The map code e.g. 3226 AB: Tarkastad is the official title, which is used when ordering copies.

The numbers represent the latitude and longitude of the grid square of which the map forms a part.
Each grid represents 1° x 1°.
The grid square is divided into four quadrants, A, B, C and D.
The first letter gives the position of the quadrant in the grid.
Each quadrant is divided into four sub-divisions, A, B, C and D.
The second letter gives the position of the map in the quadrant.

The Tarkastad Topographical map code is 3226 AB
This code can be broken down as follows:

32 = 32° Latitude South (SA is south of the equator)
26 = 26° Longitude East (SA is east of the Greenwich Meridian)
A = Quadrant A
B = Line block B in quadrant A

The sketch below illustrates the position of Tarkastad.
2. **SCALE**

The scale of the map is used to convert distances on the map to distances in reality.

Scale can be given in three ways:
- Statement or word
- Representative fraction
- Line scale

Remember that on the Orthophoto and Topographical map that two types of scale are evident, the representative fraction and the linear scale.

A **Large Scale** is used if the map shows a small area, e.g. 1:10 000 Orthophoto map (1 unit on the map represents 10 000 units in real life). Lots of detail can be seen on the map.

A **Small Scale** is used to draw a map of a large area, e.g. 1: 50 000 Topographical map (1 unit on the map represents 50 000 units in real life). Not much detail can be shown, as the map represents a vast area.

To help you, remember the following:

<table>
<thead>
<tr>
<th>Scale</th>
<th>Linear Scale</th>
<th>Representative Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:50 000</td>
<td>1 cm represents 50 000 cm</td>
<td>1 cm represents 500 m</td>
</tr>
<tr>
<td>1:10 000</td>
<td>1 cm represents 10 000 cm</td>
<td>1 cm represents 100 m</td>
</tr>
</tbody>
</table>

3. **DISTANCE**

Calculating straight line distance on the Topographical map.

Example

Calculate the length of the landing strip in blocks B3 and B4 on Topographical map 1.

$$\text{SLD} = \text{MD} \times \text{Scale}$$
$$= 2,2 \text{ cm} \times 0,5 \text{ (scale of topographical map)}$$
$$= 1,1 \text{ Km}$$

Calculating the straight line distance on the Orthophoto.

Example

Calculate the straight line distance of the landing strip F1 on the Orthophoto map 1.

$$\text{SLD} = \text{MD} \times \text{Scale}$$
$$= 2,2 \text{ cm} \times 0,1 \text{ (scale of orthophoto map)}$$
$$= 0,22 \text{ Km}$$

Use a ruler for straight line distance and a piece of string for curved distances.
Always remember the golden rule to convert the map distance measured on your map to the actual ground distance before multiplying.

A rectangular area or square is found by multiplying length $\times$ breadth.

Example
Calculate the area of block A1 from Topographical map 1

$$A = L \times B$$

$$= (1.8 \text{ cm} \times 0.5) \times (1.8 \text{ cm} \times 0.5)$$

$$= 0.9 \text{ km} \times 0.9 \text{ km}$$

$$= 0.81 \text{ km}^2$$

A triangular area is found by multiplying length $\times$ half the breadth.

$$A = L \times \frac{1}{2} B$$

Remember that whether you are asked to give your answer in square m ($\text{m}^2$) multiply your answer in Km by 1000 e.g. $0.81 \text{ Km} \times 1000 = 810 \text{ m}$.

1 square km = 100 hectares
1 hectare = 100 m $\times$ 100 m

5. **SPEED, DISTANCE AND TIME**

In order to do these calculations, you must remember that:

- Time = distance / speed or
- Speed = Distance / time or
- Distance = speed $\times$ time

Example from Topographical map 1.
How long will it take a car traveling at 60 Km per hour to drive from the center of Tarkastad along the R 344, in a SE direction, to where the secondary road meets the R 344?

We know the speed is 60 Km per hour, we need to calculate the curved distance first before using the formula.

The curved distance is approximately 17 cm = 8.5 Km

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

$$= \frac{8.5 \text{ Km}}{60 \text{ Km/h}}$$

$$= 0.142 \text{ of an hour}$$

$$= 0.142 \times 60$$

$$= 8.52 \text{ minutes}$$
You must know the 16 cardinal points of the compass. The most important word in direction is 'from,' whatever comes after the word 'from' is where you draw your North/South line and then join the other point to the N/S line and work out your direction.

True North is the top of the 1:50,000 map sheet.

Magnetic North is where the compass needle points.

7. MAGNETIC DECLINATION

Magnetic declination is the angle between the True North and Magnetic North. This angle changes over time, as Magnetic North is not constant. You must be able to calculate the Magnetic North for a specific year.

