CHAPTER 17 MAP MEASUREMENTS

Objectives

At the end of this chapter, students should be able to; i. Measure distances on map using various methods ii. Determine areas of features on the map using various methods iii. Determine the bearing of an object.
iv. Set map correctly on the field.

Measurement

Measurement is an important aspect of map reading. It is possible to determine distances between two points and the size of a feature on the map. When the scale of the map is applied to the measurement on the map, the actual distance on the ground between the two points can be determined. Two types of measurement on the map can be identified, namely; 1. **Measurement of distances**
2. Measurement of areas

17.1 Measurement of distances on the maps

Two types of distances can be identified on any given map. These are;

i. Measurement along straight courses or lines

Measurement along straight courses on a map presents little or no problem. Usually students are often asked to measure distance between two points on a map *"as the crow flies."* In other words you are asked to measure along straight route connecting two points. To do this: · Join the two points with a straight line on the map or place a ruler directly on the two point to determine the distance on the map.

- place a straight edge of plain white paper along the line joining the two points on the map, · mark the points and place the edge of the paper on a ruler.
- Determine the distance on the ground using linear scale on representative fraction.

Assuming 8cm is measured along a straight course on the map and the scale of the map is 1:50,000. The actual distance on the ground will therefore be kilometres on the ground. This is equal to 4 kilometres.

ii. Measurement along winding courses or lines

Examples of winding courses are river course, road network, foot paths *etc.* Measuring winding courses like this on maps present little difficulties because it is not possible to measure simple and direct as it is in measuring straight courses. However, three methods can be used to solve the problems of measurement along winding route.

a. Using a piece of inelastic string

Starting at the beginning of the course place a piece of inelastic string along the course, carefully follow the bends and mark the end of the course on string. Place the string on the ruler to read the measurement on the map, using the scale of the map calculate the actual distance on the ground. On the other hand place the string on the linear scale of the map and read off the distance directly.

b. Using the edge of a piece of paper

Simply align the edge of a piece of white plain paper along the curved or winding course as shown in figure 17.1, make sure you mark the starting point and the end point of your measurement on the white paper with a pencil. Place the edge of the paper on the linear scale and read off the distance or place the paper on a ruler and calculate the distance from the scale of the map.

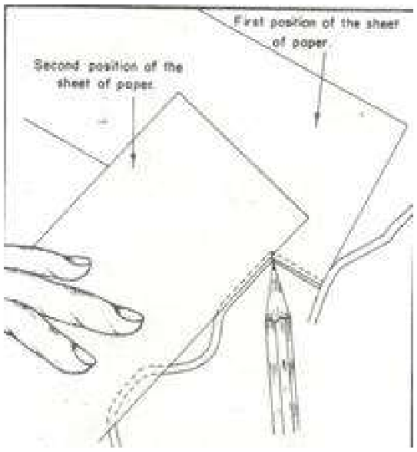

Figure 17.1: *Using the edge of a piece of paper to measure winding courses.*

c. Using a pair of divider

Set your pair of dividers to a definite length, if the course is fairly regular and the map scale is for example 1:100,000 equivalents to 1 centimetre to 1 kilometre, you can set your pair of dividers into 1centimetre. Step the pair of dividers from the beginning to the end of the course counting carefully as you progress. Then calculate the distance by multiplying the total number of steps by the unit length to which the dividers are set. If for example the total number of steps taken is 10, then $10 \times 1 = 10$, *applying the map scale you will have kilometres on the ground. This is 10 kilometres on the ground.*

Figure 17.2: Using a pair of divider to measure curved distances

17.2 Measurement of Areas

Measurement of areas on the map involves measuring areas occupied by geographic features such as agricultural field, pasture field, landform, plantation, pond, Lake *Etc.* Measurement of areas can be divided into two, namely;

i. **Measurement of regular shape**

Measuring a regular shape on the map presents little or no difficulty. For example if you are to find the area of a square or rectangle, simply multiply the length by breadth and apply the scale factor. If the length measured is 8cm and the breadth is 7cm, then the area of the shape will be 56cm. If the scale of the map is 1:50,000, then the area on the ground will be square kilometres. This is equal to 1cm to 0.25square kilometre on the ground.

