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§ 1 Cartography & Maps

Ex.1 *Find the right meanings*

graticule chart trilateration photogrammetry declination leveling geoid plat bathymetry accuracy

1. Surveying operation in which heights of objects and points are determined relative to a specified datum. ……
2. Degree of conformity with a standard. It relates to the quality of a result and is distinguished from precision which relates to the quality of the operation by which the result is obtained. ……
3. Science or art of obtaining reliable measurements or information from photographs or other sensing systems. ……
4. Figure of the Earth visualized as a mean sea level surface extended continuously through the continents. ……
5. Method of surveying wherein the lengths of the triangle sides are measured, usually by electronic methods, and the angles are computed from the measured lengths. ……
6. Science of measuring water depths (usually in the ocean) to determine bottom topography. ……
7. Diagram drawn to scale showing all essential data pertaining to the boundaries and subdivisions of a tract of land, as determined by survey or protraction. ……
8. In astronomy, the angular distance of a celestial body above (north, plus) or below (south, minus) the celestial Equator. ……
9. Network of parallels and meridians on a map or chart. ……
10. Special-purpose map designed for navigation or to present specific data or information. ……

Ex.2 *Read the text; translate the underlined words*

Cartography is an ancient discipline that dates from the prehistoric depiction of hunting and fishing territories. The Babylonians mapped the world in a flattened, disk-shaped form, but Ptolemy established the basis for subsequent efforts in the 2nd century ad with an eight-volume work on geography that showed a spherical Earth. Maps produced during the Middle Ages followed Ptolemy's guide, but they used Jerusalem as the central feature and placed East at the top. These representations are often called T-maps because they show only three continents (Europe, Asia, and Africa), separated by the "T" formed by the Mediterranean Sea and the Nile River. More accurate geographical representation began in the 14th century when portolan (seamen's) charts were compiled for navigation.

The discovery of the New World led to the need for new techniques in cartography, particularly for the systematic

……
……
……
……
……

representation on a flat surface of the features of a curved surface. The 17th and 18th centuries saw a vast outpouring of printed maps of ever-increasing accuracy and sophistication. Noteworthy among the scientific methods introduced later was the use of the telescope for determining the length of a degree of longitude. Modern cartography largely involves the use of aerial photographs as a base for any desired map or chart; the procedures for translating photographic data into maps are governed by the principles of photogrammetry and yield a degree of accuracy previously unattainable. Satellite photography has made possible the mapping of features of the Moon and of several planets and their satellites. ……

Ex.63 *Quiz*

1. Deforestation is occurring in many countries and it is therefore difficult to detect the ongoing damage. Which of the types of remote sensing would be best suited for locating deforestation? **a)** thermal infrared **b)** microwave **c)** radar **d)** sonar **e)** color infrared

2. Using the latitude and longitude system (degrees, minutes, seconds), 20 minutes is equal to what? **a)** 1/3 hour **b)** 0.20º **c)** 200 seconds **d)** 1/20º **e)** 1/3º

3. Which of the following types of remote sensing would be most useful in obtaining an accurate terrain representation of Venus?

a) radar **b)** microwave **c)** Landsat **d)** sonar **e)** thermal infrared

4. Which of the following remote sensing technologies uses sound? **a)** radar **b)** color infrared imaging **c)** thermal infrared imaging **d)** sonar **e)** microwave sensing

5. Lines connecting points of equal air temperature are known as

a) isohyets **b)** isotherms **c)** isobars **d)** contour lines

6. An oblate ellipsoid is what?

a) a circle rotated about its major axis **b)** a circle rotated about an ellipse **c)** an ellipse rotated about a circle **d)** an ellipse rotated about its longer axis **e)** an ellipse rotated about its shorter axis

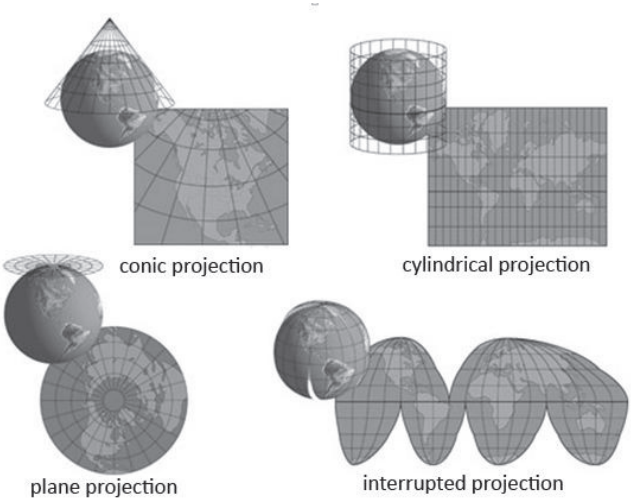
Ex.4 *Quiz*

Distortion The size of which body of water is most distorted on a Mercator projection?
A. Red Sea **B**. Arctic Ocean **C**. Bay of Bengal **D**. Atlantic Ocean

Coordinates The junction of the prime meridian and the equator is closest to ...
A. Asia **B**. Africa **C**. Europe **D**. Australia **E**. North America

Mapping The cartographic technique by which points on the sphere of the Earth are transferred to points on the plane surface of a map is ... **A**. trajection **B**. projection **C.** intersection **D.** interpolation **E.** approximation

§2 Map Projections and Grid System



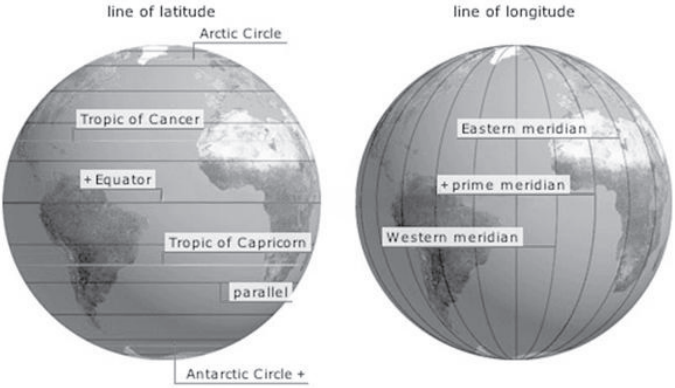
Ex. 5 *Fill in the words in the gaps*

cylindrical /plane /conic / interrupted projection; map projections

1. ……Representations of the Earth's surface on a plane.
2. ……Results in a map that is not continuous but cut off, the divisions often placed in the middle of the oceans; it is used to represent the continents.
3. ……Obtained by projecting the Earth's surface onto a cylinder; the meridians and parallels are thus straight lines intersecting at right angles.
4. ……Produced on a plane placed in such a way that it is tangent to a point on the Earth's surface; it can represent only one hemisphere.
5. ……Obtained by projecting the Earth's surface onto a cone whose base is a parallel; it can represent only a part of the globe.

Ex. 6 *Match the words from the Glossary with their meanings*

1. **l**…… The reference area on a map that lists and explains the colors, symbols, line patterns, shadings and annotations used on the map;
2. **d**…… Bank of earth or stone used to form a barrier, frequently and confusingly interchanged with levee.
3. **c**…… Imaginary line on ground, all points of which are at the same elevation above or below a specific datum.
4. **c**…… …… Points of established position or elevation, or both, which are used to fix references in positioning and correlating map features.
5. **l**…… Surveying operation in which heights of objects and points are determined relative to a specified datum.



Ex. 7 *Match the words with their meanings*

Equator/ Western meridian/ Arctic Circle/ Tropic of Capricorn/ Tropic of Cancer /Antarctic Circle/ Eastern meridian/ grid system/ line of latitude/ prime meridian/ parallel/ line of longitude

1. ……Collective term for the parallels and meridians that form an imaginary grid over the Earth's surface, making it possible to locate a specific point.
2. ……Coordinate of a point on the Earth's surface indicating, in degrees, its distance from the prime meridian.
3. ……Imaginary line connecting the poles and perpendicular to the Equator; located west of the Greenwich meridian.
4. ……Chosen by convention as the meridian of origin; its longitude, 0, divides the Eastern and Western hemispheres.
5. ……Imaginary line connecting the poles and perpendicular to the Equator; located east of the Greenwich meridian.
6. ……Coordinate of a point on the Earth's surface indicating, in degrees, its distance from the Equator.
7. ……Parallel of latitude 66°34' N; it marks the polar zone, where days and nights last 24 hours during solstices.
8. ……Imaginary line encircling the Earth at its greatest circumference and perpendicular to the polar axis; its latitude, 0, serves as a reference point for calculating other latitudes.
9. ……Parallel located at 23°26' N latitude (a distance of about 1,600 mi from the Equator).
10. ……Imaginary circle whose plane is parallel to the Equator.
11. ……Parallel located at 23°26' S latitude (a distance of about 1,600 mi from the Equator).
12. ……Parallel of latitude at 66°34' S; it marks the polar zone, where days and nights last 24 hours during solstices.

§ 3 Surveying

Ex.8 *Read the text; fill in the words in the gaps*

***implemented requirements minor** (adj.) **essential hand-held accurate apportionment reduction indicate** (verb)*

Surveying is a means of making relatively large-scale, _____ measurements of the Earth's surfaces. It includes the determination of the measurement data, the _____ and interpretation of the data to usable form, and, conversely, the establishment of relative position and size according to given measurement _____. Thus, surveying has two similar but opposite functions: (1) the determination of existing relative horizontal and vertical position, such as that used for the process of mapping, and (2) the establishment of marks to control construction or to _____ land boundaries.

Surveying has been an _____element in the development of the human environment for so many centuries that its importance is often forgotten. It is an imperative requirement in the planning and execution of nearly every form of construction. Surveying was essential at the dawn of history, and some of the most significant scientific discoveries could never have been _____ were it not for the contribution of surveying. Its principal modern uses are in the fields of transportation, building, _____ of land, and communications.

Except for _____ details of technique and the use of one or two minor _____ instruments, surveying is much the same throughout the world.

Ex.9 *Choose the right option*

1…….. Surveys are performed above and below ground to guide tunneling and other operations associated with mining 1) Alignment 2) Hydrographic 3) Mine

2…….. Surveys map property boundaries, solar access easements, position obstructions and collectors to sun angles 1) Solar 2) Original 3) Retracement

3…….. Surveys are performed using GPS to determine ground locations

1) Geodetic 2) Satellite 3) Mine

4…….. Surveys are made to plan, design and construct highways, railroads, pipelines and other linear projects 1) Satellite 2) Condominium 3) Alignment

5…….. Surveys recover previously established boundary lines

1) Solar 2) Retracement 3) Hydrographic

Ex.10 *Translate the following words; match them with the definitions below*

Field notes …….. **Benchmark……..**
Back sight …….. **Strip ……..**
Accuracy …….. **Altitude ……..**
Plat …….. **Ellipsoid ……..**
Mete …….. **Pacing……..**

1. _____A drawing of a parcel of land. More specifically, the drawing created by the surveyor that shows the field work, with bearings, distances, etc.
2. _____The vertical angle between the plane of the horizon and the line to the object which is observed.
3. _____is a "quick and dirty" method for estimating distance
4. _____ curved surface approximating the size and shape of the earth
5. _____After measuring from point A to B, reading the heading from B back to A. Various factors can cause the headings to not be exactly the reverse of one another.
6. _____In the context of surveying, a measure, i.e. the direction and distance of a property line.
7. _____Degree of conformity with a standard.
8. _____A survey mark made on a monument having a known location and elevation, serving as a reference point for surveying.
9. _____ are a permanent record of field procedures and the data collected in those procedures.
10. _____A rectangular piece of land adjoining a parcel, created when a resurvey turns up a tiny bit larger than the original survey. The difference is accounted for by temperature or other effects on measuring chains.

Ex.11 *Choose the right option*

1. **…….. Surveying is earth centered, 3 dimensional earth fixed Cartesian coordinate system**
   1) Alignment 2) Satellite 3) Geodetic
2. **…….. Surveys establish new section corners**
   1) Original 2) Satellite 3) Mine
3. **…….. Surveys are accomplished by using photogrammetry or remote sensing**
   1) Satellite 2) Retracement 3) Aerial
4. **…….. Surveys provide a legal record of ownership**
   1) Geodetic 2) Condominium 3) Alignment
5. **…….. Surveys define shorelines and depths of lakes, streams, oceans, reservoirs and other bodies of water**
   1) Original 2) Condominium 3) Hydrographic

Cartographers' jokes

1. **How do cartographers find the girl they are going to marry?**
   They datum
2. **How is an English essay like cartography?**
   In both you are asked to draw parallels

§ 4 GIS

Ex.12 *Fill in the words in the gaps*

thematic	***spatial***	***analysis***	***evolved***	***crucial***	***retrieval***
assist	***harness****(verb)*	***planners***	***producing***	***descendants***	***classified***

GIS, in full geographic information system, is a computer system for performing geographical _____. GIS has four interactive components: an input subsystem for converting into digital form (digitizing) maps and other _____ data; a storage and retrieval subsystem; an analysis subsystem; and an output subsystem for _____maps, tables, and answers to geographic queries. GIS is frequently used by environmental and urban _____, marketing researchers, retail site analysts, water resource specialists, and other professionals whose work relies on maps.

GIS _____ in part from the work of cartographers, who produce two types of maps: general-purpose maps, which contain many different themes, and _____ maps, which focus on a single theme such as soil, vegetation, zoning, population density, or roads. These thematic maps are the backbone of the GIS because they provide a method of storing large quantities of fairly specific thematic content that can later be compared. In his landmark book, Design with Nature (1967), Ian McHarg described the use of map overlays as a tool for urban and environmental planning. This system of overlays is a _____ element of GIS, which uses digital map layers rather than the transparent plastic sheets of McHarg's day.