The following information is given on a 1:50,000 map:

- MD is 23° 46' W of TN (2001)
- Annual change is 4' westwards

Remember the following:
- $1° = 60'$
- If the Magnetic North moves eastwards, subtract the total change from the declination given.
- If the Magnetic North moves westwards, add the total change to the declination given.
- The formula for calculating the Present Magnetic Declination is: 
  \[ \text{MD} = \text{MD given} \pm (\text{difference in years} \times \text{annual change}) \]
Example:
Calculate the magnetic declination for 2007 using the information below.
MD is 23° 46' W of TN (2001) Annual change is 4' westwards.
Note that the Magnetic North moves West, so we add the difference in years \times the annual change.

\[
\begin{align*}
\text{MD 2007} & = \text{MD} + (\text{difference in years} \times \text{Annual change}) \\
& = 23° 46' W + (6 \times 4') \\
& = 23° 46' W + 24' \\
& = 23° 70' W \\
& = 24° 10' W
\end{align*}
\]
Remember that \(1° = 60',\) so 23° changes to 24° and we have a balance of 10'.

8. **TRUE BEARING**

Follow these steps to calculate true bearing:
- Note from where the bearing is to be taken, whatever comes after the word from is where you draw your True North Line.
- Join the two points.
- Place your protractor along the True North Line, with 0° at the top.
- Always measure in a clockwise direction.
- Remember when bearing is to the right your answer is below 180° and when bearing is to your left you add 180° to your answer.

9. **MAGNETIC BEARING** 23° 12'

To calculate the magnetic bearing you need to calculate the true bearing and then add on the magnetic declination.

10. **ALTITUDE/HEIGHT**

Altitude is indicated on a topographical map in four ways: spot heights, trigonometrical (trig) beacons, bench marks and contour lines. The unit of measurement for altitude is meters (m).

<table>
<thead>
<tr>
<th>Spot heights</th>
<th>642</th>
<th>894</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigonometrical beacons</td>
<td>1,454</td>
<td>2,210</td>
</tr>
<tr>
<td>Bench marks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contour lines</td>
<td>690.4</td>
<td></td>
</tr>
</tbody>
</table>
To calculate the difference in height between two places you determine the heights and subtract.

E.g. Refer to Topographical map 1 and calculate the difference in height between TB 122 (N3) and spot height 1303 (B3).

\[ \text{DIH} = 1620.1 \text{ m} - 1303 \text{ m} = 317.1 \text{ m} \]

10.1. **CONTOURS**

These are lines drawn on the map joining places of equal height above sea level. Contour lines never cross one another. If the contour lines are close together it represents a steep area. If the contour lines are far apart it represents a gentle area. If the railway lines are straight it means the area is flat and if the railway lines are wavy it means the area is steep.

10.2. **SLOPES**

- **Gentle slope**
- **Steep slope**
- **Uniform slope**
- **Terraced slope**
- **Concave slope**
- **Convex slope**
- **Scarp and dip slope**
Homoclinal ridges
This is a ridge that has one steep side and one shallow side.

This means that one side of the ridge rises slowly. A shallow gradient—contour lines are far apart—Sec A of diag above.
10.4. INTERVISIBILITY

If two points are intervisible, they can be seen from each other. To determine intervisibility, you need to construct a rough cross section.

In the sketch below point A is not visible from point B and vice versa.

There is no intervisibility if there is higher ground between the points. A hill with a concave slope has intervisibility between the top and the bottom. If the slope is convex there is no intervisibility.

10.5. GRADIENT

Gradient is the relationship between:
How high you have climbed (Vertical) and How far you have walked (Horizontal)
It gives the slope of the land.

The formula for gradient is \( G = \frac{\text{Vertical Interval}}{\text{Horizontal equivalent}} \)
Therefore you need to have two measurements before you can calculate gradient:
1. Difference in height between the two points.
2. The straight line distance between the two points.

Remember to make sure that both measurements are in the same unit of measurement in meters.

Example from Topographical map 1.
Calculate the average gradient between points \( X \) and \( Y \)?

\[
G = \frac{VI}{HE} \\
VI = 1420 \text{ m} - 1340 \text{ m} = 80 \text{ m} \\
HE = 6.4 \text{ cm} \times 0.5 = 2.7 \text{ Km} \times 1000 \text{ (To convert to m)} = 2700 \text{ m} \\
G = \frac{80 \text{ m}}{2700 \text{ m}} = \frac{1}{33.75} \\
G = 0.03 \text{ (or 3.0%)}
\]

This means that for every 33.75 meters you travel along the ground the height increases by 1 meter.
10.6. **VERTICAL EXAGGERATION**

It is the amount by which the vertical scale of a cross section is bigger than the map scale.

Vertical exaggeration (VE) is calculated in order to illustrate the difference between the vertical and horizontal components of a cross section.

Remember the following formula:

\[
VE = \frac{\text{Vertical scale}}{\text{Horizontal scale}}
\]

Both the numerator and the denominator must be in m.

