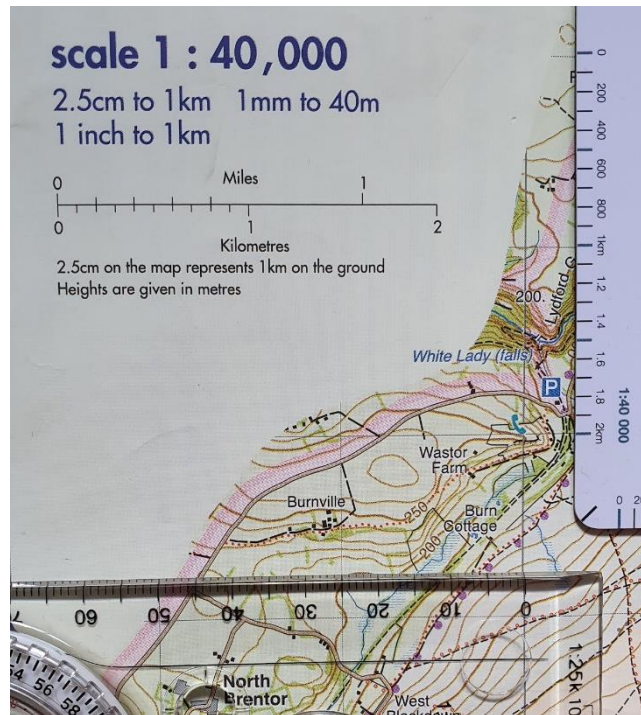"Your greatest failure is not to try"

Part 2 of my **Navigation Techniques** series will look at measuring distances and how we can use this technique to help us find features and plan a route.

Measuring Distances

We use distance measuring to calculate how long a navigational leg or whole route will take and to minimise errors in navigation. We can judge and estimate distances through sight, time, using measuring devices and even through pacing.

Judging Distances using sight:

The most basic form of distance judging is done using sight. We do this fairly regularly in our every-day life. How often have you said: "Oh, the pub is about half a mile down the road" or "There's a shop about 200m that way". The easiest way we can judge distance is by relating distances by using set distances we know of in normal life. For example:

- A football pitch is 100m from goal to goal and 50m wide
- A standard swimming pool is 25m long

Using these measurements, we can roughly judge the distance of features whilst out on a walk. For example, if we can see a footbridge in the distance and it looks to be further than a football pitch away, we can use our judgement to determine it's approximate distance, by saying it is 'x' amount of football pitches away for example, and use that information to gauge where we are on the map.

One issue we do have in the UK is our mixture of units (and not the alcoholic type!). Our maps are scaled in kilometres and metres. Distances on our road signs are marked in miles and yards. This can present problems when judging distance as we are so used to seeing 'miles' and 'yards' (in three quarters of a mile, turn right) yet want to measure map distances in kilometres and metres (the summit is 300m away from the track junction). And miles and kilometres do not convert easily.

1 mile = 1.6km

1km = 0.62 miles

It is worth taking time to go outside and judge distances to get a feel for how far things are away from you. By the end of this article, you will be able to measure distances on a map. Use this technique to measure features on a map from your position and see how they compare in terms of distance. Find an open space, mark your position on the map and find features that are:

- 50m away
- 100m away
- 250m away
- 500m away
- 1km away

This will help you gain a better understanding of judging distances using sight. Be aware though that it will not be accurate but serves as a rough guideline and that 'dead ground*' can cause errors in your judgement.

dead ground is a term used to describe an area of ground hidden from view. For example undulating ground, tree lines and valleys may hide whole areas of ground that you have not accounted for in you distance judgement.

Using measuring devices on a map:

For more accurate measurements of distance, we can use measuring devices on maps to work out distances. In my article Introduction to Maps Part 4: Resources and Care of Maps we looked at different resources available to us to help measure distances. Take time now to familiarise yourself and read the article again if need be.

Below is a list of items and resources we can use to measure distance on a map:

- **Compass roamer**
- **Distance Cards**
- **Ruler** *(with millimetre increments)*
- **String**
- **Paper and pen/pencil**
- **Opisometre**
- **Technology**

I will come onto these resources in a bit, however, the most basic form of measuring distances on a map is by using grid squares.

