ice are exposed ④.

Crevasses become more difficult to cross and/or avoid as snow bridges disappear or become too fragile to cross. In "dry" conditions at the end of summer, bare ice ⑤ (often mixed with sand and rock) starts to appear, especially in the lower sections of glaciers, and more care must be taken when walking in crampons. However, the disappearance of the snow cover also makes the layout of the glacier clearer and reveals previously hidden traps.

TEXTURES OF SNOW AND ICE

Different types of snow will have different aspects and different "feels", especially underfoot. Although many expanses of snow appear uniform at first sight, the snow may be of variable quality and it will react differently to the pressure of a footstep or an ice axe. Here are a few tips to help avoid the most common pitfalls.

The apparent uniformity of a snowfield may be reassuring to novices but it makes changes in the snowpack difficult to recognise. Just as rock climbers have to adjust their technique to the type of rock they are climbing, mountaineers have to adapt their approach to the type of snow. In addition, changes in snow are generally much less obvious than changes in rock type, and the apparent uniformity of a snowfield can lead mountaineers to become complacent. It is essential to remain vigilant, as the snow can change with every step.

Cold, powdery snow ①: In cold, recently fallen snow, your foot will sink in quite deeply (15 to 50 cm) and create a hole. When the surface of the snow has started to humidify, it may stick to and collect under your crampons (called "balling up"). If this happens, it is advisable to regularly clear the snow from under your feet (see p. 22). Ice axes and walking poles penetrate the snow very easily.

Very wet snow ②: In old, wet, transformed snow, your foot will sink in quite deeply (15 to 50 cm) and create a hole. This type of snow may build up under your crampons, but it is not dangerous, as long as the snow does not change texture and the slope is not too steep (less than 15/20°), because your feet will sink quite deeply into the snow, so slipping will either be impossible or, at worst, very slow. However, it is still advisable to regularly clear the snow from under your feet. Ice axes and walking poles penetrate the snow very easily.

Wet snow ③: When the snow is wet but compact, your foot will stay on the surface but it will make an imprint that can be up to 15-cm deep. If snow builds up under your crampons, you must clear it off at frequent intervals. An ice axe will penetrate up to about 20 cm into the snow and walking poles will penetrate up to the basket.

Crusty snow ④: In crusty snow, your foot will first stay on the surface but then break the crust and sink in up to 15 cm. Surface crust can be formed by the freeze-thaw process or by the wind. Crusty snow is often very variable and hard work to walk on. Crampons can ball up, making walking even more tiring. If snow builds up under your crampons, you must clear it off at frequent intervals. An ice axe will break through the crust and walking poles will penetrate up to the basket.

Hard snow ⑤: In hard snow, your feet will make little impression on the surface. Only the points of your crampons will break the surface of the snow. Generally, they will not ball up. Only the point of an ice axe and the tips of walking poles will penetrate the surface.

Rotten ice: The surface of the ice can be humidified to a depth of several centimetres and look like coarse salt. Crampon points go in very easily and the ice breaks up around the pick of an ice axe. Ice axe placements can be poor unless the axe is wielded with some force so it penetrates more solid ice below the surface. No risk of crampons balling up.

Soft ice ⑥: The surface of the ice is soft, or even wet. The ice is elastic and does not break under the pick of an ice axe. Crampons bite easily and the blade of an ice axe will penetrate to a depth of a few centimetres.

Very hard ice ⑦: Ice can also be very cold and dense (very few air bubbles). Some mountaineers refer to old ice mixed with rock flour as black ice. Crampons and ice axes must be wielded vigorously to make them bite into the ice. If the ice is brittle, it may shatter into "dinner plates" when struck with an ice axe. In this case, another blow of the axe will be needed to get a solid placement.

EVOLUTION OF THE SNOWPACK DURING THE SUMMER

This manual focuses primarily on the summer season, as this is the best time for learning mountaineering techniques. The following description of how snow changes during the summer applies to moderate-altitudes in the northern hemisphere. At higher altitudes, summer storms can add fresh snow (dry powder snow) to the snowpack. This snow is similar to the snow found at lower altitudes in winter and spring.

❶ Early summer: If there is a hard frost at night, a crust of frozen snow will form on the surface of the snowpack. Early in the day, this crust may be solid enough to support a person's weight (otherwise it will break under the climber's foot). The surface layer of snow may still be of a type (cold/wet) that will ball up under crampons, especially later in the day when the temperature rises. This type of snow can be quite treacherous, especially when descending, so care must be taken.

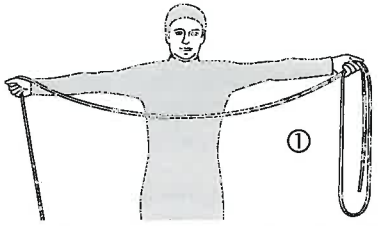
❷ Middle of summer: The snow turns into névé by a process of freeze-thaw and compaction. As the snow transforms it becomes increasingly weight bearing, even during the hottest part of the day.

❸ End of summer: The sun has less effect on the snow, only melting the top few centimetres, even during the hottest part of the day. This type of snow will not ball up under crampons. In these circumstances, shorter routes can be started 1 or 2 hours later in the day in order to have softer snow for the walk in. However, it is important not to start too late in order to avoid getting benighted if the route takes longer than expected.

At high altitude (above 3200/3500 m), there may be little difference between summer and winter snowfalls (transport of fresh snow, formation of friable wind slabs, formation of wind crust), and cold, powdery snow can be encountered at any time of year. Of course, this will depend on the freezing level.

1-3 KNOTS

COILING A ROPE



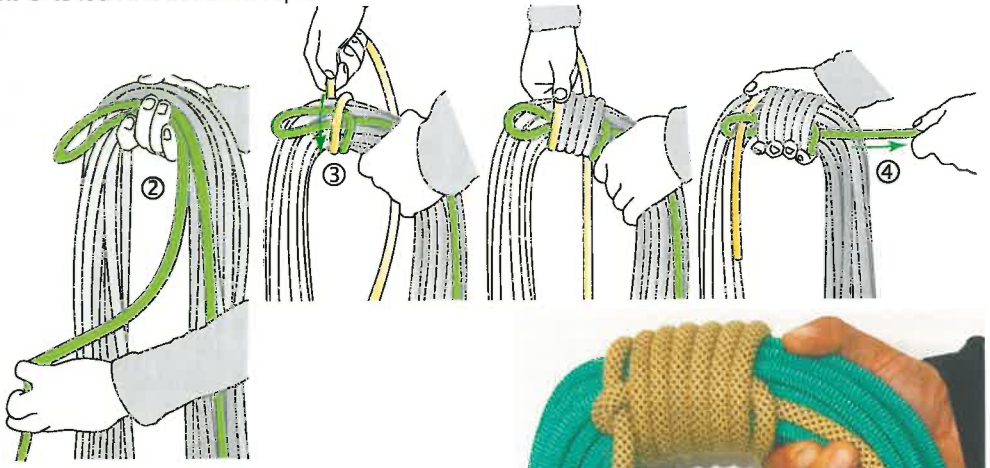
The coiled part of the rope is held in one hand, while the other hand is used to form new coils of the same length ①.

Each new coil is placed in the stationary hand until the rope is fully coiled.

To tie-off the coils, make a short loop ② (15 cm) with the remaining rope (minimum 1.5 m) and place it on top of the coils.

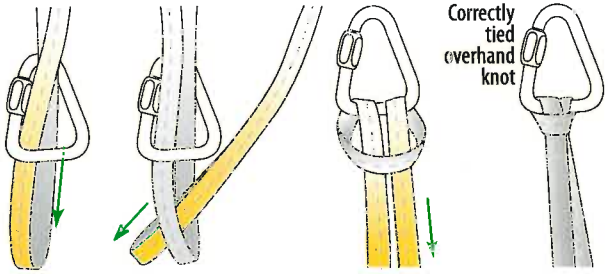
Take the other end of the rope and wrap it round all the coils ③ and the loop (5 to 10 turns), leaving the closed end of the loop free.

After the final turn of the rope, thread the end through the loop and pull the free end of the loop tight ④ to lock the threaded rope.



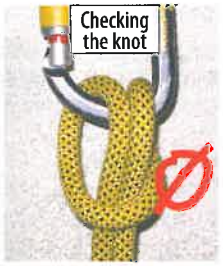
OVERHAND KNOT ON THE BIGHT

This knot is simple to tie but it is harder to untie than a figure-of-eight on the bight after it has been put under tension. Nevertheless, the simplicity of the overhand knot makes it a useful option when you need to tie a knot quickly to clip into a belay in a stressful situation.



LARK'S FOOT (GIRTH hitch)

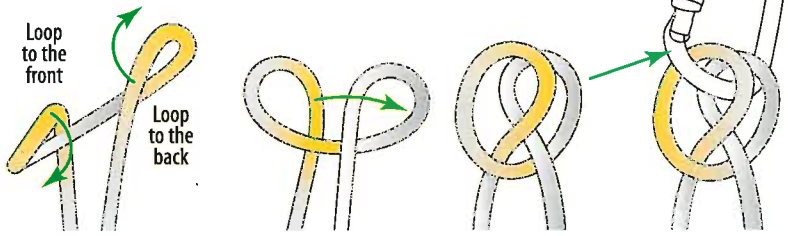
A lark's foot (Girth hitch) is the simplest way to tie a sling or a loop of rope to an ice axe or harness, etc. The finished knot should be symmetrical.



NO, this is a lark's foot

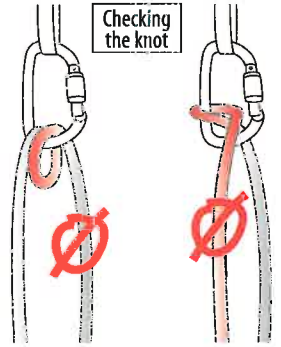
CLOVE HITCH

This knot is used to tie into an anchor point, as the length of rope between the climber and the anchor can be easily adjusted by slightly loosening the knot and sliding the rope round.

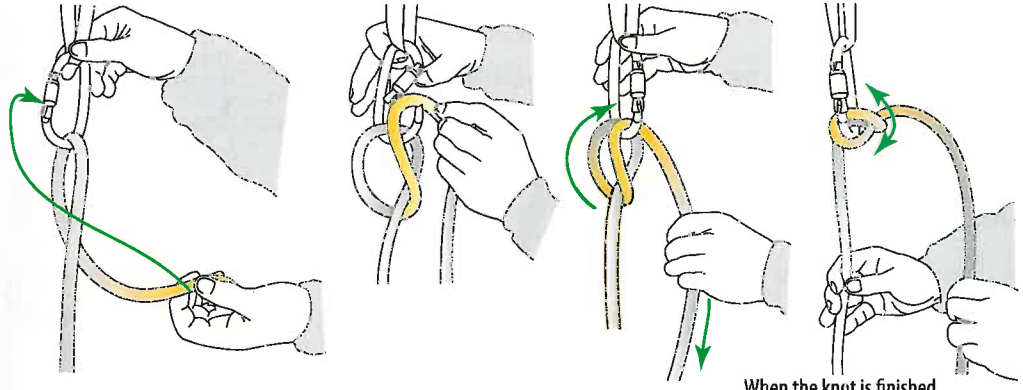


ITALIAN HITCH (MUNTER hitch)

An Italian hitch (Munter hitch) is an "unfinished" clove hitch that can pivot around the karabiner to which it is tied. It can be used with a screwgate karabiner to replace a belay device. When under tension (climber slips, abseil) it provides a very effective break in both directions.



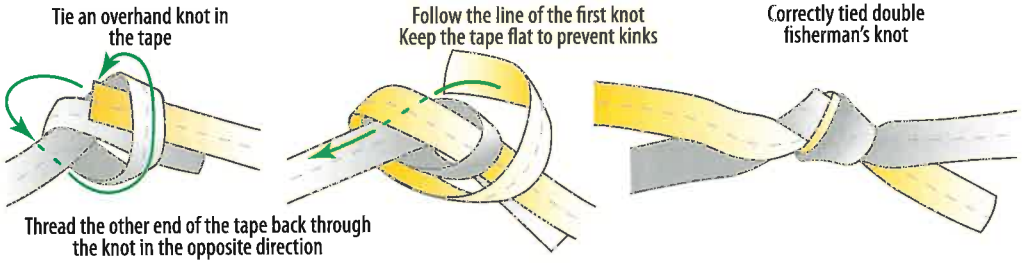
NO, this is just a round turn



When the knot is finished, the rope should run in both directions

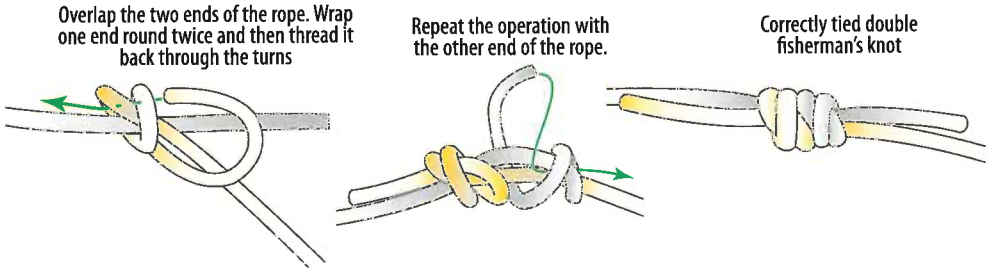
TAPE KNOT

A tape knot is used to join the two ends of a length of tape (or rope) to form a sling. When tied and tightened, make sure there are 5-10 cm (or at least 10 times the tape diameter) tails of tape protruding from the knot in case the tape slips when the sling is under tension.



DOUBLE FISHERMAN'S KNOT

This knot is also used to tie slings but it can only be used with rope. When tied and tightened, make sure that there are 5-10 cm (or at least 10 times the rope diameter) tails of rope protruding from the knot in case the rope slips when the sling is under tension.

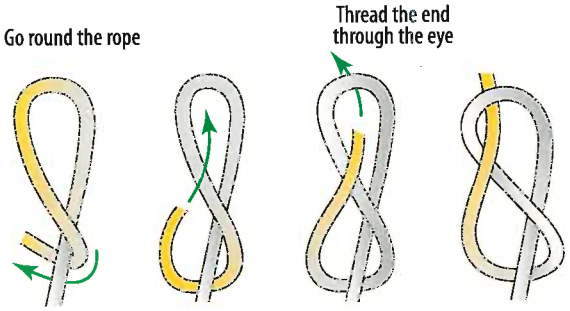


RETHREADED FIGURE-OF-EIGHT

This is the most important knot in the climber's repertoire, so it is essential to master all its uses.

It can be used to tie two ends of rope together and to tie into a harness. When tied and tightened, make sure that there are 5-10 cm (or at least 10 times the rope diameter) tails of rope protruding from the knot.

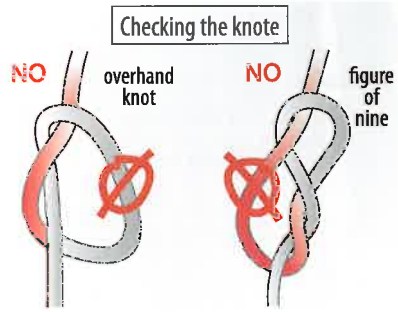
For the first part of the knot, make a loop in the rope, pass the free end back under the rope, and then thread it through the initial loop.

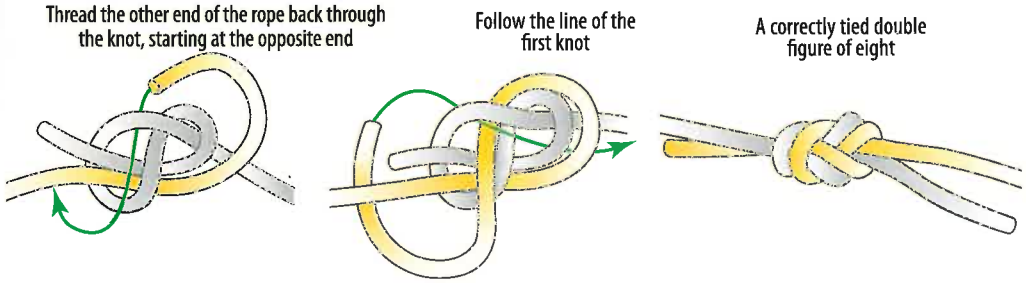


It is easy to check if the knot is correctly tied:

- Not enough loops round the rope = simple overhand knot.
- Too many loops round the rope = figure-of-nine.