Example:

Calculate the vertical exaggeration if the vertical scale is 1 cm represents 20 m and the horizontal scale is 1 cm represents 50 000.

\[
VE = \frac{\text{Vertical scale}}{\text{Horizontal scale}} = \frac{1 \text{ cm} \text{ rep } 20 \text{ m}}{1 \text{ cm} \text{ rep } 50 000 \text{ cm}} = \frac{1:20 \text{ m}}{1:500 \text{ m}} = \frac{1 \text{ cm}}{20 \text{ m}} \times \frac{500 \text{ m}}{1} = 25 \text{ times}
\]
11. DRAINAGE

11.1. DIRECTION OF RIVER FLOW

The following gives an indication of river flow:
- The heights along the river. A river always flows from a high lying area to a low-lying area.
- The tributaries always join the main river at acute angles in the direction of flow.
- Check the shape of the contour lines along the river, as the 'V' shape points upstream.
- Dam walls are on the downward side of the river.

The sketch below illustrates the criteria in determining the direction of river flow.

![Diagram showing direction of river flow](image)

11.2. TYPE OF RAINFALL

The presence of many non-perennial streams, many dams, windmills, furrows, reservoirs, water towers and the absence of natural vegetation indicates seasonal (non-perennial rainfall).

The presence of many perennial streams and natural vegetation and the absence of dams, windmills, furrows, reservoirs, water towers indicates perennial rainfall.

11.3. TYPE OF RIVER

Rivers can be perennial or non-perennial and this is indicated by the key on the reference.
Example:

- It is a side view or profile across a landscape.

Cross section between A and B

---

Rough cross-section

Practicing to draw accurate cross-sections will prepare you to draw rough cross-sections.

The following are important points to consider:

- Heights of the contour lines (note the highest and lowest points)
12. **CO-ORDINATES / GRID REFERENCE**

Grid references are used to give exact locations of particular places on a map. In order to be accurate as possible, degrees of latitude and longitude are subdivided into minutes and seconds.

1 degree (1°) = 60 minutes (60') and 1 minute (1') = 60 seconds (60")

When using grid references latitude is always given first. On the 1:50 000 SA topographical map series, the grids on the borders of the sheets indicates degrees and minutes.

**E.G. 1.** Give the co-ordinates for the reservoir in B2.

1. You first have to give the co-ordinates for the letter B which is 28° 33' S; you leave space to work out the seconds south last.

2. You then give the co-ordinates for the number 2 which is 27° 46' E; you leave space to work out the seconds east last.

3. You now have the following

   28° 33' S; 27° 46' E

   This gives you the alphabet which is B

   12

   This gives you the letter which is 2
- Arrangement of contour lines (i.e. where they are close together – steep slope, and where they are far apart – gentle slope)
- The distance between contour lines.

Activity

Draw cross profiles for each of the diagrams below.

1. Draw a cross-section from A to B.
2. Calculate the VE for this cross-section.
3. Calculate the gradient from C to D.
E.G. 2: What is found at the following co-ordinates

1. The degrees and minutes South 28° 34' gives you the letter C and the degrees and minutes East 27° 47' gives you the number 3.

2. Now that you know which block to look at C3 we refer to this block only.
   Remember that each block is 60 seconds long and 60 seconds wide.
   You then divide the block in 4 quarters of 15 seconds each in a southerly and then easterly direction.

3. We require 15° S, so we mark off a line across the block at 15° S (a).

4. We require 45° E, so mark off a line vertically across the block at 45° E (b).

5. Where these two lines intersect state what is found at that point on the map – excavation.
4. Once you have the block which is B2, you can calculate the seconds south and east.

5. For the seconds south:

5.1. Measure from the start of the block to the exact point R in a southerly direction (a) in mm.
5.2. Then divide by the length of the block in mm (b).
5.3. Multiply your answer by 60 and insert your answer in the seconds south co-ordinates.

\[
\begin{align*}
\text{e.g.} & \quad \frac{20\text{mm} \ (a)}{25\text{mm} \ (b)} \times 60 \\
& = \ 0.8 \times 60 \\
& = \ \text{48 seconds}
\end{align*}
\]

28° 33' 48" S;

6. For the seconds east:

6.1. Measure from the start of the block to the exact point R in an easterly direction (c) in mm.
6.2. Then divide by the width of the block in mm (d).
6.3. Multiply your answer by 60 and insert your answer in the seconds east co-ordinates.

\[
\begin{align*}
\text{e.g.} & \quad \frac{15\text{mm} \ (c)}{23\text{mm} \ (d)} \times 60 \\
& = \ 0.652 \times 60 \\
& = \ \text{39 seconds}
\end{align*}
\]

28° 33' 48" S; 27° 46' 39" E
DETERMINING THE TIME THE ORTHOPHOTO WAS TAKEN

In the southern hemisphere the shadow of objects always falls to the south. The angle of the shadow southeast or southwest will give us an idea of the time the photo was taken.

If the shadow is in the SW it means that the sun is in the East which makes it the morning.
If the shadow is in the SE it means that the sun is in the West which makes it the afternoon.