As we already know, a grid square is 1km x 1km and roughly 1.4km across the diagonal. Knowing this, we can roughly estimate distances by looking at the grid squares. Take a look at the example below. Estimate the distance from Haytor (point A, circled in yellow) to Rippon Tor (point B, circled in yellow) in a straight line:
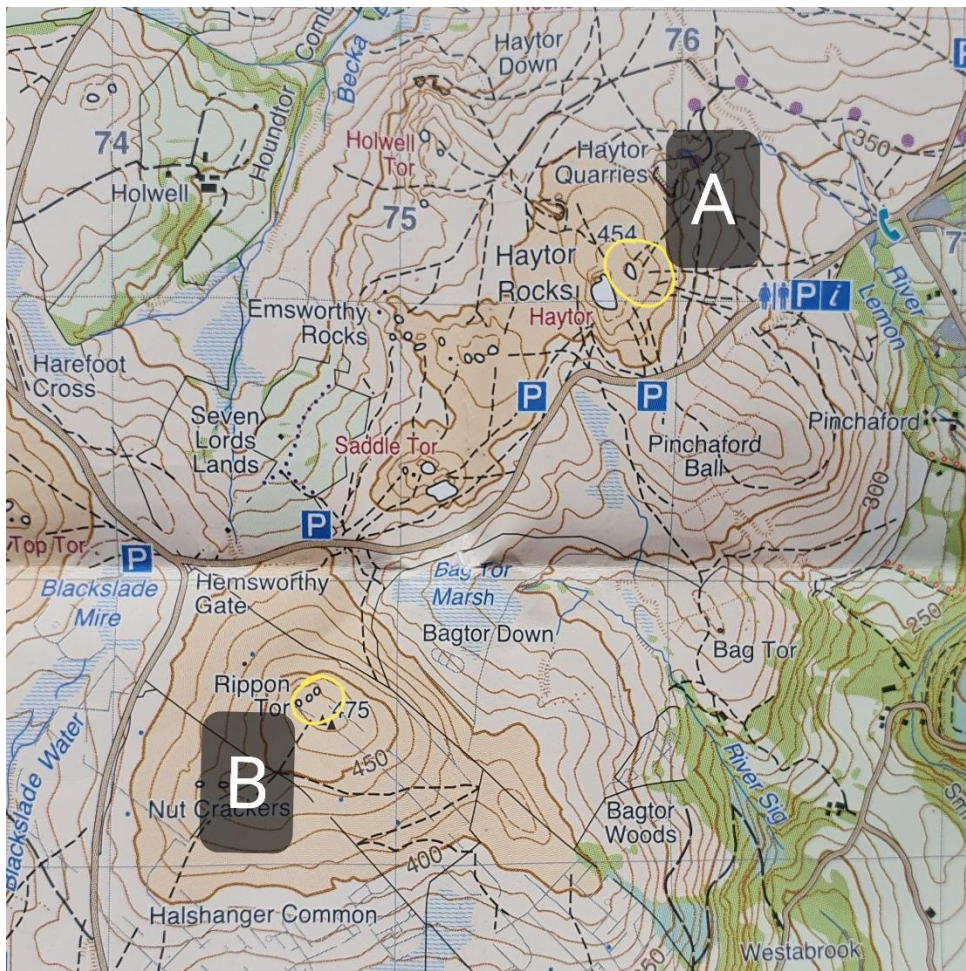
At first glance, it would appear to be about 2km. But how can we work out the distance more accurately?