The arrival of the computer in the 1950s brought another essential component of GIS. By 1959 the American geographer Waldo Tobler had developed a simple model to _____ the computer for cartography. His MIMO ("map in–map out") system made it possible to convert maps into a computer-usable form, manipulate the files, and produce a new map as the output. This innovation and its earliest _____ are generally _____as computerized cartography, but they set the stage for GIS.

In 1963 the English-born Canadian geographer Roger Tomlinson began developing what would eventually become the first true GIS in order to _____ the Canadian government with monitoring and managing the country's natural resources. Tomlinson built on the work of Tobler and others who had produced the first cartographic digital input device (digitizer) and the computer code necessary to perform data _____and analysis; they had also developed the concept of explicitly linking geographic data (entities) and descriptions (attributes).

Ex.13 *Quiz*

1. To compare, overlay, or cross-analyze two maps in a GIS

a) *both maps must be in digital form.* ***b)*** *both maps must be in the same map projection.* ***c)*** *both maps must be at the same equivalent scale.* ***d)*** *both maps must be on the same coordinate system.* ***e)*** *all of the above.*

2. An automated system for the capture, storage, retreival, analysis, and display of spatial data is known as

a) *a GPS* ***b)*** *Landsat* ***c)*** *GIS* ***d)*** *none of the listed.*

3. Precise measurement of Earth features can be obtained from

a) *high-oblique photographs.* ***b)*** *low-oblique photographs.* ***c)*** *vertical aerial photographs.* ***d)*** *only high- and low-oblique aerial photographs.*

Ex.14 *Write the translation of the words; fill them in the correct places*

remote sensing …….. overlay ……..

bench mark …….. datum (pl. datums) ……..

adjustment …….. traverse ……..

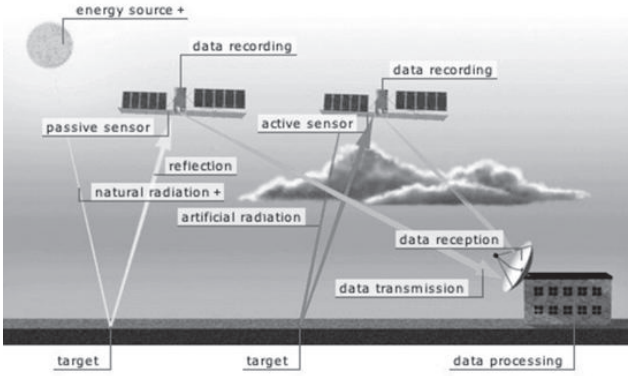
stereocompilation …….. triangulation ……..

altimeter ……..

1. _____Method of extending horizontal position on the surface of the Earth by measuring the angles of triangles and the included sides of selected triangles.
2. _____Printing or drawing on a transparent or translucent medium intended to be placed in register on a map or other graphic and which shows details not appearing or requiring special emphasis on the base material.
3. _____Relatively permanent material object, natural or artificial, bearing a marked point whose elevation above or below an adopted datum is known.
4. _____Process designed to remove inconsistencies in measured or computed quantities by applying derived corrections to compensate for random or accidental errors.
5. _____Instrument for measuring altitudes or elevations with respect to a reference level, usually mean sea level.
6. _____In surveying, a reference system for computing or correlating the results of surveys.
7. _____Process of detecting and (or) monitoring chemical or physical properties of an area by measuring its reflected and emitted radiation.
8. _____Production of a map or chart manuscript from aerial photographs and geodetic control data by means of photogrammetric instruments.
9. _____Sequence of lengths and directions of lines connecting a series of stations, obtained from field measurements, and used in determining positions of the stations.

§5 Remote Sensing

Satellite remote sensing



Ex. 15 *Match the words with their meanings*

data reception /data transmission / reflection / data recording / passive sensor /data processing / satellite remote sensing / artificial radiation/ natural radiation/ active sensor/energy source/ target

1. ……Observation of the Earth's surface and atmosphere by a satellite equipped with a sensor.
2. ……Instrument that itself emits the energy required to illuminate the target and receives the waves it reflects.
3. ……If the satellite in unable to communicate with the terrestrial station, data is registered onboard and transmitted later.
4. ……Instrument that receives the waves produced when the target reflects the Sun's natural rays.
5. ……At the origin of the remote sensing process is an energy source, for example the Sun, used to illuminate the target.
6. ……When the sky is clear, the satellite captures the reflection of the Sun's rays from the Earth's surface.
7. ……Raw data is interpreted and analyzed to extract information about the target.
8. ……Surface or object that reflects the Sun's rays.
9. ……Raw data reaches the terrestrial station in digital form.
10. ……Phenomenon by which natural or artificial waves bounce off the target and toward the satellite.
11. ……When atmospheric conditions hide the Sun's rays, the active sensor itself emits radiation waves.
12. ……The sensor transmits raw data, if possible immediately, to a terrestrial station for processing.

Ex.16 *Read the text; find the* ***adjectives*** *in the text which mean the following*

1. §2 kept or keeping within reasonable or proper limits; not extreme or intense ……

2. §2 achieving or having achieved significant progress ……
3. §4 commonly or generally known or seen ……
4. §4 practicable and feasible; workable and alive ……
5. §1 (of an airborne camera or scanner) capable of sensing and recording radiation from invisible as well as visible parts of the electromagnetic spectrum ……
6. §2 occurring or coming later or after……
7. §3 distributed over a wide region, or occurring in many places or among many persons or individuals ……
8. §1 of considerable use, or importance ……
9. §3 important and critical; of consequence ……
10. §2 able to yield or make a profit in business ……
11. §1 that can be seen; perceptible to the eye……
12. §1 differing one from another……

§1 Remote sensing is a term applied to the use of satellites to observe various characteristics of Earth's land and water surfaces in order to obtain information valuable in mapping, mineral exploration, land-use planning, resource management, and other activities. Remote sensing is carried out from orbit with multispectral sensors; i.e., observations are made in several discrete regions of the electromagnetic spectrum that include visible light and usually other wavelengths. From multispectral imagery, analysts are able to derive information on such varied areas of interest as crop condition and type, pollution patterns, and sea conditions.
§2 Because many applications of remote sensing have a public-good character, a commercial remote-sensing industry has been slow to develop. In addition, the secrecy surrounding intelligence-gathering satellites during the Cold War era set stringent limits on the capabilities that could be offered on a commercial basis. Since then, however, very high resolution images (about 0.5 metre [1.5 feet]) have been gathered by several commercial systems. The United States launched the first remote-sensing satellite, NASA's Landsat 1 (originally called Earth Resources Technology Satellite), in 1972. The goals of the Landsat program, which by 1999 had included six successful satellites, were to demonstrate the value of multispectral observation and to prepare the system for transfer to private operators. Despite two decades of attempts at such a transfer, Landsat has remained a U.S. government program. In 1986 France launched the first of its SPOT remote-sensing satellites and created a marketing organization, Spot Image, to promote use of its imagery. Four subsequent SPOT satellites have been launched. Both Landsat's and SPOT's multispectral images offered a moderate ground resolution of 10–30 metres (about 33–100 feet). Japan and India also launched multispectral remote-sensing satellites.
§3 Since the 1990s, with the end of the Cold War, some of the technology used in reconnaissance satellites has been declassified. In addition, technological developments in India and several countries in Europe enabled those countries to develop both optical and radar Earth-observation satellites with high ground resolution and to market imagery on a commercial basis. Among major customers for high-resolution imagery are governments that lack their own reconnaissance satellites; the U.S. government has also purchased significant amounts of such imagery from U.S. commercial firms rather than obtaining it from government-operated satellites. The global availability of imagery previously available only to the leaders of a few countries is troubling to some observers, who express concern that it could lead to increased military threats. Others suggest that this widespread availability will contribute to a more stable world.
§4 Remote sensing from space is only slowly developing into a viable commercial business. Nevertheless, as users become more familiar with the benefits of combining space-derived data with other sources of geographic information, the possibility of commercial success is likely to improve.

§6 Space Applications

§1 Space visionaries in the early 20th century recognized that putting satellites into orbit could furnish direct and tangible benefits to people on Earth. For example, Arthur C. Clarke in 1945 described a way in which three satellites in orbit about 35,800 km above the Equator could relay communications around the globe. In this orbit, called a geostationary orbit, the satellites would have an orbital period equal to Earth's rotational period and thus appear from the ground to be stationary in the sky.

§2 Space development, the practical application of the capabilities of spacecraft and of the data collected from space, has evolved in parallel with space exploration. There are two general categories of space applications. One provides benefits that are considered public goods and thus are usually provided by governments, using public funds. Examples of public-good space applications include meteorology; navigation, position location, and timing; and military and national security uses.

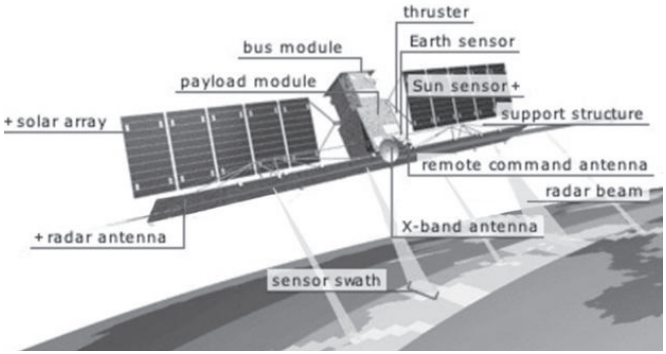
§3 The other category of applications provides goods or services that can be sold to purchasers at a profit. These applications are the basis for the commercial development of space by the private sector. Examples of existing commercial space applications include various forms of telecommunications and data transmission via satellites, remote sensing of Earth's surface, and commercial space transportation.

§4 Other applications, such as space tourism, space-based power generation, the manufacture of high-value materials in a microgravity environment, and the commercial development of extraterrestrial resources, may appear in the future. Many space applications have both civilian and military uses, and thus similar systems have been developed by both sectors. How to manage and use these dual-purpose systems effectively is a continuing policy issue.

Ex.17 *Find the words in the text above which mean the following*

1. §1 (noun, plural) a person of unusually keen foresight; a person who is given to highly impractical ideas; dreamer ……..
2. §1(verb) to retransmit (a signal, message, etc.) ……
3. §1 (adj.) standing still; not moving ……..
4. §2 (noun) the quality of being usable for a particular purpose or in a special way ……..
5. §2 (noun) the study of the earth's atmosphere, esp. of weather-forming processes and weather forecasting ……..
6. §3 (adj.) able to yield or make a profit ……..
7. §3 (noun) the outer face, outside, or exterior boundary of a thing; outermost or uppermost layer or area ……..
8. §4 (noun) a condition, especially in space orbit, where the force of gravity is so weak that weightlessness results ……..
9. §4 (adj.) outside, or originating outside, the limits of the earth ……..
10. §4 (verb) to employ for some purpose; put into service ……..

Radarsat satellite



Ex. 18 *Match the words with their meanings*

payload module / X-band antenna / remote command antenna /Earth sensor / solar array radar antenna /bus module /radar beam / Radarsat satellite/ Sun sensor /sensor swath/ thruster

1. ……Canadian-built Earth observation satellite used to monitor environmental changes and natural resource use.
2. ……Power supply device that converts solar energy into immediately usable electrical energy.
3. ……Antenna designed to emit electromagnetic wave beams and to capture the echo reflected by the Earth's surface.
4. ……Type of antenna that allows the ground operation center to transmit commands to the satellite.
5. ……Instrument that positions the solar panels in the direction of the Sun to capture its energy.
6. ……Instrument that locates the Earth's horizon so that the radar antenna can be positioned correctly.
7. ……Piece of equipment that generates the impetus required to move the satellite.
8. ……Type of antenna that emits and receives extremely high-frequency waves.
9. ……Section of the satellite connected to the payload and equipped with the resources needed to make it function.
10. ……Section of the satellite that houses detection materials and maintenance equipment.
11. ……Collective term for the fan-shaped trajectories of electromagnetic waves emitted in a given direction by a radar.
12. ……Width of the Earth's surface observed during the passage of a satellite

§ 7 History and Modern Surveying

Ex.19 *Read the text; translate the unknown words*

Plane tables were in use in Europe in the 16th century, and the principle of graphic **triangulation** and **intersection** was practiced by surveyors. In 1615 Willebrord Snell, a Dutch mathematician, measured an arc of meridian by instrumental triangulation. In 1620 the English mathematician Edmund Gunter developed a surveying chain, which was superseded only by the steel tape beginning in the late 19th century.

The study of astronomy resulted in the development of angle-reading devices that were based on arcs of large radii, making such instruments too large for field use. With the publication of logarithmic tables in 1620, portable angle-measuring instruments came into use. They were called topographic instruments, or **theodolites**. They included pivoted arms for sighting and could be used for measuring both horizontal and vertical angles. Magnetic compasses may have been included on some.

Stadia hairs were first applied by James Watt in 1771. The development of the circle-dividing engine about 1775, a device for dividing a circle into degrees with great **accuracy**, brought one of the greatest advances in surveying methods, as it enabled angle measurements to be made with portable instruments far more accurately than had previously been possible.

Modern surveying can be said to have begun by the late 18th century. One of the most notable early feats of surveyors was the measurement in the 1790s of the **meridian** from Barcelona to Dunkirk, France, by two French engineers, Jean Delambre and Pierre Méchain, to establish the basic unit for the metric system of measurement.

