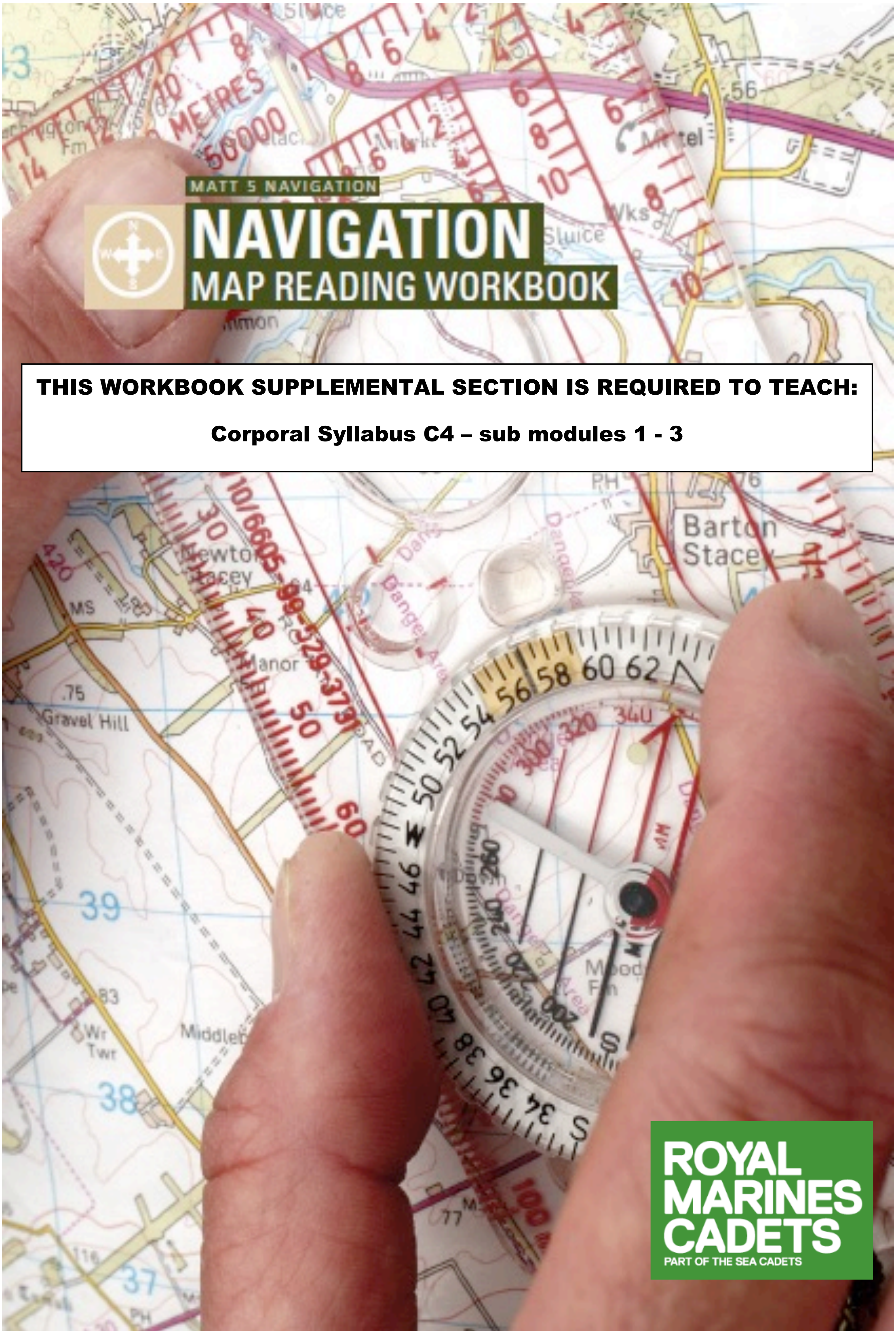
THIS SECTION IS TO BE USED AS SELF LEARNING AS PART OF THE CONSOLIDATION PHASE

MATT 5 NAVIGATION

NAVIGATION
MAP READING WORKBOOK

THIS WORKBOOK SUPPLEMENTAL SECTION IS REQUIRED TO TEACH:

Corporal Syllabus C4 – sub modules 1 - 3



ROYAL MARINES CADETS
PART OF THE SEA CADETS

ALTERNATE WAYS OF FINDING DIRECTION

INTRODUCTION

The sun and stars, when visible, can be used to find any approximate direction when no other means are available. They may be used to 'set' a map or find an approximate direction in an emergency in the Temperate Zones (north of Latitude 23.5° N or south of Latitude 23.5° S). At certain times of the year in the equatorial region, or when the sun is overhead, specialist knowledge is required as the sun may indicate the wrong direction.