## Compass romer and Distance Cards

We can use the romer on a compass or a dedicated distance card to help us gain better accuracy when measuring distances. It is important you know the scale of the map so you know which scale to use on romers and distance cards. Dependent on scale, we can be accurate up to roughly 50m. Using the image above, we can confirm as to whether our estimation of 2km was accurate or not:
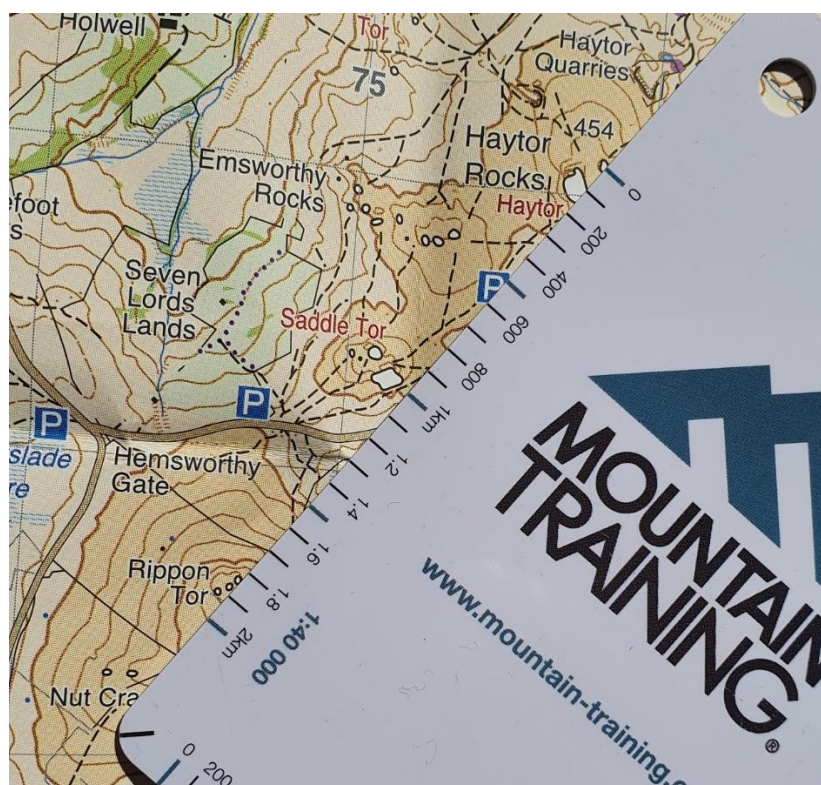
Using a distance card, we can see in the above image that the actual distance was between 1.8km and 1.9km. That gives us an error of roughly 10%. This level of error is acceptable, and we can adjust accordingly, however we will aim to improve this.

See below for another example looking at measuring distances with romers and cards:

First, estimate the distance from Devil's Tor to the middle of the buildings on Rough Tor:
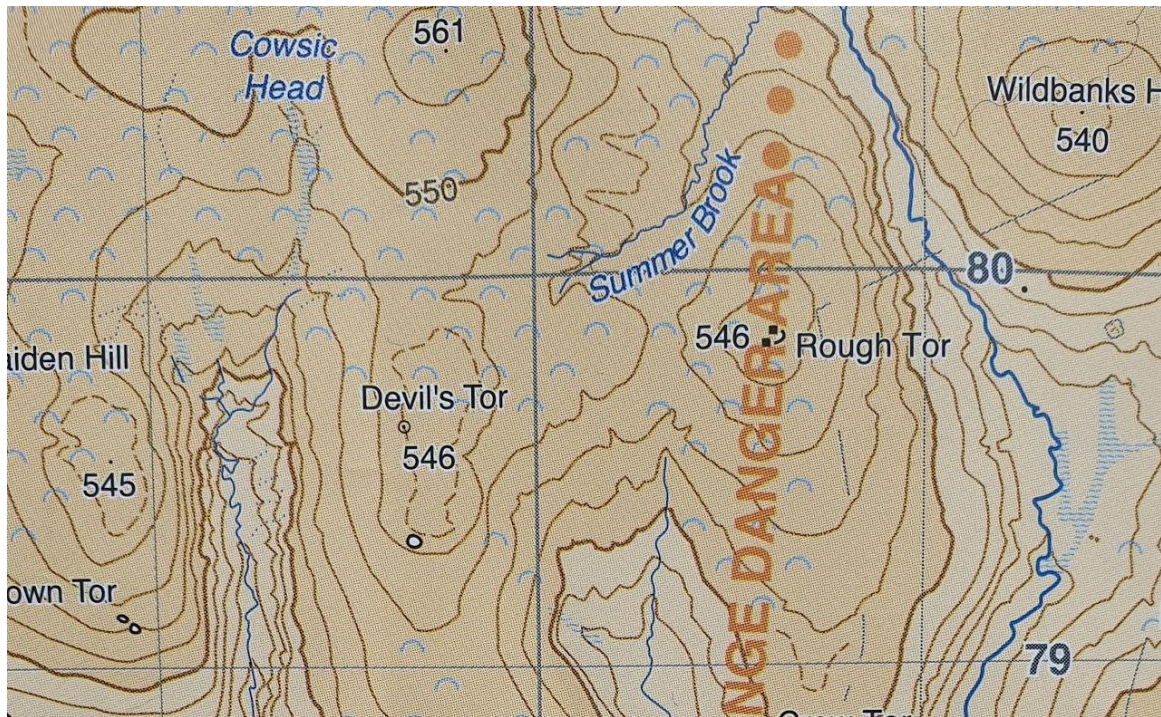
Now see below to see how you did. Were you within 10 percent?
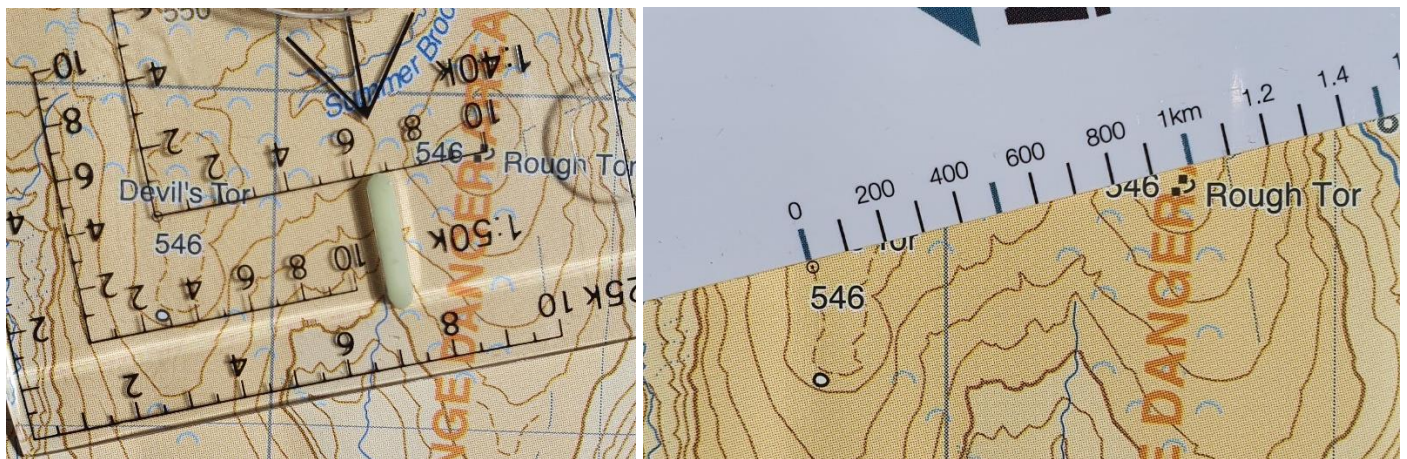
In image 1, notice how the compass is being used: The correct scale romer has been used (1:40k) as this is a Harvey 1:40,000 British Mountain Map. The corner of the romer has been put accurately on *Devil's Tor* and the romer positioned so that it accurately sits over *Rough Tor.*