To make a loop, thread the other end of the rope through the knot, following the original knot in the opposite direction. The two ends should be at opposite sides of the knot.



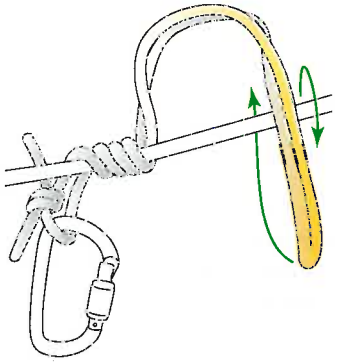


FRENCH PRUSIK (MACHARD) KNOT

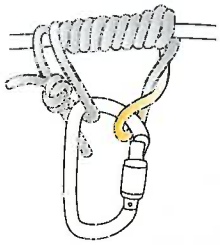
This knot is used when abseiling and in rescue operations (e.g., crevasse rescue). It can be made with either a loop of accessory cord (45 to 60 cm) or a 60-cm sling.

A prusik knot that locks too quickly is as problematic as a knot that does not lock at all. Generally, it is necessary to twist the accessory cord 4 to 6 times round the rope, but the optimum number of turns will depend on the thickness and state of both the rope and the accessory cord.

The greater the difference in the diameters of the rope and the accessory cord, the quicker the knot will lock (e.g., 7-mm accessory cord on a no-longer-new 8.6-mm rope). Slightly worn accessory cord locks more easily than new cord. It is possible to "take the shine off" new accessory cord by gently rubbing it across a piece of rock.

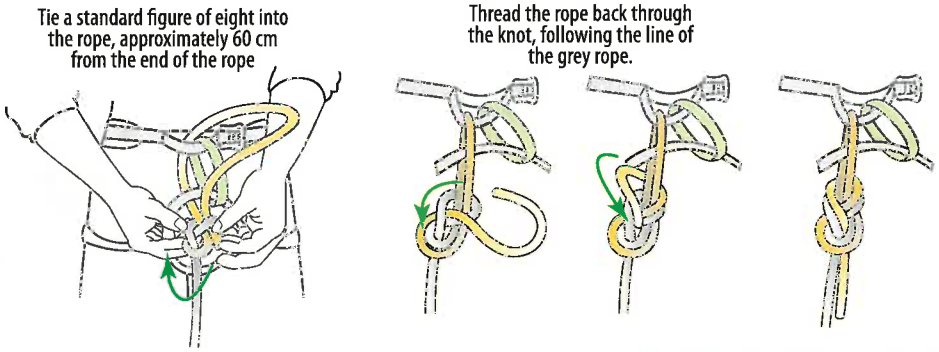


To release a prusik knot that has been under tension, simply "knead" the rope to gradually loosen the knot. The knot can then be slid along the rope, taking care to prevent it over-tightening.



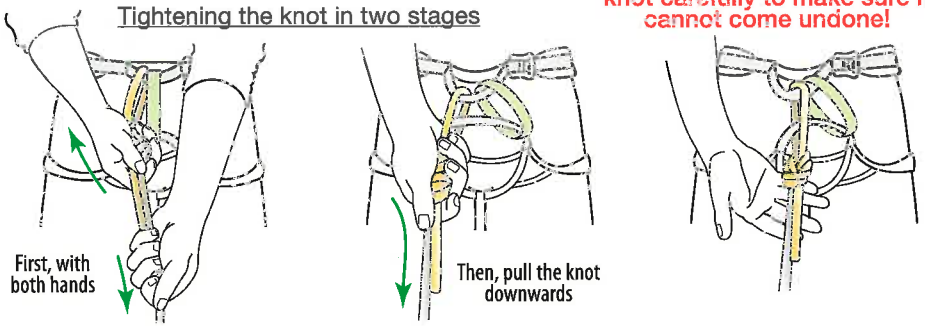
TYING IN WITH A RETHREADED FIGURE-OF-EIGHT

A rethreaded figure-of-eight is used to tie the rope directly to the harness. For harnesses with two tie-in points, thread the rope through both. When tied, the knot is easy to check.



Tightening the knot in two stages

It is essential to tighten the knot carefully to make sure it cannot come undone!



TYING IN WITH A DIRECTIONNAL SAFETY CARABINER

This method is used to tie into the middle of a rope of three. Compared with tying the rope directly into the harness, having a loop of rope between the knot and the karabiner gives the climber greater freedom to turn round without putting tension on the rope.

A figure-of-eight on the bight is a standard figure of eight knot tied into a double strand of rope that has been "folded" to form a loop. The tied-off loop (bight) is clipped into a directional karabiner on the belay loop (or two karabiners placed back-to-back, e.g., a screwgate and a snapgate karabiner). The bight must not be too long (20 cm), so the climber does not trip over the rope.

To save time, it is also possible to use a simple overhand knot on the bight, but this type of knot is harder to undo when it has been under tension.

TAKING COILS ROUND THE SHOULDER

Coils are taken in round the shoulder to adjust the length of rope between climbers. Starting from the tie-in point, take the rope along your arm, behind your neck, over your shoulder and back down to your waist.

Use your free hand ① to hold the coils level with your hip as they are made, in order to ensure they are all of equal length. The coils must then be tied off. This can be done in two ways:

Using a figure-of-eight (or overhand knot) on the bight:

Clip the resulting bight into the directional karabiner on the belay loop of your harness.

This method is easy to undo and can be used to pre-adjust different lengths of rope. However, the coils tend to slip off your shoulder.

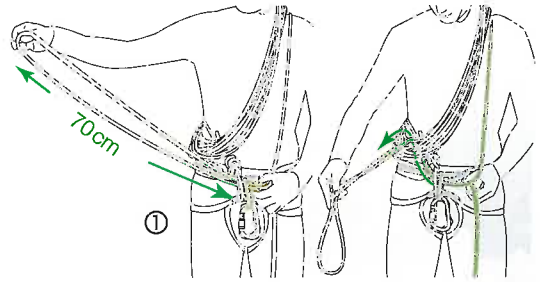
Using a fisherman's knot:

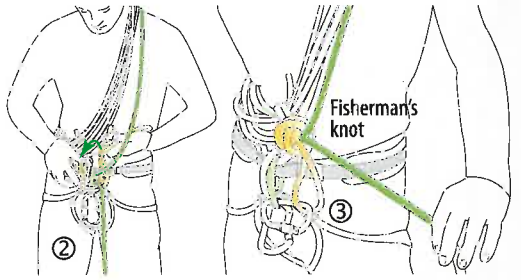
Make a 70-cm loop and thread it through the coils, the two tie-in points on your harness (or single belay loop) and through the tied knot (figure-of-eight) ①.

Tie-off the loop using a fisherman's knot around the free end of the rope ② (that goes to your climbing partner) and the other part of the loop. The remaining loop can be attached to the screwgate karabiner ③ (or directional karabiner) on the belay loop.

This method holds the coils in place, and is therefore more comfortable for long traverses across glaciers when there is no need to change the length of rope between climbers.

Whichever method is used, when undoing coils to lengthen the rope (or when taking the rope off when it is no longer needed) the coils should be released one-by-one to avoid ending up with a pile of tangled knots that will take forever to undo.





1-4 WALKING TECHNIQUES

On easy-angled ground (up to 15/20°), it is possible to walk directly up or down the slope and the ice axe can be held with the blade facing either forwards or backwards. The main reason for using an ice axe or walking poles is to help with balance. In addition, the rope can be on either the uphill or the downhill side of the climbers. On easy-angled ground, it is possible to walk straight up or straight down the slope.

When descending, press down slightly on your heels to ensure the soles of your boots get a good grip on the snow.

On steeper slopes (more than 15/20°), keep the rope on the downhill side ① and carry your ice axe (or walking pole) in your uphill hand ②. This means having to change everything round each time you change direction. If you prefer using walking poles to an ice axe, one of the poles can be carried on your rucksack to keep a hand free for dealing with the rope.

Keep the ice axe blade as close as possible to, and pointing into the slope (and to the snow), so it is facing the right direction if you need to quickly plant it in the snow to stop a slide (see ice-axe braking p. 26).

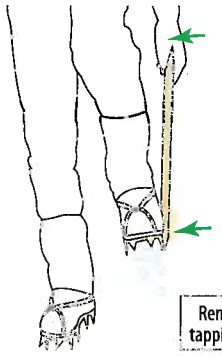
Walking roped up, whether with an ice axe or with walking poles, is a compromise between moving easily and moving safely.

CLEARING SNOW FROM CRAMPONS

Snow sometimes "balls up" on the bottom of crampons. When this happens, knock the snow off by tapping the side of your foot with the shaft of your ice axe or walking pole. In the worst cases, this has to be done at every step!

"Balling-up" can be exacerbated by the position of your foot on the snow. For example, if you realise that your crampons are balling up during a descent, it is tempting to press more firmly on your heels, leaving the front of the crampon in the air.

This may feel more secure, but it is the worst thing you can do because it allows even more snow to build up under your crampon. If your crampons are balling up quickly, it is important to knock the snow off at every step before putting your foot back onto the snow.



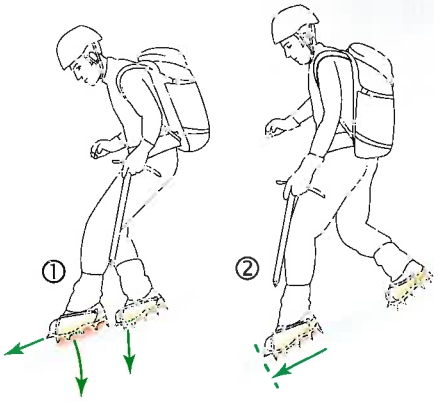
Remove the snow by firmly tapping the side of the boot.

If your crampons are balling up it is important to keep as much of the crampon as possible in contact with the snow.

This is quite hard to do but your technique will improve with practice.

At each step, the crampon will tend to slide downhill slightly, removing some or all of the accumulated snow.

If there is sufficient weight on your foot ①, the slide will stop naturally after about 10 to 40 cm ②, but the movement will prevent the balls of snow under your crampons building up as quickly.

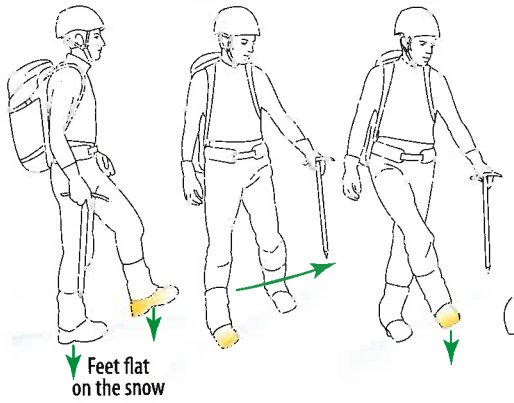


Keeping your crampons in contact with the snow has two advantages:

- It increases the solidity of each crampon placement, thereby reducing the risk of sliding and falling.
- It reduces the frequency with which you will have to knock the snow off your crampons, perhaps to every second or third step, rather than every step.

NB. Although modern crampons are fitted with anti-balling plates, some types of snow (depending on humidity and temperature) will still stick to crampons. Anti-balling plates are not miracle cures; like every piece of safety equipment, they have their limits. In all circumstances, it is essential to remain attentive. Most accidents occur during descents from routes!

WALKING ON SNOW WITHOUT CRAMPONS

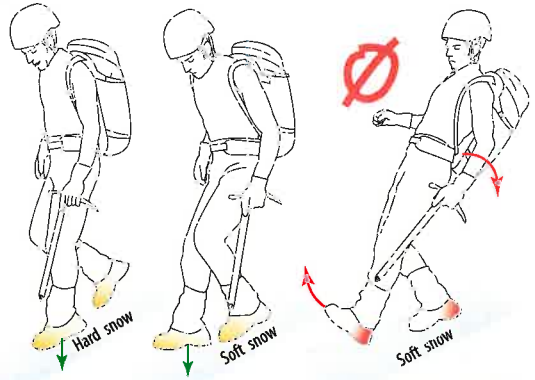


Crampons may not be needed for walking on snow if the slope is gentle (generally less than 20°), if the snow is soft, and if you are not on a glacier.

Take small steps, placing each foot carefully to ensure a firm and stable contact with the snow. When going uphill or downhill, place your feet flat on the slope.

If the surface of the snow is soft, it is possible to walk (when moving horizontally) with a natural step, as the snow will provide enough grip to prevent your foot slipping.

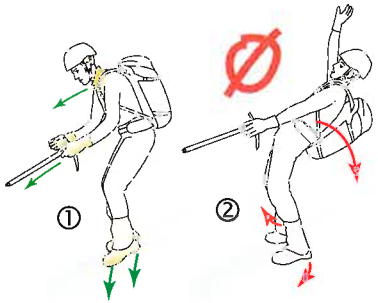
On harder snow, it will be necessary to stamp each foot into the snow to create a slight step.



When descending, it is sometimes possible to "ski" on the soles of your boots.

Place your feet flat on the snow (as when skiing), lean forward and hold your arms slightly in front of you (as when skiing). You can control your speed by varying the pressure on the soles of your boots:

- Press on the front of the sole = gentle braking.
- Press on the middle ① of the sole = slide faster.
- Press too hard on your heels ③ = likely to tumble (as when skiing).



WALKING ON SNOW/ICE WITH CRAMPONS

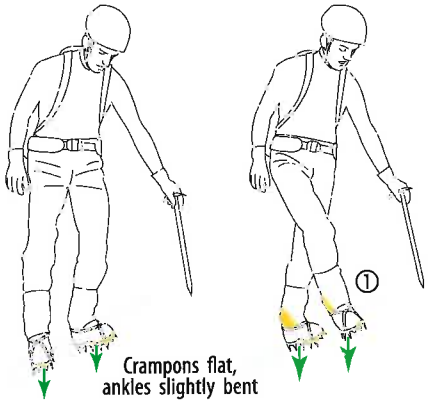
Crampons (and a helmet) should always be worn when walking on a glacier, even if the glacier is almost flat and there are no visible crevasses. If you are not wearing crampons you will not be able to stop a fall should a member of the party slip or fall into a crevasse.

Take small steps, placing each foot carefully to ensure a firm and stable contact with the snow. When going uphill or downhill, place your crampons flat on the slope.

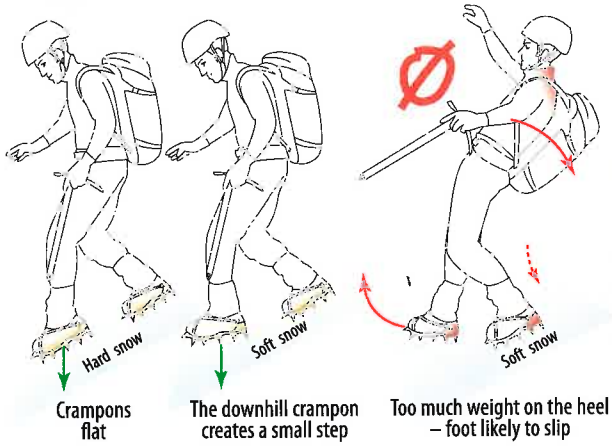
If the surface of the snow is soft, it is possible to walk (when moving horizontally) with a natural step, as the snow will provide enough grip to prevent your foot slipping.

If the snow is hard, bend your ankles slightly ① to keep the points of your crampons as perpendicular to the snow as you can.

This requires reasonably flexible ankles but it is the key to ensuring that all the crampon points bite into the snow or ice.



The main pitfall when walking in crampons is snagging the points on your trousers and/or gaiters. Because this can easily result in a fall, it is essential to concentrate on what you are doing.