Therefore $56 \times 0.25 = 14$ square kilometre, the area of the shape is 14 square kilometres on the ground.

ii. Measurement of irregular shape.

Finding areas of irregular shape is a bit difficult; however the following three methods can be used to calculate areas of irregular shape

a. The method of squares

This involves covering the area with unit squares either by tracing the outline to a graph paper or by tracing the area out on a light tracing paper and then place it on a graph paper. Count the number of complete and partial block of squares and sum up. Then apply the map scale to get the actual size of the area on the ground. In figure 17.3 the number of complete centimetre blocks of squares is 12 square centimetres, complete quarter centimetre blocks (which is more than half of a block) is = 5.75 and the total partial quarter centimetre blocks (which less than half of a block) is 49, that is which is equal to 6.125 sq. cm

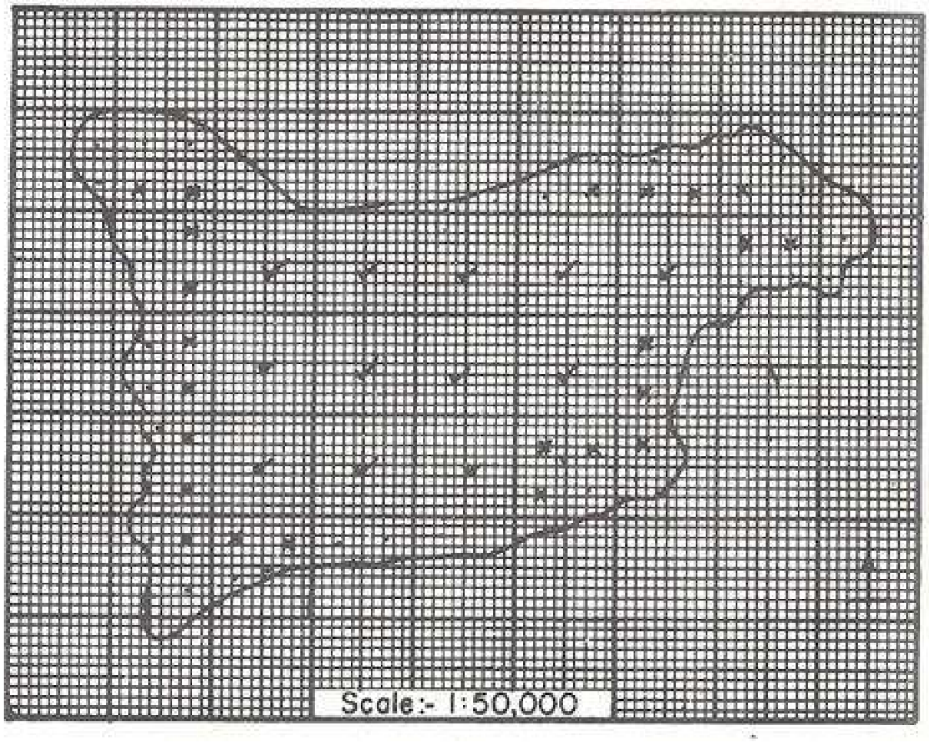

Figure 17.3: Victoria Island, Lagos. Illustrating area calculated using square method
Source: Okoye, 1977.

The total centimetres blocks of squares =23.875sq.km. Since the scale of the map is 1:50,000, 1 square centimetre on the map therefore will represent 0.25 square kilometres on the ground. The area of Victoria Island calculated is 23.875×0.25 = 5.97sq km.

b. The strip method

This method is faster than the square method but less accurate. It is done by ruling a series of parallel lines of a unit distance apart either on the face of the map or on the tracing paper with which you trace out the features you want to measure. The smaller the unit the more precise will be the measurement. To obtain the total area, multiply the total length of the strips by the width of one of the strips and then apply the map scale to determine the actual size on the ground.