Using rulers

Rulers with millimetre increments give us the greatest level of accuracy when it comes to measuring distances. On a 1:25,000 scale map, 1mm measured on the map is 25m on the ground.

Distance Metres	Scale		
	1:25,000	1:40,000	1:50,000
25m	1mm	-	0.5mm
40m	-	1mm	-
50m	2mm	-	1mm
100m	4mm	2.5mm	2mm
200m	8mm	5mm	4mm
300m	12mm	7.5mm	6mm
400m	16mm	10mm	8mm
500m	20mm	12.5mm	10mm
1000m	40mm	25mm	20mm

Most base plate compasses have a millimetre ruler printed on the base. We can use this to get a better level of accuracy when measuring distances on the map.

Let's use the map example from above:
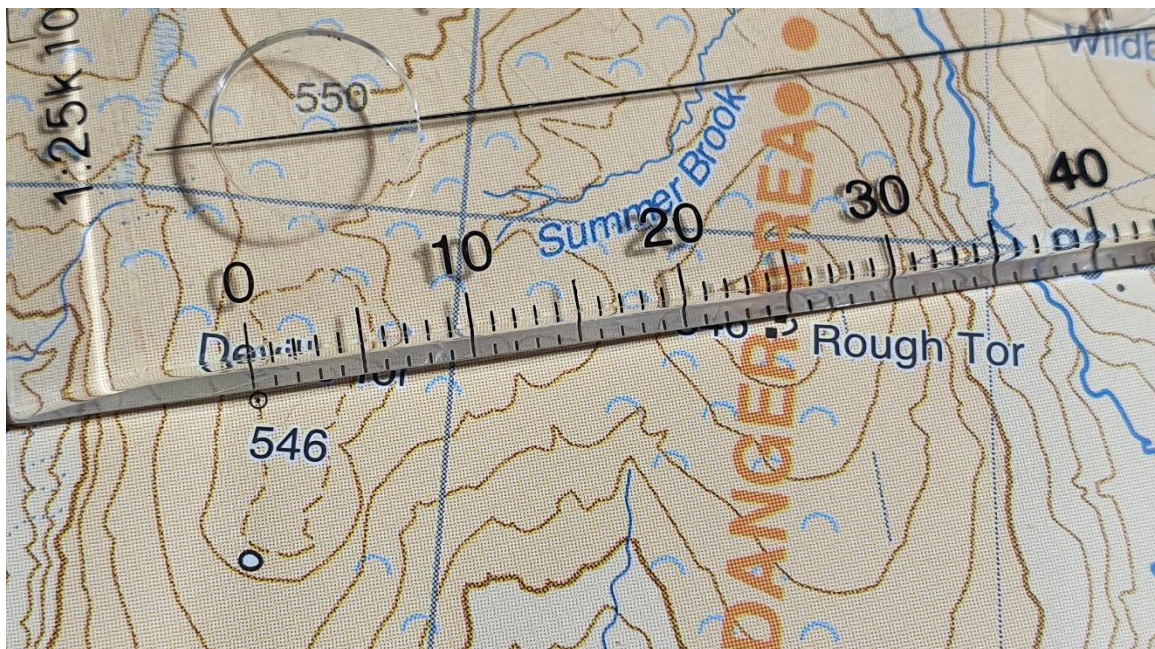
The distance to the middle of the two buildings is 24mm. Using the table above and knowing this is a 1:40,000 scale map, we can calculate the distance to be 960m. If you said they were 1km apart, you are well within the 10% tolerance.