Many improvements and refinements have been incorporated in all the basic surveying instruments. These have opened up possibilities for improved methods in the field. In addition to modification of existing instruments, two revolutionary mapping changes were introduced: **photogrammetry**, or mapping from aerial photographs, and electronic distance measurement, including the adoption of the laser for this purpose as well as for **alignment** (in the 1960s). Important technological developments starting in the late 20th century include the use of satellites as reference points for geodetic surveys and electronic computers to speed the processing and recording of survey data.

Ex.20 *In the text above find the meaning to the underlined words; write them in the gaps*

1. _____ The method of surveying measurement where a baseline is established and the angles between stations are determined to calculate distance.
2. _____ The science or art of obtaining reliable measurements by means of photographs.
3. _____ A precision surveying instrument for measuring horizontal and vertical angles. The graduated circles are usually read by means of optical microscopes and are more precisely graduated than are the circles on a transit.
4. _____ A north-south line from which longitudes (or departures) and azimuths are reckoned; or a plane, normal to the geoid or spheroid, defining such a line.

5. _____ It relates to the quality of a result, and is distinguished from precision which relates to the quality of the operation by which the result is obtained. The degree of perfection obtained in measurements.
6. _____ In railway or highway surveying: The ground plan, showing the alignment or direction, and components of the centerline, as distinguished from a profile, which shows the vertical element.
7. _____ A method of measurement using the optics of an instrument. The intercept between the stadia wires on an instrument that is calculated and used to determine distance.
8. _____ The method of establishing the legal center of section and the centers of the various quarter sections.

Ex.21 *Match the words with their definitions*

Declination Baseline Error Zenith angle
Azimuth Line Tree Landmark Control Points Traverse

1. _____ the number of degrees from north (or other reference direction) that a line runs, measured clockwise.
2. _____ the difference between a measured value and the true value.
3. _____ are fixed points of known coordinates.
4. _____ The difference between magnetic north and geographic (true) north.
5. _____ any tree that is on a property line, specifically one that is also a corner to another property.
6. _____ 1) any line surveyed across a parcel 2) a series of such lines connecting a number of points, often used as a base for triangulation.
7. _____ an angle measured from a vertical reference.
8. _____ a surveyed east-west (i.e. latitudinal) reference line.
9. _____ A survey mark made on a 'permanent' feature of the land such as a tree, pile of stones, etc.

Ex.22 *Quiz*

1. What colour does living vegetation appears as on false-colour IR images?
A. Green **B**. Red **C**. Black **D**. Blue **E**. Yellow

2. What is remote sensing? **A**. Ability to gather information about a distant or unseen target using paranormal means or extra-sensory perception **B**. Small or large-scale acquisition of information of an object or phenomenon not in physical or intimate contact **C**. Any system that captures, stores, analyzes, manages, and presents data that are linked to location.

3. Electromagnetic waves are defined to behave in the same way of which of the following waves? **A.** Longitudinal waves **B**. Transverse waves **C**. Mechanical wave **D**. Sound waves

4. Which of the types of waves below has the longest wavelength? **A**. X-Rays **B**. Gamma Rays **C.** Hertzian Waves **D**. Radio Waves **E**. Near Infrared Waves

§ 8 International Organizations for Maps and Mapping

Ex.23 *Read the text; find the* ***verbs*** *in the text which mean the following*

1. §2…… to keep in existence or continuance; preserve; retain
2. §4…… to help to exist and further flourish and progress
3. §3…… to act as sponsor for; promise, vouch, or answer for
4. §1…… to be busy or occupied; involved in an activity
5. §3…… to make moving ahead or further along in progress, skill, etc.
6. §4…… to render assistance; to be of use; to provide help in something
7. §2…… to issue (printed or reproduced material) for distribution to the public.
8. §1…… to be interested or affected, sometimes worried about something
9. §4…… to establish association or connection with other things
10. §1…… to stimulate and give support, to foster

§1 Many societies and other types of organizations are now engaged in activities associated with maps and mapping. In general, they encourage cooperation through meetings and articles in their journals; some are more directly concerned with the dissemination of information on the progress of particular kinds of mapping and charting. Standardizations of map treatments and conventional signs as well as the promotion of progress in technical processes are further objectives of such groups.

§2 The United Nations Office of Cartography plays an important role in all of the activities noted above. It maintains records of progress on the International Map of the World and performs related services formerly handled by the Central Bureau of the IMW. Technical assistance in the development of mapping facilities and programs is provided on request. Occasional regional meetings are arranged for groups of countries having similar problems, while the journal World Cartography publishes related papers.

§3 The Inter-American Geodetic Survey is organized to forward the completion of geodetic surveys and mapping in the Americas. Through technical training and assistance with programs, geodetic surveys in Central and South America have been greatly advanced in recent years. The Pan American Institute of Geography and History has sponsored regular meetings and consultations on cartography, much in the manner of scientific societies. The consultations are held in different countries each year.

§4 The International Hydrographic Bureau was founded in 1921 in Monaco. It serves as a clearinghouse for information related to hydrography and charting and maintains a General Bathymetric Chart of the World, which is revised periodically to include data furnished by the maritime nations participating in their programs and conferences. Other organizations that promote progress in the various aspects of mapping and charting are the International Association of Geodesy and the International Union of Geodesy and Geophysics, etc.

21

Ex.24 *Match the words with the correct definitions*

alidade rectification, differential theodolite latitude grid planetable hachure longitude elevation

1. Network of uniformly spaced parallel lines intersecting at right angles. ……
2. Any series of lines used on a map to indicate the general direction and steepness of slopes. ……
3. Angular distance, in degrees, minutes, and seconds of a point north or south of the Equator. ……
4. Angular distance, in degrees, minutes, and seconds, of a point east or west of the Greenwich meridian. ……
5. Instrument consisting essentially of a drawing board on a tripod and some type of sighting device (alidade) with attached straightedge, used for plotting the lines of survey directly from observation in the field. ……
6. The process of scanning and reprojecting a photograph onto a horizontal plane in differential elements to remove displacements caused by tilt and relief. ……
7. Precision surveying instrument for measuring horizontal and vertical angles. ……
8. Vertical distance of a point above or below a reference surface or datum. ……
9. Instrument, or part of an instrument , for determining direction , either either horizontal or vertical. ……

Ex.25 *Quiz*

1. Contour Lines: The contour interval on a topographic map is 40 feet. There are 132 contour lines between your base camp and a mountain peak 1 mile away. The slope of the mountain is about...

A. 20 degrees **B.** 32 degrees **C.** 45 degrees **D.** 54 degrees E. 68 degrees

2. Compasses: A compass indicates direction by detecting ...

A. pressure differences **B.** variations in gravity **C.** solar wind directions **D.** magnetic lines of force **E.** differences in temperature

3. Topo Maps: One of the distinctive features of a topographic map is that it shows ...

A. roads **B.** latitudes **C.** elevations **D.** scale of distances **E.** man-made structures

4. Latitudes: Which country shares a line of latitude with Mexico?

A. Libya **B.** Denmark **C.** Mozambique **D.** North Korea **E.** New Zealand

5. Persistent Problems: The most enduring and elusive challenge to navigators was accurately determining ...

A. latitude **B.** longitude **C.** elevation **D.** true north **E.** magnetic north

§ 9 Remote Sensing Techniques

Ex.26 *Read the text; in the gaps write the relevant nouns to their definitions*

1. ……the altitude of a place above sea level or ground level.

2. ……a division into lines.

3. ……magnitude; size

4. ……a fact, occurrence, or circumstance observed or observable:

5. …… (*used with a plural verb*) individual facts, statistics, or items of information

6. ……method of performance; way of accomplishing.

7. ……the height of anything above a given planetary reference plane, especially above sea level on earth.

8. ……the outer face, outside, or exterior boundary of a thing; outermost or uppermost layer or area.

9. ……any reflecting surface, as the surface of calm water under certain lighting conditions

10. ……relative worth, merit, or importance

Remote-sensing **techniques** involve using combinations of images. Images from different flight paths can be combined to allow an interpreter to perceive features in three **dimensions**, while those in different spectral bands may identify specific types of rock, soil, vegetation, and other entities, where species have distinctive reflectance **values** in different spectral regions (i.e., tone signatures). Images taken at intervals make it possible to observe changes that occur over time, such as the seasonal growth of a crop or changes wrought by a storm or flood. Those taken at different times of the day or at different sun angles may reveal quite distinct features; for example, seafloor features in relatively shallow water in a calm sea can be mapped when the Sun is high. Radar radiation penetrates clouds and thus permits mapping from above them. Side-looking airborne radar (SLAR) is sensitive to changes in land slope and surface roughness. By registering images from adjacent flight paths, synthetic stereo pairs may give ground **elevations**.

Thermal infrared energy is detected by an optical-mechanical scanner. The detector is cooled by a liquid-nitrogen (or liquid-helium) jacket that encloses it, making the instrument sensitive at long wavelengths and isolating it from heat radiation from the immediate surroundings. A rotating **mirror** directs radiation coming from various directions onto the sensor. An image can be created by displaying the output in a form synchronized with the direction of the beam (as with a cathode-ray tube). Infrared radiation permits mapping surface temperatures to a precision of less than a degree and thus shows the effects of **phenomena** that produce temperature variations, such as groundwater movement.

Landsat images are among the most commonly used. They are produced with data obtained from a multispectral scanner carried aboard certain U.S. Landsat satellites orbiting the Earth at an **altitude** of about 900 kilometres. Images covering an area of 185 kilometres square are available for every segment of the Earth's surface. Scanner measurements are made in four spectral bands: green and red in the visible portion of the spectrum, and two infrared bands. The **data** are usually displayed by arbitrarily assigning different colours to the bands and then superimposing these to make "false-colour" images.

In geology, Landsat images are used to delineate landforms, rock outcrops and **surface** lithology, structural features, hydrothermal areas, and sites of mineral resources. Changes in vegetation revealed in the images may distinguish different soil types, subtle elevation differences, subsurface water distribution, subcropping rocks, and trace element distribution, among other things. **Lineations** of features may distinguish folded-rock strata or fault ruptures even where the primary features are not evident.

Ex.27 *Match the words and word combinations with their definitions*

scattering	***target***	***pixel***	***wavelength***	***absorption***	***Landsat***
spatial resolution		***particle theory***		***optical axis***	***frequency***

1. _____the distance from one crest to another crest

2. _____how many crests go by a measuring device in one second

3. _____the object that you are trying to study

4. _____the most used satellite to study the Earth's surface

5. _____picture element

6. _____indication of how well a sensor records spatial detail

7. _____ says that light was composed of corpuscles (particles of matter) which were emitted in all directions from a source

8. _____redirection of energy with no change in other properties

9. _____radiant energy is taken in by mattery and converted into other forms of energy

10. _____line from the focal point to the center of scene

§ 10 Photogrammetry & Aerial Photography

Ex.28 *Fill in the words in the gaps*

terrestrial inaccessible sophisticated scaled complications perceived mapmaking

Photogrammetry is the technique that uses photographs for _____and surveying. As early as 1851 the French inventor Aimé Laussedat _____the possibilities of the application of the newly invented camera to mapping, but it was not until 50 years later that the technique was successfully employed. In the decade before World War I, _____ photogrammetry, as it came to be known later, was widely used; during the war the much more effective technique of aerial photogrammetry was introduced. Although aerial photogrammetry was used primarily for military purposes until the end of World War II, thereafter peacetime uses expanded enormously. Photography is today the principal method of making maps, especially of _____areas, and is also heavily used in ecological studies and in forestry, among other uses.

From the air, large areas can be photographed quickly using special cameras, and blind areas, hidden from terrestrial cameras, are minimized. Each photograph is _____, using marked and known ground reference points; thus, a mosaic can be constructed that may include thousands of photographs. Plotting machines and computers are used to overcome _____.

Instruments used in photogrammetry have become very _____. Developments in the second half of the 20th century include satellite photography, very large scale photographs, automatic visual scanning, high-quality colour photographs, use of films sensitive to radiations beyond the visible spectrum, and numerical photogrammetry.

Ex.29 *Quiz*

1. What is photogrammetry?

A. Determining the geometric properties of objects from photographic images **B**. Estimating the three-dimensional coordinates of points on an object **C**. Acquisition of objects without contact of large complex scenes in 3D **D**. Analysing a real-world object or environment to collect data on its shape and possibly its appearance **E.** Optical illusion of depth created from flat, two-dimensional image or images

2. At the start of the 19th century, how were pigeons used in the early form of remote sensing? A. They carried pictures from the battlefield to remote sensing stations **B**. They conveyed messages from remote sensing stations to another **C**. They were used to test tracking equipment **D.** They carried cameras which automatically took pictures
E. They were never used

3. Which famous French photographer first practiced aerial photography and made photographs of Paris from his balloon in the mid 18th century? A. Charles Nègre **B**. Jean-Marie Périer **C**. André Giroux **D**. François-Simon-Alphonse Giroux **E.** Félix Nadar

4. What range of colours are used is for the sensing, representation, and display of images in modern electronic systems and photography.
A. Cyan, Magneta, Yellow **B**. Red, Green, Blue **C**. Cyan, Green, Yellow
D. Cyan, Magneta, Yellow, Black **E**. Red, Green, Yellow

5. During the middle of the 14th century, who came up with the idea of Camera Obscura in their notebook?
A. Galileo Galilei **B**. Thomas Alva Edison **C**. Leonardo Da Vinci
D. Isaac Newton **E**. Rene Descartes

Ex.30 *Fill in the words in the gaps*

features simultaneous overlapping obtained resources depicts

Aerial photography is the technique of photographing the Earth's surface or features of its atmosphere or hydrosphere with cameras mounted on aircraft, rockets, or Earth-orbiting satellites and other spacecraft.