APPARENT MOVEMENT OF SUN

The sun rises in the east and sets in the west and, when it is visible, its position can provide a rough guide to direction. In the northern hemisphere, it moves right through the southern sky and, at midday local time, the approximate direction of the sun is south (*see* Figure 1a). In the southern hemisphere, the sun rises in the east, moves left to north at midday, continues left and sets in the west (*see* Figure 1b).

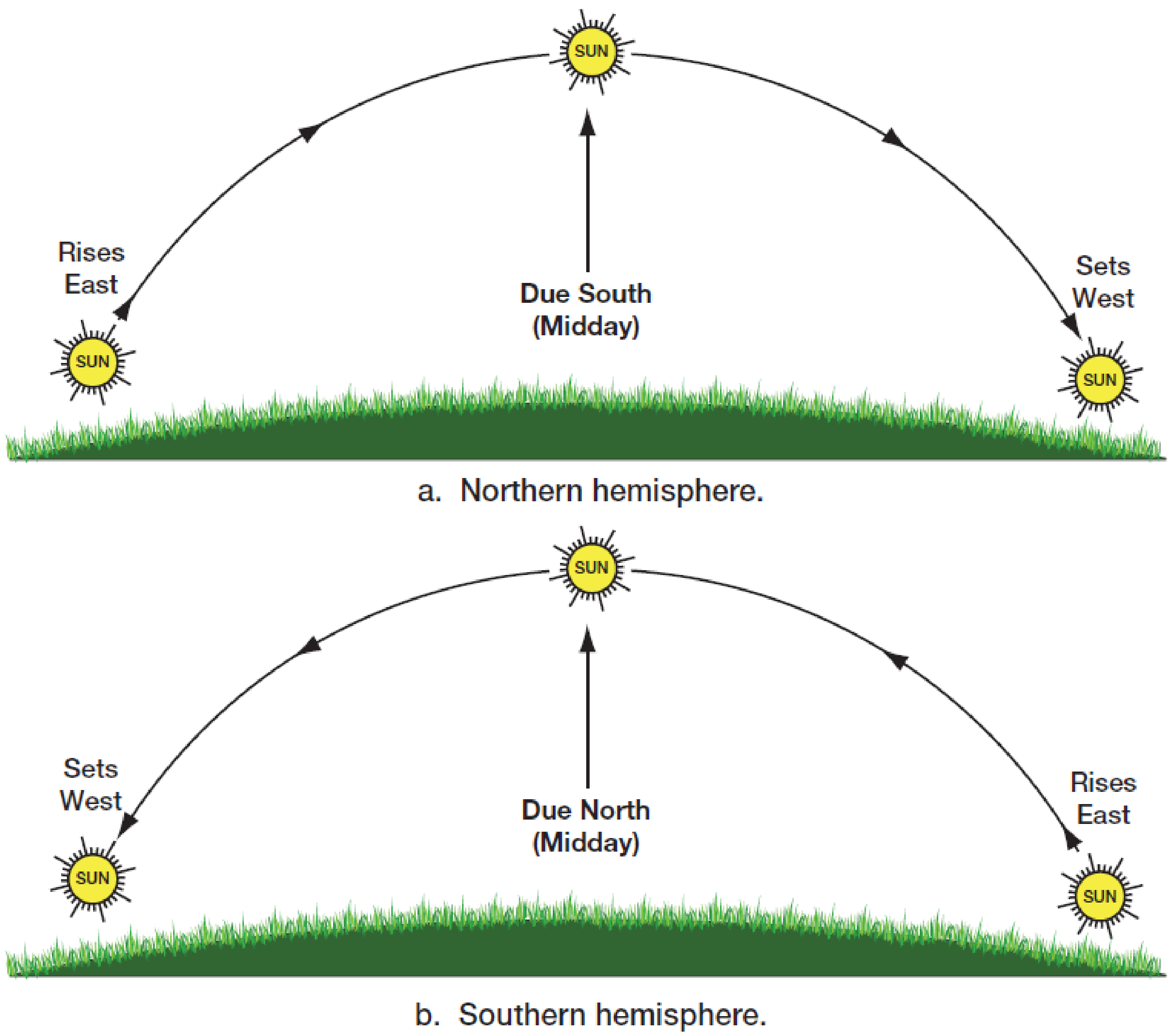


Figure 1. Position of the sun

DIRECTION USING SUN AND HAND SPANS

The most effective method, using the sun, is to use hand spans to find south (in the northern hemisphere), or north (in the southern hemisphere), and, from there, any other approximate direction. In the northern hemisphere, the direction of the sun at its highest point in the sky, at midday, is approximately south. One extended hand span, at arm's length, is roughly equivalent to one hour's movement of the sun. So, if it is 11:00 hours local time (Greenwich Mean Time (GMT) in the UK), one hand span to the right of the sun shows the approximate direction of south at midday (*see* Figure 2a). From this, any other approximate direction can be found. To avoid damage to the eyes, the sun should not be stared at directly.