Using string

We don't always measure distances in a straight line. We usually follow paths or use other features to navigate to and from and these are rarely in a straight line. If we want a more accurate distance of our route or leg, we can measure along the route using string. The age-old question of 'how long is a piece of string?' is about to be answered!

Look at the map below. We can use string to work out the distance between Carnedd Llywelyn and Carnedd Dafydd as a straight-line distance would be inaccurate and impossible for us to walk in, mainly due to the cliffs.
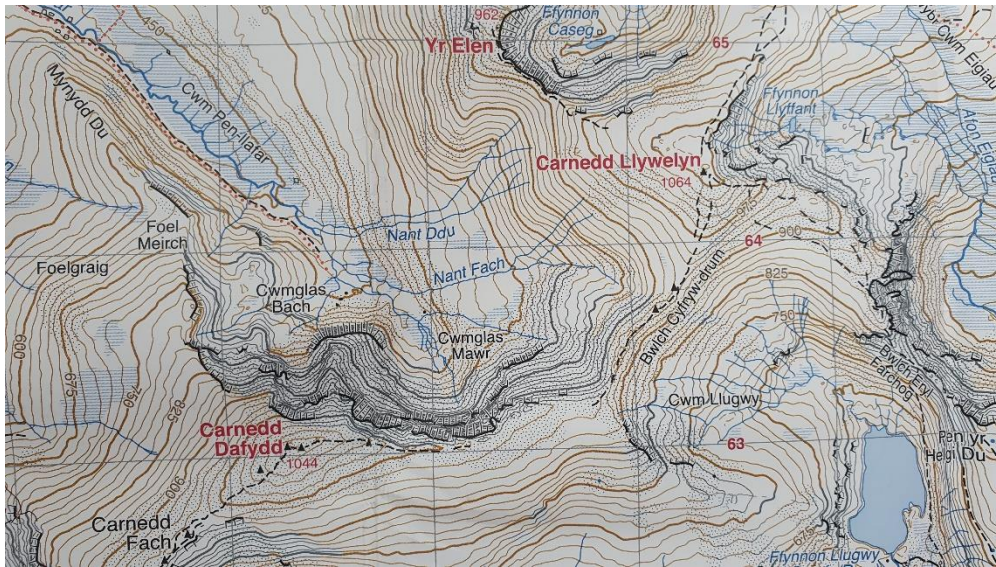
We use string to follow the path SW off Carnedd Llywelyn, across Bwlch Cyfrym drum and then West to Carnedd Dafydd. I have used sticky pointers to hold the string down and act as reference points on the string for when I come to measure it.
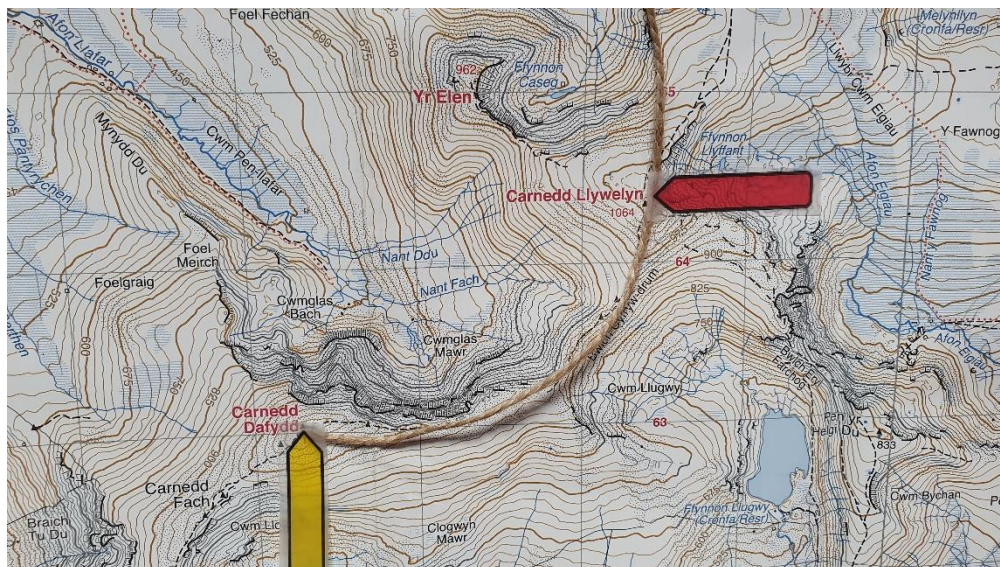