IDENTIFYING FEATURES ON AN ORTHOPHOTO MAP

<table>
<thead>
<tr>
<th>Size and Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>The size of an object can help us to determine what it may be. For example, size will help us to identify single dwellings or houses, shopping centres and factories.</td>
</tr>
<tr>
<td>Regular or even shapes are usually associated with human-made objects such as buildings and roads, whereas shapes in nature are usually irregular or uneven, such as rivers, mountains and vegetation.</td>
</tr>
<tr>
<td>By looking at the size and shape of an object together we can identify what it is. Roads may be broader than railway lines and may have sharp turns which railway lines will not have.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tones and Shades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rough surfaces usually appear darker than smooth surfaces, for example, long grass will be darker than short grass.</td>
</tr>
<tr>
<td>Water surfaces may reflect light if the sun is shining on them and may appear lighter in colour.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Textures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Look for smooth or rough textures and use this to help you identify features on the photograph.</td>
</tr>
<tr>
<td>A plantation forest will have a different texture to an indigenous forest.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shadows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objects will cast shadows in a photograph.</td>
</tr>
<tr>
<td>Shadows will help you to identify tall buildings, telephone poles, chimney stacks, etc.</td>
</tr>
<tr>
<td>Shadows from mountains can also give a sense of height on an aerial photograph, as shadows from mountains fall to the outside of the feature.</td>
</tr>
<tr>
<td>If the shadow falls to the inside of a feature then this is a valley or a depression.</td>
</tr>
<tr>
<td>Shadows also help you to identify the time of day the photograph was taken. In the southern hemisphere shadows fall to the south-west of an object before midday and they fall to the south-east of the object after midday.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>The pattern of a plantation will be different from the pattern of a vineyard. Trees are planted individually while vines are connected to each other.</td>
</tr>
<tr>
<td>The arrangement of streets and buildings in relation to each other tell us about patterns of urban settlement.</td>
</tr>
<tr>
<td>Patterns of streams in river systems tell us about rock types. Softer rock usually causes a regular branching of streams and faulting in the rock structure causes stream patterns to be more angular.</td>
</tr>
</tbody>
</table>
Geomorphology

Drainage patterns help us to interpret underlying rock structures.

Direction of river flow:
- Check spot heights.
- Check the angle at which the tributary joins the trunk stream. (A river cannot flow uphill.)
- Check the shape of the contour lines, as the V-shape points upstream.
- Dam walls are on the downstream side of the dam.

Rivers usually take the direct route over steep relief, but the railway lines follow the contour path and zigzag up the hill.

Contour patterns reveal features. They give us a clue as to the area of study and whether rejuvenation has occurred.

You are also asked to draw or recognize the profile of the land by looking at contours.

An elbow of capture indicates if and where river capture has taken place.

(You are not expected to know marine geomorphology in detail, but you should remember from your Grade 11 syllabus the formation of sandbars, spits, pocket beaches and tombolas, and have an understanding of littoral drift and wave refraction.)
1. **Slopes**
   - Any piece of land that is not level has what we call a slope.

   Note: When reading a contour diagram to identify a slope or landform always read from the lowest contour line towards the highest.

**Slope types**

1. **Gentle slope:** contour lines are far apart

   ![Gentle slope diagram](image1)

2. **Steep slope:** contour lines are close together

   ![Steep slope diagram](image2)

3. **Concave slope:** Refers to a slope that is steep at the top and gentle at the bottom.

   ![Concave slope diagram](image3)
5. Stepped slope
Contour lines are found in pairs.

Slip-off and undercut slope
Located on the bend of a meander. The undercut slope is on the steep outer bend of the meander and the slip-off slope is on the gentle inner bend of the meander.

2. Landforms

A plateau is a high lying land that has a flat or nearly flat surface. It has steep slopes.
<table>
<thead>
<tr>
<th><strong>Valley</strong></th>
<th><strong>Spur</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Indicated by ‘V’ shaped contour lines. &lt;br&gt; - It is a low area of ground usually cut by a river or stream between areas of higher ground. &lt;br&gt; - The lowest contour lines are on the inside of the V.</td>
<td>- Indicated by ‘V’ shaped contour lines &lt;br&gt; - It is the wedge of land between two valleys. &lt;br&gt; - The highest contour lines are on the inside.</td>
</tr>
</tbody>
</table>

**Hill/Mountain**

- These are high land areas rising above the surrounding lands. <br> Unlike hills, mountains rise above 300m

**Waterfall**

- Occurs when a river flows over resistant rock and drops down into a plunge pool. <br> It is depicted when 2 or more contour lines meet at a point.
Saddles and Passes

- Land that is between two mountain peaks or hills is known as a saddle/col.
- If the connecting strip of land is used as a transport route it is termed a pass.
- If the connecting strip of land has a river flowing through it, it is termed a poort.

Ridge (watershed)

A high lying area. When it separates drainage basins it is called a watershed.