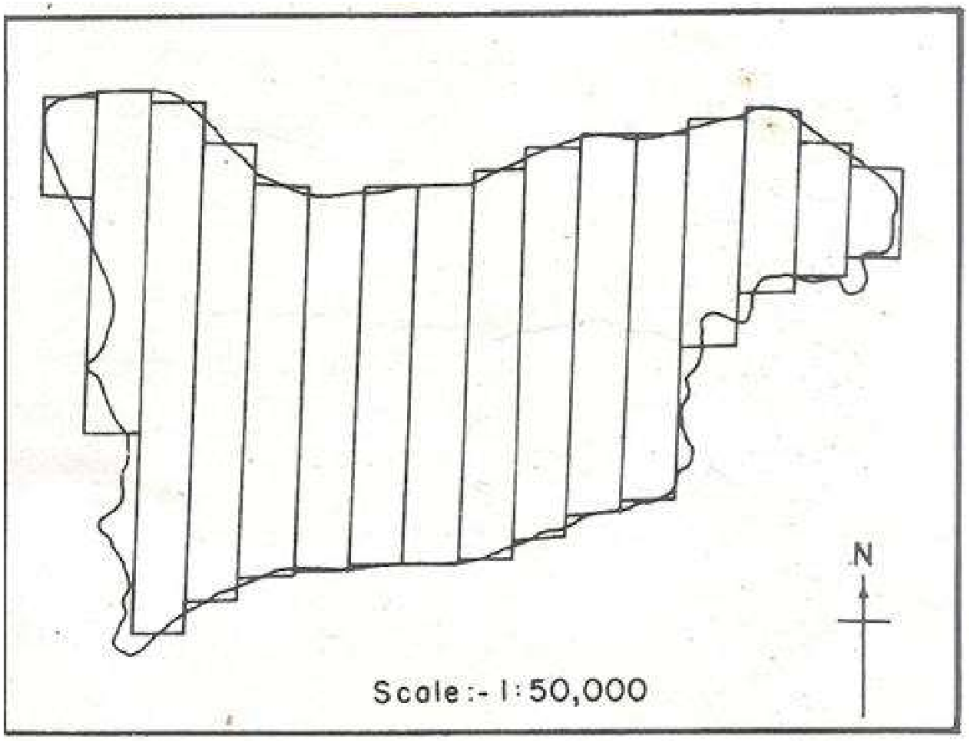

Figure 17.4: Victoria Island, Lagos. Illustrating area calculated using strip method

Source: Okoye, 1977.

The width of each strip is 0.5cm and the total length of the strips is 47.8cm. The area on the map is $47.8 \times 0.5 = 23.9$ square centimetres. Applying the scale (1:50,000) the actual distance on the ground will be

17.3 Direction and Bearing

Direction is usually determined with reference to something. On maps direction is indicated by cardinal points.

7.3.1 The cardinal points

On a map, only the direction of the north is shown others can be deduced from it. Figure 17.5 shows the cardinal points with the names of intermediate positions.

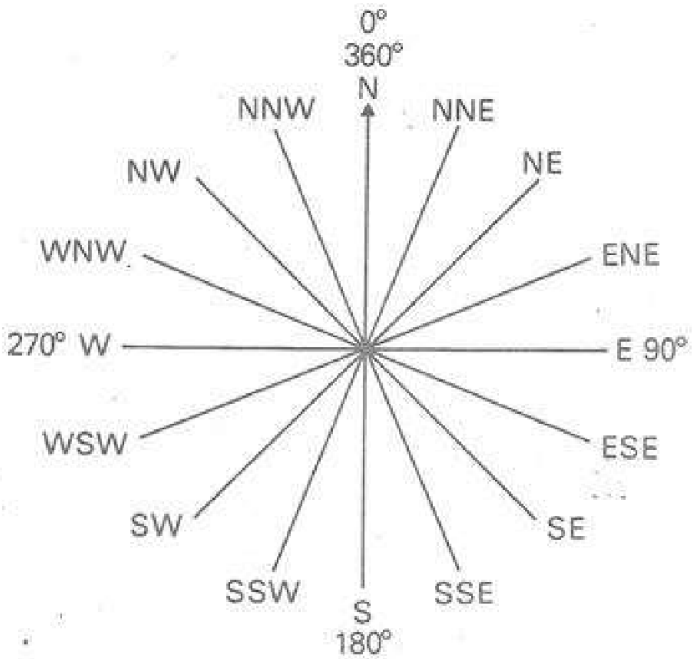

Figure 17.5: The cardinal points/Compass points.