For the mapping of terrestrial _____, aerial photographs usually are taken in _____series from an aircraft following a systematic flight pattern at a fixed altitude. Each photograph _____ an area that includes several control points, the locations of which are determined by ground-surveying techniques. A technique known as photogrammetry, which involves the _____ projection of the overlapping views, makes possible the preparation of contour maps or three-dimensional models of the terrestrial surface that has been photographed. Valuable data on topography, geology, hydrology, soil and vegetation, meteorology, ocean currents, and fish _____ have become accessible with the use of satellite technology and expert interpretation. Views of cloud patterns _____from orbiting satellites are valuable in weather forecasting. Aerial photography also has vital military reconnaissance and intelligence-gathering applications.

Cartographers' jokes

1. How do cartographers sign up for their classes?
At Re-GIS-tration
2. How is the US government like a map?
In theory they both have representative fractions
3. Why does west longitude need to be cheered up?
Because it is always negative.

§11 Cartography & Mapmaking Techniques

Ex. 31 *Translate the words*

cape ……..
mountain mass ……..
strait ……..
bay ……..
map projections ……..
prairie ……..
mountain range ……..
river estuary ……..
archipelago ……..
peninsula ……..
isthmus ……..
plateau……..

Ex. 32 *Match the words from the picture with their meanings*

1. ……..Group of closely spaced mountains.
2. ……..Vast expanse of relatively flat land, higher than the surrounding region and bounded by deep valleys with sheer cliffs.
3. ……..Massive elevated headland extending into the sea/a river estuary.
4. ……..Narrow strip of land between two bodies of water; it connects two larger expanses of land.
5. ……..A piece of land connected to a larger body;extending into water.
6. ……..Group of islands.
7. ……..Mouth of a river that is influenced by the tides; it forms an indentation in the coastline that varies in width and depth.
8. ……..Natural arm of a sea between two coasts; it connects two bodies of water.

9. ……..Indentation in a shoreline that reaches far inland and is delimited by two capes.

10. ……..A row of connected mountains characterized by high summits and deep valleys.

11. ……..Vast expanse of relatively flat land that is characterized by grasses and is naturally devoid of trees.

12. ……..Representations of the Earth's surface on a plane.

Ex. 33 *Fill in the words in the gaps*

compiled appropriate ambiguities changed require essentially minor chores assembled boundary evident

The preparation of derived maps—*i.e.,* maps that are …… (1) from other maps or existing data—involves the search for, and evaluation of, all extant data pertaining to the subject area. Depending on the nature of the map to be compiled, thoroughgoing research includes …… (2) references, historical records, name derivations, and other materials. Selection of the most authentic items, on the frequent occasions when some …… (3) are detected, requires careful study and references to related materials. The sources finally selected may …… (4) some adjustment or compromise in order to fit properly with adjacent data. When it becomes …… (5) that some sources are of questionable reliability, the cartographer explains this in the margin of his compilation. Sometimes this is placed in the body of the map where the doubtful features or delineations are located.

When selected materials have been …… (6) they are reduced to a common scale and copied on the compilation base, often in differentiating colours for the respective features. Reductions to a common scale are usually made by photography but may be made by projection and traced directly on the drawing. …… (7) adjustments may have to be made during compilation even though the source materials are of good quality. In particular, the need to make …… (8) generalizations, omitting some details in smaller scale maps, requires much study and judgment.

Except for the new methods of preparing final colour-separation plates by scribing, rather than by drafting or copperplate engraving, compilation processes have …… (9) little over the years. Automatic-focusing projectors and better illumination have made the tracing of selected data at compilation scale easier. Better and more extensive facilities for photoreduction and copying, improved light tables, and a wider choice of drafting materials and instruments have served to facilitate compilation. The basic …… (10) of research, selection of best data, and adjustment of these into the compilation, however, remain …… (11) the same.

§12 Internet Mapping

§1 ***Internet mapping is wiping the rich geography and history of Britain off the map, the president of the British Cartographic Society has said.***

Mary Spence said internet maps such as Google and Multimap were good for driving but left out crucial data people need to understand a landscape. Ms Spence was speaking at the Institute of British Geographers conference in London. Google said traditional landmarks were still mapped but must be searched for.

§2 Ms Spence said landmarks such as churches, ancient woodlands and stately homes were in danger of being forgotten because many internet maps fail to include them. She said: "Corporate cartographers are demolishing thousands of years of history - not to mention Britain's remarkable geography - at a stroke by not including them on maps which millions of us now use every day. We're in real danger of losing what makes maps so unique, giving us a feel for a place even if we've never been there. Projects such as Open Street Map, through which thousands of Britons have contributed their local knowledge to map pubs, landmarks and even post boxes online, are the first step in the fight back against "corporate blankwash", she added.

Missing landmarks

§3 By way of example, Ms Spence said that if someone walked around the South Kensington area of London, they would encounter landmarks such as the Science Museum, Royal Albert Hall and the Natural History Museum, which could not be found on Google Maps. Elsewhere, Worcester Cathedral and Tewkesbury Abbey are not on their respective Google Maps. "But it's not just Google - it's Nokia, Microsoft, maps on satellite navigation tools. It's diluting the quality of the graphic image that we call a map."

§4Ms Spence believes that the consequence will be long-term damage to future generations of map readers, because this skill is not being taught in schools and people are simply handling "geographical data". But Ed Parsons, geospatial technologist at Google, said the way in which people used maps was changing. He said: "Internet maps can now be personalised, allowing people to include landmarks and information that is of interest to them. Anyone can create their own maps or use experiences to collaborate with others in charting their local knowledge. These traditional landmarks are still on the map but people need to search for them. Interactive maps will display precisely the information people want, when they want it. You couldn't possibly have everything already pinpointed.

Ex. 34 *Find the words in the text which mean the following; mind the paragraphs order*

1. **§1**..... (adj.) involving an extremely important decision or result; decisive; critical
2. ..... (noun; plural) a prominent or conspicuous object on land that serves as a guide, especially to ships at sea or to travelers on a road; a distinguishing landscape feature marking a site or location
3. **§2** ..... (verb) to destroy or ruin (a building or other structure), especially on purpose
4. **§3** ..... (verb) to come upon or meet with, especially unexpectedly
5. ..... (adj.) corresponding a number of things
6. **§4** ..... (noun) a plural of datum
7. ..... (adv.) definitely or strictly stated, defined, or fixed

Ex. 35 *Match the words from the Glossary with their meanings*

1. **h**…… A picture in which the gradations of light are obtained by the relative darkness and density of tiny dots produced by photographing the subject through a fine screen.
2. **f**…… **s**……Process of preparing a separate drawing, engraving, or negative for selected types of data in the preparation of a map or chart.
3. **e**…… Group of natural processes including weathering, dissolution, abrasion, corrosion, and transportation that remove material from any part of the Earth's surface.
4. **b**…… **s**…… Survey made to establish or to reestablish a boundary line on the ground, or to obtain data for constructing a map or plat showing a boundary line.
5. **h**…… Science that deals with the measurement and description of the physical features of the oceans, seas, lakes, rivers, and their adjoining coastal areas, with particular reference to their use for navigation.
6. **i**…… Visible representation of objects and (or) phenomena as sensed or detected by cameras, infrared and multispectral scanners, radar, and photometers.
7. **n**…… Line separating the body of a map from the map margin.
8. **o**…… Any portion of a map lying outside the nominal map border.

Ex. 36 QUIZ

1. ***Which of the following is NOT a benefit of using GIS in business applications?***

A. To improve decision making B. To increase efficiency
C. To reduce the productivity D. To increase communication

2. ***Who is the leading company for GIS business applications?***

A. MapInfo Inc B. ESRI C. AccuGrade D. Google Earth

3. ***You work for the corporate office of a popular retail company that has recently begun using a GIS system. Which of the following would NOT be a good reason to use this system?*** A. To track new retail locations B. To track competitors
C. To track existing retail locations D. To track store credit card customers who have since closed their accounts E. To track customers

4. ***Aspects of a GIS system do NOT include...***

A. legal representation of a physical location B. cartography and remote sensing
C. photogrammetry and geography D. land surveying and mathematics

5. ***What can GIS NOT be used to visualize?***

A. Patterns B. Tables C. Trends D. Relationships

§13 Modern Surveying & GIS

Ex. 37 *Translate the underlined expressions*

Basic control surveys

Geodetic surveys involve such extensive areas that allowance must be made for the Earth's curvature. Baseline measurements for classical triangulation (the basic survey method that consists of accurately measuring a base line and computing other locations by angle measurement) are therefore reduced to sea-level length to start computations, and corrections are made for spherical excess in the angular determinations. Geodetic operations are classified into four "orders," according to accuracy, the first-order surveys having the smallest permissible error. Primary triangulation is performed under rigid specifications to assure first-order accuracy.

Efforts are now under way to extend and tie together existing continental networks by satellite triangulation so as to facilitate the adjustment of all major geodetic surveys into a single world datum and determine the size and shape of the Earth spheroid with much greater accuracy than heretofore obtained. At the same time, current national networks will be strengthened, while the remaining amount of work to be done may be somewhat reduced. Satellite triangulation became operational in the United States in 1963 with observations by Rebound A-13, launched that year, and some prior work using the Echo 1 and Echo 2 passive reflecting satellites. The first satellite specifically designed for geodetic work, Pageos 1, was launched in 1966.

A first requirement for topographic mapping of a given area is an adequate pattern of horizontal and vertical control points, and an initial step is the assembly of all such existing information. This consists of descriptions of points for which positions (in terms of latitude and longitude) and elevations above mean sea level have been determined. They are occasionally located at some distance from the immediate project, in which case it is necessary to expand from the existing work. This is usually done on second- or third-order standards, depending upon the length of circuits involved.

GIS: Growth, depth, and fragmentation in the late 20th century

§1 Once the switch from inductive reasoning based on field evidence to deductive modeling and field-testing had been generally accepted within physical geography, change in that section of the discipline became more gradual and progressive rather than punctuated by significant advances. The last decades of the 20th century were marked by greater sophistication in modeling, data collection, and analysis.

§2 Increasingly, physical geographers identified themselves as earth systems scientists, and their peer group became practitioners in a wide range of sciences, rather than other (especially, but not only, human) geographers. Physical geographers have retained distinctiveness in this wider enterprise through their abilities at handling spatial data and the problems of collecting and analyzing field data—skills increasingly deployed in large multidisciplinary projects.

§3 Such continuity was not so readily apparent in human geography, whose practitioners have generated almost constant debate over its nature and methods without any one approach becoming dominant. As a result, human geography has become more fragmented than physical geography. This has been facilitated by continued growth in the number of practicing geographers, especially in the United Kingdom, where the discipline's popularity and strength in the universities has ensured the needed resources.

Ex. 38 *Find the words in the text above which mean the following; mind the paragraph order*

1. **§1**…… (adj.) refers to logical processes; based on facts

2. …… (noun; plural) a forward movement; progress in space

3. …… (noun) making more complex or refined

4. **§2**…… (verb) to recognize or establish as being a particular person or thing

5. …… (verb) to keep possession of something; to continue to use, etc.

6. **§3** …… (adj.) readily seen; exposed to sight; open to view; visible

7. …… (noun) a discussion, as of a public question in an assembly, involving opposing viewpoints

8. …… (verb) to secure or guarantee

Ex. 39 QUIZ

1. An oblate ellipsoid is: 1) A circle rotated about an ellipse. 2) An ellipse rotated about its shorter axis. 3) A circle rotated about its major axis. 4) An ellipse rotated about its longer axis. 5) An ellipse rotated about a circle.

2. What is unique about the number 10 million? 1) It is the length of the earth's minor axis of the best-fit ellipsoid. 2) It is the approximate distance from the South to the North pole, in meters, along the meridian passing through Paris. 3) It is the approximate distance from the equator to the North pole, in meters, along the meridian passing through Paris. 4) It is the approximate distance from the South to the North pole, in meters, along the parallel passing through Paris.

§14 Data and GIS

Ex. 40 *Fill in the words*

combines digital overlaid capture projections
transfer perfectly curved uploaded land use

Data in many different forms can be entered into GIS. Data that are already in map form can be included in GIS. This includes such information as the location of rivers and roads, hills and valleys. ……(1), or computerized, data can also be entered into GIS. An example of this kind of information is data collected by satellites that show ……(2)—the location of farms, towns, or forests. GIS can also include data in table form, such as population information. GIS technology allows all these different types of information, no matter their source or original format, to be ……(3) on top of one another on a single map.

Putting information into GIS is called data ……(4). Data that are already in digital form, such as images taken by satellites and most tables, can simply be ……(5) into GIS. Maps must be scanned, or converted into digital information.

GIS must make the information from all the various maps and sources align, so they fit together. One reason this is necessary is because maps have different scales. A scale is the relationship between the distance on a map and the actual distance on Earth. GIS ……(6) the information from different sources in such a way that it all has the same scale.

Often, GIS must also manipulate the data because different maps have different projections. A projection is the method of transferring information from Earth's ……(7) surface to a flat piece of paper or computer screen. No projection can copy the reality of Earth's curved surface ……(8). Different types of projections accomplish this task in different ways, but all result in some distortion. To ……(9) a curved, three-dimensional shape onto a flat surface inevitably requires stretching some parts and squeezing other parts. A world map can show either the correct sizes of countries or their correct shapes, but it can't do both. GIS takes data from maps that were made using different ……(10) and combines them so all the information can be displayed using one common projection.