Homoclinal ridge

A homoclinal ridge has a steep and gentle slope.

Mesa
A mesa is a flat topped mountain that has steep sides and is capped by a hard layer of rock. Has all 4 slope elements.

Butte

Forms when a mesa is further eroded. The diameter of the top is smaller than the height.

Activity

Identify the landforms below.
<table>
<thead>
<tr>
<th>Pattern</th>
<th>Description</th>
<th>Underlying rock structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dendritic</td>
<td>Resembles the branch of a tree. Tributaries join the main river at acute angles</td>
<td>Occurs on rocks that have uniform resistance to erosion. Occurs in horizontal sedimentary rocks, massive igneous rocks or metamorphic rocks</td>
</tr>
<tr>
<td>Rectangular</td>
<td>The main streams are parallel to each other. Short tributaries join the main river at right angles. Tributaries often flow from gaps or pools.</td>
<td>Forms on rocks which have varying resistance to erosion. Found in folded mountain regions and areas of inclined strata. Associated with sedimentary rocks which have alternate layers of hard and soft rock.</td>
</tr>
<tr>
<td>Treliss</td>
<td>The main streams have 90° bends along its course. The tributaries join the main stream at 90°.</td>
<td>Forms on igneous rocks that have many joints. Also forms in horizontal sedimentary rocks with many joints and faults.</td>
</tr>
<tr>
<td>Radial centrifugal</td>
<td>Rivers flow away from a central point such as a volcano or a dome. It resembles the spokes of a wheel.</td>
<td>It forms in areas where domes and volcanoes occur. It is associated with massive igneous rocks.</td>
</tr>
<tr>
<td>Radial centripetal</td>
<td>Rivers flow towards a central point or depression. The central point could be a lake, a pan or a basin.</td>
<td>Associated with massive igneous rocks.</td>
</tr>
<tr>
<td></td>
<td>It has a haphazard pattern. There are many lakes and swamps. Developing from the</td>
<td>It forms in areas that have been recently exposed or formed (geologically young).</td>
</tr>
</tbody>
</table>

Trellis patterns occur on rocks that have a uniform resistance to erosion. Occurs in horizontal sedimentary rocks, massive igneous rocks or metamorphic rocks.
Settlement Patterns (Shape)

The following basic settlement patterns can be identified:

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Dispersed</td>
<td>(Houses or farms are far apart or scattered (isolated))</td>
</tr>
<tr>
<td></td>
<td>Advantages:</td>
</tr>
<tr>
<td></td>
<td>- Farmers are independent and can experiment with modern methods and equipment</td>
</tr>
<tr>
<td></td>
<td>- Dispersed farmsteads make larger profits.</td>
</tr>
<tr>
<td></td>
<td>- Lots of privacy</td>
</tr>
<tr>
<td></td>
<td>Disadvantages:</td>
</tr>
<tr>
<td></td>
<td>- Lack of social contact and a security risk.</td>
</tr>
<tr>
<td></td>
<td>- These farms require large amounts of capital to be sustained.</td>
</tr>
<tr>
<td></td>
<td>- Basic services such as schooling is far away.</td>
</tr>
<tr>
<td>2 Nucleated</td>
<td>Advantages:</td>
</tr>
<tr>
<td></td>
<td>- Sharing of farming equipment and ideas.</td>
</tr>
<tr>
<td></td>
<td>- Communal activities (social advantage).</td>
</tr>
<tr>
<td></td>
<td>- Safety advantage because of larger numbers.</td>
</tr>
<tr>
<td></td>
<td>Disadvantages:</td>
</tr>
<tr>
<td></td>
<td>- Lack of privacy</td>
</tr>
<tr>
<td></td>
<td>- Small profits</td>
</tr>
<tr>
<td></td>
<td>- Time wastage should the farmer have fragmented plots of land.</td>
</tr>
<tr>
<td>3 Linear/ribbon development</td>
<td>Houses are in a line along a road, river or in a valley</td>
</tr>
<tr>
<td></td>
<td>- Individual farmsteads (elongated, rectangular) in this pattern tend to have small frontages to gain direct access to the road or river.</td>
</tr>
<tr>
<td>4 Planned (circular or square)</td>
<td>Masal kraal (Kenya)</td>
</tr>
<tr>
<td></td>
<td>- Houses are grouped around a market square, church, water, village green or around animals to protect them, e.g. the Masal kraal or traditional Zulu village.</td>
</tr>
</tbody>
</table>
D. Planned/ Irregular

- It is a feature of new urban developments.
- It ensures a smooth flow of traffic, e.g., Sasolburg.
- Saves fuel and travelling time.
- Outer ring roads are common features of this pattern.
- Characteristic of hilly relief.