When the sun is shining, you can easily locate the cardinal points by observing the position of the sun and the shadows. In the morning when the sun shines in the east, the shadow is cast in the opposite direction, the west. After the midday the sun moves towards the west and the shadow is cast towards the east. The time of the day can be determined by observing the position of the sun and the direction to which the shadow is cast.

17.3.2 Angular bearing

The angular bearing of a place from a point of observation is the angle which a line from the place to the observer makes with north-south line passing through the position of the observer. The angle is measured in degrees in a clockwise direction starting from the north. The angular bearing is usually measured in reference to the true north. The true north refers to the geographic north or the position of the North Pole (90^0N). A place directly east of an observer has a true bearing of 90^0 from the observer. A place directly south of the observer has a true bearing of 180^0.

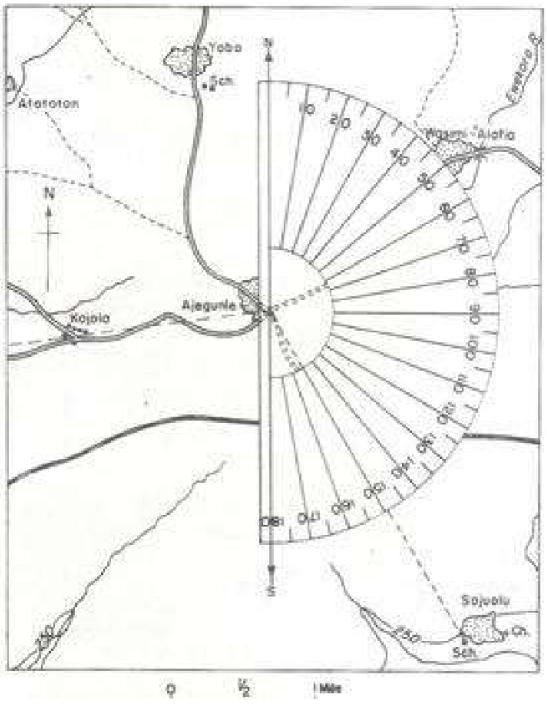

Figure 17.6: Measuring angular bearing from the map
Source: Okoye, 1977.

To find the true angular bearing of Sojuolu from Ajegunle in figure 17.6, follow the steps below:

1. Draw a true north-south line through the position of an observer at the Ajegunle cross roads.
2. Draw a line from the point of observation from Ajegunle to Sojuolu and make the line long enough to be able to measure it with the protractor.
3. Measure the angle formed by the two lines with the protractor in a clockwise direction starting from the north. The angular bearing of Sojuolu from Ajegunle is 149^0 30'.

17.3.3 Magnetic Bearing

The magnetic bearing of a place or object is the angle which a line from the object or a place to the observer makes with the magnetic north-south line passing through the position of the observer. Magnetic bearing is

usually given by the instrument used by surveyors on the field called prismatic compass. It is called magnetic bearing because the instrument is a magnetic instrument.

Figure 17.7: Prismatic Compass

The compass consists of a bar magnet mounted on the underside of a circular graduated card, which is suspended by a cap on a metal pin inside a circular box as shown in figure 17.7. On one side of the box is the peep sight containing a glass prism which magnifies and reflects the graduation on the graduated card. On the other side of the box, directly opposite the peep sight, is a vane with a hair wire in the middle. When siting an object, the compass is held in such a way that the hair wire falls in line with the object sighted and a reading is taken. Note that while using prismatic compass, do not hold or have any metal objects around. This will cause magnetic attraction that affect the reading.

Magnetic bearings are read with reference to the magnetic north. The magnetic north deviates a little bit from to the East or West of the true north depending on place and time.