QUIZ

1. An example of a datum NOT used in mapping is:

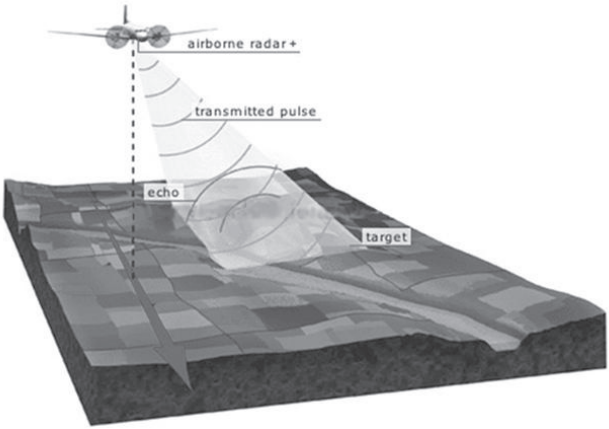
1) NAD27 2) Mean Wave Height 3) GRS80 4) WGS84 5)Mean Sea Level

2. Three models that have been used by geodesy and cartography over time are:

1) Circle, cone, and cylinder. 2) Ellipsoid, spheroid, and prolate circle.
3) Heirarchical, relational, and flat. 4) Prolate spheroid, oblate cylindroid, and geoid.
5) Ellipsoid, sphere, and geoid.

3. In the latitude and longitude system (using degrees, minutes, seconds), 20 minutes is equal to: 1) 200 seconds 2) 1/20th of a degree 3) 1/3 of an hour 4) 0.20 degrees 5)1/3 of a degree

Radar in remote sensing



Ex. 41 *Match the words with their meanings*

echo /transmitted pulse/ airborne radar / target/ radar

1. ……Detection device that emits electromagnetic waves and receives their echoes.

2. ……Brief emission of electromagnetic waves produced by a radar.

3. ……Surface or object from which radar waves reflect.

4. ……Radar used aboard an aircraft.

5. ……Waves reflected by the target and measured by a remote sensing device.

Ex. 42 *Match the words from the Glossary with their meanings*

1. d……The process of removing boundaries between adjacent polygons that have the same values for a specified attribute.

2. a……A program (software) or web mapping service designed to perform a specific task.

3. s……Technique of distance measurement wherein the observer reads the intercept subtended on a graduated rod between two marks on the reticle of the telescope.

4. b……A zone of a specified distance around coverage features, useful for proximity analysis.

§ 15 Application of GIS

Boost for poor world's cities/from BBC news

§1 The United Nations has been given $15m to help it tackle poverty and the spread of cities. The grant will provide geographic information systems software to urban planners, and train them in its use. The money is to be shared among 1,000 cities in the developing world and comes from the Environmental Systems Research Institute (Esri), a US company. The cash is going to the UN Human Settlements Programme (UN-Habitat), set up to help governments tackle the problems of rapid urbanisation.

Map making

§2Habitat is also responsible for implementing one of the Millennium Development Goals, the commitment to improve the lives of 100 million slum dwellers by 2020.

The grant was announced during the meeting in Nairobi of the governing council of the UN Environment Programme (Unep), which shares Habitat's Kenya offices.

"Most local authorities in the world have outdated information about the state of their cities," said Mrs Anna Tibaijuka, Habitat's Executive Director. "Few of them have the technologies to collect and analyse data about basic infrastructure and the current status of housing. If we are going to improve the living conditions of the urban poor, city authorities must be provided with the necessary tools, technology and training," she said.

§3"This generous grant will enable cities in the developing world to produce accurate and accessible information." She said it would help city planners to identify areas with high infant mortality rates, for example, or slums without basic services, helping them to target their resources. Urban indicators they will be able to quantify include poverty, environmental degradation, inadequate services, infrastructure degeneration, and lack of access to land and shelter.

Instant indicator

§4Mrs Tibaijuka told BBC News Online: "Habitat doesn't get $15m given to it every day, so I'm quite excited."

The grant, which totals $15,162,500, will provide each city with about $15,000-worth of geographic information systems (GIS) software, technical support, upgrades and training. In 2003 about 350 cities are likely to benefit, with the others included later. Esri says it has more than 1m GIS users in over 100 countries.

§5"GIS is based on the supposition that there's power in geography, and that you can see things better on a map," said Jeanne Rebstock Foust of Esri, "and the software works over the net, enabling cities to link up. It was used in the floods in Mozambique, for example, and it's been used in an HIV/Aids project in Nairobi. But it hasn't been made systematic. Modern society has got away from thinking about the power of place - we've lost our spatial sense. The real strength of GIS is its ability to integrate information from a range of sources - satellite imagery, say, or aerial photographs, or census data - and then analyse it. Then you can see the results in an entirely new way," said Ms Foust. "I'm

convinced this is going to make a difference in tackling poverty and city life. It's going to let us take the pulse of our cities across the world."

Ex. 43 *Find the words in the texts which mean the following; mind the paragraphs order*

1. **§1** …… (verb) to make available; to supply or equip

2. …… (verb) to undertake to handle, master, solve, etc; to deal with (a person) on some problem, issue

3. …… (noun)to cause the migration of an increasing proportion of (rural dwellers) into cities

4. **§2** …… (noun) a pledge or promise; obligation

5. …… (adjective) no longer in use or fashionable; out-of-date

6. **§3** …… …… (adj. + noun) (of a nation or geographical area) having a standard of living or level of industrial production well below that possible with financial or technical aid; not yet highly industrialized

7. …… (noun) the ability, right, or permission to approach, enter, or use

8. **§4** …… (noun) the programs used to direct the operation of a computer, as well as documentation giving instructions on how to use them

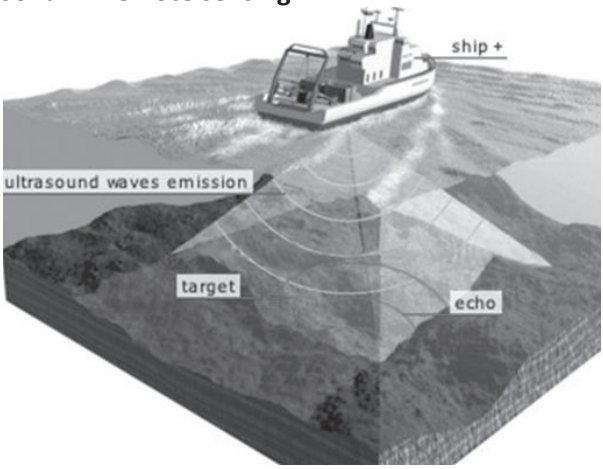
9. …… (verb) to derive an advantage; profit; make improvement

10. **§5** …… (noun; plural) a great flowing or overflowing of water, especially over land not usually submerged

11. …… (adj.) existing or occurring in space

12. …… (noun) an official enumeration of the population, with details as to age, sex, occupation

Sonar in remote sensing



Ex. 44 *Match the words from the picture with their meanings*

echo/ ultrasound waves emission/ target / sonar

1……..Detection system emitting ultrasound; it is used for detection mainly in a marine environment.

2……..Waves reflected by the target and measured by a remote sensing device.

3.……..Production of very high-frequency sound vibrations whose echo is captured and analyzed.

4……..Surface or object from which sonar waves reflect.

§ 16 GIS Maps

Ex. 45 *Translate the underlined expressions*

Once all of the desired data have been entered into a GIS system, they can be combined to produce a wide variety of individual maps, depending on which data layers are included. For instance, using GIS technology, many kinds of information can be shown about a single city. Maps can be produced that relate such information as average income, book sales, and voting patterns. Any GIS data layer can be added or subtracted to the same map. ……

GIS maps can be used to show information about number and density. ……
For example, GIS can be used to show what is near what, such as which homes and businesses are in areas prone to flooding. ……

With GIS technology, researchers can also look at change over time. They can use satellite data to study topics such as how much of the polar regions is covered in ice. A police department can study changes in crime data to help determine where to assign officers. ……

GIS often contains a large variety of data that do not appear in an onscreen or printed map. GIS technology sometimes allows users to ……
access this information. A person can point to a spot on a computerized map to find other information stored in the GIS about that location. For example, a user might click on a school to find how ……
many students are enrolled, how many students there are per teacher, or what sports facilities the school has.

GIS systems are often used to produce three-dimensional images. This is useful, for example, to geologists studying faults. ……

GIS technology makes updating maps much easier. Updated data can simply be added to the existing GIS program. A new map can then be printed or displayed on screen. This skips the traditional process of drawing a map, which can be time-consuming and expensive. ……

People working in many different fields use GIS technology. Many businesses use GIS to help them determine where to locate a new store. Biologists use GIS to track animal migration patterns. City officials use GIS to help plan their response in the case of a natural ……
disaster such as an earthquake or hurricane. GIS maps can show these officials what neighborhoods are most in danger, where to locate shelters, and what routes people should take to reach safety. ……
Scientists use GIS to compare population growth to resources such as drinking water, or to try to determine a region's future needs for ……
public services like parking, roads, and electricity. There is no limit to the kind of information that can be analyzed using GIS technology.

Ex. 46 *Match the words from the Glossary with their meanings*

1. **r**…….. **s**…….. Technique for making hypsography on a map appear three dimensional by the use of graded shadow effects. Generally, the features are shaded as though illuminated from the northwest.

2. **s**…….. Decrease in the elevation of land surface due to tectonic, seismic, or artificial forces, without removal of surface material.

3. **t**…….. Method of surveying wherein the lengths of the triangle sides are measured, usually by electronic methods, and the angles are computed from the measured lengths. Compare with triangulation.

4. **a**…….. Degree of conformity with a standard.

5. **a**…….. Horizontal direction reckoned clockwise from the meridian plane.

QUIZ

1. What colour does living vegetation appears as on false-colour IR images?

A. Green **B.** Red **C.** Black **D.** Blue **E.** Yellow

2. What is remote sensing?

A. Ability to gather information about a distant or unseen target using paranormal means or extra-sensory perception
B. Small or large-scale acquisition of information of an object or phenomenon not in physical or intimate contact
C. Electrical impedance measuring technique that uses separate pairs of current-carrying and voltage-sensing electrodes to make more accurate measurements
D. Allowing graphical applications to be run remotely on a server, while being displayed locally
E. Any system that captures, stores, analyzes, manages, and presents data that are linked to location.

3. Electromagnetic waves are defined to behave in the same way of which of the following waves?

A. Longitudinal waves **B.** Transverse waves **C.** Compressional waves
D. Mechanical wave **E.** Sound waves

4. Which of the types of waves below has the longest wavelength?

A. X-Rays **B.** Gamma Rays **C.** Hertzian Waves
D. Radio Waves **E.** Near Infrared Waves

§ 17 Magnetic Compass

Instrument for finding directions; it has a graduated compass card and a magnetic needle that points toward magnetic north.

Ex. 47 *Match the words with their meanings*

graduated dial baseline compass cover meridian line
sight base plate sighting line magnetic needle
compass card scale pivot edge sighting mirror

1. _____ Transparent surface that supports the compass card and has markings and scales.
2. _____ Line marked on the base plate that is placed on top of a topographic map; it shows the direction of the place toward which the person wishes to travel.
3. _____ Graduated line used to judge the distance to be traveled on a topographic map, in conjunction with the map's scale.
4. _____ Point around which the magnetic needle moves.
5. _____ Pointer with a red magnetized part that points to Earth's magnetic north pole.
6. _____ Line running parallel to the baselines; it is used to indicate the direction of travel.
7. _____ Device used to select a landmark in the direction a person chooses to walk.
8. _____ Each of the equal intervals marked on the dial that indicate the angle in degrees of the points on the compass card.
9. _____ Rotating device that is graduated in degrees and marked with the four cardinal points; it is used to indicate the direction of travel with respect to true north.
10. _____ Line that, when matched with the meridian line on a map, can be used to determine the direction of travel in degrees.

11. _____ Compass card marks where the needle's red dot comes to rest when the compass is aligned with magnetic north.

12. _____ Compartment that contains the mirror and protects the compass card when it is folded over the base plate.

13. _____ Polished glass surface that reflects the image of the compass card and confirms the direction of travel.

Ex. 48*Match the words from the Glossary with their meanings*

1. **b**……. Science of measuring water depths (usually in the ocean) to determine bottom topography

2. **d**……. In surveying, a reference system for computing or correlating the results of surveys.

3. **o**……. Printing or drawing on a transparent or translucent medium intended to be placed in register on a map or other graphic and which shows details not appearing or requiring special emphasis on the base material.

4. **a**…… Degree of conformity with a standard. It relates to the quality of a result, and is distinguished from precision, which relates to the quality of the operation by which the result is obtained.

5. **p**……. **m**…… Meridian of longitude 0 degrees, used as the origin for measurements of longitude.

6. **s**……. Relationship existing between a distance on a map, chart, or photograph and the corresponding distance on the Earth.

7. **a**…… Since all real measurements are imperfect, some amount of error will accumulate in the course of a survey. That error can be logically distributed throughout the survey by various adjustment procedures (i.e., manipulation of the data to produce a more logical result).

8. **b**…… **s**…… After measuring from point A to B, reading the heading from B back to A. Various factors can cause the headings to not be exactly the reverse of one another.

9. **a**…… The vertical angle between the plane of the horizon and the line to the object which is observed.