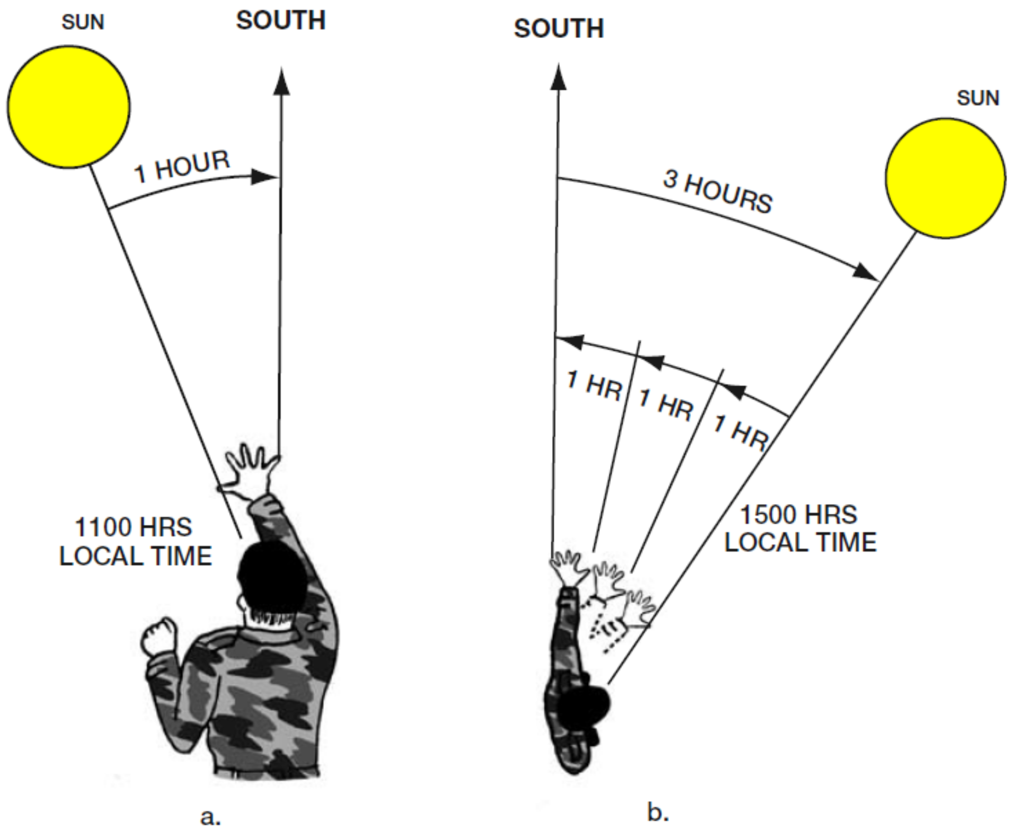


Figure 2. Finding South using handspans [Northern Hemisphere]

If the time is 15:00 hours local time, as the sun has passed midday, the hand spans are measured to the left of the sun back towards approximate south (*see* Figure b).

If the clocks go 1 hour forward in the spring, from local time to Daylight Saving Time (British Summer Time (BST) in the UK), 1 hour must be subtracted from the time before the number of hand spans are calculated.

For example, 0800 hrs BST = 0700 hrs GMT = 5 hand spans right
1700 hrs BST = 1600 hrs GMT = 4 hand spans left.

In the southern hemisphere, the sun at midday is due north and moves right to left.

Then, for example, 0800 hrs GMT = 4 hand spans left
1500 hrs GMT = 3 hand spans right.

DIRECTION USING SUN AND WATCH

The sun and watch method is slower and more complicated than the hand span method.

An analogue watch is held flat with the hour hand pointing towards the sun (the minute hand is ignored). In the northern hemisphere, south is midway between the hour hand and twelve o'clock on the watch (*see* Figure 3a). In the southern hemisphere, the watch is held with twelve o'clock pointing to the sun; north then lies midway between the hour hand and twelve o'clock (*see* Figure 3b). If using summer time, the watch should be converted mentally to local time and the appropriate hour pointed towards the sun. The sun should not be stared at directly.