Urban Settlements

Functions found in urban areas

- It is represented in shades of grey on the topographic map.
- Certain buildings such as factories, shopping centres, schools, hospitals, etc., are depicted by means of black geometric shapes (regular or irregular).
- Some urban settlements are called central places when they provide goods and services to the surrounding rural population.
The influence of the Dutch and British settlers can be clearly seen on South African streets.
- The Dutch usually laid out a grid pattern which is a criss-cross network of streets that consists of rectangular blocks, e.g. Vryheid.
- The British settler on the other hand set out a varied network of curved streets with roads converging at the centre (spider web), e.g. Queenstown.

Urban settlements have a combination of different street patterns. The following basic street patterns can generally be identified:

### A. Grid Iron
- Streets intersect at right angles and are parallel to each other.
- Easy to plan and layout on land that is flat or gently sloping.
- Easy to subdivide into smaller plots.
- The regular shaped plots make building easy.
- Hampers traffic flow because it has too many stops (intersections).
- Does not work on steep land as roads may be too steep in some parts.
- Associated with old settlements or indicates the oldest part of a settlement, e.g. central Johannesburg.

### B. Radial/spider web
- Dates back to a time when European cities built walls around the city for security reasons, e.g. Paris.
- Roads radiate away from a central point and are joined by ring roads.
- Results in traffic congestion at the centre.
- Example: Queenstown in South Africa.

### C. Unplanned/irregular
- It has a maze of streets with no apparent order.
- No focal point.
- It is associated with broken relief, e.g. Windhoek.
Crossroads settlements develop from the different ways in which the roads meet. Accessibility to transport is the main reason for settlements developing. Crossroads settlements can be T shaped, cross shaped or star shaped. A settlement resembles a star or stellar shape when development takes place along roads that radiate in different directions away from a central point. Note that as a settlement grows, growth cannot take place indefinitely along the roads. The gaps between the roads fill with development changing the shape to circular eventually.

Settlements that are located along the coast generally assume a semi-circular shape because the sea is a physical barrier to expansion.

Function of a settlement

The main factor that is used to differentiate between rural and urban settlements is its function.
INTRODUCTION TO GIS

Geography is dependant on information about people, places, the environment and the interaction thereof. GIS is computer representations of some aspects of the real world. GIS software can store and use data describing places on the earth's surface. It is used as a tool in decision making.

HOW GIS WORKS?

It is not just a computer system for making maps. It is a tool which allows you to store a representation of the world in thematic layers.

Representations of the world's features on layers.
Set of geographical data stacked on top of one another.
You can overlay these desired layers and ask questions that display relationships across layers.
PROCESS OF WORKING WITH GIS

For a GIS to work geographical data needs to be entered into the computer, stored in files or databases, manipulated using GIS functions and presented in the form of maps, tables and graphs for decision makers.

COMPONENTS OF GIS

The user manipulates the computer, which engages the software, to work on the data.
1. GIS
A collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate, analyse and display all forms of geographically referenced data.

2. SYSTEM
Any collection of component elements that work together to form a task.

3. INFORMATION SYSTEM
A computer programme that is used to handle geographic information/data.

4. REMOTE SENSING
Any method used to obtain information about an object or area from a distance; mainly by using aircrafts and satellites.

**ADVANTAGES OF REMOTE SENSING**
1. Covers large areas.
2. Data can be collected from inaccessible areas.
3. Image quality is consistent.
4. Observations can be made over a period of time.

5. GENERALISATION
It is a method of grouping objects in terms of similar characteristics under a common name. Eg wheat, sugar cane can be grouped under agricultural products.

6. ABSTRACTION
The process of selecting the most relevant information and leaving out unnecessary information.

7. ENTITY
It is anything for which we can capture and store data.

8. SPATIAL OBJECTS
Refer to buildings, roads, railways, rivers, mountains, settlements etc. found in a particular landscape. Spatial objects may be defined as points, lines and area.

9. POINT
A single co-ordinate used to describe the location of an object too small to be represented as a polygon or area feature.

10. LINE
A line connects two points, such as a road, river, railway line, power line etc.

11. NODE
Represents the beginning or the end point of a line.
12. POLYGON/AREA
It is a two dimensional object; it includes the perimeter of an object.

13. SPATIAL INFORMATION
Data that is accurately linked to a point, a line or an area on the surface of the earth.

14. SPATIAL RESOLUTION
The smallest area on the ground for which the satellite sensor can register a reading.

15. SPECTRAL RESOLUTION
Refers to the sensitivity of the sensor for detecting reflection in different spectral bands.

16. DATA
A collection of information of a specific topic or area.

17. PRIMARY DATA
Data that is obtained from fieldwork, e.g. collection of soil and rock samples, recording rainfall and temperature.

18. SECONDARY DATA
Data that is obtained from other sources, e.g. textbooks, reference books, magazines, Censuses etc.

19. DATA ANALYSIS
The processing of data to extract useful information and relevant patterns. Data can be analyzed to produce charts and graphs.