10. **b**……. A survey mark made on a monument having a known location and elevation, serving as a reference point for surveying.

11. **e**…… curved surface approximating the size and shape of the earth.

§18 Mapping

Ex. 49 *Fill in the words in the gaps*

differ charts aerial precise accommodate cadastral scale surveys refinement volume facilitated precision

The instrumentation, procedures, and standards involved in making original surveys have improved remarkably in recent years. Geodetic, topographic, hydrographic, and cadastral surveys have been …….. (1) by the application of electronics and computer sciences. At the same time, superior optics and more refined instruments, in general, have enhanced the …….. (2) of observations and accuracies of the end products.

The improved quality of surveys has increased the reliability of maps and …….. (3) based on them. In turn, the greater output of basic data has accelerated the production of maps and charts, while parallel improvements in processing steps have increased the …….. (4) and improved the final product. In a sense the production of maps from original surveys parallels the process steps after a compilation is made from derived sources. This phase is sometimes referred to as map finishing and involves editing, colour separation, and printing. In original …….. (5) for topographic maps and nautical charts, however, the end products are provided for in all the process steps leading to the completed basic manuscript. The manuscript scale is, for example, selected to …….. (6) the plotting instruments involved as well as the final rendering for printing. In early years it was usual to choose a manuscript …….. (7) somewhat larger than that prescribed for publication. This was to allow for some generalization and line …….. (8) in the final reduction. With modern photogrammetric instruments, plotting is usually at reproduction scale.

Maps are not directly derived from geodetic surveys, and only land-line plats are produced from …….. (9) surveys. Accordingly, the primary original map and chart productions are those from topographic and hydrographic surveys. The surveys are somewhat similar as the nautical chart is, in effect, a topographic map of the coast with generalized offshore topography interpolated from depth soundings.

A variety of electronic devices are used to determine a survey ship's …….. (10) location while taking soundings, which are also made with electronic equipment. Both hydrographic and topographic surveys now employ …….. (11) photography and precise plotting instruments to develop the base map. In order to simplify the description of modern mapmaking techniques, the process developed for topographic mapping will be described below, with comments where procedures for nautical charts …….. (12) significantly. Both processes start by expanding upon the basic control previously established from geodetic surveys.

Automation in mapping

1….. Achievements in the fields of electronics, high-speed digital computers, and related technologies provided a favourable period for such progress. In Great Britain, development of a set of procedures utilizing automatic elements, known as the Oxford System, was begun.
Some success was also achieved in the difficult area of automatic plotting. Instruments now available can automatically scan a stereo model and generate approximate profiles from which contours may be interpolated. **2…..** Contouring interpolated from a profile scan is inferior to an operator's delineation. This contouring meets some less exacting requirements for elevation data, and refinements in the system are improving its precision. The need for human intervention when automatic devices get "lost" is not a decisive drawback, as one operator can monitor several machines. **3…..**
Coordinatographs with high repeat accuracies facilitate the automatic plotting of control points and projection intersections. Line work can also be drafted or scribed automatically by the same process, but the respective features must first be coded to provide the necessary input tapes. Automatic colour scanning and discrimination is operational but has not become widely used; it is still necessary for an operator to trace the various features on the manuscript to code them. Obviously, little is to be gained by automatic scribing until the input can be provided automatically. Coded line work can be displayed on a cathode-ray tube and corrected with a light pen, but it is much simpler to check and correct the manuscript or finished drawing. Systems of automatic type placement at present offer only marginal advantages over conventional methods. **4…..**
An aspect of automation that is developing rapidly concerns graphic data acquisition, storage, and retrieval. Data banks are being accumulated by specialized users of topographic information, often to produce thematic maps showing soil types, vegetation classifications, and a variety of other information. Such data banks are usually organized in two parts: one for line work, such as boundaries, and the other for descriptive information or classifications. **5……** Examples of such graphics include profiles showing elevations along a selected radio propagation path and cross sections for earthwork on roads and other construction.

Ex. 50 *Read the text; put the missing sentences in the correct places*

A. The reduction of tedious and repetitive steps for stereo-operators offers a significant advancement.

B. In short, automation has made substantial advances but has not become fully operational in a practical sense.

C. Assuming that the necessary inputs have been made to the data bank, special plats can be generated speedily.

D. During the past few decades, there was much interest in the automation of mapping processes, and considerable progress was made in this area.

E. Some steps, however, must be closely monitored or else performed completely by the operator.

Grammar part

Revision of tenses

Ex. 1 *Underline the correct form.*

1 **I don't usually have** / **I'm not usually having** supper, but I'll have one tonight.
2 Jake **tries** / **is trying** to be fit for the gymnastics competition next month.
3 Mary **don't work** / **isn't working** tomorrow, so we're meeting for lunch.
4 What **are you doing** / **do you do** tonight?
5 In the spring, **I often walk** / **I'm often walking** to work.
6 Jane buys a lot of takeaways, but **I prefer** / **I'm preferring** home-made food.

Ex. 2 *Complete the sentences. Use the correct form of the verb in brackets.*

1 I _____ (already / finish) ironing when Jane offered to help.
2 As soon as I came in the cafe, we _____ (order) our food – everyone had waited for me.
3 A football team _____ (win) 2–0 at half time, but they lost the match 3–2.
4 We were exhausted when we arrived because we _____ (not sleep) for 26 hours.
5 You're lucky I'm still here. I _____ (get) ready to go out when you phoned.
6 I was thinking about him when he _____ (ring) me!
7 Last week the boss _____ (say) he would give me a pay rise, because I was so hard-working.

Ex. 3 *Complete the sentences with the present simple or present continuous forms of the verbs in brackets.*

1 I have to go. My flight _____ right now. (board)
2 Anna _____ on Thursdays or Fridays. She's part-time. (not work)
3 Where _____ for her holiday this year? (she / go)
4 He _____ a word she says. (not believe)
5 I'm writing an email and Pablo _____ a rest at the moment. (have)
6 _____ sightseeing or relaxing on the beach? (you / prefer)
7 We _____ at the moment, before it gets too busy. (shop)
8 According to the timetable, the train _____ at 6 p.m. (arrive)
9 We _____ to take insect repellent. The mosquitoes are vicious. (need)
10 You don't look very happy. What _____ about? (you / think)

Ex.4 *Complete the sentences with shall / going to / will or the present continuous.*

1 **A** I _____ (go) to town this afternoon. _____ (I / go) to the supermarket on my way back?

B Yes, we need bread, milk and some fruit.
A OK. I _____ (get) all that, and some eggs, too.

2 **A** I heard on the radio that the weather _____ (be) excellent this weekend.
B That's good, because my parents _____ (come) to stay with me.

3 **A** I went to see the new *Star wars* yesterday at the cinema. It's marvellous.
B Oh good. I _____ (see) it tomorrow.
A I know you _____ (love) it.

Ex. 5 *Complete the dialogues. Use the verbs in brackets in the present perfect simple or the past simple.*

Andy Hello, could I speak to Mr Smith, please?
Beth I'm sorry, he 1 _____ (just / go) into a meeting.

Ian 2 _____ (you / ever/ lend) anyone your car?
Steve Yes, I lent it to my brother and I would never do it again!

Petra 3 _____ (you / take) out any money from the cash machine this morning?
Toby No, because I had £30 in my wallet.

Doctor What seems to be the problem?
Jack I 4 _____ (fall) over playing basketball. I think I 5 _____ (break) my finger.

Paul How long 6 _____ (you / know) each other?
Lisa Well, we 7 _____ (meet) in 1998 and we've been good friends since.

Ex. 6 *Underline the correct word or phrase.*

1 How long has your brother **been working / does your brother work** in Moscow?
2 I'm writing an email to my best friend. I've **known / been knowing** her for years.
3 Don't worry. I **haven't been crying / cried** – I've got a flu.
4 I've been waiting for this moment **since / for** a long time.
5 He**'s doing** / **been doing** jogging for three years now.
6 I'**ve disliked / been disliking** bananas since I was a child.

Ex. 7 *Complete the sentences with used to / didn't use to / Did … use to, or the present simple + usually.*

1 He _____ (not / be) so quiet at the lesson. He must be tired today.
2 _____ (you / work) in the Spring Street office before you came here?
3 When we were younger, we often _____ (go) snorkeling in the sea.
4 I _____ (go) to the cinema on Mondays, as it is cheaper on that day.
5 I _____ (not / like) Monica much, but now we get on really well.
6 I _____ (be) an IT programmer, but then I trained to be a designer.

Ex. 8 *Complete the sentences. Use the correct form of the verb in brackets.*

1 Ted _____ (buy) a new car next week.
2 I _____ (need) a lot of sleep at the moment so I can concentrate on my exams.
3 We hardly ever _____ (eat) together as a family.
4 Hi, Alexey. Sorry, I can't talk right now. I _____ (drive).
5 You look very serious! What _____ (think) about?
6 I know that Oleg _____ (hate) me! He never says anything nice to me.
7 I _____ (have) dinner with my younger brother at 8.00 tonight.

Ex. 9 *Complete the sentences with shall / going to / will or the present continuous.*

1 A I _____ (go) into town this afternoon. _____ (I / go) to the supermarket on my way back?
B Yes, we need bread, milk and some fruit.
A OK. I _____ (get) all that, and some eggs, too.
2 A I heard on the radio that the weather _____ (be) excellent this weekend.
B That's good, because my parents _____ (come) to stay with me.
3 A I went to see Cloud Atlas yesterday at the cinema. It's excellent.
B Oh good. I _____ (see) it tomorrow.
A I think you _____ (love) it.

Ex. 10 *Complete the sentences with the correct form of the verb in brackets.*

1 Jane _____ Arabic since last year, and _____ it quite well now. (learn, speak)
2 I _____ you _____ to tell them until tomorrow. (think, not ought)
3 We _____ early yesterday, but we _____ to catch the last train. (leave, not manage)
4 Dad _____ me how to drive when I _____ 17 next year. (teach, be)
5 They _____ us the tickets _____ out. (tell, already sell)
6 I _____ go on the walk yesterday because I _____ all day. (not can, work)
7 You _____ better in the exam last week if you _____ harder. (do, study)
8 My husband _____ he _____ me up after work. (promise, pick)
9 The boss _____ me the files so I _____ at home. (send, can work)

10 _____ yet which parts of the US you _____ next summer? (you decide, visit)

Comparative or superlative forms

Ex. 11 *Write the comparative or superlative form of the adjective.*

1 I think this design is _____ (fascinating) than that one.
2 When we all checked in, Maria's baggage was _____ (heavy).
3 Is transport here _____ (costly) as in your country?
4 The trains in Germany are _____ (modern) I've ever travelled on.
5 That was probably _____ (bad) meal we've ever had in a restaurant!
6 She looks much _____ (good) with fair hair.
7 My new office is _____ (tiny) as my previous one.

Ex. 12 *Write the comparative or superlative form.*

1 The subway in Athens is _____ (modern) one I've ever been on.
2 What's _____ (quick) way to get around London?
3 Are trains here _____ (expensive) as in Britain?
4 I think my old car was _____ (economical) than my new one.
5 You look much _____ (good) with short hair!
6 Unfortunately my new office is just _____ (tiny) as my last one.
7 That was probably _____ (bad) coffee I've ever drunk!
8 Mary speaks _____ (slowly) than Anna, so she's easier to understand.

Modal verbs

Ex. 13 *Complete the sentences with have to, don't have to, must, mustn't, should, or shouldn't.*

1 Great! It's a holiday today – we _____ go to work.
2 I need your advice. Where do you think we _____ stay in Saratov, in a hotel or a bed and breakfast?
3 There are hungry crocodiles in that river. You _____ swim in it!
4 It's a great movie. You _____ see it.
5 You _____ talk loudly on your mobile in a restaurant. It's bad manners.
6 You _____ drive on the right in Germany.
7 You _____ pay to get into that exhibition – it's free.

Ex. 14 *Complete the dialogues with must, can't, or might.*

1 'You're getting married? You _____ be serious!'
'You're right. I'm just joking.'
2 'I thought you _____ like to borrow this book.'
'Oh great, thanks. I was thinking about buying it.'

3 ‘I’ve just run 20km. I’m training for a marathon.’
‘Really? You _____ feel exhausted.’
4 ‘Marilyn and Bob are on holiday in Sicily this week.’
‘They _____ be. I’ve just seen Marilyn in town.’
5 ‘I passed my driving test!’
‘Congratulations! You _____ be very happy.’
6 ‘Look, Maria left her bag here.’
‘It _____ be Jane’s– her bag is black.’
7 ‘Where’s Irina?’
‘I don’t know. She _____ be in a meeting. Shall I look in her diary?’

Ex. 15 *Complete the sentences with the correct form of can, could, be able to, or managed to.*

1 Stefan _____ play chess brilliantly when he was eight.
2 After a long wait, the journalist _____ speak to the director.
3 I’m afraid you _____ see the doctor today. She’s fully booked.
4 Don’t you think _____ to buy everything online these days is brilliant?
5 _____ I borrow your phone to make a quick call? I’ve left mine at home.
6 Elena’s credit card was out of date, so she _____ use it on holiday.
7 I’m not sure I _____ finish my report today.
8 That _____ be the real price! It’s usually much cheaper.
9 Ask at the information desk. They should _____ help you.
10 We _____ to get to the bank before it closed. It was too late.