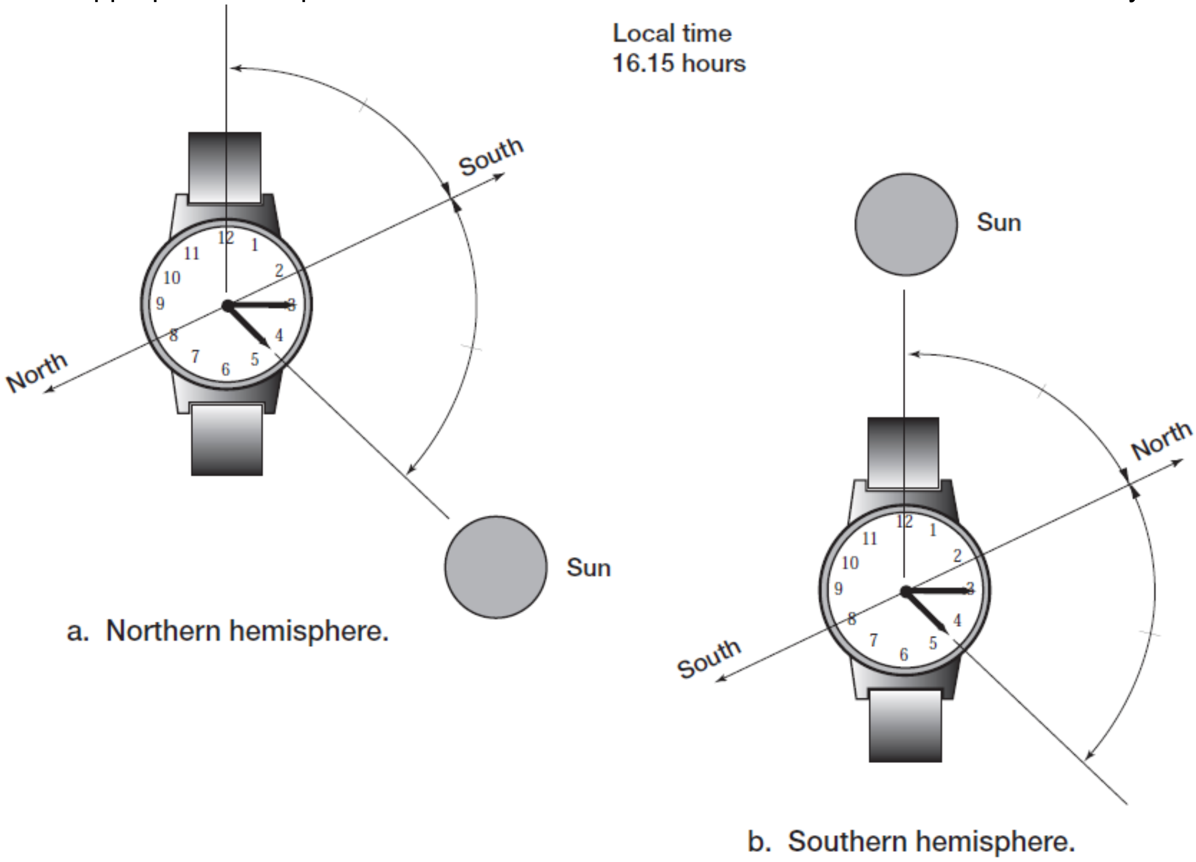


Figure 3. Finding north-south line with an analogue watch

DIRECTION USING STICK AND STRING

If a watch is not available or if the sun is high in the sky, north can be found by observing the shadow of a stick positioned vertically in the ground. This is more accurate than the watch method but is not effective in equatorial regions.

Level ground free from shadow and easily marked is selected, e.g. sand or plain earth. A straight stick, AB, 1 m to 2 m in length, is placed vertically in the ground (*see* Figure 4a). About 2 hours before noon, the position of the end of the shadow of the stick, C, is marked on the ground. A string is tied to the foot of the stick at B and the arc of a circle of radius BC marked on the ground in the direction of the movement of the shadow of the stick. The shadow grows shorter until noon and the end of it recedes from the marked circle. After noon, it lengthens and about 2 hours after noon it reaches the circle again. The point where it reaches the circle, D, is marked. The point, X, midway between C and D is found and marked. The line joining X and B is the north-south line. In the northern hemisphere, B is in the south and the sun moves clockwise; in the southern hemisphere, B is in the north and the sun moves anticlockwise.

If time is short, the observations can be made after some 10 to 15 minutes to give an approximate east-west line and thence a north-south line (*see* Figure 4b). If the position of the end of the shadow is marked regularly, the point at which it starts to lengthen indicates 'X' to give an even more approximate north-south line.