Notice how it is not 100% accurate but not far off. However, it gives us much greater accuracy of actual walking distance than a straight line from summit to summit. Using the sticky pointers as our references, we can then measure the distance using a ruler or the scale on the map.
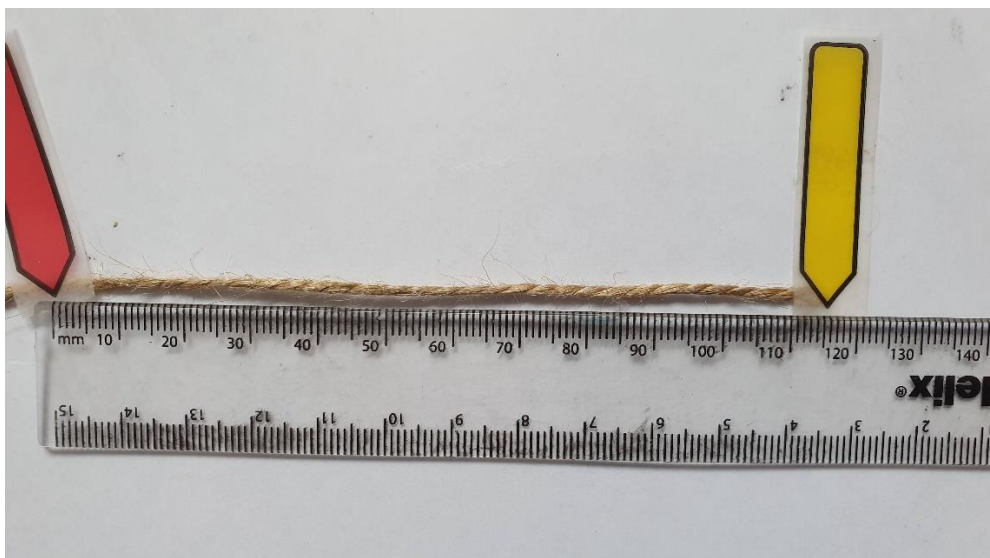
My ruler measures 116mm. This is a 1:25,000 scale map so we can work out that the distance is 2.9km.

And just to confirm that we are correct, I have used the OS Maps App and plotted the route (*more on this later*):
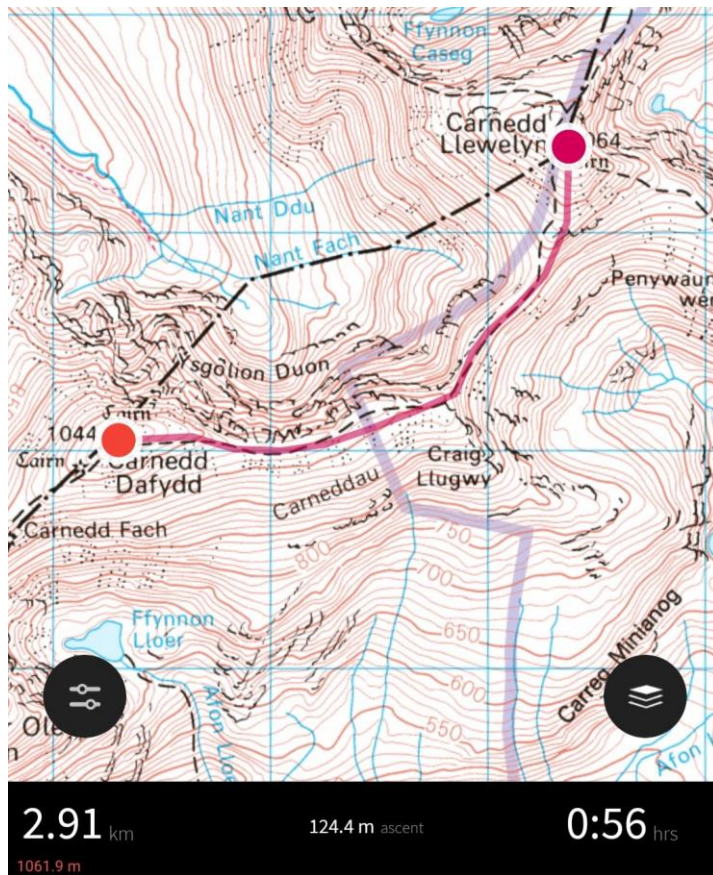
String can be difficult to use and in untrained hands, it can present a greater degree of inaccuracy. It takes practice and if in doubt, use other measuring methods to confirm or clarify.