Ex. 16 *Complete the sentences with the correct word(s).*

1 Great! We don’t _____ to get up early tomorrow. It’s a holiday.
have must
2 _____ I buy a new drill? This one’s very old now.
Ought Should
3 You really _____ visit Denmark if you like good design.
have must
4 There are lots of nails in the toolbox. We _____ get any more.
haven’t needn’t
5 Did they really _____ cut down that beautiful tree? It was fine!
must need to
6 We _____ leave late if we want to get the train.
mustn’t don’t have to
7 She _____ to take the jumper back to the shop. The size was wrong.
had must
8 Mark _____ to eat less fast food. It’s very bad for him.

should ought

9 I live on my own, so I often _____ do small repairs myself.
have to need

10 Sue's just decorated her flat. She _____ to do it again for a long time.
won't need mustn't

Ex. 17 *Complete the sentences with the correct form of can, could, or be able to.*

1 What does this label say? I _____ see without my glasses.
2 I've never _____draw well, but my brother is brilliant.
3 _____ you lend me a pen, please?
4 I'm free tonight, so I'll _____ come and help you if you like.
5 After three months living here, I _____ understand quite a lot of Japanese.
6 I'd love _____ play a musical instrument.

Conditionals

Ex. 18 *Underline the correct word(s).*

1 She won't go **if / unless** Rob goes, because she can't drive.
2 They said they'd phone us **as soon as / until** their plane lands.
3 Don't eat anything now! Wait **until / when** dinner's ready.
4 You won't get there on time **unless / if** you don't leave work early.
5 This is an urgent message. Please call me as soon **as / if** you get home.

Ex. 19 *Complete the sentences. Use the correct form of the verb in brackets.*

1 She wouldn't help you if she _____ (not want) to.
2 I _____ (buy) you a present if you are good.
3 He _____ (not do) such a dangerous job unless he enjoyed it.
4 If you _____ (not ask) for a pay rise, you won't get one.
5 If I _____ (have) better qualifications, I could be a professor.
6 I _____ (not complain) if I had their lifestyle!
7 If he _____ (not pass) the exam, he'll be so disappointed.
8 His teacher won't be angry if he _____ (tell) her the truth.
9 If I were you, I _____ (buy) a more reliable car.

Ex. 20 *Complete the sentences with the correct form of the verb in brackets.*

1 If they _____ her a part-time job, would she accept it? (offer)
2 You _____ get good marks in your exams if you want to study Law. (have to)
3 He _____ me if he had enough time, but he's too busy right now. (help)
4 They'd offer me the job if I _____ the right experience. (have)

5 I _____ an appointment to see the doctor if I feel worse tomorrow. (make)
6 If you want to earn some money, _____ an intern. (not become)
7 He _____ finish the report unless he stays at work late. (be able to)
8 If you _____ her the truth, she would probably understand. (tell)
9 Students _____ to get a holiday job if they had more money. (not need)
10 _____ us tomorrow if you feel like going out. (phone)

Ex. 21 *Complete the sentences with the correct form of the verb in brackets.*
1 I _____ (not / finish) my homework if you hadn't helped me.
2 If she _____ (not / pass) her driving test, she would have been really disappointed.
3 We _____ (look after) the children last night if you had asked.
4 He would have resigned if he _____ (not / be) promoted.
5 She _____ (be) worried if you hadn't phoned to say you were OK.
6 We wouldn't have had the accident if you _____ (pay) more attention.

Reported speech

Ex. 22 *Complete the sentences using reported speech.*
1 'Don't walk on the grass!'
The man told us _____ walk on the grass.
2 'We may not have it in stock.'
The shop assistant said they _____ have it in stock.
3 'I'll give you a lift.'
He said he _____ give me a lift.
4 'What are your names?'
They asked us what our names _____.
5 'I must be back at 3 p.m.'
He said he _____ be back at 3 p.m.
6 'Are you listening?'
The teacher asked us _____ we were listening.
7 'I've left my homework at home.'
She said she _____ her homework at home.

Ex. 23 *Complete the sentences using reported speech.*
1 'How long has Adam been working here?'
Carlos asked _____.
2 'Don't forget to send the application form.'
She told me _____.
3 'We're flying to Rio tomorrow.'

Robert said _ _____.

4 'I don't want to work for another company.'
He told me _____.

5 'Paul's already visited New Zealand twice.'
Mia said _____.

Ex. 24 *Write the sentences using direct speech.*

1 She said she'd never forget the first time she met Frank.
' _____ _____ '

2 Tom asked her why she hadn't finished her report the week before.
' _____ _____ '

3 She told me they had to leave before 9.30.
' _____ _____ '

4 He asked me if I'd bought the food for the camping trip.
' _____ _____ '

5 She said James had lived there for nearly five years.
' _____ _____ '

Passive voice

Ex. 25 *Complete the sentences with the correct passive form of the verb in brackets.*

1 Please wait in the lounge while your room _____ (clean).
2 From next week, you _____ (expect) to arrive at work on time.
3 Too much money _____ (spend) last year on personal expenses.
4 Most of the pollution in city centres _____ (cause) by traffic jams.
5 Around £500,000 _____ (steal) from a bank in Zurich this afternoon.
6 Next year over 2,000,000 mobile phones _____ (make) in South Korea.
7 Kill Bill _____ (direct) by Quentin Tarantino.

Ex. 26 *Complete the second sentence so that it means the same as the first.*

1 Local farmers find items from the war here.
Items from the war _____ here by local farmers.

2 More people will probably visit the museum this year.
The museum _____ by more people this year.

3 You have to switch off your phone inside the library.
Phones _____ inside the library.

4 They were restoring some paintings at the time we went.
Some paintings _____ at the time we went.

5 Do you like people asking you personal questions?
Do you like _____ personal questions?

6 They have discovered new information about Stonehenge.
New information about Stonehenge _____.

7 A helmet should be worn when cycling.

You _____ a helmet when cycling.

8 People regard Shakespeare as a genius.
Shakespeare _____ as a genius.

9 Companies oughtn't to call people in the evenings.
People _____ by companies in the evenings.

10 It's impossible to learn to drive in a week.
You _____ to drive in a week.

Gerund and Infinitive

Ex. 27 *Complete the sentences with the -ing form or the infinitive (with or without to) of the verb in brackets.*

1 I love _____ (not / have) to get up at 5.30 a.m. any more.
2 Ian doesn't seem _____ (enjoy) his job very much.
3 I've given up _____ (try) to learn how to dance salsa – I'm hopeless!
4 Natalie said I should _____ (learn) to do yoga to relieve stress.
5 Would you mind _____ (turn) your music down? I can't concentrate.
6 Kate's just gone to the shop _____ (get) a newspaper.

Ex. 28 *Complete the sentences with the gerund or infinitive form of the verb in brackets.*

1 I can't afford _____ a car any more. Petrol's so expensive. (have)
2 She tried _____ tickets for the concert but it was too late. (get)
3 We never feel like _____ out during the week. (go)
4 How good are you at _____ names? I'm terrible. (remember)
5 The teacher made them _____ late at the end of lesson. (stay)
6 I can't imagine _____ to each other every day. (not talk)
7 You should stop _____ so many pizzas. It's unhealthy! (eat)
8 It's much more difficult _____ tickets for football matches now. (buy)
9 They told me _____ my videogame, but I did it anyway. (not play)

Ex. 29 *Complete the second sentence so that it means the same as the first.*

1 He doesn't help me with my homework on Russian language any more.
He's given up _____ with my Russian language homework.
2 My aunt thinks I should take more time off work.
My aunt wants me _____ more time off work.
3 Their boss said they could go home early.
Their boss let _____ home early.
4 She said she would call Andrei tomorrow.
She agreed _____ Andrei tomorrow.

Grammar revision

Ex.30 *Complete the sentences. Use the correct form of the verb in brackets.*

1 Jaime isn't in the office today. He _____ (work) at home.
2 I _____ (answer) sixteen emails since ten o'clock this morning.
3 They _____ (watch) a football match on TV when we arrived.
4 What _____ you _____ (give) Pete for his birthday last week?
5 I _____ (go) to the doctor's at 4.30. I'll see you at 5.00.
6 _____ he _____ (finish) his homework yet? Oh, that was quick!
7 Don't get a taxi. I _____ (meet) you after the class in the car.
8 _____ you _____ (see) the new James Bond film next week?
9 We _____ (stay) with my parents at the moment while we look for a flat.
10 _____ you ever _____ (drive) a sports car?
11 _____ David _____ (look for) me at 10.30? I was in a meeting.
12 We _____ (just finish) lunch when Joe arrived.
13 Sorry I'm late. _____ you _____ (wait) long?
14 Will you _____ (can) help us move house next week?
15 The train _____ (not arrive) yet. It's an hour late.

Ex. 31 *Underline the correct word(s).*

1 My sister's *a science teacher* / *science teacher* in a secondary school.
2 Tom *was playing* / *used to play* cricket when he was young.
3 You *mustn't* / *don't have to* pay for museums in the UK. They're usually free.
4 I'm afraid you *can't* / *couldn't* speak to Mr Jones. He's in a meeting.
5 My boyfriend drives *more slowly* / *slowlier* than I do.
6 I dropped my mobile phone in the bath last month so I *must* / *had to* get a new one.
7 You *shouldn't* / *don't have to* eat so much salt. It isn't good for you.
8 *Do you like* / *Are you liking* going to hot places on holiday?
9 Have you *been having* / *had* that computer for a long time?
10 This summer wasn't as hot *than* / *as* it was last summer.
11 He *doesn't need* / *isn't needing* to do any work this evening.
12 What time *do you go* / *are you going* out tonight?
13 You listened to the instructions *more* / *most* carefully than I did.
14 She's been working with us *for* / *since* 2004.
15 We like going to *restaurants* / *the restaurants* at the weekends.

Ex. 32 *Complete the sentences. Use the correct form of the verb in brackets.*

1 James _____ (like) pasta, doesn't he?
2 If I _____ (be) taller, I'd be a brilliant basketball player.
3 As soon as Tina gets here we _____ (start) the meeting.
4 If we don't burn less oil and coal, global warming _____ (get) worse.
5 You would have passed the exam if you _____ (answer) all the questions.

6 I _____ (get) home much earlier if the train had been on time.
7 Whales _____ often _____ (see) off the coast of Norway in winter.
8 Elena rang and said that she _____ (call) back later.
9 The doctor told me _____ (sit) down and take my shirt off.
10 My car _____ (repair) at the moment so Dave gave me a lift to work today.
11 When we _____ (check in), I'll ask for a window seat for you.
12 That photo _____ (take) so long ago, it doesn't even look like me now!
13 Fran is celebrating. She _____ just _____ (offer) a new job.
14 _____ (go) to live in New Zealand if you had the opportunity?
15 Landing cards _____ (hand) out in a few minutes before the plane lands.

Ex.33 <u>Underline</u> the correct word or phrase.

1 Gillian *must* / *can't* be paid well. She's always going on foreign holidays.
2 I'm really bad at *to cook* / *cooking*, but I'm very good at buying takeaways.
3 I didn't have *time enough* / *enough time* in the exam to check my answers.
4 It's *too much* / *too* cold in here – can you put the heating on?
5 People *who* / *what* ask questions usually learn the most.
6 I asked Jon whether *did he speak* / *he spoke* Chinese.
7 Excuse me, could I have a *little* / *few* more milk in my coffee, please?
8 My house is easy *to find* / *finding* – it's opposite the train station.
9 If I needed to buy a car, I *had borrowed* / *would borrow* money from the bank.
10 There are *any* / *no* good sports facilities in this town.
11 I don't think I can afford *going* / *to go* abroad on holiday this year.
12 She *can't* / *mustn't* be at home. Her car isn't there.
13 You forgot *turning* / *to turn* off the television when you went to bed last night.
14 Steve said he would call you later, *did* / *didn't* he?
15 If you'd asked me, I *'d be* / *'d have been* glad to help you.

Ex. 34 *Complete the sentences. Use the correct form of the verb in brackets.*

1 Sonia _____ (work) in the garden. Shall I call her for you?
2 We _____ (go) to the Edinburgh Festival in August last year.
3 If I found £20 on the floor in a shop, I _____ (give) it to one of the assistants.
4 My mother _____ (go) to salsa dance classes for the last two months – she loves it!
5 Wait until Roberto _____ (get) here and then the meeting can begin.
6 I think I _____ (send) Pedro the wrong file when I emailed him yesterday.
7 Diana told me she _____ (want) to start learning French.
8 I _____ (drink) less coffee at the moment to see if it helps with my headaches.
9 'Is Mike at home?' 'He _____ (go) to the shops. He'll be back in an hour.'
10 When we returned, we saw that somebody _____ (break) one of our windows.
11 I would have invited you to the party if I _____ (know) you were around!

12 Students will get their results in June. A letter _____ (send) to their home address.
13 I don't want to eat curry again! We _____ (have) it twice last week.
14 'Didn't you hear your phone ring?' 'No, I _____ (listen) to music on headphones.'
15 Mary _____ (meet) Anna for lunch most days. Their offices are very close.

Ex.35 *Underline the correct word(s).*

1 I don't mind people *disagree* / *disagreeing* with me.
2 Could you drive more *slower* / *slowly*? I hate it when you drive fast.
3 Sally *wouldn't* / *won't* pass her driving test if she doesn't practise more.
4 That's the man *whose* / *who's* dog bit me last month!
5 You *mustn't* / *shouldn't* record films in the cinema. It's illegal!
6 My sister *said* / *told* me not to tell anyone about her new boyfriend.
7 *Will* / *Shall* you call me when William arrives?
8 If you sent him a birthday card, *he'll* / *he'd* really appreciate it.
9 Lisa *usually* / *use to* listens to the radio when she works.
10 There were very *few* / *little* people at the concert because of the weather.
11 We'll come and see you again *the next* / *next* Saturday.
12 There aren't *any* / *no* eggs in the fridge. Shall I get some?
13 You won't be able to get home *unless* / *if* you call a taxi.
14 Richard has always worked much harder *than* / *that* I do.
15 The Olympics and Paralympics *held* / *were held* in London in 2012.