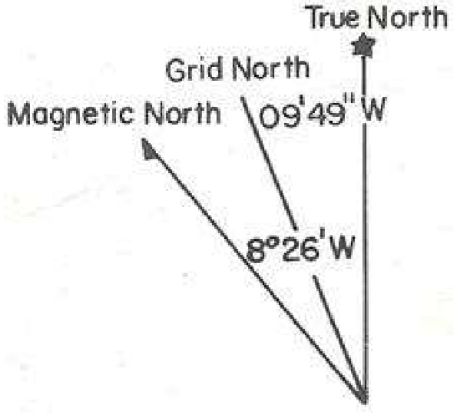

Figure 17.8: The position of Magnetic North to the west

The difference between the Magnetic North and the True North is called angle of Variation or Magnetic Variation or Magnetic Declination. The annual rate of movement of the magnetic north is known as the annual change. Conversions of the magnetic bearing into a true bearing is done by subtracting the magnetic declination from the magnetic bearing if the magnetic north is west of the true north or add if the magnetic bearing is east of the true north. You will learn more about this in your advanced level.

17.3.4 Map Reference Systems

Map reference systems refer to those several methods by which features can be quickly referred to at any part of the map. The most prominent methods used are; *i.* ***Latitude and Longitude***

Latitude of a place refers to its distance north or south of the equator measured in degrees, minutes and seconds. The lines of latitudes are called Northings. The Lines of longitudes are called Eastings can be defined as distance on the earth's surface measured in degree, minutes and second east or west of the standard meridian (longitude 0^0). The standard meridian passes through the observatory at Greenwich, London.

It is possible to locate places on the earth surface once their latitude and longitude is known. On most topographical maps the lines of longitudes are the vertical lines that run through the map, while the lines of latitude are the horizontal lines that run through the map as demonstrated in figure 17.9b