Paper and pen/pencil

Another option which is similar to using string is to use the edge of a blank piece of paper and a pen to mark turning points on the leg. The Mountain Training publication: Navigation in the Mountains has a good example of this method:

FIGURE 2.16   MEASURING DISTANCE WITH STRING OR PAPER

NAVIGATION IN THE MOUNTAINS – NAVIGATION T
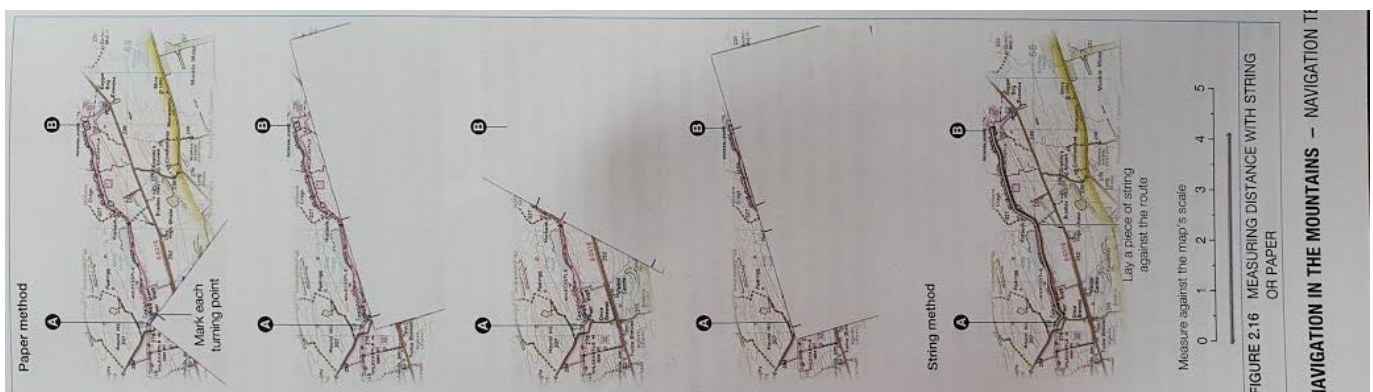
Starting with the corner of the paper, lay the edge along the route and mark each turning point. Continue to turn the paper and mark the turning points along the route until you get to your intended checkpoint. You can then measure the distance on the paper against the scale of the map or a ruler.

Using an Opisometre

An opisometre is a measuring wheel you can use to trace the route with on the map. It will then give you an accurate distance traveled. Be aware to reset the device to '0' every time you use it and to ensure you use the correct scale on the device compared to the map.

Illustration from 'Navigation in the Mountains' © MTUK/VG 2012

Technology

We can measure distances using mapping software on our laptops and tablets or phone apps such as OS Maps and Viewranger. I'm not going to go into too much detail about apps etc, but only to point out how they can be used to measure distance.

Above, when talking about using string to measure distances, I mentioned how I can confirm the distance by using an app and plotting the route. We can zoom right into the map on a screen and plot routes to a high degree of accuracy by following the route by every turn.

I only ever use technology like this to CONFIRM another method. The reason being is I don't want to rely on technology and become lazy.

Links to where you can download OS Maps and Viewranger can be found in my DOWNLOADS and RESOURCES tab under MOUNTAINEERING RESOURCES on my website

Measuring Distance on the Ground

After we have measured a distance on the map, we can then measure this on the ground. This is useful for us to work out how long it is going to take to get to our destination by using timing (more on this in my next article) and also to find features in poor visibility.