20. DATA PROSECCING
The analysis and organization of data by using one or more computer programmes.

21. DATABASE
Any collection of data organized in a computer and designed for easy access. Data may be in the form of text, numbers or graphics.

22. SPATIAL DATA
Data that is linked to a specific location.

23. ATTRIBUTE DATA
Data that is descriptive.

24. VECTOR DATA
The real world is shown by means of points, lines and polygons.

25. RASTER DATA
Features are shown by means of pixels.

26. DATA MANAGEMENT
It is the consolidation of data in a manner that is easy to access, manage and maintain.
27. **DATA MANIPULATION AND ANALYSIS**
   The usage of data to make certain decisions.

28. **DATA INTEGRATION**
   The process of combining different types of data on a single map.

29. **DATA STANDARDISATION**
   Where captured data conforms to a predetermined agreed format. E.g., all ID nos in SA have 13 digits.

   **ADVANTAGES OF DATA STANDARDISATION**
   - Helps to prevent and detect errors.
   - Can be used to compare data.
   - Can group data in a meaningful way.

30. **DIGITISING**
   A technique to transform map data into vector format.

31. **SCANNING**
   A technique to transform map data into raster format.

32. **QUERYING**
   Used to get information from a database using predefined questions.

33. **BUFFERING**
   The creation of a zone of specified width around a point, line or polygon area.

34. **OVERLAYING**
   The combination of different layers for a particular area to produce a new area showing combined layers. E.g., layers are dams, rivers, roads, railway lines, shops, schools, vegetation, etc.

35. **SPATIAL ANALYSIS**
   Methods used to explore the spatial relationships between features both real and theoretical. Studies the locations and shapes of geographic features and the relationships between them.

**VECTOR AND RASTER DATA**

**VECTOR DATA** is represented by points, lines and polygons, with a combination of x, y coordinates. It is discrete data.

**RASTER DATA** is represented by pixels (grid cells). It does not represent individual features. It is continuous data.
USES OF GIS

1. Mobile Phone Company (Vodacom, MTN)
   To locate masts for communication.

2. Military
   Planning troop movements or terrain suitability.

3. Fire / Emergency Medical Services / Disaster
   Planning quickest routes to assist people.

4. Agriculture
   Finding the most suitable location to grow certain crops.

5. Mining
   Locating mineral reserves.

6. Law Enforcement
   GIS is an effective tool to fight crime. Police analysts use GIS to identify high crime areas, where to deploy extra police, to predict crime patterns.

7. Health
   Health care services can use GIS to show what resources are needed and where they are needed. They can track areas with high rates of diseases (TB).

8. Transportation
   GIS can offer insight for planning of roads, vehicle tracking, can analyse congestion patterns.

9. Private Companies
   Can determine needs of markets, look at population sizes and demand for goods.

10. Industries.
    Can plan for the site based on availability of raw materials, water, transport etc.

SPATIAL RESOLUTION

Is the detail with which a map depicts the location and shape of geographic features. The larger the map scale, the higher the spatial resolution, therefore the more detail will be shown.

Low spatial resolution

High spatial resolution
PIXEL RESOLUTION

It is the area represented by each cell or pixel in a raster.

High resolution means more detail and a smaller area.

Low resolution means less detail and a larger area.

GEOGRAPHIC CO-ORDINATE SYSTEMS

Uses a three-dimensional spherical surface to define locations on the earth. Latitudes and longitudes are used to locate anything, anywhere on the earth. These are angles measured in degrees from the earth's centre to a point on the earth's surface.
Map makers realized the difficulties of presenting a spherical earth on a flat surface very early. For the purpose of drawing accurate maps, map projections were designed. Locations on a map are measured using x and y coordinates. A projection converts locations from spherical to planar coordinates.
Map projections are used to show the earth which is spherical (round) on a flat piece of paper.

Sketching the round surface of the earth on a flat piece of paper has been a problem for map drawers (cartographers) for years.

It is impossible to accurately transfer details such as shape, scale, area, distance and direction from a round to a flat surface.

Since all flat maps have some form of distortion we use different map projections to meet different needs.

Note that no single map projection can show all the main characteristics (scale, shape, distance and direction) accurately.

Related concepts

Rhumb-line
It shows true direction.

Orthomorphic (conformal)
It is a grid system where the east-west stretching (distortion) is matched by the north-south distortion. It maintains the true shape of features.

Longitudes (meridians)
These are grid lines that circle the earth from north to south.
The prime meridian (Greenwich meridian) is 0°

Latitudes (parallels)
These are grid lines that circle the earth from west to east.
The equator (0°) is the central latitude which divides the earth into the northern and southern hemisphere.

Note: Latitudes and longitudes are used as a basis for drawing a map on a flat surface.
Reasons to project the Earth's surface onto a plane, rather than use a curved surface

- The paper used to print GIS maps is flat.
- Flat maps are scanned and digitized to create GIS databases.
- Rasters (topographical maps) are flat, it's impossible to create a raster on a curved surface.
- The Earth has to be projected as a flat map to see all of it at once.
- It's much easier to measure distance on a flat map.