Crampons flat

The downhill crampon creates a small step

Too much weight on the heel – foot likely to slip

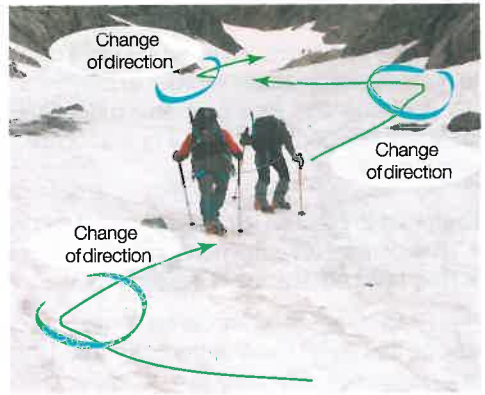
Climbing rock with crampons on (Col du Glacier Blanc - Écrins Massif / France).

ZIGZAGGING

Unless there are already well-formed steps, the easiest way to walk up steeper slopes (above 15/20°) is to zigzag.

This means walking (with or without crampons) with your feet almost perpendicular to the fall line, giving the impression that you are going across the slope, not up it.

Every change in direction requires a short pause (e.g., for changing the rope from one side to the other). Do not forget to talk to the other members of the party (who won't necessarily be able to see you), so they know what you are doing.



FRONT-POINTING

This technique is used on slopes that are too steep to walk up with your feet flat on the snow/ice.

Front-pointing involves climbing with your feet (and therefore the points of your crampons) directly facing the slope, as in climbing a ladder.

On hard snow (and ice), only the front part of the crampon bites into the snow.

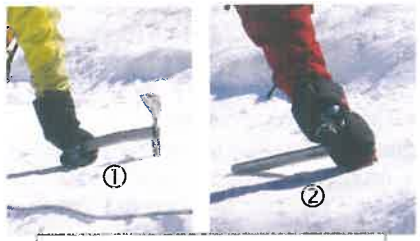
It is important to place both hands (with or without ice axe) on the snow/ice in order to maintain your balance, and to keep your heels pointing slightly downwards.

Climbers front-pointing (short-roping) on a non-glacial slope (Col du Glacier Blanc - Écrins Massif / France).

Hold your ice axe either:

- By its shaft so you can plant the blade solidly into the snow/ice, or
- By the top of the blade/adze ②, with the blade pointing into the slope (not suitable for ice).

On steep ground (45/50° snow or ice), placing your knees on the snow/ice can increase stability and prevent you leaning too far backwards, a position from which it is almost impossible to regain your balance.



Holding an ice axe when on a steep slope.

A variation on this technique involves front-pointing with one foot ① and using the flat of the crampon with the other ②, trying to get as many of the crampon points into the snow/ice by flexing the ankle. This hybrid technique is known as the American technique.

Climbers using the American technique (short-roping) on a non-glacial slope (Calotte des Agneaux - Écrins Massif / France).

ICE AXE SELF ARREST

In the mountains, as when driving a car, things can happen in the blink of an eye. It is essential to react instantaneously in order to prevent an incident turning into an accident.

A climber that slips on even a moderately steep slope (30°) will pick up speed very quickly. If a fall is not stopped in the first 2 or 3 seconds, it may be too late, as it may no longer be possible to stop the fall.

Exercises to practice ice axe self-arrest techniques serve two functions:
- They demonstrate the need to stop a slide very quickly;
- They build confidence in the technique.

Practice sessions should be carried out on a snowfield with a slope that eases towards the bottom and that does not present any dangerous obstacles (e.g., boulders). Exercises should be carried out wearing a helmet and gloves, but preferably without crampons. In order to practice ice axe self arrest with crampons, very soft snow is needed (the falling climber will accelerate less quickly) to avoid the risk of breaking an ankle. In most exercises, the falling climber ends up on all fours (all-fours position).

Demonstrating an ice-axe brake.

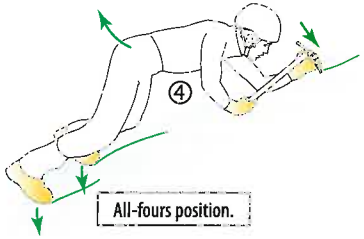
Possible exercises include:

Sliding on your bottom and braking with one ice axe:

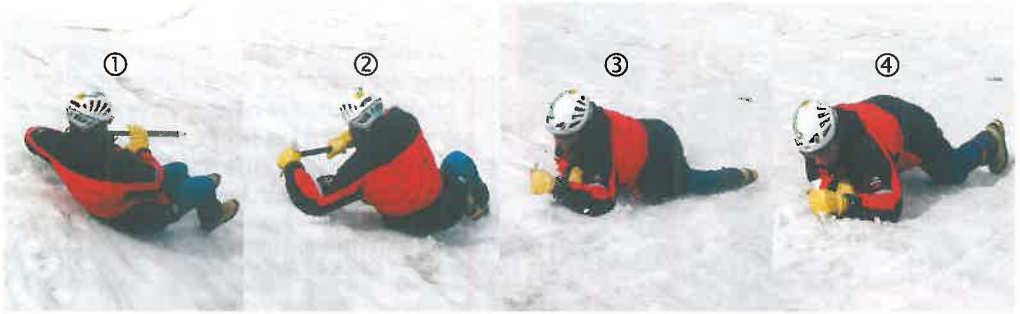
Let yourself slide on your bottom, holding the head of your ice axe with the pick facing backwards (towards the snow).
- Push the pick into the snow and press down on it.
- At the same time, push your heels into the snow. These two actions should bring you to a halt.

Sliding on your bottom and braking with one ice axe on all fours (then do it without the ice axe, just using your hands):

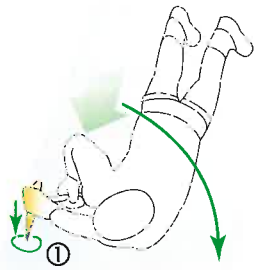
Let yourself slide on your bottom ①, with one hand cupping the top of the ice axe (pick facing into the snow).
- Twist your upper body round sharply so you are facing the snow ②.
- The hand cupping the ice axe will naturally turn with you ③, the other hand grips the shaft.
- Arch your back so your stomach and legs come off the snow. Only your arms/ice axe and feet ④ remain in contact with the snow ("all-fours" position).

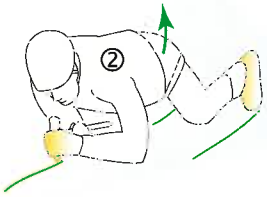


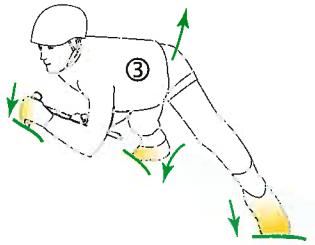
All-fours position.



Sliding on your front (or back) with your head pointing downhill and braking with one ice axe on all fours (then do it without the ice axe, just using your hands): Let yourself slide on your front (or back), with one hand cupping the top of the ice axe (pick facing backwards, towards the snow).
- Twist your upper body round sharply so you are facing the snow.
- Plant the pick of the ice axe into the snow ①. It will provide a point around which your whole body will rotate.
- The hand cupping the ice axe will naturally turn with you; the other hand grips the shaft.
- At the same time, your upper body will rotate downhill. Arch your back so your stomach and legs come off the snow ②.
- Only your arms/ice axe and feet ③ remain in contact with the snow ("all-fours" position).







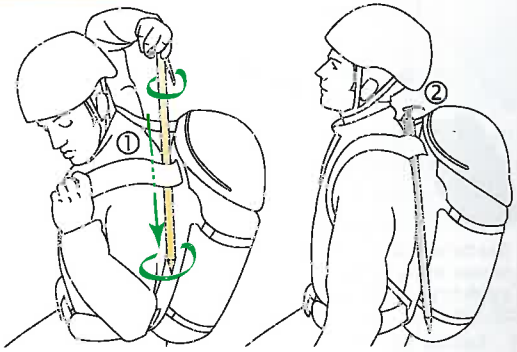
Stopping a fall by the downhill climber (2 people on a rope, 5-m apart): The falling climber remains passive during this exercise. There are two possible methods:
- The climber stopping the fall can drop into the "all-fours" braking position and hold this position until the rope comes tight between his/her legs and stops the falling climber.
- If the climber stopping the fall is in a stable position, he/she should put his/her feet perpendicular to the slope (and crouch down to lower his/her centre of gravity).

Stopping a fall by the climber in front during a horizontal traverse (2 people on a rope, 5-m apart): The falling climber remains passive during this exercise: Same technique as above.

CARRYING AN ICE AXE IN A RUCKSACK STRAP

This is a good way of stowing an ice axe (e.g., to climb a short section of rock), as it allows you to get the axe out quickly again without taking your rucksack off.

The ice axe shaft can be slid into one of the straps ① behind your shoulder, so it lies on your side between your back and the rucksack. The pick rests on the opposite shoulder strap ②.



1-5 ANCHORS and ROPE WORK

PLACING AN ICE SCREW

Ice screws should be placed perpendicular to the slope, preferably in solid ice. Start by clearing away the top level of ice if it is of poor quality (like coarse salt).

If the ice is thick enough, screws should be inserted to the hilt. It is useful to carry at least one short ice screw (10 cm) for placements in thin ice.

If the ice screw protrudes from the ice, tie it off with a sling using a lark's foot (as close as possible to the ice to reduce the leverage on the screw), then clip the karabiner into the sling.

ABALAKOV BELAYS

Abalakov threaded using a prusik loop.

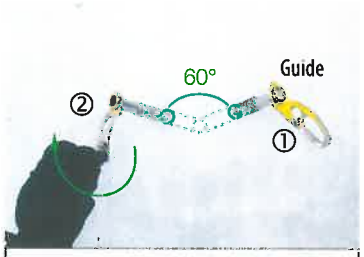
An Abalakov belay is a thread made using ice screws to drill two holes in the ice. Start by clearing away the top level of ice if it is of poor quality. Use an ice screw to drill a hole diagonally into the ice, then drill a second hole at an angle to the first so the two holes intersect.

If you are using a 13-cm ice screw the two holes should be 8-10 cm apart (strength 600 kg with 8-mm accessory cord[1]).

If you are using a 17-cm ice screw the two holes can be 12-14 cm apart (strength 1000 kg with 8-mm accessory cord).

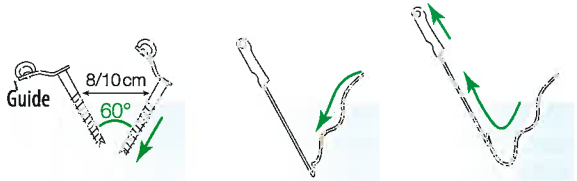
To produce a good thread, the two holes must be at the same level.

- If you have two ice screws, unscrew the first one slightly, but leave it in place to provide a visual guide for inserting the second.
- When you have almost finished the thread, remove the first ice screw and look down the hole to make sure the two holes connect.
- Once the two holes have been drilled, thread accessory cord or tape into one hole and pull it out the other with a threading hook (may require patience).
- Tie together the two ends of the cord or tape using a double fisherman's or double figure-of-eight knot (see Knots, p.16).



Once the first hole ① has been made, unscrew the ice screw slightly, leaving it in the hole to serve as a guide for judging the angle of the second ②.

Producing a good thread is a skill that is quickly learnt, especially if you practice regularly. A common mistake is to start the second hole too far from the first, so the ice screw has to go in at too great an angle and the two holes don't meet.



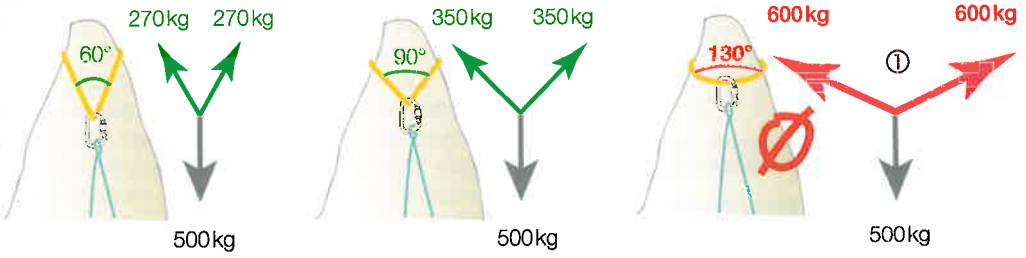
Be wary of in-situ ice threads (knot, ice melt). Check them carefully and if in doubt, drill a new one.

1 Technical data: Petzl catalogue 2011.

SETTING UP A BELAY

A belay is a place where a climber anchors himself/herself to the rock or ice in order to secure a partner. Being attached to a belay makes it much easier to stop a fall (by the leader or the second).

If there is a risk of a long fall subjecting the belay to a high shock load, it is important to ensure that the angle between the two anchors (slings, pegs, ice screws, etc.) forming the belay is not too great ①. See explanatory diagram for angles.

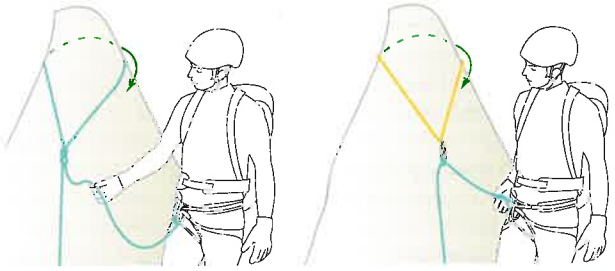


Using a solid spike of rock:

Put a 120-cm or 60-cm sling around the spike (look out for sharp edges) and tie into it with a clove hitch.

If a sling is only just long enough (generate large forces), make a larger sling from a loop of the rope (using a figure-of-eight on the bight).

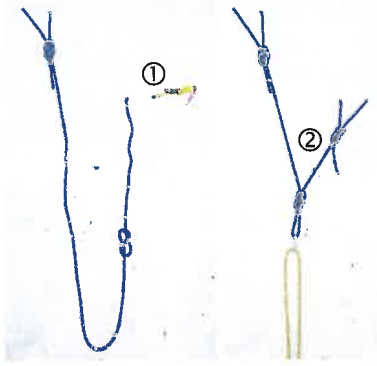
You will then be tied into the belay and the longer loop of rope round the spike will reduce the stresses a fall would put on the belay.



With two ice screws:

Use the adze of your ice axe to clear away any poor quality surface ice. Try to place the ice screws about 40-50 cm apart to reduce the stresses on the ice and thus increase the solidity of the belay.

If this is not possible (e.g., ice screws 15-cm apart because there is not enough ice to separate them further), the belay will be more fragile and should be used with caution.

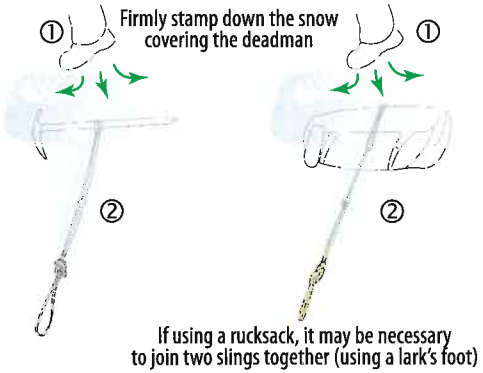


Link the ice screws using a sling with a figure-of-eight on the bight, which should point in the expected direction of any shock load.

On an Abalakov:

If the ice is of poor quality, use two Abalakovs ① (40-50 cm apart) linked together with a sling or accessory cord tied off with a figure-of-eight on the bight ② (make sure the angles formed by the sling will not amplify any shock load on the belay).

If the ice is solid, one Abalakov is usually sufficient for an abseil belay.



Dead man with an ice axe/rucksack: Dig a 30-50 cm deep hole perpendicular to the slope (the depth will depend on the quality of the snow).

Use a lark's foot (girth hitch) to tie a sling round the middle of the ice axe shaft/rucksack and place it in the hole. Cover the ice axe/rucksack with snow (at least 20/30 cm) and tamp it down well with your feet ①.