The technique we use is called Pacing, commonly referred to as Double Pacing.

Pacing

We can use our natural stride length to measure distances on the ground with a bit of knowledge about it and practice.

Everyone's stride length is different, so it is important that you conduct the following test to determine your own number of double paces per 100m:

You will need to head to a standard sized football pitch or 100m running track. Failing this, you will need to measure out a 100m long strip on flat, even ground. You can do this by using a 50m rope or by finding an area on a map that you can easily measure 100m between two points.

Starting with a clear start and end point spaced 100m apart, step off with your right foot and count every left foot (or vice versa). Walk naturally, as if you are walking down the street. Once you have crossed the 100m point take a note of your number. The average pace for an adult is roughly 64 double paces per 100m.

Once you have this number, turn around and do it again. Your number may or may not be the same. If you have the same number, excellent! If not, find the average by adding the two numbers together and dividing by 2.

For example, if you walked the 100m distance twice and got 60 and then 64, add these numbers together to get 124. Divid it by 2 (the number of times you walked 100m) to get 62. This is then your double pace number per 100m.

I would advise you continue to practice this from time to time as your number may change. Once you have your double pace number for flat even ground, try doing the same exercise but this time with a heavy rucksack and see how your pacing changes.

Another point to note: When going uphill you tend to take smaller paces. Likewise, in rough terrain. With this in mind, your paces will vary and going up a steep hill on rough terrain, your paces may even double, going from 62 paces per 100m to possibly 124! If you have a steep hill near you and the ability to measure out 100m on that hill, practice pacing and see how your number differs to the flat.

See the example below from Mountain Training: Navigation in the Mountains:

Double paces per 100m	Conditions underfoot		
	Good	Moderate	Poor
Flat	60	70	90
Uphill	80	100	120
Downhill	65	70	90

Illustration from 'Navigation in the Mountains' © MTUK/VG 2012

A word on pacing: Pacing is a very effective way of finding features in poor visibility, however it does limit your ability to converse with other members of you group. It is usually best to pace short distances, typically less than 1km at most. To keep track of pacing, you can use pacing beads, which I mentioned in Part 4 of my Introduction to Maps article. Another way we can measure distances on the ground and a way in which we can partially take our mind off measuring the distance is Timing.

And this will be the next article in this series!

For the set of questions to follow, you will need the following:

- The PDF download of the OS Map (Found at the end of my online article)
  OR
- OS Explorer map – Dartmoor – OL28
- A ruler with millimetre increments and/or a compass base plate with ruler
- Blank paper and pen/pencil
- A distance measuring card (Found at the end of my online article)
  - You will need to print this out but **ENSURE** your print it **ACTUAL SIZE** and not FIT/FILL TO PAGE. Take a look at and check your **printer settings** before printing and then **check the measurements** with a ruler using the table in the PDF. You will need to cut the distance card. You can then laminate it for use on the hills and mountains!

Questions:

In these questions the prefix 'GR' stands for Grid Reference and does not correspond to the two-letter map prefix (for this area it is 'SX' for those who are interested)

Q1: Using a romer or a distance card, how far is it from Hart Tor (GR 581,720) to Black Tor (GR 573, 717) to the nearest 100m?

……………………………………..

Q2: Using a ruler, how far is it from South Hessary Tor (GR 597, 723) to the Trig Point (GR 592, 712) to the nearest 50m?

…………………………………….

Q3: From where the bridleway meets the road (GR 590, 734) to where the bridleway meets the end of the embankment (GR 582, 702) follow this bridleway and measure the distance to the nearest 100m.

……………………………………

Q4: In straight lines measure the following distances to the nearest 25m and work out the total distance:

- **Footbridge (GR 583, 705) to Cramber Tor (583, 711)** ………………………………

- **Cramber Tor (GR 583, 711) to small pond (GR 589, 711)** …………………………….

- **Small Pond (GR 589, 711) to Small Pond (GR 596, 716)** …………………………..

- **TOTAL DISTANCE: ……………………………………………………**

Q5: Using any way to measure distances, measure the following distances to the nearest 25m and work out the total distance:

- **Where the bridleway meets the road (GR 590, 734) to where the footpath meets the road (GR 580, 728)**

   ……………………………………..
- **Where the footpath meets the road (GR 580, 728) to Hart Tor (GR 581, 720)** …………………………………..

- **From Hart Tor (GR 581, 720) to the Trig Point (GR 592, 712)** …………………………………….

- **TOTAL DISTANCE: …………………………………………**