**Telling Directions from the Sun and the Moon – A Carlson**

(Last revised 2000-03-21)

(Note: The rules presented here are Eurocentric, that is expressed for mid-latitudes in the Northern hemisphere. I apologize for this, at least half-heartedly, and promise to write alternative versions later. Comments on this page will be appreciated and may be sent to me)

Nothing beats a compass for finding directions in the field, but sometimes you don't have one when you need it. In that case it can be handy, or even life-saving, to be able to orient yourself some other way. The sun and the moon offer excellent alternatives, if you know how to use them. The techniques taught to do this, particularly using the moon, are often more complicated than they need be. I hope here to make the process easy to understand, use, and remember. At the end, for those who are interested in greater accuracy, I will describe a method that is not much more complicated but that is significantly more precise than that usually presented.

But first I would like to ask how much accuracy is really needed. I would say not much, in most cases. If you are trying to find your way back to civilization, then it is often sufficient to be able to decide which ridge of a mountain to descend or whether to go left or right down a path you have found. If you know there is a road or river south of you, then you won't waste too much time as long as you proceed on a bearing somewhere between SE and SW. If you don't even know where the next road is, then the best you can do is to avoid walking in circles. In all these cases, an accuracy of +/-45 degrees should be plenty.

**Rough orientation using the Sun**

This degree of accuracy is almost trivial to obtain with the sun. Near sunrise, the sun is roughly in the east, at mid-morning it is roughly SE, at mid-day roughly south, and so on. One generally has a rough idea of the time of day within an hour or two even without a watch, so no special techniques are needed to achieve the accuracy mentioned above.

**Rough orientation using the Moon**

If we are lucky enough to see the moon near the horizon, then we can probably figure out without too much trouble whether it is rising (in the East) or setting (in the West). If we saw it rise and then see it later in the sky, we can use it for orientation just as we use the sun, i.e., it rises in the East, 3 hours later it is somewhere toward the SE, 3 hours after that it is roughly south of us, etc.

The situation is rather different if we don't see it rise, but catch a glimpse of it later, e.g., through a break in the clouds or the trees. Fortunately the moon has something the sun doesn't have: a shadow line ("terminator"). One method often taught is to use the phase of the moon to determine how far it is ahead or behind the sun (e.g., 6 hours for a half moon), then to add or subtract that many hours (add if the moon is C-shaped, subtract if it is D-shaped), and tell the direction just as you would using the sun at the calculated time. This method has a number of shortcomings, but the worst is its complexity. The principle is straightforward enough, but it is not easy to remember how to translate phase to hours and whether to add or subtract these hours.

An easier way is to ignore the phase and just look which way the shadow runs. If the shadow is vertical, then the moon is close to due south. More generally you can mentally construct a great circle passing through the moon and perpendicular to the shadow. The left end of this circle will intersect the horizon in the East, the right end in the West. This method also saves you from having to figure out if the moon you see on the horizon just rose or is about to set. If the shadow is tilted to the left, for example, then the left end of the imaginary circle cuts the horizon there, so that is East. It has the further advantage that you don't need to know the time. Most important, all you really need to remember is that the moon moves from East to South to West along a path perpendicular to the shadow line.

**Precise orientation using the Sun**

Though you will seldom need it, you may, for reasons of recreation or survival, sometime want a more accurate bearing. The method usually recommended is just to use the East-South-West rule more carefully, for example, by treating the dial face of a watch as a compass rose. That of course helps, but there are systematic errors. For example, even if you have properly adjusted for local solar time, at mid-afternoon in mid-summer at mid-latitudes, the bearing found this way is wrong by 30 degrees. Fortunately, this error can be substantially eliminated by the simple expedient of tilting the dial face toward the North, as I will here explain more fully.

The first thing you need to do is to adjust your watch from legal time to read local solar time. The most important adjustment, accounting for a whole hour, which is equivalent to 15 degrees of azimuth, is summer time. So if summer time is in effect, start by setting your watch back one hour ("fall back"). The next potential source of error, up to about half an hour either way, is your displacement east or west of the central longitude of your time zone. Obviously the solar time does not jump by an hour when crossing a time zone, but changes gradually when moving away from the center of the zone. If the legal time in one zone is 1 pm (winter time) and that in the adjacent zone is 2 pm, then the solar time at the boundary will be about 1:30 pm. If you know your longitude, you can make an exact adjustment, but it will generally be good enough to just move your watch 20 minutes or so toward the time in the adjacent zone if you know you are near the border. Finally, there is a correction called the "Equation of Time", which can be as large as +/-16 minutes in fall and winter but is never larger than +/-7 minutes in spring and summer. It would be asking too much for hikers to remember this function, so we will just consider it, possibly in conjunction with uncertainties in the longitude, to be the ultimate limit of accuracy. If you can adjust your watch to within 15 minutes of local solar time, then you have a chance of orienting yourself to within +/-4 degrees of azimuth, which is certainly respectable.

Even using the correct local solar time and interpolating carefully, the East-South-West method will not give you exactly the right direction. On reason for this is the familiar fact that the sun rises and sets farther north in the summer than in the winter. The second is the less well-known fact that the sun tends to linger in the East and West and hasten across the South. This is most easily realized by considering a location in the tropics. There, as everywhere, the sun rises in the East. During the course of the morning it climbs higher and higher, but it always stays in the East. Around noon it is nearly overhead so its bearing is poorly defined, but throughout the afternoon it is in the West. At any season, the sun circles around the pole, so both these effects can be accounted for by casting the shadow with a rod parallel to the Earth's axis and measuring the angle on the plane perpendicular to it. In other words, to find accurate bearings, you need to tip your watch and the stick you are using to cast the shadow both toward the North by an angle equal to the number of degrees of latitude your position is from the North Pole (your "co-latitude"). (45 degrees is a good place to start, a bit flatter if you are farther North, a bit steeper if you are closer to the tropics.

There is a final complication when using a watch dial, namely that the hour hand goes around the circle twice while the sun goes around once. This can be dealt with, assuming the shadow casting rod is in the center of the dial plate, by not using the actual hour hand, but an imaginary one lying halfway between the real one and the 12 o'clock position. An alternative method is to put the rod on the 6 and let its shadow cross the number the hour hand is actually pointing to. One can hold a matchstick or straw over the surface of the watch, but I find this somewhat awkward, and it doesn't work at all in fall and winter, when the tilted face of the watch will be entirely in shadow. My favorite method is to make a 90 degree fold in a small piece of paper and hold it on the dial such that the fold crosses the 6 and the current hour. Generally, the vertical part of the paper will cast a shadow to one side or the other. When the sunlight just grazes both sides and the shadow disappears, then I know the paper is pointing toward the sun, and the 6 o'clock side of the watch is pointing south.

**Summary of the Rules**

1. Usually it is enough to remember that the sun (and moon) rises in the East, moves through the South, and sets in the West.
2. The moon moves perpendicular to the line of the shadow on its face, so you don't even need to know the time to apply the above rule.
3. If you want an accurate bearing:
4. Adjust your watch, if necessary, to read winter time.
5. Adjust your watch, if necessary, toward the next nearest time zone.
6. Fold a small piece of paper at a right angle and hold it on the surface of the watch so that the fold extends from the 6 to the current hour.
7. Turn the 12 toward you and tilt the face down on that side by the number of degrees your latitude is away from the North pole.
8. Turn around until the paper casts no shadow.
9. The 6 is now pointing South, with a potential error of perhaps 10 degrees to either side.

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