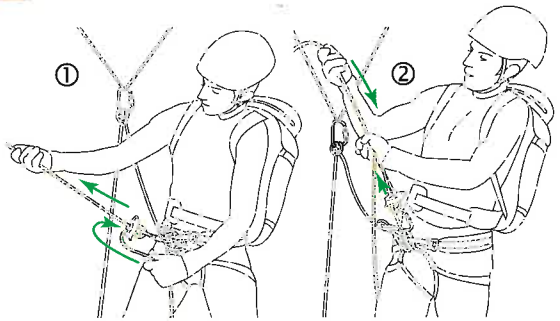
Dig a groove for the sling ②, so it does not pull the ice axe upwards if the belay is subject to a sudden shock loading.

BELAYING A SECOND OR A LEADER

Belaying a leader with a belay device (Reverso, belay plate, figure-of-eight, Tubus, ATC, Toucan, etc.) or an **Italian hitch**:

Modern belay devices make it very easy to stop a fall or a slide when the belayer is attached to solid anchors. Belay devices are attached to the belay loop via a screwgate karabiner.

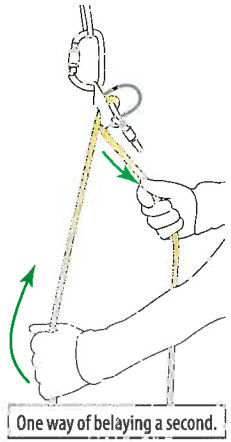
"Slack!" ① means pay out some more rope.
"Take in" ② means take in any excess rope.



Both hands should be kept on the rope at all times (leather gloves provide a good grip), sliding back and forth along the rope to pass it through the belay device.

When changing the position of your hands on the rope, relax your grip, but do not take your hands off the rope!

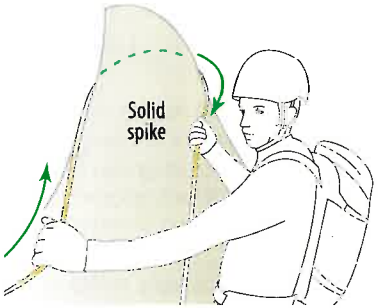
Use small, rapid movements rather than long movements, which are more likely to lead you to let go of the rope.


One way of belaying a second.

Belaying a second with a belay device (Reverso, ATC, Toucan, belay plate, figure-of-eight etc.) or an **Italian hitch**:

Some belay devices have a special mode that locks the rope if the second(s) should fall, allowing the belayer to temporarily let go of the rope. The belayer should never let go of the rope when belaying using an Italian hitch.

When belaying a second, the belay device can be attached directly to the belay.



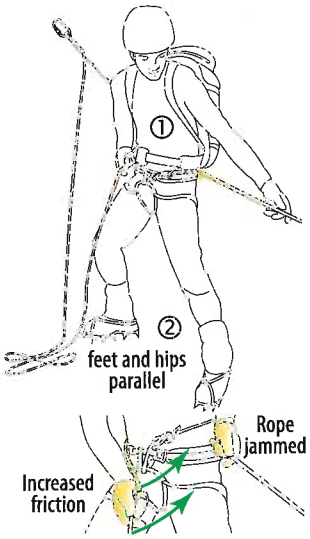
Belaying round a spike (leader and second): To save time on easy ground, the rope can be placed directly behind a solid spike, which then provides both a brake and a belay.

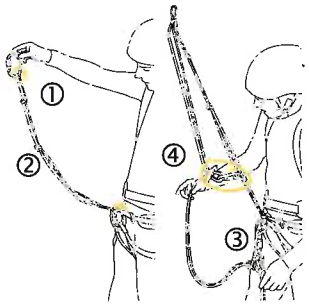
Body belays (leader and second): A body/hip belay can be used when crossing easy ground or very short technical sections. It is safer with gloves. Body belays have two main advantages: Very quick to set up; Very easy to take in or give out rope. I recommend using the British belaying method, in which the rope is placed around the waist ①, rather than the French method of placing the rope over the shoulder.

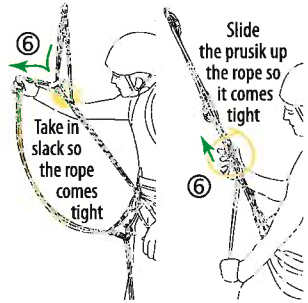
When belaying a second using the British method, there is less leverage on the belayer because the rope is held about 60 cm lower.

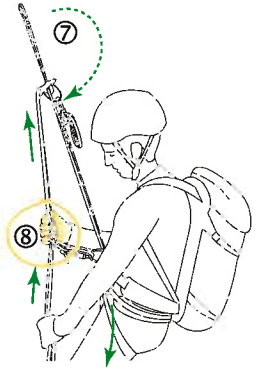
When holding a fall using the French method, the sensation of the rope cutting into the shoulder is terrifying and much more painful than when the rope is round the waist.

The belayer should position himself very carefully so he is in a direct line with any potential load on the rope. Keep your feet apart and solidly positioned on the ground. Your feet and hips should be parallel ② to the fall line when belaying a second.









ABSEILING

❶ Thread a 120-cm sling through the two (or single) tie-in points on your harness, and tie it off with a lark's foot (girth hitch).

❷ Tie two figure-of-eight knots in the sling, the first approximately 45 cm from the belay loop, the second in the remaining part of the sling (this gives two possible lengths for clipping into a belay). Clip the sling into the belay with a screwgate karabiner.

❸ Tie a French prusik knot round the abseil rope, then clip the prusik into the belay loop on your harness using a screwgate karabiner. So it can lock freely, the prusik must be attached to the rope at least 20-30 cm below the descender, which is clipped to the first loop of the sling.

❹ Pull about 30 cm of rope through the prusik, which will then prevent the rope slipping back down. This gives a length of loose rope for attaching the descender and allows you to check that the prusik will lock.

❺ Once the descender has been put on the rope, check that all the karabiners are screwed closed.

❻ Take in the slack through the descender so your weight is on the rope. Slide the prusik back up the rope. If necessary, put your gloves back on before starting to abseil.

❼ Take your weight off the sling attaching you to the belay. Unclip the karabiner from the belay and start abseiling.

❽ While descending, the lower hand holds the prusik, keeping it loose so it slides down the rope. Keep your upper hand lightly on the rope, near the descender.

❾ At the bottom of the abseil (e.g., on a snow slope.), take the descender off the rope and pull through 1 or 2 metres of slack. Remain attached to the rope via the prusik.

❿ When all members of the party are down, choose a safe place (away from crevasses, stonefall, etc.) to pull down the rope. The leader ties back into one end of the rope before pulling it down.

Put a prusik on the rope even if the abseil is short (e.g., to get over a bergschrund).

II – A DAY IN THE MOUNTAINS

2-1 FROM DANGER TO RISK TAKING

Without taking away from the emotional and affective aspects of mountaineering, my objective is to open mountaineers' eyes to the risks they choose to take[1].

I believe that providing information to raise awareness of risk and focusing on prevention will lead most climbers to adopt more responsible behaviours.

But first it is essential to differentiate between three notions that are often confused - danger, risk and risk taking.

Seracs below the Dôme des Ecrins -Écrins Massif / France.

DANGERS in the mountains are hazards, that is to say events that may or may not happen at a given time and in a given place.

Such events may be due to natural phenomena, such as a serac fall, the collapse of a snow bridge, an avalanche, a storm or lightning. The mountains are not dangerous in themselves; it is the events that occur in them that may have unwelcome consequences for human beings.

The dangers of the mountains are not Cartesian, but our sense of discernment must try to be. The mistakes people make are often the result of omission, or of allowing ambition, the search for peer approval or the need for recognition to blind them to certain parameters.

A little slip can lead to a long slide…

RISK is a hazard to which a mountaineer or group of mountaineers decides to expose themselves. With no human presence there is no risk.

The climbing community regularly highlights the idea that mountain sports are risky. Some people even make this a point of pride, a way of claiming social distinction through the effort needed to overcome difficulties and to manage risky situations.

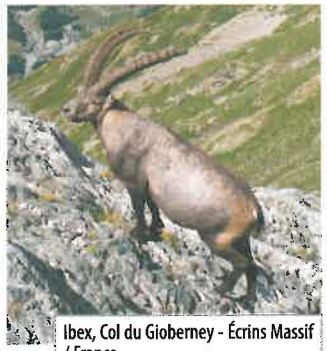
Far from wanting to belittle mountain activities or the behaviour of mountaineers, my intention is to raise awareness of the issues involved, so climbers are free to make their own choices and to take responsibility for those choices.

RISK TAKING is the result of a choice (or a non-choice) made by a party of climbers.

In today's society, each person perceives risk differently and "our perceptions, which come from our experience, depend on the social groups to which we belong"[2].

1 Bastien Soulé, Véronique Reynier, Jean Corneloup (2007), *La communication préventive sur les risques: le cas des stations de sports d'hiver en Franvce*, Revue Communication, Vol. 26/1, p. 2 of the article.

2 Veyret Yvette, Beucher Stéphanie, Reghezza Malagi (2004), *Les risques*, Bréal, Rosny-sous-Bois, p. 29.



Ibex, Col du Gioberney - Écrins Massif / France.

Taking a risk means accepting a degree of uncertainty that is, to a certain extent, measured and measurable. Risk is a factor that has to be taken into account in mountaineering, but to do this a person must be aware of the risks being taken. Ignorance of certain rules can increase the probability of an incident occurring.

Attitudes to risk vary between the need for total safety and total recklessness. Decisions about how much risk one is prepared to take are both extremely personal and very subjective. As long as all the members of the party accept the consequences of their choices, these choices can be considered responsible and, hence, worthy of respect.

An outright refusal to take risks would result in never going into the mountains. This would be a shame, as there is so much to discover (wide-open spaces, others, oneself, etc.) in this fascinating and marvellous world. Consequently, it is sensible to try and identify potential traps in order to avoid them.

It is impossible to entirely eliminate the risk of having an accident but there are simple things that can be done to minimise the consequences, for example, roping up on a glacier, carrying a first-aid kit, or wearing a helmet.

Matterhorn - Valais / Switzerland.

Through better training, better skills, better use of gear, better adaptation to the terrain and better ability to listen to your feelings (and fears), your expertise in this domain will improve.

Give yourself time to explore all the different facets of mountaineering and to increase your technical and strategic skills. Remain modest, do not get over-confident and do not over estimate your abilities or those of your companions.

This may seem old-fashioned, but don't try to run before you can walk by too quickly attempting hard routes that are beyond your technical, physical and psychological abilities.

Q. What place does risk have in modern society?

A. The place a group accords it in their social environment.

In fact, all actions and behaviours in the social sphere have consequences on others; therefore all actions have to face other people's "limits", whether these people are climbing partners, other climbers, relatives or friends, etc.

Taking into account others when deciding whether or not to take a risk is a way of ensuring your approach to mountaineering is in accord with your own human values.

In summary: It is the mountaineer who chooses to confront the hazards presented by the mountains; therefore, it is the mountaineer who chooses and accepts the resulting risks.

2-2 PREPARING AN OUTING

This phase takes place at home. A summit or a route should be chosen to suit the skills of the least experienced member of the party, not the most experienced member. By basing the choice round the least experienced person in the team you will avoid having to deal with situations for which one or more members of the group are not prepared.

This is the starting point for planning any trip. The most important consideration is to choose a route that is technically and strategically feasible and one that is (or will be) in a viable condition at the moment of the ascent. Parameters to take into account include the length of the route, the total time required, specific hazards (e.g., seracs) and the descent, etc.

HAVE MULTIPLE OBJECTIVES

However focused you are on a particular objective, it is important to be aware of alternative routes so your trip is not "wasted" if the original objective is not practicable.

When preparing your trip, check guidebooks and other sources of information to find out about other routes that can be climbed from the same start point or the same hut. It is best to set off with the idea that you are there to share time in the mountains with your companions, whichever summit you climb, rather than to "tick" a particular peak or route come what may.

The more flexible you are in your choice of route, the more likely you are to have an enjoyable adventure that makes the most of the prevailing conditions.

For example, you and your companion are flicking through the guidebook at home. You ring the hut to book your places and the hut warden tells you that there are good snow conditions on the normal routes to five summits around the hut. You have the technical ability and experience to climb three of these routes. Even if you have a marked preference for one of the three routes, you should gather information about all three so the final decision about which one to climb can be made at the last minute, taking into account how you feel, the number of other climbers on each route, the freezing level, etc.

COLLECT AS MUCH INFORMATION AS POSSIBLE

It is difficult to visualize a route in all its complexity merely from the brief and sometimes vague descriptions provided by guidebooks. To get a clear picture of an itinerary it is necessary to combine the guidebook description with photos of the route and the topographical map. Once you have chosen the route(s) that interest(s) you, you can prepare your ascent by:

- Looking at guidebooks and websites to obtain details of the approach, the route, the descent, the access (cable car, path) and the hut.
- Consult community websites to see if they can provide up-to-date information about conditions, such as the quantity and quality of the snow, and whether the snowpack is freezing at night.
- Analyse the map to extract other relevant information, such as height gain and the exact location of the hut.
- Check the weather forecast (freezing level, likelihood of afternoon storms, avalanche risk, etc.).

Do not forget to book places in the hut. The hut staff may also be able to provide information about conditions on the route(s) you want to do.

If, at the last minute, you decide not to go up to the hut (change of plan, change in the weather, illness, etc.), it is good manners to telephone the hut and cancel your booking. This is always appreciated, as it will allow the hut to take in other people. In addition, if your night in the hut is part of a multi-day trip, the hut warden will be worried if you don't turn up and he/she may needlessly call out the mountain rescue.


Old Monte Rosa Hütte - Valais / Switzerland.

TECHNICAL DIFFICULTY, COMMITMENT AND EXPOSURE

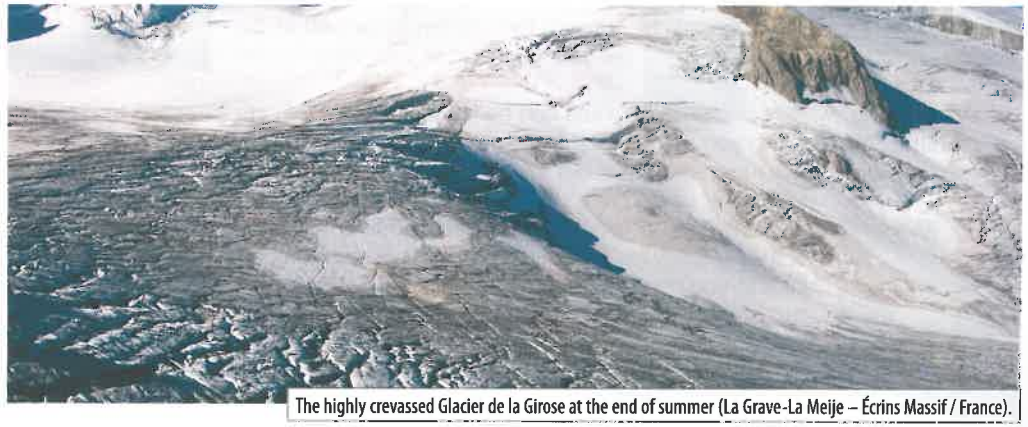
The technical difficulty of the intended route is an essential parameter to take into account when planning a trip into the mountains. Even when the same rating scale is used, the way the grades are applied will be different in each country and each area. Read guidebook introductions and explanations carefully in order to get a realistic idea of what a certain grade means and allow for a margin of error with respect to your technical and strategic skills.

Ratings of the technical difficulty of a route or sections of a route can only give an indication of the difficulties you will encounter and they must be interpreted with (great) caution.

Evaluate the party's expertise and the amount of risk the party is prepared to accept. A given route can be considered a reasonable objective for a party if:

- The route is feasible (difficulty, time, in-situ gear, descent via the same route or by a different route, etc.),
- All the members have the experience needed to climb the route given the prevailing conditions in the mountains (whether or not the route is practicable),
- The route to follow is obvious,
- The party has the technical skills to efficiently overcome the obstacles and technical difficulties presented by the route,
- There are alternative routes that can be climbed if necessary

. For all routes (particularly snow and ice routes), the actual grade will depend on conditions. Consequently, the grade given in guidebooks must always be seen as an approximation that may underestimate (or overestimate) the true difficulty of the climbing. The actual difficulty will depend on the quality of the snow, ice or rock.