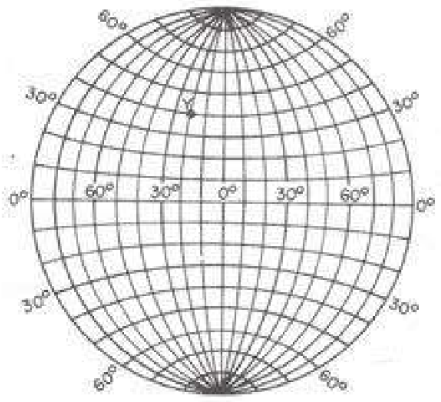

Figure 17.9a; Latitude and Longitude

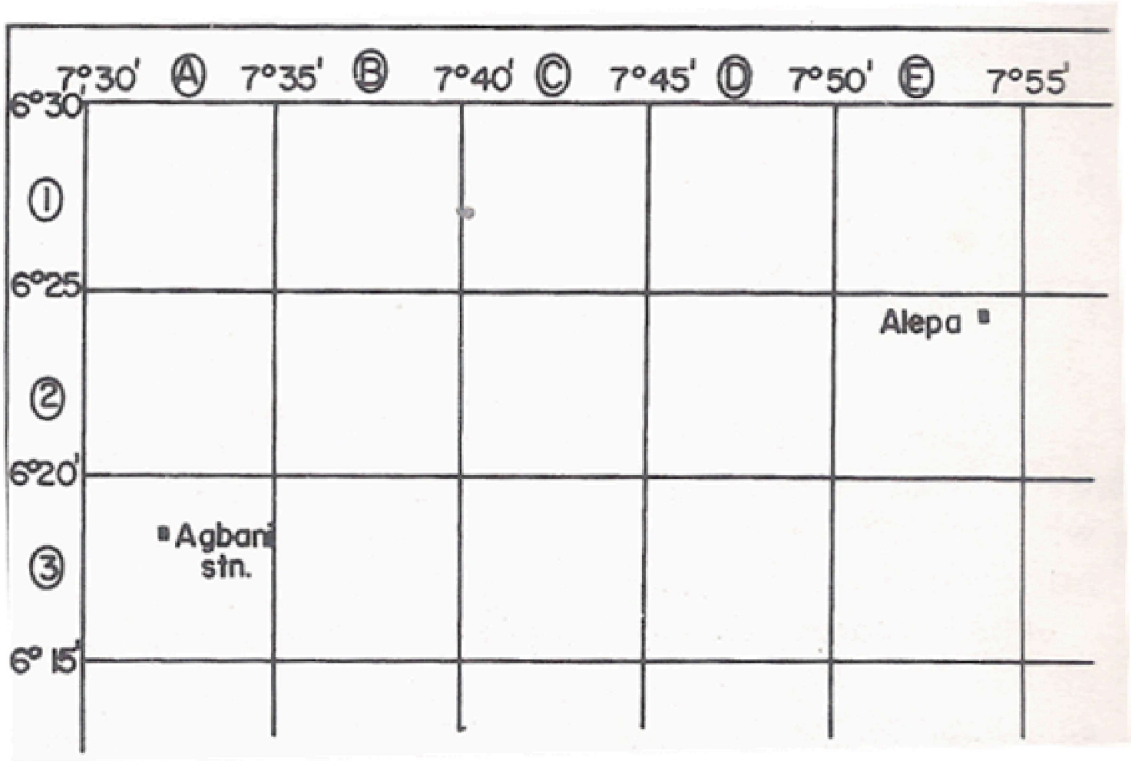

Figure 17.9b; Lines of Latitude and Longitude on a map

ii. The grid Systems

The grid system makes use of squares; it is made of a series of horizontal and vertical lines drawn on a map. These lines are not lines of latitude and longitude in reality. The space between one line and the other can be subdivided into units of ten or hundred though this is not usually shown on the map. Various systems of grid

reference can be identified; a. Four Figure Reference - The four figure reference is used to describe the approximate position of feature on the map using four figures.

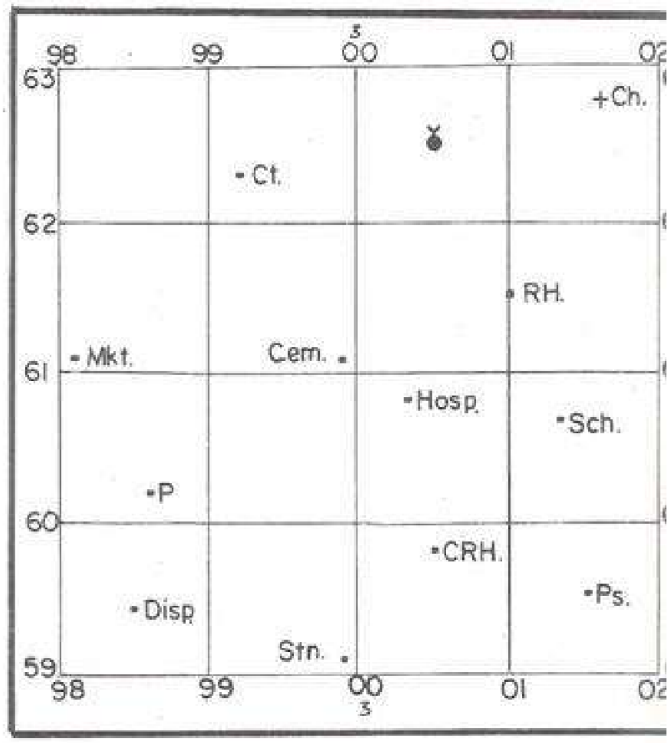

Figure 17.10; Four Figure Reference

In figure 17.10 the precise location of the market (Mkt) is 9861, the mosque location is 0062 and the location of the dispensary (Disp) is 9859.

b. Six Figure Reference –This gives a more precise location than a four figure Grid Reference. Six figures are used in this method and subdivision is into tenths. The third figure indicates the position of the object of interest as you move towards the East while the six numbers indicates the position of the object as you move towards the North. Figure 17.11 shows a six figure reference system.