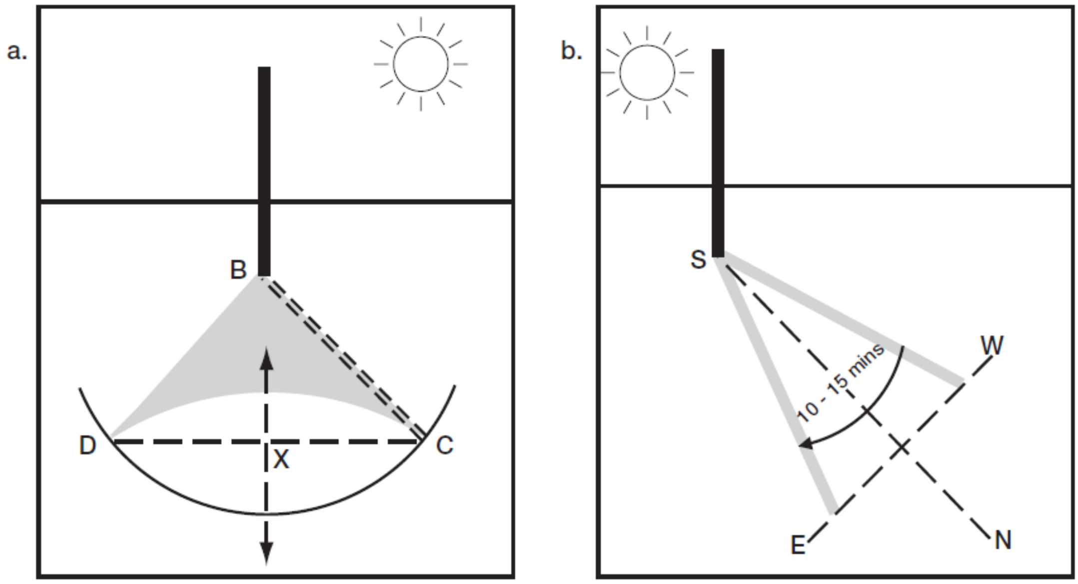


Figure 4. Finding a north-south line by movement of the sun

DIRECTION FROM STARS

The direction of the North or South Pole roughly coincides with the direction of the corresponding North and South Celestial Poles because the earth's spin axis is a straight line defining the poles (*see* Figure 5).

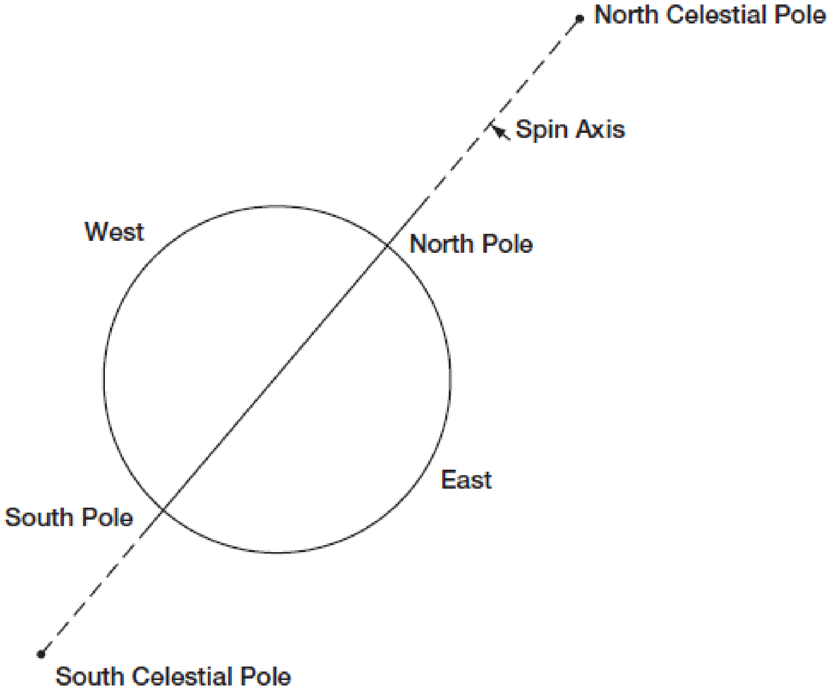


Figure 5. Earth's spin axis

In the northern hemisphere, the direction of north can be identified by the Pole Star (Polaris) in the constellation of the Little Bear. The distance from the Pole Star to the North Pole never exceeds more than 40 mils. Once the Pole Star is identified, any other approximate direction can be found; e.g. when marching west at night, the Pole Star is to the right.

Except for the Pole Star, the stars of the Little Bear are not very prominent. The usual way of locating the Pole Star is to identify the very distinctive stars of the Great Bear and to extend the line from the so-called 'pointers' about five times to the first bright star. This is the Pole Star. If the Great Bear is obscured for any reason, the constellation Cassiopeia may be used. Cassiopeia has a distinctive 'W' configuration and is easily identified. The relative positions of the Pole Star, the Little Bear, the Great Bear and Cassiopeia are illustrated in Figure 6.