The highly crevassed Glacier de la Girose at the end of summer (La Grave-La Meije – Écrins Massif / France).

TIMING

Mountaineers are used to setting off very early in the morning, often before dawn. This is primarily because most routes take a long time.

The time required is one aspect that can be used to assess how committing and serious a route is. It is important to calculate how much time you are likely to spend on a route. In all cases, allow a reasonable margin of error to avoid having to do the descent in the dark or being caught out by a late-afternoon storm. The best time to set off will also depend on the exact time of year (how hard it freezes at night, length of the day, etc.) and the weather forecast (e.g., are afternoon storms likely?).

At the end of summer, it is possible to break some of the rules about timings for short routes, especially when the snow has turned into very compact névé that is unlikely to change much during the day. In these cases, you can set off an hour or more later than usual, as long as you keep a sufficiently large margin of error in case something goes wrong.

The following times give an idea of how long an "average" party of novices is likely to take for the various stages of a climb (in good weather). For example, to climb the normal route on summit X, it is necessary to allow:

- 1hr of preparation time between waking up and setting out (breakfast, sorting gear, etc.);
- 4hr for the ascent (including breaks);
- 30-minute break at the summit;
- 2hr 30min to descend to the hut;
- 1hr break if you stop at the hut on the way down;
- 2hr to get back to the car park.

This gives a total of 11 hours - let's say 12 hours, to allow a little leeway. This is a long day. In order to be back in the valley at 4.30 pm, thereby leaving a sufficiently large margin to deal with any unforeseen circumstances, it will be necessary to get up at 4.30 am.
Getting up at 7 am would mean getting back to the valley at 7 pm, or even 8 pm if the descent is slow because the snow is softer and more tiring to walk on. As a result, the party would have much less room for manoeuvre.

THINK AHEAD AT THE HUT

If you go up to a hut the day before doing a route, try to get to the hut early enough to have time to organise things for the next day. In addition, the earlier you get to the hut, the more time you have to recover.

In the Alps, unless otherwise indicated (e.g., in an unstaffed shelter), all huts provide mattresses and blankets, whether or not the warden is present. It is therefore unnecessary to take a sleeping pad or sleeping bag with you.

Once you have checked into the hut with the warden (or arrived at the bivvy site if you are bivouacking), sort out your gear and fill your water bottle/ hydration pack.

Anything you will not need for the route can be left in the hut if you are intending to descend via the hut. Put everything you will use first (e.g., gaiters, helmet, harness, etc.) in the top part of your rucksack. Small items, such as knife, sun cream, sunglasses, hat, leather gloves and cereal bars, can be put in the top pocket of the rucksack.

Before the evening meal, take the time to check the start of the route for the next day (path from the hut, access route onto the glacier, waymarkers, etc.), so you don't have to hunt around in the dark for a hypothetical cairn at the start of the path.

Strategies for bivouacking (with or wihtout a tent) will be outlined in *Mountain Essentials® - Ice and Mixed Routes* (in preparation, for publication details go to my web site www.sebastien-constant.com).

DECISION-MAKING IN THE FIELD

Decision-making does not necessarily mean making the best possible decision, it means making the most sensible choice at a given time. Consciously deciding what to do means choosing to apply a specific strategy.

Do not let yourself be influenced by others. Make your own decisions. When you are about to cross a highly crevassed glacier that is exposed to serac fall, take the time to analyse the situation, taking into account all the information at your disposal, including the weather conditions. This will help you decide what to do.

A failed attempt on the Pointe Dufour of Monte Rosa - we'll be back (Valais / Switzerland).

If you have the chance to talk to a mountain guide or hut warden, listen to what they have to say but remember that their assessment is not the gospel truth; it is just another piece of information. People who spend all their working lives in the mountains can become blasé about the risks. They are so used to the dangers (hazards such as crevasses, seracs and stonefall) that they tend to minimise them

Follow your intuition, especially if something "does not feel right" and your fear is sending you warning signals.

There are always reasons why fear comes to the fore of the consciousness, whether these reasons are founded or not. Listening to your feelings can simplify many decisions and help you avoid difficult situations for which the party is not prepared. Leave yourself ways out; allow yourself the possibility and/or right to be frightened and to tell others that you are. Never forget that the main objective is to spend an enjoyable day in the mountains.

Before making an important decision during a climb:

- Stop. Assess the situation and get everyone's opinion.
- Each person must feel free to express his/her point of view.
- If only one person wants to turn back (getting late, section too hard, fear, whether justified or not), it is reasonable to respect that person's choice and for the whole party to turn back.

In summary: The simplest decision in many situations is to turn back but this is often the most difficult decision to take.

Globerney Traverse -Écrins Massif / France.

Climbing a route in the mountains can be divided into three main phases: the approach, the climb and the descent (the most critical phase). It is important to learn how to manage fatigue and to take breaks (to eat or to rest) in order to have enough energy for the descent. Do not overlook this parameter.

The descent is the phase that requires the greatest amount of concentration, as the members of the party are likely to be physically and mentally tired. It is for this reason that the most experienced member of the party generally descends last.

WHAT TO DO IN THE CASE OF AN ACCIDENT

If a member of the party is injured but the injured person can still walk, the best thing to do is to descend as best you can, if necessary, stopping off at the hut. If the injured person cannot walk and you are unable to rescue him/her yourself, you will need to call out the rescue services for the area you are in (see useful information, p. 63)

If you suspect a spinal injury (head, back or pelvis), the injured person should not be moved unless the risk of staying in the same place (serac fall, stone fall, weak snow bridge) is greater than the risk of moving him/her. If you have to move the injured person, try to keep his/her back immobilized.

Giving the alert:

- By mobile phone (if there is a signal)
- By radio (e.g., via a guide with another party)
- If there is no other way of getting help quickly, split the party in two (if there are four people in your group) or ask another party to give the alert via a hut warden or from the valley (write the details the rescue services will need on a piece of paper). The people who descend may get a mobile phone signal or meet a guide with a radio before they get to the valley.
- If your party is alone and cannot split up, use a whistle (or head torch at night) to attract attention.

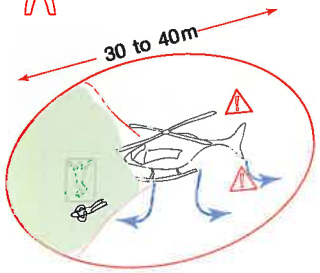
To speed up the rescue process it is essential to provide the following information:

Yes

Yes, I need help

No

No, I don't need help



- Name and telephone number of the person calling (in case the rescue team need to call back)
- Precise location of the accident (valley, summit, face, name of the route, where on the route, altitude)
- Nature and time of the accident
- Number of people injured
- Type of injuries (consciousness, visible fractures, etc.)
- For the rescue team – visibility, cloud cover, wind, presence of a possible helicopter landing area

If a helicopter lands:
One person kneels beside the victim, facing the pilot and with their hands held up in a Y. Wait for instructions from the pilot.
Clear all unsecured items from a 30 to 40-m diameter area around the landing zone. Make sure rucksacks are closed and held down. If the injured person has been placed in a survival blanket, remove it at the last minute. Prepare an easily visible cow's tail with a screwgate karabiner that can be used to winch the victim if necessary.

2-3 MOVING OVER SNOW AND ICE

Novices should avoid walking with coils of rope in their hands, as it is much more difficult to stop a fall or slide using this method. Techniques for walking carrying coils and for navigating in poor weather (with map, compass and altimeter) will be discussed in volume 2 of this manual: *Mountain Essentials - Ice and Mixed Routes, Level 2 Advanced,* (in preparation, go to www.sebastien-constant.com for publication details).

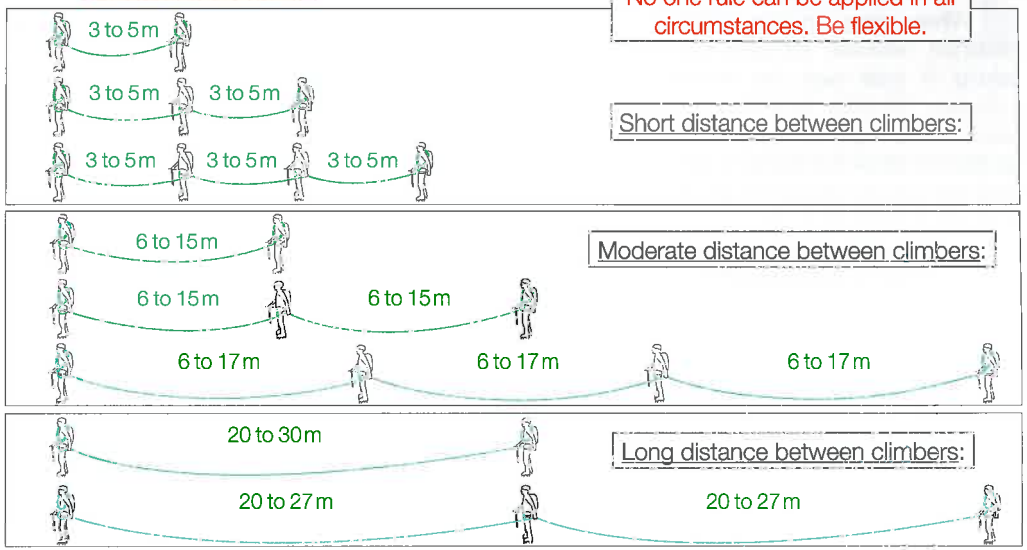
In most cases, the leader (the person with the most experience, not the person with the strongest character) goes first when climbing and last when descending.

The choice of which belay method to use, the distance between the people on the rope and the mode of progression will be a compromise between speed and safety.

Part of making choices is learning how to anticipate the next move. As in a game of chess, it is a question of ensuring you keep the upper hand and of avoiding excessively difficult situations you are not used to coping with.

MOVING TOGETHER

No one rule can be applied in all circumstances. Be flexible.



Two people on a rope: The two climbers tie into opposite ends of the rope and adjust the distance between them by taking coils round the shoulder.

Three people on a rope: Two climbers tie into opposite ends of the rope and the third ties into the middle (tying into the belay loop). The climbers at the ends of the rope adjust the length of the rope by taking coils round the shoulder.

Three people on a rope is a good compromise for glacier travel, as it makes it easier to stop a slide or a fall into a crevasse when the party is going straight up an easy-angled slope.

Four people on a rope: Two climbers tie into opposite ends of the rope and the other two climbers tie in so the distances between the climbers are equal. All four members of the party adjust the length of the rope between them by taking coils round the shoulder.

With four people, it is impossible to have a long distance between the members of the party, even when using a 60-m rope. Consequently, it is better to rope up in teams of two or three when crossing highly crevassed glaciers.

The greater the risk of falling into a crevasse (snow quality, size of snow bridges, width of the crevasses), the greater the distance should be between the climbers. The more technical the terrain, the more important it is to keep the rope between the climbers tight. These two basic rules reduce the risk of more than one member of the party falling into the same crevasse.

Should a climber fall on easy-angled terrain (slope of less than 15/20°), the friction of the rope running through the snow will act as a break, making it relatively easy to stop the fall.

- When there is a considerable thickness of soft and/or wet snow, the friction will be great enough to provide a very effective brake.
- When the snow is hard and frozen there is much less friction.
- On ice there is very little friction.

For the leader and for the climbers in the middle of a rope of three or four, it is advisable to keep hold of the trailing rope. The last person on the rope can hold the rope in front. This allows you to constantly assess what your companion is doing, without having to turn round.

MOVING OVER SNOW

When going up non-glacial snow slopes, the distance between climbers can be shortened by taking in coils over the shoulder: short distance between climbers. It is important to walk with no slack in the rope, so it does not touch the ground, as this will allow the leader to almost instantaneously stop the second should he/she slip.

The length of rope between climbers can be easily estimated by counting "arm spans" of rope. Each arm span will be about 1.5 m (Col du Glacier Blanc - Écrins Massif / France).

MOVING OVER GLACIERS WITH FEW VISIBLE CREVASSES

When walking on glaciers, whether they are covered in snow or bare ice, it is essential to keep the rope tight and to be able to stop yourself very quickly should you slip.
Even if there is a thick covering of snow over the crevasses, which is the case at the beginning of the summer season, rope up with at least a moderate distance between climbers.

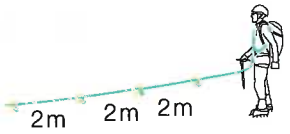
MOVING OVER HIGHLY CREVASSED GLACIERS

On highly crevassed glaciers it is necessary to have a rope that is long enough (50 m) to be able rope up with a long distance between the members of the party.
All choices are compromises that favour one or more parameters. For example,

- Having a long distance between the members of the party greatly reduces the risk of more than one person falling into the same crevasse, but it makes it more difficult to stop a fall if a climber slips during a traverse (hence the need to be able to stop yourself quickly).
- When traversing a 25° slope in a highly crevassed part of a glacier, you may decide to give priority to the ability to quickly stop a slide should a member of the party slip (e.g., due to fatigue during the descent). In this case, you could take in some coils so there is only a short/moderate distance between the climbers, accepting the fact that this increases the risk of more than one person falling into a crevasse.

These two climbers are roped up about 15-m apart. Note that the rope is not completely "tight" and slides over the snow, except when tackling an obstacle (Col de la temple – Écrins Massif / France).

Knots (figure-of-eight or overhand knots on the bight) can be tied into the rope to act as brakes should a climber fall into a crevasse (effective in soft snow but the system will not work on hard ice). The disadvantages of tying knots into the rope are:



- It reduces the amount of "useful" rope available,
- If the rope cuts into the lip of the crevasse during a fall, winching the fallen climber out of the crevasse becomes an extremely difficult operation that requires great expertise.

For novices it is more important to keep the rope tight when walking than to tie knots in the rope to act as brakes.

When overcoming an obstacle, keeping the rope tight is essential for the safety of the party.

Experience has shown that it is almost impossible to have a long distance between climbers and to walk without the middle of the rope touching the ground. Therefore, you needn't be too rigid about the tight-rope "rule", but be careful to ensure there is no slack in the rope when overcoming an obstacle.

Mont-Blanc Massif / France.

TRAVERSING UNDER SERACS

If there is no other option than to traverse under a serac, remember:

- It is best to stay as far below the serac as possible.
- There is nothing to be gained by rushing across the danger zone. It is better to take a short break before crossing the danger zone (well downhill or uphill) and to keep an eye out for anything that might fall down from above.
- Do not stop in the danger zone.

MOVING OVER MIXED GROUND

It is sometimes advisable to keep your crampons on when moving over rock or mixed ground (snow and rock), especially if the section of rock is very short. If nothing else, this avoids wasting time taking crampons on and off.

On easy ground, such as a scree slope (with or without crampons), it is best to have a short distance between the members of the party.

On an easy ridge with no obstacles (snow, mixed ground or rock where hands are used for balance but not for climbing), keep a moderate or long distance between the members of the party, as this will allow you to pass the rope behind rock spikes (or clip the rope into a sling placed over a spike). All the members of the party climb together.

Pic du Glacier d'Arsine - Écrins Massif / France.

III - SCENARIOS AND SOLUTIONS

Because decisions made in the mountains can only be as good as the information on which they are based, the following pages present the scenarios most commonly encountered during glacier travel, describing their potential dangers and suggesting suitable solutions. These scenarios will help you reduce the risks you take, widen the range of options open to you and ensure your days in the mountains are even more enjoyable. By helping you build a better picture of "reality", they will enable you to avoid falling into traps you may otherwise create for yourself.

Each scenario is presented with just one solution that is suitable for people setting out on their mountaineering careers. However, these are not "obligatory" solutions that must be applied at all costs; other options may be equally valid, depending on the exact nature of each situation.

I often draw a parallel between mountaineering and a game of chess. Parts 1, **Technical Information**, and 2, **A Day in the Mountains**, present the rules of the game and the ways in which the pieces can be moved. Part 3 describes the strategies that can be adopted to successfully negotiate different phases of the game.

Each outing in the mountains is a new "game" involving billions of possible combinations. As in chess, it takes time to gain the experience needed to make the best strategic choices and to progress from the "novice stage" to the "expert stage".