Properties of map projections

Conformal: This means that the angle/shape of features on the map is the same as its shape on earth. All conformal projections have meridians and parallels crossing each other at right angles.

Equal Area: This means that the relative size of features is maintained.

Equidistant: Relative distances from one point to another are maintained.

Types of map projections

Azimuthal (Planar)

In this projection the globe is placed on a flat sheet.
- The sheet only touches the globe surface at one point and this is where the scale is most accurate.

Advantages
- These projections are good for maps that focus on a hemisphere, continent or the poles.
- Distances are generally accurate.

Disadvantages
- It can only show less than half the earth at any one time.
- Distortion is great at the edge of the map.
In this projection the grid of the globe is transferred onto a piece of paper shaped like a cone.

Example
Lambert's conformal conical projection
- This projection gives rise to a map in the shape of a fan.
- Shows true direction from a single tangent point (A)
- The longitudes radiate as straight lines from the poles while the latitudes form concentric circles.
- It is best suited for smaller areas.

Advantages:
- It is most accurate for drawing maps in the middle latitudes (between equator and poles).
- This projection is ideal for aeronautical charts, weather maps, navigation charts, topographical and military maps.
- It gives true direction in the middle latitudes.
- The scale of these maps is true to a large degree.
- The South African synoptic charts use a conical projection with two standard parallels (30° S and 40° S)

Disadvantages:
- The disadvantage is that it cannot be used for the drawing of a world map as shapes become squashed towards the poles.
- Distances are greatly distorted towards the bottom of the map.

Cylindrical

In this projection a sheet of paper is folded in the form of a cylinder around a globe. The cylinder is positioned in a north-south direction.

Example: Mercator projection
- This is a conformal projection
- Lines of longitude and latitude intersect at right angles.
- Within 15° of the equator the projection is free of distortions.
- The distance between latitudes increases in a north and south direction away from the equator.

Advantages:
- It shows the correct compass bearing anywhere on the map by means of straight lines referred to as rhumb-lines.
- Used for plotting the route of aircraft and navigation of ships.
- Shows small areas such as continents and islands accurately.

Disadvantages:
- The map is extremely distorted at the poles.
- Areas are stretched further away at the poles.
- This results in landmasses that are found further north and south of the equator to appear bigger than they are in reality.
- An example is Greenland that appears to be the same size as South America although it is only one-eight the size.
Cylindrical

Example: Transverse Mercator (Gauss Conformal)

- The cylinder is positioned in an east-west direction (secant).
- The meridians and parallels intersect at right angles. Therefore the projections are conformal.
- It uses 2° zones.
- The 1: 50 000 topographic map series in South Africa uses the 19° meridian as its central meridian.

Universal Transverse Mercator (UTM)

- It uses a grid coordinate system.
- The earth's surface is divided into 60 narrow zones which is 6° wide.
- Each zone has a different central meridian.
- It has military, GIS and GPS uses.

Advantages

- Scale, shape and directions are accurate within 15" on either side of a central meridian.
- It is good for large scale topographic maps.
- It is useful for mapping countries that are elongated from north to south as there is minimal distortion.

Disadvantage

- It does not allow for maps projected in two different zones to be joined.
TYPES OF PHOTOGRAPHS

<table>
<thead>
<tr>
<th>Vertical</th>
<th>High oblique</th>
<th>Low oblique</th>
<th>Orthophotos</th>
</tr>
</thead>
</table>
| - Horizon not visible.  
  - Camera axis coincides with vertical axis. | - Horizon visible.  
  - Camera axis 60°–90° to vertical. | - Horizon not visible.  
  - Camera axis 0°–60° to vertical. | - This is a combination of a vertical aerial photograph and a map.  
  - It has a scale that is larger than the map, i.e. 1:10 000.  
  - It has contour lines and other features printed on it. |

**Advantages**
- Scale same throughout.  
- Plan view.  
- Stereo pair used for drawing maps.

**Disadvantages**
- Expensive to obtain.

**Advantages**
- Can determine relative heights.  
- Cheap to obtain.

**Disadvantages**
- Some features are hidden by objects in the foreground.  
- Scale is not the same throughout.

**Advantages**
- Can determine relative heights.  
- Cheap to obtain.

**Disadvantages**
- Some features are hidden by objects in the foreground.  
- Scale is not the same throughout.

**Advantages**
- Bigger scale.  
- Specific detail can be seen.  
- Cheap to obtain.

**Disadvantages**
- Cannot be used to draw maps.

IDENTIFICATION AND INTERPRETATION OF PHOTOS

- Houses and forestry have a rough texture while water has a smooth surface.
- Vegetation and water have darker shades while fields and buildings are lighter.
- Linear features such as roads, railway lines and rivers can be used to orientate the orthophoto with the topographical map.
- Natural features have irregular outlines while manmade features are regular in shape.