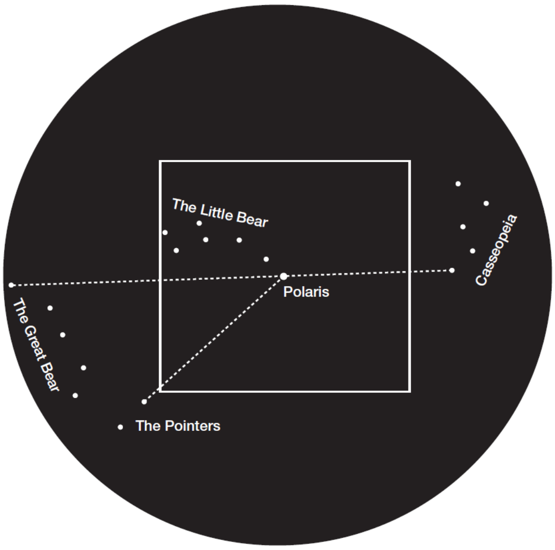


Figure 6. Relative positions of stars about the Pole Star.

This is a method for discovering the *general* direction of South:

If the moon is in a crescent phase, simply draw an imaginary line or hold a stick through the tips of the moon's "horns" (from one moon crescent point to the other) down to the horizon. The point where it touches the horizon is roughly South for the northern hemisphere and North for the southern hemisphere. The higher the moon is in the sky, the more accurate this method.

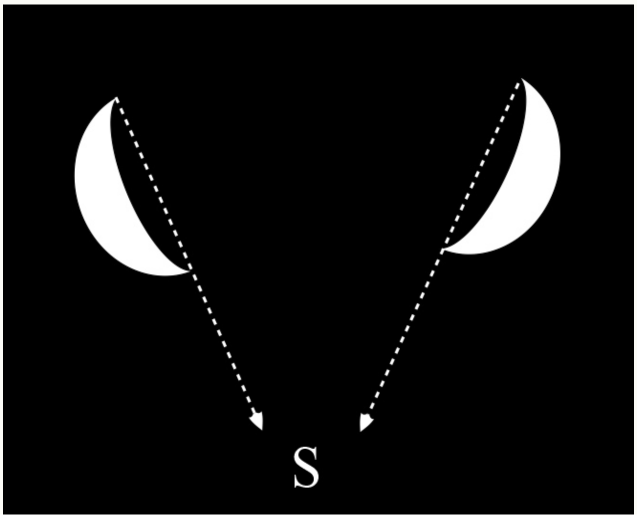


Figure 7. Horns of the moon

POSITION FIXES

Sometimes there is not enough local detail to ascertain an accurate fix when using DDCRAPS. In this case, alternative methods are required.

FINDING LOCATION BY INTERSECTION

Line Intersection. A line intersection is carried out to confirm a distant location on a linear feature e.g., a road, track, wood edge or ridge line. *See* Figure 8.

a. At a known location, take a magnetic bearing of the unknown location on the linear feature.
b. Apply the grid magnetic angle (GMA) and plot the bearing from the known location on the map.
c. The unknown location is where the bearing crosses the linear feature.

The best results are obtained when the bearing crosses the linear feature at a right angle.

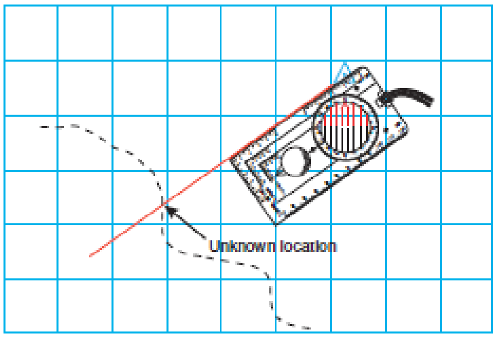


Figure 8. Line Intersection

Intersection. A distant location can be confirmed by observing and plotting an intersection using the following steps:

a. Take magnetic bearings of the unknown location from at least two known locations.
b. After applying GMA, plot the bearings from each of the locations.
c. The unknown location is where the lines cross.
d. A third location and bearing provides more confidence in the fix but may give a small triangle.

An intersection can be carried out either by a lightweight or prismatic compass and a RA protractor. Figure 9 shows how the two bearings are applied to the map using a lightweight compass.

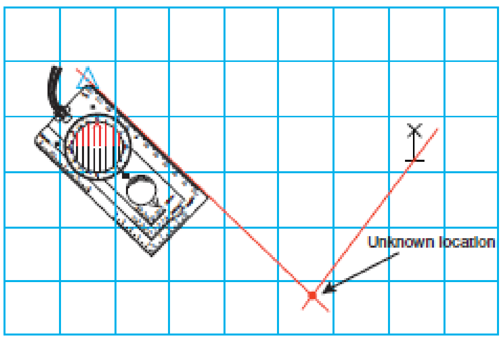


Figure 9. Intersection

FINDING A LOCATION BY RESECTION

Line Resection. A line resection is used to confirm the position of an observer on a linear feature, e.g. a road, track, wood edge or ridge line (*see* Figure 10).

a. Find a feature that can be identified both on the map and on the ground.
b. Take a bearing to the feature on the ground.
c. Apply the GMA and plot the back bearing from the feature on the map.
d. The unknown position is where the back bearing crosses the linear feature.