The solutions described in the scenarios leave open the possibility of giving up and turning back should you feel you are getting out of your depth and into a situation requiring "expert" skills you have not yet acquired.

While still in the "novice stage", you should not try to tackle technically difficult routes (harder than PD-/PD), and you must not forget that even a usually straightforward "normal route" can sometimes be technically challenging, for example, at the end of a dry summer.

When climbing, you have to be able to make your own decisions. If you are unsure as to which decision to take, which route to follow, it is probably time to turn round – you can always come back to finish the game another time.

In addition, you should not necessarily try to base your decisions on those taken by mountain guides, who are seasoned "experts" with the skills to deal with difficult situations. Guides will not make the same decisions as novices and they will react very differently should an incident occur.

If you feel that the solution described in one of these scenarios is not right for a specific set of circumstances, you must be able to adapt or change your approach to suit the situation.

If the conditions in the mountains are poor (open crevasses, bad weather, etc.) and you do not have the skills and experience to safely complete the climb in such conditions, turn back.

Life is much more precious than a day in the mountains or reaching a summit.

The situations mountaineers may have to face have been colour-coded as follows:

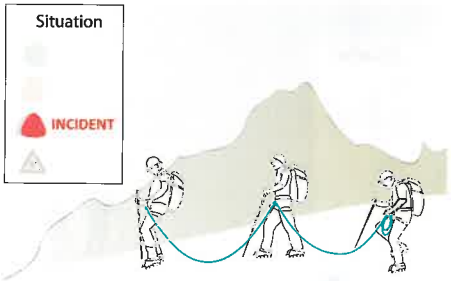
Green situation: Situation presenting **low risk** (minimal) due to the nature of the terrain and/or the strategy adopted by the climbers

Amber situation: Presence of an obstacle or a section of technical climbing. The strategy chosen to overcome this obstacle must be chosen carefully (caution) in order to avoid taking unnecessary risks.

Red situation: A potentially dangerous situation in which an **incident** can occur at any moment. When still in the "novice stage" it is better to avoid this type of situation.

Black situation: When an incident turns into an **accident**. No one, not even a mountain guide, can predict the outcome of an accident.

3-1 CROSSING A CREVASSE



These three climbers are in a **Red situation**:

- They are roped-up too close together for moving over a crevassed glacier.
- There is too much slack in the rope as they cross the crevasse.
- They are not wearing helmets or gloves.

The situation could turn into an **accident** at any moment.

This scenario occurs very frequently in the Alps, for example, when climbing/descending to/from a hut on the edge of a glacier, or at the end of a glacier that appears to be crevasse-free.

Novices also see other climbers roped-up like this and tend to do likewise.

Remember that guides and experienced climbers have the skills to extricate themselves from difficult situations - do not try to emulate what they do.

To get back to an **Amber situation**, as shown by the climbers below:

- Increase the distance between the climbers (moderate distance).
- Keep the rope tight when crossing the crevasse.
- Wear a helmet and gloves.

3-2 TAKING A BREAK

These climbers are in an Amber situation:

- They have stopped too close to the snow bridge, almost directly above a very wide and very obvious crevasse.
- They are next to each other.
- The rope is not tight.

If the snow bridge collapses (**Black situation**), at least one, if not both, of the climbers will almost certainly fall into the crevasse, and neither of them will have any chance of stopping the other's fall.

This common scenario often occurs when climbers are too preoccupied with their climb and therefore overlook this very important detail.

To avoid this type of situation (remain in a Green situation) and enjoy a risk-free break, it is best to:

- Move at least 10/15 m from the edge of the crevasse or snow bridge.
- Make sure you are not on another snow bridge.
- If you are unsure as to whether or not you are on a snow bridge over a hidden crevasse, keep the rope tight between you and your companion(s).

If you are roped-up close together and you have to cross a snow bridge over a large crevasse (plus non-frozen snow), increase the distance between you (moderate or long) before getting to the snow bridge. This will reduce the risk of falling into the crevasse.

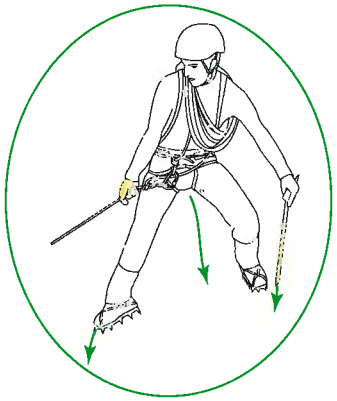
3-3 TRIPPING OVER THE ROPE

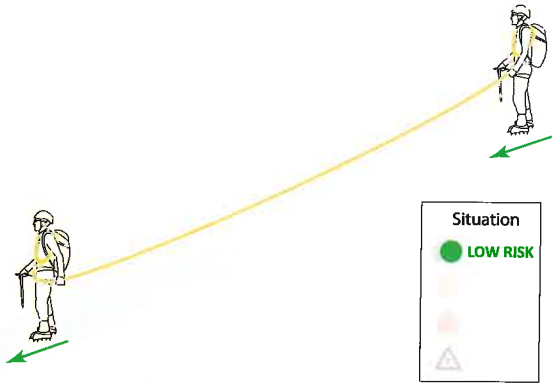
These climbers are going down a glacier with few crevasses when the incident occurs. The downhill climber trips over the slack rope and starts sliding head first.

To prevent this Red situation turning into an **accident** (**Black**), the uphill climber must react quickly to stop the slide. To do this:

- He places his feet and hips in line with the fall.
- He lowers his centre of gravity so there is as little leverage as possible on his downhill leg;
- He plants the shaft of his ice axe into the snow.

In this scenario, it was the uphill climber who caused the incident, as he was descending faster than the downhill climber, thus creating 2/3 m of slack in the rope.





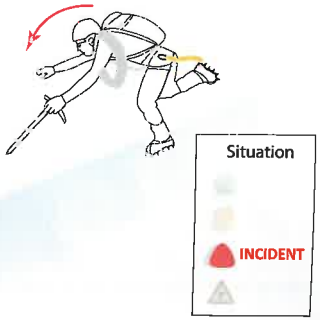
To remain in a Green situation when descending, it is important to keep the rope tight, even when there are very few crevasses to cross. If the rope is tight, it is impossible to trip over it.

Another type of incident that often occurs during descents is for a climber to trip over a sling or prusik loop that is hanging too low from his harness.

What was a Green situation instantly turns Red, as snagging a crampon on a sling or prusik loop will inevitably lead to a fall.

In order to stay in the Green zone, it is important to;

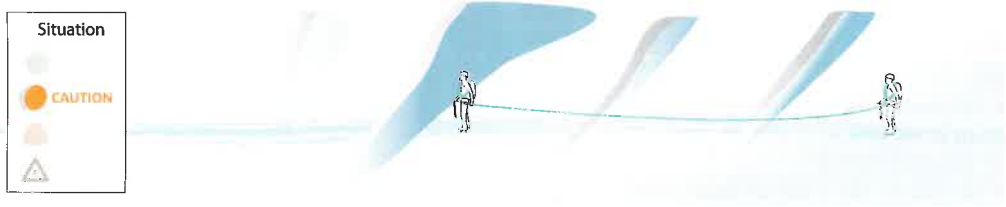
- Rack gear tidily, if possible on the front gear loops.
- Walk with your feet apart.

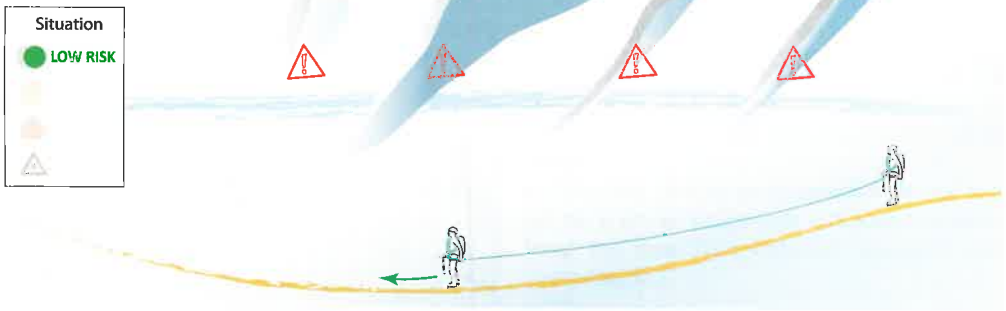


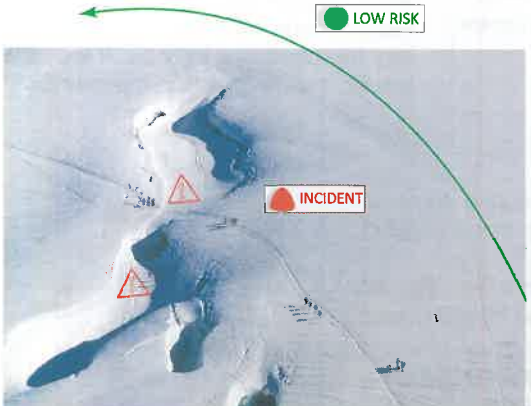
3-4 AVOIDING CREVASSES

These climbers are walking across a highly crevassed, but easy-angled glacier (Amber situation). They are crossing a succession of crevasses, following a track made by other climbers, probably much earlier in the season when the crevasses were hidden. Although the conditions on the glacier have changed through the season, climbers continue to follow the same track, as this is the easiest option (no route finding involved).

It is possible to get back into a **Green situation** by following a different route that avoids the visible parts of the crevasses. This means making a new track to the side of the old (falsely reassuring) track. The climbers should be roped-up a long distance apart.







Normal Route on the Râteau W (Glacier de la Girose - Écrins Massif / France).

In this photo, the main track crosses one of the biggest snow bridges over one of the biggest crevasses: **Red situation**.
Some parties are even taking a break on the snow bridge! The situation could turn **black** at any time.

In order to stay in the **Green zone** when crossing this vast glacier:
- Follow a route about 20 metres from the main track, where there are no crevasses
- Stay roped-up a long distance apart.

When there is no choice but to cross/jump over a crevasse (Amber situation), do so where the crevasse is narrowest, even if other tracks go over wider parts of the crevasse.

The first person to jump must have enough slack to reach the other side of the crevasse.

After jumping over the crevasse, the person in front turns round to watch the second, remaining ready to hold a fall (Glacier de la Girose - Écrins Massif / France).

This is a delicate moment, as it means having a relatively large amount of slack in the rope, so as not to hamper the person jumping, despite there being a non-negligible risk of the jumping climber falling into the crevasse. Consequently, the other member(s) of the party must be alert and ready to hold a fall.

When it is the second's turn to jump, the leader should turn round and walk backwards, in order to keep the rope tight, while watching the person jumping – holding the rope in her hand and keeping her hips parallel to the line of the potential fall.

On an easy-angled but highly crevassed glacier, it is best for two parties of two to join forces and form one rope of four with a moderate distance between the climbers. This requires a 60-m rope.

3-5 A CREVASSE THAT IS TOO DIFFICULT TO CROSS

This climber is at the foot of a steep wall of snow, with no nearby ice in which to place an ice screw. The second waits lower down the slope, keeping the rope snug (Amber situation).

The leader does not have the technical ability or experience to comfortably cross this overhanging crevasse. In such situations, discretion is the better part of valour.

In addition, such obstacles are much easier to climb with two more-technical ice axes (advanced technique).

This type of scenario most frequently arises in the middle of summer, when the crevasses are more open. Novices confronted with such situations should turn back - even if they safely cross the crevasse on the ascent, it will be much more difficult to get back across during the descent because it is almost impossible to down-climb such terrain. As a result, they would have to set up an abseil from a deadman (in the snow). Such situations are best left to more experienced parties.

On some of the more popular routes, guides will occasionally leave gear in-situ to help people cross difficult sections - in this case, a ladder and a runner (Dôme des Écrins Normal Route - Écrins Massif / France).

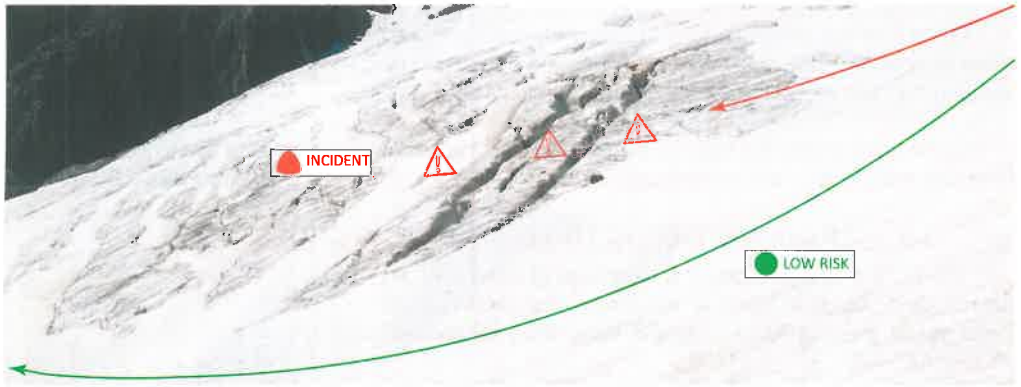
The most sensible way to get back into a **Green situation** is to turn back and go down the ascent route. To do this, all the climbers need to do is reverse their roles, so:
- The leader (at the foot of the crevasse) is at the back during the descent.
- The second goes down first, following the up track (as long as it is reliable).

3-6 THERE IS NO TRACK; WHERE SHOULD I GO?

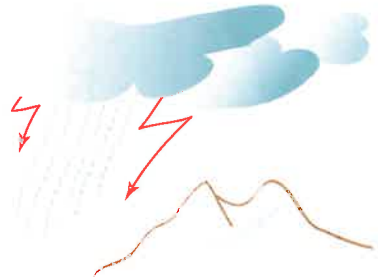
The glacier is covered in snow, so where are the crevasses? The shadowy hollows on this photo are snow bridges over crevasses that have slumped slightly under gravity – the shadows indicate layers of snow covering hidden traps.

If there is no track across a glacier, choose a route that avoids elongated dips in the snow and open crevasses.

To ensure the situation stays **Green** , keep a reasonable distance from such obstacles.



3-7 THE WEATHER IS CHANGING and IT IS LATE



The weather is looking threatening; storm clouds are building.

Tired climbers are moving very slowly and the summit is still some distance away. The situation could easily turn **Red** .

This is the time to take stock of the situation, in order to make a reasoned decision that takes into account all relevant factors:

- Are the members of the party in good physical and mental shape (human factor)? Is this a factor in moving slowly?
- Is the slow progress due to the conditions on the route (presence of ice, crevasses)?
- Is there enough time to finish the route, including the descent?
- Bearing in mind these factors, is the weather likely to hold long enough to complete the route?
- If the party decides to continue, are the climbers prepared to accept a greater level of risk (e.g., risk of lightning)?

If you have doubts about the wisdom of continuing, it is best to turn back. In this way you will ensure the situation stays **Green** and avoid getting into difficulties you are unable to manage (i.e., requiring expert skills).

3-8 BELAYING FROM A SPIKE ABOVE A BERGSCHRUND

At the top of a glacier with few crevasses, a deep, open bergschrund bars access to the summit ridge.

These climbers are in a **Red situation** , as they are crossing the bergschrund roped up close together and without belaying each other.

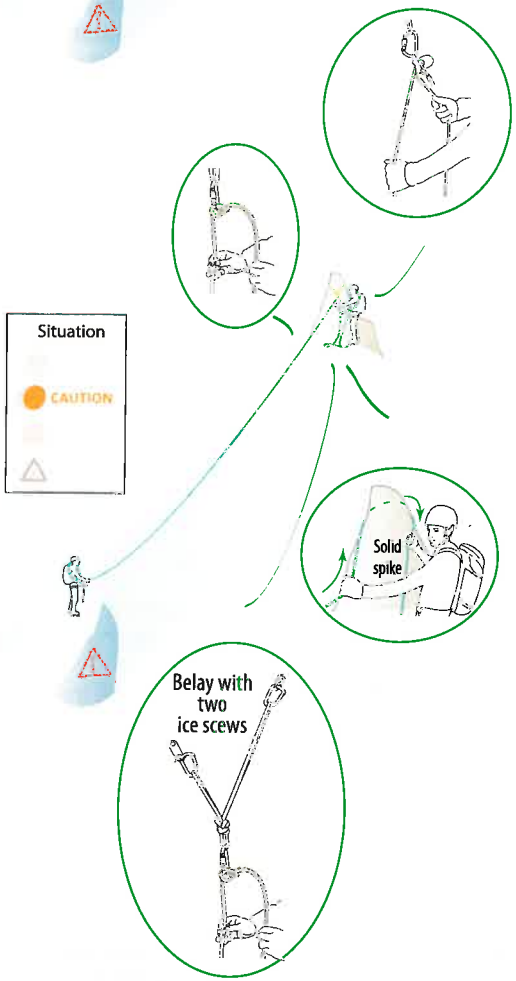
If the leader slips and the second does not immediately stop the fall, there is a good chance they will both end up in the bergschrund - **Black situation** .