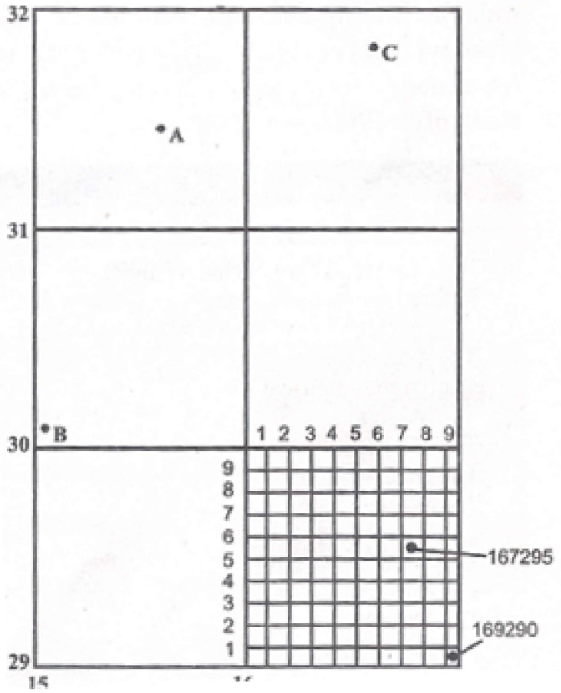

Figure 17.11: Six Figure Reference

c. Eight Figure Reference - This gives a more precise location than the first two. Eight figures are used in this method and subdivision is into hundredths.

17.3.6 Map orientation

The process of placing maps correctly on the field so that the north on the map corresponds to the north on the ground is referred to as map orientation. This is an important step to take first when on the field using map. Four important methods can be used to orient map on the field and these include; i. Making use of celestial bodies particularly the position of the star and the sun to determine the position of the true north.

ii. By using compass. The compass is placed on the flat map on the ground and the map is turn around till it aligns with the position of the north as indicated by the compass.

iii. Comparison with a prominent linear feature and iv. By the use of features easily identified on the map and on the ground.

Summary

In this chapter, you have learnt that; · It is possible to determine the distances between two points on any given map · The actual size of an object on the ground can be determined from the map by square method and strip method using the scale of the map.

- Direction and bearing can be determined using angular bearing, magnetic bearing, latitude and longitude.
- The grid system is designed to make the location of places and features on the earth surface possible and convenient. Four figure, six figure and eight figure reference systems can be used.
- The knowledge of how to set out map on the field is called map orientation. It is the first step to take when using map on the field.