The best results are obtained when the bearing cuts the linear feature at a right angle as shown in Figure 10.

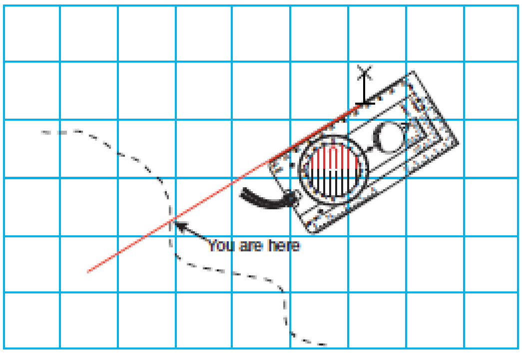


Figure 10. Line Resection

Resection. Where the position of the observer cannot be fixed by other methods, it can be determined accurately by observing and plotting a resection (*see* Figure 11).

a. Find two or more features that can be identified both on the map and on the ground; ideally, they should be at right angles to the approximate location.
b. Take bearings to the features on the ground.
c. Apply GMA and plot the back bearings from the features on the map.
d. Where the lines cross on the map is the accurate position.

A third bearing gives more confidence in the location but may give a small triangle. A resection can be carried out either by lightweight compass, as shown in Figure 11, or prismatic compass and RA protractor.

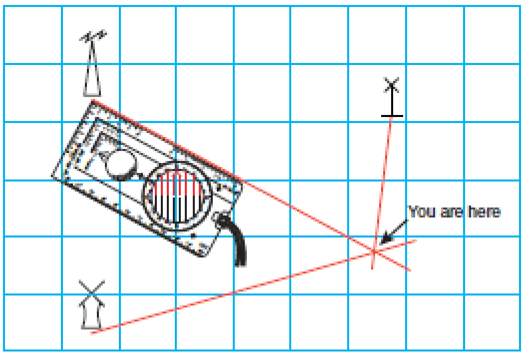


Figure 11. Resection

LAND NAVIGATION TECHNIQUES ON FOOT

The main source of error in maintaining a planned direction, or heading, results from the need to circumvent obstacles or hazards for which adequate allowance could not be made in the route plan. Examples of such obstacles include recent landslips not shown on the map, ravines concealed under a tree canopy and flooded watercourses. Diversions are necessary in such circumstances and it is essential to maintain a careful log of changes in direction and of distances travelled to get back on the planned course.

If it is possible to see beyond the obstacle, scouts may be sent round it and brought on to line by signal; the distance across the obstacle is estimated. If it is not possible to see beyond the obstacle, bearing and distances must be plotted to retrieve the planned route. In the simplest case, a diversion may be achieved by walking a measured distance at right-angles to the planned route, then walking parallel to the planned route for a measured distance until the obstacle is passed, then turning back through a right-angle and walking the same distance back to the planned route (*see* Figure 12).

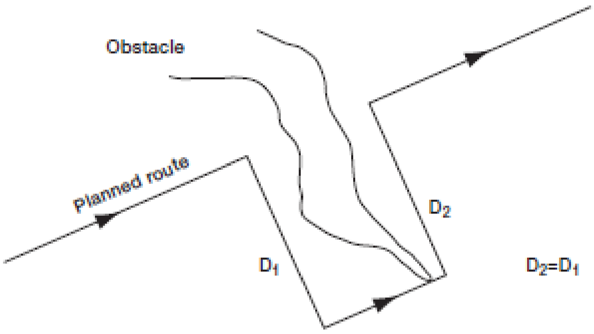


Figure 12. Boxing Method

'Handrail' Features. Long features that run in the general direction of the required route can be followed. These include features such as streams, power lines and ridges. Under certain circumstances, it might be essential to keep a safe distance from the feature to avoid detection (especially when following roads). Figure 13 shows a cross-country route from the road to the track using the stream to navigate by.

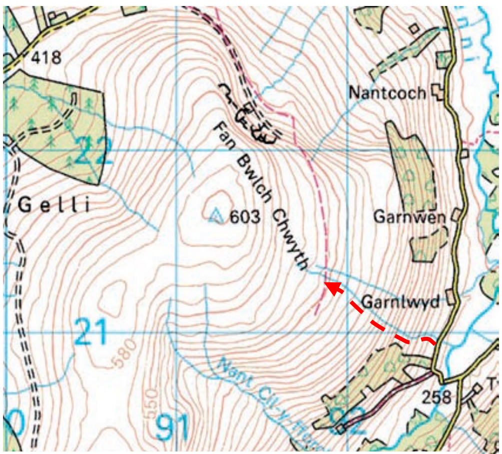


Figure 13. Using a Handrail feature

Aiming Off. If it is necessary to go to a specific point along a linear feature e.g., a track junction, any bearing error may result in it being missed and, when the track is reached, it may be unclear which direction along the track leads to the junction. By aiming off to one side of the junction, when the track is reached the direction of travel along the track to find the junction is known (see Figure 14).