To get back to a more normal situation (Amber):

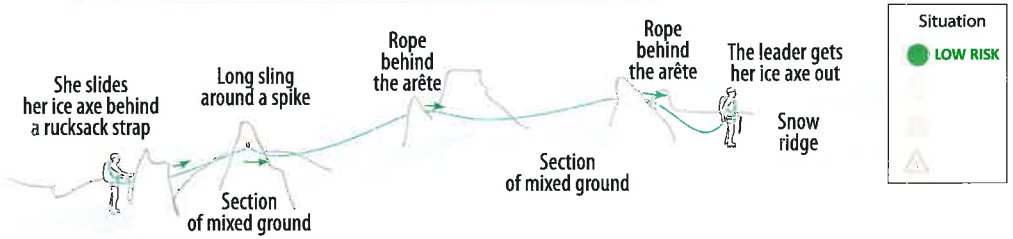
- The climbers release some coils so the leader has enough rope to get to the top of the technical section.
- The second belays the leader, either using a belay plate or a waist belay.
- The second does not need to set up a belay, as the slope below the bergschrund is almost horizontal. However, she must position her feet and hips so they are in line with a potential fall (into the bergschrund).
- If necessary (and if there is ice on the upper lip of the bergschrund), the leader places an ice screw as a runner to reduce the risk of falling into the bergschrund.
- Once at the top of the difficult section, the leader sets up a belay.
- She belays the second, using a belay plate, an Italian hitch or directly around a spike of rock.

If there are no spikes to belay from, and if there is ice, a belay can be set up using two ice screws (see p. 29).

To ensure the situation remains Amber when descending, the climbers can abseil (abseil device + prusik) over the bergschrund from a tape or rope sling around the spike.



3-9 PROGRESSION ALONG AN EASY RIDGE

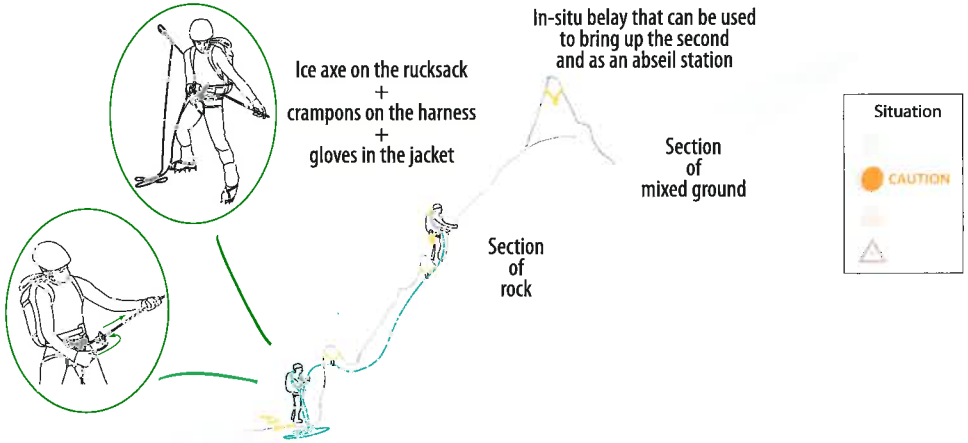


Easy mixed ridges can be climbed moving together with a moderate distance between the climbers.

Although this is referred to as "tight roping", the rope is not kept tight in the strict sense of the word, so as to avoid upsetting the climbers' balance. Without having too much slack in the system, the rope trails along the ground or round rock ridges.

The climbers on this ridge have placed runners (slings round spikes), or have run the rope "behind" spikes. This is a **Green situation** .

On a snowy ridge, it is important to keep well away from the lips of cornices (Amber situation), which could break at any time causing an **accident** .



The snowy ridge above includes a section of rock that cannot be climbed in crampons. This is an Amber situation . They tackle the difficult section correctly, by:

- Dropping some coils,
- Taking off their crampons to make the climbing easier,
- Belaying each other,
- Placing runners (slings on spikes).

To save time and make things easier for the leader, they:

- Put their gloves in their jackets,
- Clip their crampons to their harnesses
- Slide their ice axes behind their rucksack straps.

The second takes off his crampons and puts them to one side with his ice axe. He can then clip them onto his harness/slide them behind his rucksack strap before starting to climb. At the end of the rock section, the climbers put their crampons back on.

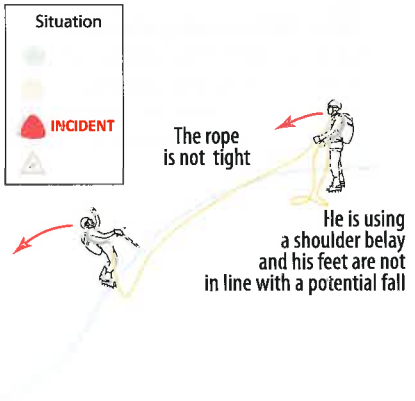
On the descent, they can use the in-situ belay to abseil down this section.

3-10 A TECHNICAL SECTION TO DESCEND

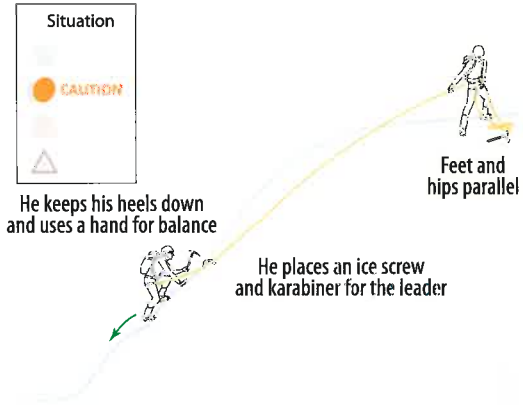
The descent includes a short, steep section (40/45°) of ice (summer conditions). The easy-angled slope below this step is covered in soft, wet snow. For these climbers, what should be an Amber situation is already potentially **Red** because:

- The leader is using a shoulder belay to belay the person descending and she does not have her feet and hips in line with the potential fall (it would be almost impossible for her to stop a fall due to the leverage caused by having the rope over her shoulder).
- The rope is not tight.
- The person climbing down has not placed an ice screw to protect the leader when it is the leader's turn to descend.

Should the person climbing down slip backwards and fall head first, this **Red situation** could easily turn **Black** .



In order to remain in an Amber situation (crossing technical ground), the climbers should drop some coils before they start going down the steep ground, so there is enough rope available to cross this section.



They should then adopt the following strategy. The leader:

- Wears gloves and uses a body belay (hip belay) to protect the person descending (less leverage than with the rope over the shoulder).
- Ensures there is no slack in the rope.
- Keeps her feet and hips parallel with the rope.
- Keeps her downhill leg straight, with her crampons well anchored in the snow.

The person descending:

- Climbs down using the front points of her crampons and taking small steps.
- Keeps one hand on the ice for balance.
- Plants the blade of the ice axe into the ice, gripping firmly onto the shaft.
- Cleans away any rotten surface ice and places an ice screw, to which she clips the rope.
- Once at the bottom, she belays the leader using a belay plate.

Before setting off again, the climbers adjust the length of the rope between them as a function of the terrain to be crossed.

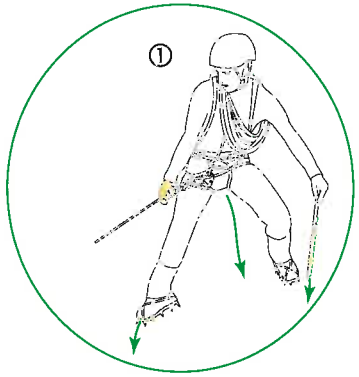
3-11 CREVASSE RESCUE – THE VICTIM CLIMBS OUT

These climbers are going down a highly crevassed glacier (roped up a moderate distance apart) with the rope tight. The bottom of the glacier is in summer conditions (bare ice or ice under a thin layer of snow). They are wearing gloves, helmets and crampons.

One of the two climbers slides 2 metres into a crevasse, without injuring himself or dropping his ice axe. The leader manages to stop the fall, thereby preventing a Red situation becoming **Black** .

To get back into an Amber situation (moving over crevassed terrain):

- The leader, who stopped the fall, has his feet and hips parallel with the line of the rope ①.
- Keeping the downhill leg straight and lowering his centre of gravity were key factors in being able to stop the fall. The leader plants the shaft of his ice axe into the snow on the surface of the glacier (uphill hand) and holds the rope tight with his downhill hand.
- He asks his companion if he is OK, checking for physical injuries, emotional state and loss of gear. This conversation is essential, as it will affect the choices to be made.



Based on this conversation, the party jointly decides that the situation is best resolved by the victim climbing out of the crevasse. Thus:

- The fallen climber climbs out ② using his ice axe and the front points of his crampons.
- The leader gradually moves backwards ③ to keep the rope under maximum tension.

Before setting off again, the climbers take a few minutes to catch their breath and to choose a better route through the crevasses.

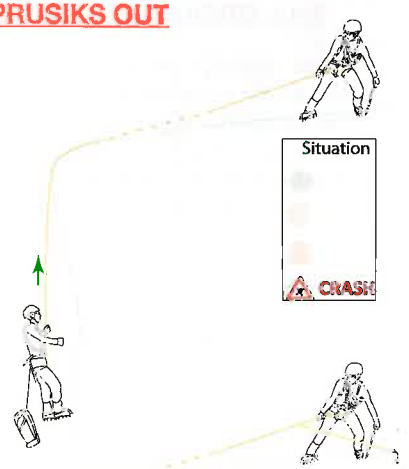
3-12 CREVASSE RESCUE – THE VICTIM PRUSIKS OUT

These climbers are in an Amber situation , crossing a crevassed glacier, in summer conditions, with ice under a thin layer of snow.

The accident happened when one of the climbers fell into a crevasse while trying to cross it.

The two climbers can communicate. They decide that the climber who fell into the crevasse should prusik out. The rope has not cut into the surface of the glacier because there is very little snow on top of the ice.

Keeping the rope as tight as possible at all times, the climber on the surface places an ice screw to protect the manoeuvre. He then ties into the ice screw via a prusik knot attached to the rope.



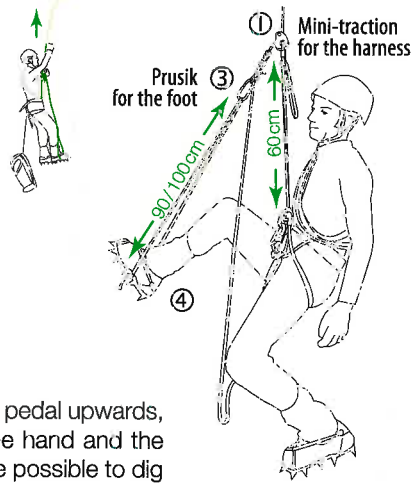
Tying prusiks onto the rope:

❶ Put a Mini-traction (or a French prusik) on the rope.

❷ Use a lark's foot to tie a sling into your harness, in order to make a cow's tail (see p. 31), and then tie a figure-of-eight knot in the sling, approximately 60 cm from the lark's foot. Clip the cow's tail into the Mini-traction. Adjust the position of the knot so you can grab hold of and move the Mini-traction when sitting in your harness. The most common mistake is to make the knot too high.

❸ Put a prusik below the Mini-traction and clip it to a 120-cm sling. This sling provides a pedal for your foot (make a knot in the sling if it is too long).

❹ Put your foot in the pedal so the sling sits in the middle of your crampon.



To make climbing out easier, hang the ice axe and rucksack from your harness, if possible, out of the way of your feet.

Basic cycle for climbing up:

❺ Push the prusik attached to the pedal upwards, holding the karabiner/prusik in one hand and the Mini-traction in the other. It may be possible to dig the front points of your crampons into the ice to help you move up.

❻ Stand up in the pedal, holding the karabiner/prusik in one hand. Push the Mini-traction as high as possible up the rope with the other hand.

❼ Put your weight onto the cow's tail + Mini-traction.

❽ Slide the prusik + pedal up the rope.

Repeat the cycle until you get to the lip of the crevasse.

When the mini traction comes into contact with the lip of the crevasse, the easiest way to continue is to:

❾ Get out your ice axe and use the axe and your crampons to climb onto the surface. While you are doing this, the person on the surface keeps moving back, pulling the rope to take in any slack and to help the person climbing out.

3-13 CREVASSE RESCUE – ASSISTED HOIST

These climbers are in an Amber situation, crossing a crevassed glacier, in summer conditions, with ice under a thin layer of snow.

The accident happened when one of the climbers fell 3 metres into a crevasse while trying to cross it. The two climbers can communicate. The climber who fell is hanging in space and cannot get out alone. The rope has not cut into the surface of the glacier because there is very little snow on top of the ice.

To get back into an Amber situation (moving over crevassed terrain):

- The leader, who held the fall, has her feet and hips parallel with the line of the rope.
- Keeping her downhill leg straight and lowering her centre of gravity were key factors in being able to stop the fall. She plants her ice axe into the snow on the surface of the glacier (uphill hand) and holds the rope tight with her downhill hand.
- She asks her companion if he is OK, checking for physical injuries, emotional state and loss of gear. This conversation is essential, as it will affect the choices to be made.

In this scenario, the climber who fell can help with the manoeuvre. The two climbers decide that the quickest and most effective way to extract the fallen climber is to set up an assisted hoist. This involves fixing a solid anchor on the surface of the glacier as the basis for a pulley system, and then passing the victim a loop of rope. This loop is attached to the victim's harness by a karabiner, which acts as a second pulley through which the rope can slide. This system gives a theoretical mechanical advantage of around 2 to 3.

Setting up a belay + ascender on the rope:

❶ While keeping maximum tension in the rope, the leader (on the surface) rigs a belay using two ice screws linked together with a sling.

❷ She then attaches the tight rope (**Green strand**) to the sling via a Mini-traction or a French prusik + safety karabiner ❸. This belay will form the anchor point for the pulley system. She can now free herself from the system and undo some of the coils so there is enough rope available for the next step.

❹ She attaches herself to the "free" end of the rope from the Mini-traction (Yellow strand in the diagram) using a French prusik and a long cow's tail, and then moves down to the lip of the crevasse.

❺ Next, she throws a loop of rope to the climber in the crevasse, who clips this loop to the belay loop on his harness with a karabiner. This karabiner forms a pulley around which the rope can slide. The climber in the crevasse now has three strands of rope through his harness – the strand he was originally tied to, which goes up to the Mini-traction (**Green strand** in the diagram); the "descending" end of the loop (Yellow strand) formed by the "free" end of the rope from the Mini-traction; and the "ascending" end of the loop from the fallen climber (**Red strand**).

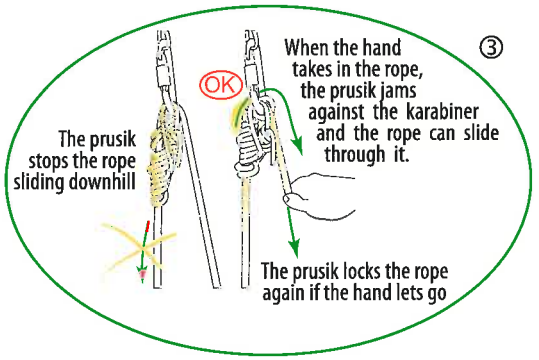
❻ The leader transfers her French prusik (from the Yellow strand) onto the "ascending" strand (**Red strand**). When pulling on the rope, the leader must make sure she does not fall into the crevasse (she is only attached to the red strand and not to the belay).