Revision Questions

Use the map provided to answer questions 1-5

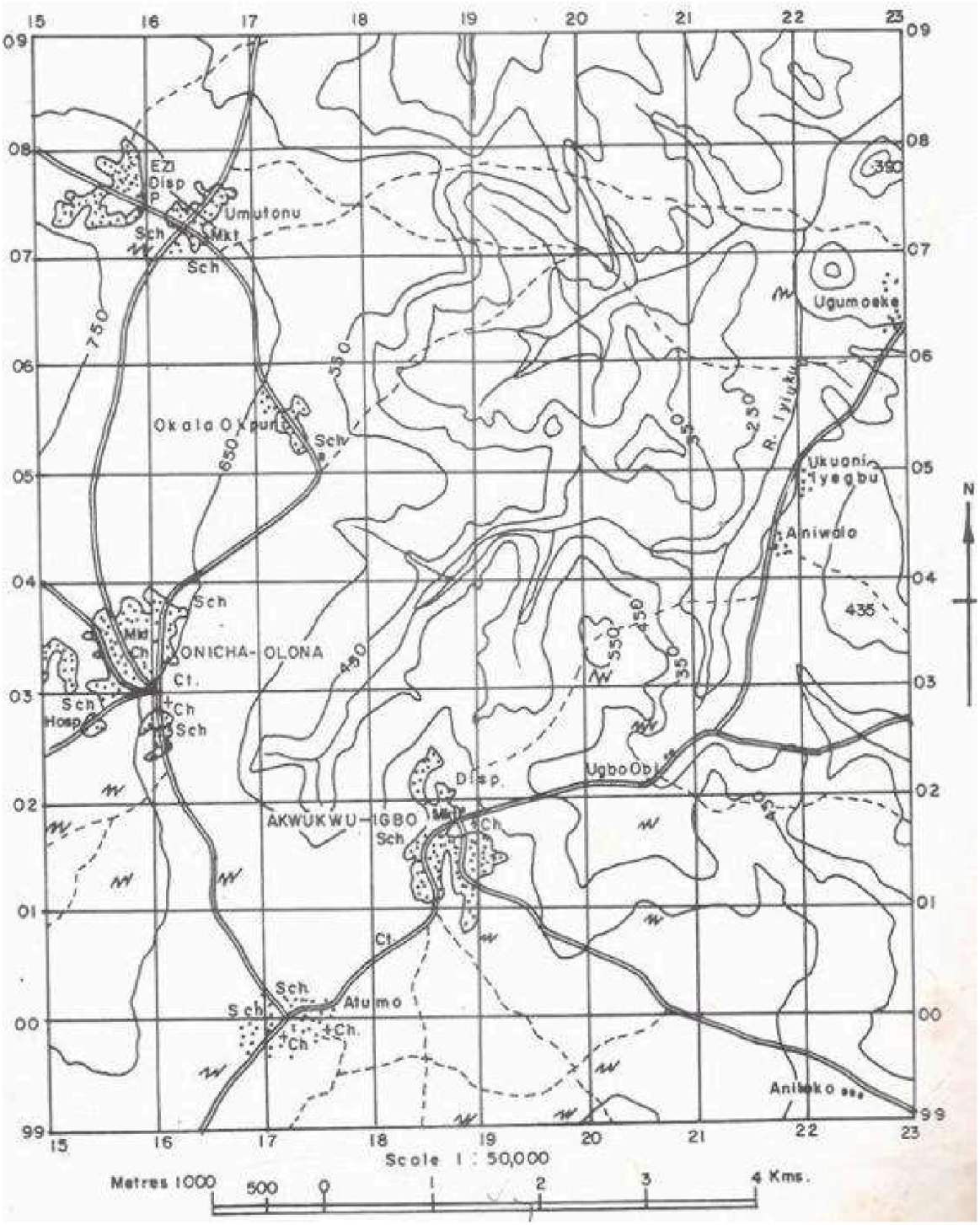

Figure 17.12: Extract from Onitsha N.W Sheet.

Sourse, Okoye, 1977.

1. The distance between Umutonu and Ukuani Iyagbu as the crow flies is; A. 5km B. 15km C. 10km D. 10.1km.

2. The length of the road from Akwukwu-Igbo to Aniboko is approximately; A. 5.0km B. 5.2km C. 10.3km D. 10.0km 3. If the total areas of Onicha-Olona settlement is 15 square centimetres on the map what is the actual area on the ground A. 2.75 sq km B. 5.75 sq km C. 4.3 sq km D. 3.75 sq km 4. What is the direction of Ukuani Iyagbu from Akwukwu-Igbo A. South-West B. North-West C. South-East D. North-East 5. What is the precise location of Ugumoeke using four figure reference; A. 2308

   B. 2208

   C. 0807

   D. 2207

6. The True North refers to; A. The Magnetic North B. The Angular North C. The Geographic North D. The Position of the Sun 7. The difference between the Magnetic North and the True North is called; A.

Magnetic Declination B. Annual change C. Magnetic Bearing D. Magnetic change 8. The standard meridian is; A. Longitude 90^0

B. Longitude 60^0

C. Longitude 0^0

D. Longitude 30^0

9. Lines of latitudes are called; A. Northings B. Eastings C. Westings D. Southings 10. Which of this is not a method of setting map on the field; A. Making use of celestial bodies.

B. By using compass.

C. Comparison with a prominent linear feature.

D. Methods of overlay

Answer

1. A 2. B 3. D 4. D 5. B 6. C 7. A 8. C 9. A 10. D

Practical and Essay Questions

From the map in figure 17.12; 1. Determine the bearing of Aniwalo from Umutonu.

2. Find the six figure reference for the school at Umutonu.

3. Calculate the length of all roads on the map.

4. What advantages do you think six figure reference has over four figure reference.

5. Discuss the method of setting map on the field.