Figure 14. Aiming Off

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RESECTION TASK

You have become disorientated whilst on a patrol and need to identify your position using a resection. You select 3 object that you can see around you and take the following compass bearing to them [shown as red dots with 6 fig GR]

A (025355) = 5700mils

B (061371) = 900 mils

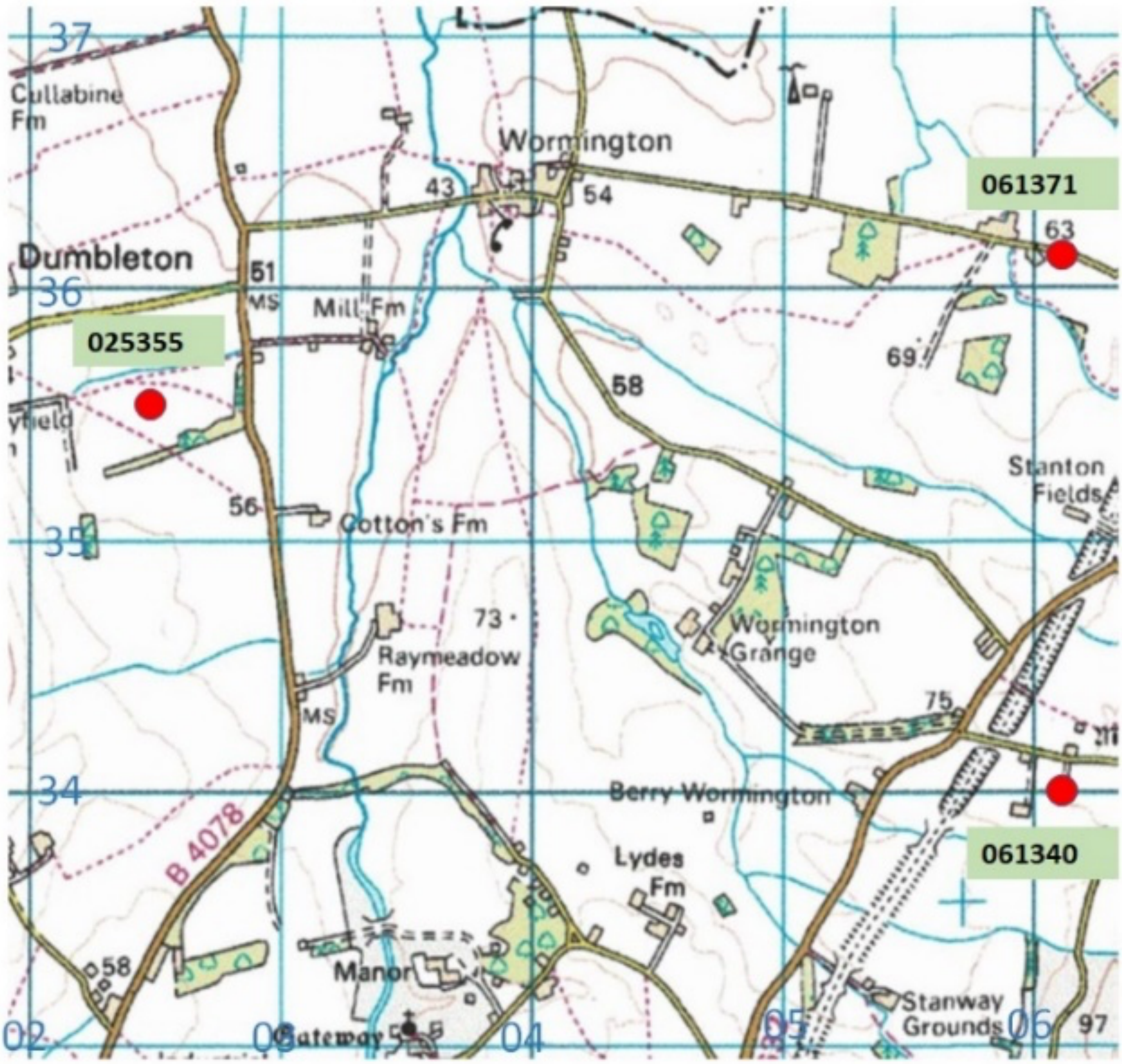
C (061340) = 1700 mils

Fill in the answers below using a **GMA of 100 mils** so you can then plot them on the map segment and then approximate your 6-figure grid location [figures only] [*It's easier than it looks and you should get an exact location*]

Back Bearing A

Back Bearing B

Back Bearing C



6-figure Grid Reference