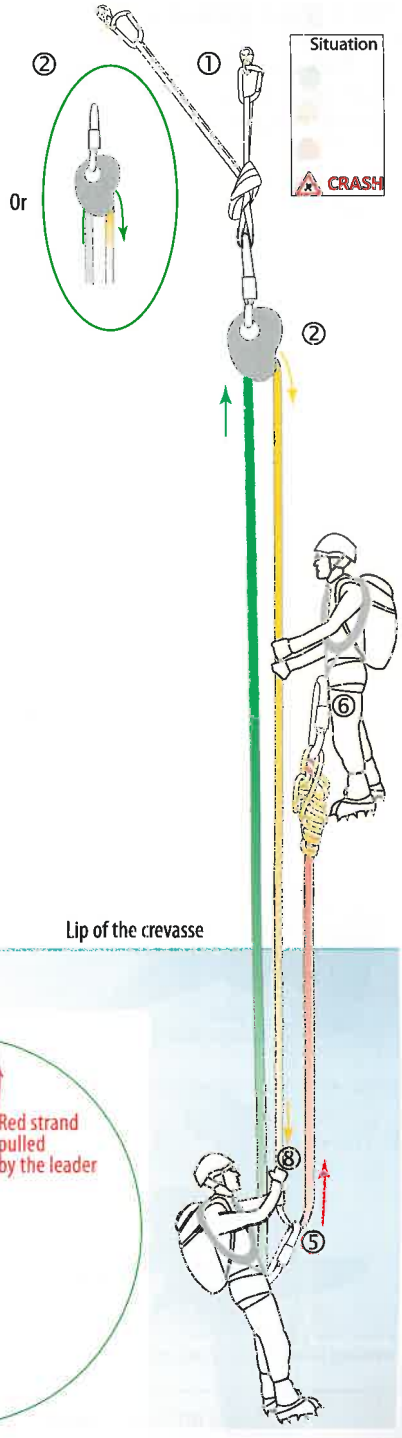
Basic cycle for bringing someone up:

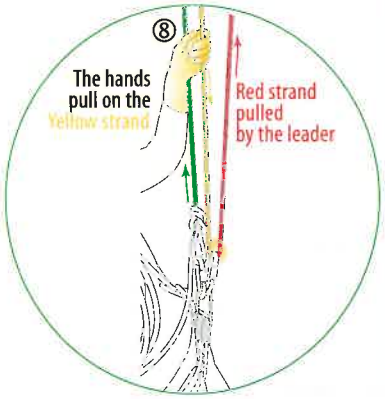
❼ The leader pulls on the "descending" strand (Yellow strand) and pushes with her feet, so she can push the French prusik down the "ascending" strand (**Red strand**). This action pulls the "descending" strand (Yellow strand) through the Mini-traction, there by shortening the **Green strand** and raising the person in the crevasse.

❽ The person in the crevasse pulls up on the Yellow strand to help the leader.

When the person in the crevasse gets to the lip, the easiest thing for him to do ❾ is to climb out using his crampons. The leader continues to pull on the rope to help him.



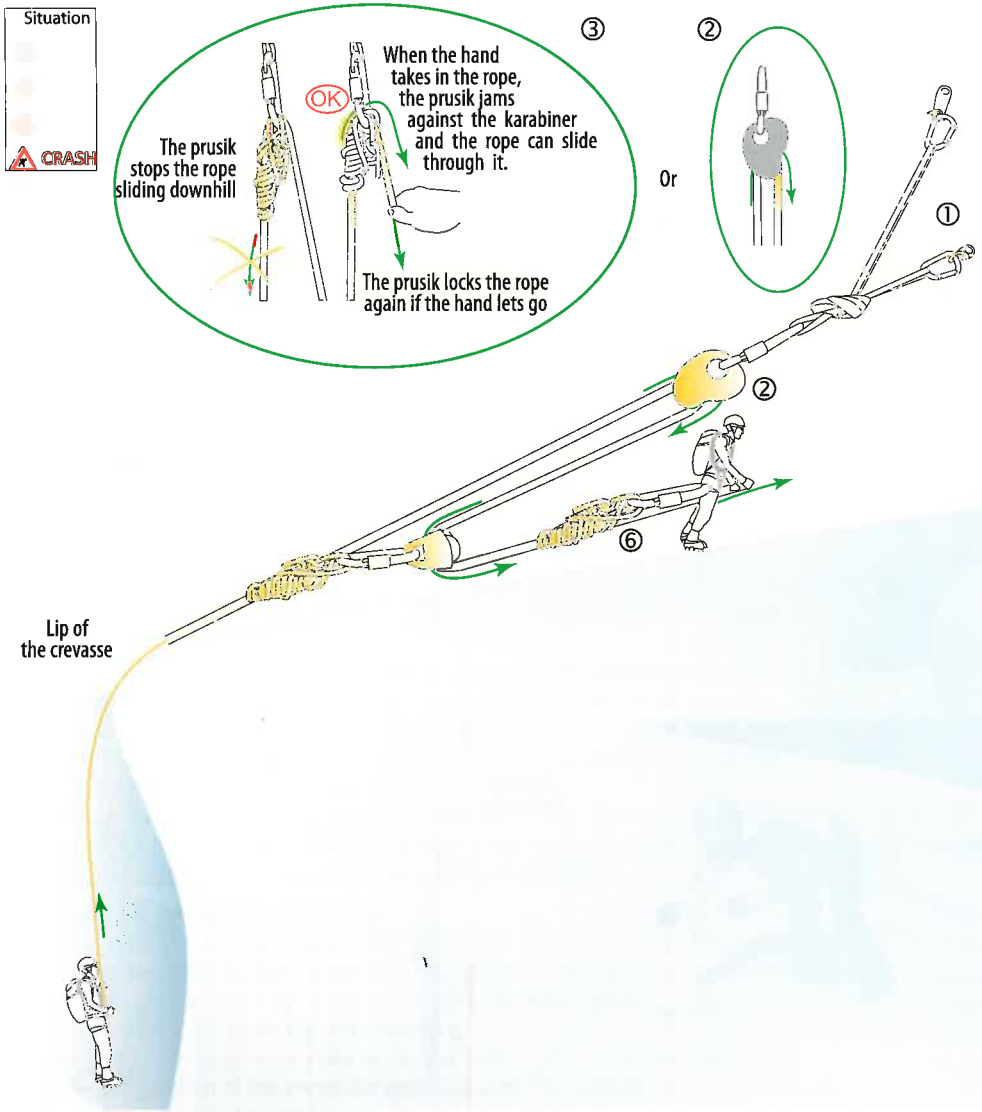




3-14 CREVASSE RESCUE – UNASSISTED HOIST

This scenario is presented for information only, as it is an advanced technique that requires much greater expertise than can be expected of climbers at the beginning of their mountaineering careers. In addition, a large number of factors can affect the successful use of this rescue method.

Unassisted hoist rescues involve using pulleys to increase the mechanical advantage in the system, thereby reducing the effort required to hoist a person from a crevasse. However, the theoretical reduction in effort (between 1.5 and 3 times) will be reduced by friction effects (rope cutting through the lip of the crevasse, friction from karabiners, etc.).



As a result, it is important to set up a simple system, in order to avoid merely producing a cat's cradle of ropes that doesn't work. It is even more important to try and avoid getting into this type of "extreme" situation in the first place!

These climbers are descending a crevassed glacier and are roped up a moderate distance apart (Amber situation). It is late summer and there is only a thin layer of snow on top of the ice.

The accident involved a snow bridge collapsing and one of the climbers falling 4 metres into a crevasse. The leader managed to stop **the fall**.

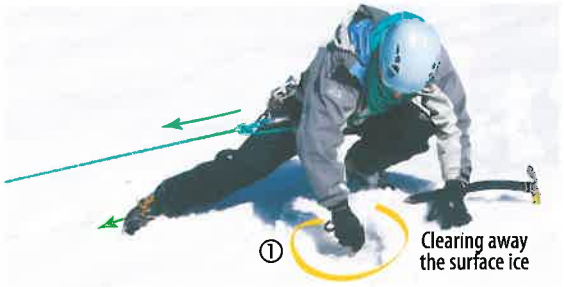
The two climbers can communicate. The climber who fell is hanging in space and cannot get out alone. The rope has not cut into the surface of the glacier because there is very little snow on top of the ice.

To get back to a **Red situation** (the fallen climber is suffering from shock):
- The leader, who held the fall, has his feet and hips parallel with the line of the rope.
- Keeping his downhill leg straight and lowering his centre of gravity were key factors in being able to stop the fall. He plants his ice axe into the snow on the surface of the glacier (uphill hand) and holds the rope tight with his downhill hand.
- He asks his companion if she is OK, checking for physical injuries, emotional state and loss of gear. This conversation is essential, as it will affect the choices to be made.

In this scenario, the climber who fell cannot help with the manoeuvre due to shock. The leader sets up a simple hoist system.

Setting up a belay + ascender on the rope:

❶ While keeping maximum tension in the rope, the leader (on the surface) sets up a belay using two ice screws linked together with a sling (or, if necessary, using a rucksack buried in the snow as a deadman – advanced technique).



❷ He attaches the tight rope to the belay sling using a Mini-traction or a French prusik + safety karabiner ❸. This belay will form the anchor point for the pulley system. It also allows the leader to free himself from the system and undo some of the coils so there is enough rope available for the next step.

❹ He attaches himself to the rope using a French prusik and a long cow's tail, and then moves down to the lip of the crevasse.

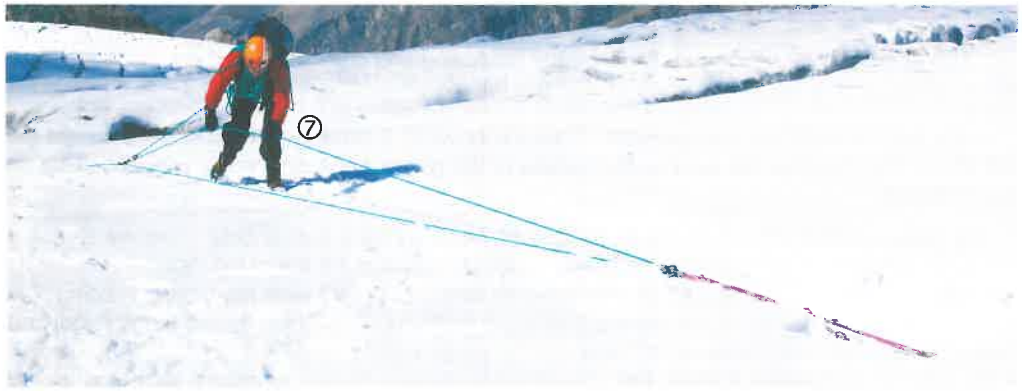
❺ He attaches a French prusik + karabiner + pulley to the tight part of the rope, as close as possible to the lip of the crevasse.

If you don't have a pulley, you can use a prussic and a karabiner (less efficient).

❻ He then transfers his prusik to the free end of the rope that comes out of the pulley.

Basic cycle for bringing someone up:

❼ While pulling on the strand attached to the pulley anchor point, he pushes with his feet to pull on the prusik. This raises the person in the crevasse.



❽ When the leader gets close to the pulley anchor point, he slides the French prusik + karabiner + pulley, system towards the lip of the crevasse. He also moves his own prusik towards the pulley, so the "hoist" manoeuvre can be repeated, thereby raising his companion out of the crevasse.

❾ When the person in the crevasse gets to the lip, the easiest thing for her to do is to climb out using her crampons. The leader continues to pull on the rope to help her.

Both climbers are on top of the glacier, although the situation must still be considered Red, as one of the climbers is suffering from shock. However, they are both capable of descending unaided. To get back to the valley, they have to find a "safe" route down the glacier, roping up with at least a moderate distance between them.

Once back in the valley, they can mull over their experience over a well-earned drink.

3-15 THE GAME OF CHESS IS OVER, IT IS TIME TO GO HOME

Strategic choices: The mountain environment presents climbers with an almost infinite number of choices; it is up to each person to make and accept their own decisions.

One last situation for the road – a very exposed horizontal traverse, just above a gaping crevasse. The climbers have a difficult choice to make, involving a compromise that will favour either:

- Reducing the risk of a slip turning into a potentially dangerous fall by roping up close together, or
- Reducing the risk of more than one member of the party falling into the crevasse by roping up a moderate or long distance apart.

Neither choice is perfect. This is why it is important to stop and consider all the options (including turning back) and to make sure that all the members of the party agree on the choice that is made. On this traverse, falling is not an option.

For now, the game of chess is over.

Through good training, especially learning how to walk in crampons properly, most incidents can be avoided.

It is time to go home, put away that jumble of gear and reflect on all those manoeuvres that are clogging up your brain.

This is the end of the scenarios and the end of this handbook.

Now you can enjoy the mountains with your eyes wide open, capable of recognizing and avoiding the traps waiting to trip you up.

Now you can enjoy those long moments of solitude, get closer to those magnificent summits, and savour the salty taste on your lips after a long and beautiful day in the mountains.

OK, Murray. Stop mucking about. Get out of your hole. It's time for a beer. These Scottish guides never give up!

(Special thanks to Anaïs Longchamp, Murray Hamilton, Paul Henderson and Tof Trombert for their precious help.)

MOUNTAIN ESSENTIALS®, part 2

A volume will present advanced techniques for travelling over glacial and mixed terrain:
Mountain Essentials® - Ice and Mixed Routes

A Volume will present the more advanced techniques needed for trad routes and multi-pitch climbs:
Mountain Essentials® - Rock Climbing.

LIST OF ASCENTS

Date | Route, Summit, Col, etc.

Name of companions and/or guide | comments

NOTES

www.dat.rs

USEFULL INFORMATION

EUROPE
Weather & avalanche forecast: www.avalanches.org

AUSTRIA
Weather & avalanche forecast: www.alpenverein.at/portal/Wetter www.lawine.at
Huts, Clubs, Parks, etc.: http://www.alpenverein.at
Rescue: 112 or 140

CANADA
Weather & avalanche forecast: www.weatheroffice.gc.ca
Conditions: www.acmg.ca
Clubs, Parks, etc.: www.pc.gc.ca www.alpineclubofcanada.ca

FRANCE
Weather & avalanche forecast: www.meteo.fr www.meteociel.fr www.avalanche-net.com www.alea-avalanche.com
Conditions: www.camptocamp.org http://metaskirando.free.fr www.volopress.net www.skitour.fr
Huts, Clubs, Parks, etc.: www.ffcam.fr
Rescue: 112

GERMANY
Weather & avalanche forecast: www.lawinenwarndienst-bayern.de
Huts, Clubs, Parks, etc.: www.alpenverein.de

GREAT BRITAIN
Weather & avalanche forecast: www.sais.gov.uk
Clubs, Parks, etc.: www.alpine-club.org.uk
Rescue: 999

ITALY
Weather & avalanche forecast: www.aineva.it/ www.nimbus.it
Conditions: www.gulliver.it
Huts, Clubs, etc.: www.cai.it
Rescue: 118

NORWAY
Weather & avalanches forecast: www.met.no
Rescue: 112

SPAIN
Weather & avalanche forecast: www.aemet.es www.meteocat.com
Huts, Clubs, Parks, etc.: www.madteam.net
Rescue: 112

SWEDEN
Weather & avalanche forecast: www.fjallsakerhetsradet.se www.smhi.se
Rescue: 112

SWITZERLAND
Weather & avalanche forecast: www.meteosuisse.ch www.slf.ch
Conditions: www.gipfelbuch.ch www.bergtour.ch
Huts, Clubs, etc.: www.sac-cas.ch
Rescue: 112 (Valais, Lötschental, Aletschgebiet 144 / REGA 1414)

UNITED-STATES
Weather & avalanche forecast: www.avalanche.org http://avalanche.state.co.us/index.php
Huts, Clubs, Parks, etc.: www.americanalpineclub.org www.nps.gov
Rescue: 911

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