Extra reading

Geographic Information System (GIS)

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. GIS can show many different kinds of data on one map. This enables people to more easily see, analyze, and understand patterns and relationships.

With GIS technology, people can compare the locations of different things in order to discover how they relate to each other. For example, using GIS, the same map could include sites that produce pollution, such as gas stations, and sites that are sensitive to pollution, such as wetlands. Such a map would help people determine which wetlands are most at risk.

GIS can use any information that includes location. The location can be expressed in many different ways, such as latitude and longitude, address, or ZIP code. Many different types of information can be compared and contrasted using GIS. The system can include data about people, such as population, income, or education level. It can include information about the land, such as the location of streams, different kinds of vegetation, and different kinds of soil. It can include information about the sites of factories, farms, and schools, or storm drains, roads, and electric power lines.

GIS: computer graphic formats

The two most common computer graphic formats are vector and raster, both of which are used to store graphic map elements. Vector-based GIS represents the locations of point entities as coordinate pairs in geographic space, lines as multiple points, and areas as multiple lines. Topographic surfaces are frequently represented in vector format as a series of nonoverlapping triangles, each representing a uniform slope. This representation is known as Triangulated Irregular Network (TIN). Map descriptions are stored as tabular data with pointers back to the entities. This allows the GIS to store more than one set of descriptions for each graphic map object.

Raster-based GIS represents points as individual, uniform chunks of the Earth, usually squares, called grid cells. Collections of grid cells represent lines and areas. Surfaces are stored in raster format as a matrix of point elevation values, one for each grid cell, in a format known as a digital elevation model

(DEM). DEM data can be converted to TIN models if needed. Whether raster or vector, the data are stored as a collection of thematic maps, variously referred to as layers, themes, or coverages.

Computer algorithms enable the GIS operator to manipulate data within a single thematic map. The GIS user may also compare and overlay data from multiple thematic maps, just as planners used to do by hand in the mid-1900s. A GIS can also find optimal routes, locate the best sites for businesses, establish service areas, create line-of-sight maps called viewsheds, and perform a wide range of other statistical and cartographic manipulations. GIS operators often combine analytical operations into map-based models through a process called cartographic modeling. Experienced GIS users devise highly sophisticated models to simulate a wide range of geographic problem-solving tasks. Some of the most complex models represent flows, such as rush-hour traffic or moving water, that include a temporal element.

History of Surveying

It is quite probable that surveying had its origin in ancient Egypt. The Great Pyramid of Khufu at Giza was built about 2700 bce, 755 feet (230 metres) long and 481 feet (147 metres) high. Its nearly perfect squareness and north–south orientation affirm the ancient Egyptians' command of surveying.

Evidence of some form of boundary surveying as early as 1400 bce has been found in the fertile valleys and plains of the Tigris, Euphrates, and Nile rivers. Clay tablets of the Sumerians show records of land measurement and plans of cities and nearby agricultural areas. Boundary stones marking land plots have been preserved. There is a representation of land measurement on the wall of a tomb at Thebes (1400 bce) showing head and rear chainmen measuring a grainfield with what appears to be a rope with knots or marks at uniform intervals. Other persons are shown. Two are of high estate, according to their clothing, probably a land overseer and an inspector of boundary stones.

There is some evidence that, in addition to a marked cord, wooden rods were used by the Egyptians for distance measurement. There is no record of any angle-measuring instruments of that time, but there was a level consisting of a vertical wooden A-frame with a plumb bob supported at the peak of the A so that its cord hung past an indicator, or index, on the horizontal bar. The index could be properly placed by standing the device on two supports at approximately the same elevation, marking the position of the cord, reversing

the A, and making a similar mark. Halfway between the two marks would be the correct place for the index. Thus, with their simple devices, the ancient Egyptians were able to measure land areas, replace property corners lost when the Nile covered the markers with silt during floods, and build the huge pyramids to exact dimensions.

The Greeks used a form of log line for recording the distances run from point to point along the coast while making their slow voyages from the Indus to the Persian Gulf about 325 bce. The magnetic compass was brought to the West by Arab traders in the 12th century ce. The astrolabe was introduced by the Greeks in the 2nd century bce. An instrument for measuring the altitudes of stars, or their angle of elevation above the horizon, took the form of a graduated arc suspended from a hand-held cord. A pivoted pointer that moved over the graduations was pointed at the star. The instrument was not used for nautical surveying for several centuries, remaining a scientific aid only.

The Greeks also possibly originated the use of the groma, a device used to establish right angles, but Roman surveyors made it a standard tool. It was made of a horizontal wooden cross pivoted at the middle and supported from above. From the end of each of the four arms hung a plumb bob. By sighting along each pair of plumb bob cords in turn, the right angle could be established. The device could be adjusted to a precise right angle by observing the same angle after turning the device approximately 90°. By shifting one of the cords to take up half the error, a perfect right angle would result.

About 15 bce the Roman architect and engineer Vitruvius mounted a large wheel of known circumference in a small frame, in much the same fashion as the wheel is mounted on a wheelbarrow; when it was pushed along the ground by hand it automatically dropped a pebble into a container at each revolution, giving a measure of the distance traveled. It was, in effect, the first odometer.

The water level consisted of either a trough or a tube turned upward at the ends and filled with water. At each end there was a sight made of crossed horizontal and vertical slits. When these were lined up just above the water level, the sights determined a level line accurate enough to establish the grades of the Roman aqueducts. In laying out their great road system, the Romans are said to have used the plane table. It consists of a drawing board mounted on a tripod or other stable support and of a straightedge—usually with sights for accurate aim (the alidade) to the objects to be mapped—along which lines are drawn. It was

the first device capable of recording or establishing angles. Later adaptations of the plane table had magnetic compasses attached.

Modern surveying

Geodetic surveys involve such extensive areas that allowance must be made for the Earth's curvature. Baseline measurements for classical triangulation (the basic survey method that consists of accurately measuring a base line and computing other locations by angle measurement) are therefore reduced to sea-level length to start computations, and corrections are made for spherical excess in the angular determinations. Geodetic operations are classified into four "orders," according to accuracy, the first-order surveys having the smallest permissible error. Primary triangulation is performed under rigid specifications to assure first-order accuracy.

Efforts are now under way to extend and tie together existing continental networks by satellite triangulation so as to facilitate the adjustment of all major geodetic surveys into a single world datum and determine the size and shape of the Earth spheroid with much greater accuracy than heretofore obtained. At the same time, current national networks will be strengthened, while the remaining amount of work to be done may be somewhat reduced. Satellite triangulation became operational in the United States in 1963 with observations by Rebound A-13, launched that year, and some prior work using the Echo 1 and Echo 2 passive reflecting satellites. The first satellite specifically designed for geodetic work, Pageos 1, was launched in 1966.

A first requirement for topographic mapping of a given area is an adequate pattern of horizontal and vertical control points, and an initial step is the assembly of all such existing information. This consists of descriptions of points for which positions (in terms of latitude and longitude) and elevations above mean sea level have been determined. They are occasionally located at some distance from the immediate project, in which case it is necessary to expand from the existing work. This is usually done on second- or third-order standards, depending upon the length of circuits involved.

The accuracy of survey measurements can be improved almost indefinitely but only at increased cost. Accordingly, control surveys are used; these consist of a comparatively few accurate measurements that cover the area of the project and from which short, less accurate measurements are made to the objects to be located. The simplest form of horizontal control is the traverse, which consists of

a series of marked stations connected by measured courses and the measured angles between them. When such a series of distances and angles returns to its point of beginning or begins and ends at stations of superior (more accurate) control, it can be checked and the small errors of measurement adjusted for mathematical consistency. By assuming or measuring a direction of one of the courses and rectangular coordinates of one of the stations, the rectangular coordinates of all the stations can be computed.

Surveying

Surveying, in which the facts are discovered and recorded, must precede mapping, in which the facts are presented in graphic form. Surveying involves (1) global positioning, in which the area to be mapped is located on the Earth's surface, usually by fixing a number of points in the area by astronomical observations or, after the techniques became available, by satellite or radar procedures; (2) establishing the framework, in which these points, and commonly many others connected by some combination of distance and angle measurements, are integrated into an accurately defined structure—like the steel framework of a modern building—on which the detail survey is based; and (3) making the detail survey, which establishes by less accurate (and therefore cheaper) methods the relative positions and shapes of the features being mapped. Constant reference to the framework prevents the errors in the detail survey from accumulating and growing unacceptably large.

Mapping also consists of three steps: (1) fair drawing, in which the accurate but not publishable surveyor's plot is redrawn by a skilled cartographer with uniform lines and lettering and, if a multicoloured map is being produced, is separated into several drawings, one for each colour; (2) reproduction, in which a negative is prepared from each of the fair-drawn originals and special colouring (to represent areas of vegetation, for example) is added; and (3) printing, in which a printing plate is made from each negative, the plates are mounted on a press, proofs (a few trial copies) are made to facilitate correction of errors and blemishes, and the final maps are produced.

GIS Maps

Once all of the desired data have been entered into a GIS system, they can be combined to produce a wide variety of individual maps, depending on which

data layers are included. For instance, using GIS technology, many kinds of information can be shown about a single city. Maps can be produced that relate such information as average income, book sales, and voting patterns. Any GIS data layer can be added or subtracted to the same map.

GIS maps can be used to show information about number and density. For example, GIS can be used to show how many doctors there are in different areas compared with the population. They can also show what is near what, such as which homes and businesses are in areas prone to flooding. With GIS technology, researchers can also look at change over time. They can use satellite data to study topics such as how much of the polar regions is covered in ice. A police department can study changes in crime data to help determine where to assign officers.

GIS often contains a large variety of data that do not appear in an onscreen or printed map. GIS technology sometimes allows users to access this information. A person can point to a spot on a computerized map to find other information stored in the GIS about that location. For example, a user might click on a school to find how many students are enrolled, how many students there are per teacher, or what sports facilities the school has. GIS systems are often used to produce three-dimensional images. This is useful, for example, to geologists studying faults. GIS technology makes updating maps much easier. Updated data can simply be added to the existing GIS program. A new map can then be printed or displayed on screen. This skips the traditional process of drawing a map, which can be time-consuming and expensive.

People working in many different fields use GIS technology. Many businesses use GIS to help them determine where to locate a new store. Biologists use GIS to track animal migration patterns. City officials use GIS to help plan their response in the case of a natural disaster such as an earthquake or hurricane. GIS maps can show these officials what neighborhoods are most in danger, where to locate shelters, and what routes people should take to reach safety. Scientists use GIS to compare population growth to resources such as drinking water, or to try to determine a region's future needs for public services like parking, roads, and electricity. There is no limit to the kind of information that can be analyzed using GIS technology.

Application of GIS in Geological Mapping – Fast, Accurate, and Cost-Effective

Geological mapping was a difficult procedure involving multiple complex technologies until researchers discovered the potential of GIS. With the application of GIS in geological mapping, it became very easy for surveyors to create 3D maps for any area with precise and desired scaling.

Geological features are dependent on space and time. The Geographical Information Systems (GIS) are capable of defining all three factors of space (represented by the X, Y, and Z planes) and time. The signals from the satellites allow the GIS to read information in term of longitude, latitude, and elevation (compared to the sea level). This information helps in determining all three planes that guide GIS tools in creating a 3-D image of the area under survey.

The satellite signals also send in information about the time when the satellite released the signals, clock redundancy of the transmitters in the satellites, and coefficient of error through the speed of signal in the space as well as in the different layers of atmosphere. Based on these four factors, surveyors can create accurate geological maps of the area under survey.

Though the old methods of geological methods (based on multivariate statistics) are still in use in some countries, the GIS is the most preferred as it is cost-effective and offers more accurate data, thereby easing the scaling process when studying geological maps.

GIS helps in scanning, referencing, and reproducing older maps at any desired scale. Using GIS, several archeological geological maps (having different scales) have been combined into a single map (with single scaling) with even more accuracy, thus saving the time of scientists, engineers, and researchers who need to study the area.

Using the accurate scaling obtained from GIS, different projects can be planned without the need of additional equipments for surveying the area. The different projects that can be planned and implemented using applications of GIS in geological mapping can be anything from creating a dam or reservoir to roads, highways and railroads to an entire town. The benefits of application of GIS in geological mapping are visible when different projects can be entirely planned without even leaving the conference room!

History of Aerial Photography

Dark Room in a Hot-Air Balloon

The first known aerial photograph was taken in 1858 by French photographer and balloonist, Gaspar Felix Tournachon, known as "Nadar". In 1855 he had patented the idea of using aerial photographs in mapmaking and surveying, but it took him 3 years of experimenting before he successfully produced the very first aerial photograph. It was a view of the French village of Petit-Becetre taken from a tethered hot-air balloon, 80 meters above the ground. This was no mean feat, given the complexity of the early collodion photographic process, which required a complete darkroom to be carried in the basket of the balloon! Unfortunately, Nadar's earliest photographs no longer survive, and the oldest aerial photograph known to be still in existence is James Wallace Black's image of Boston from a hot-air balloon, taken in 1860. Following the development of the dry-plate process, it was no longer necessary carry so much equipment, and the first free flight balloon photo mission was carried out by Triboulet over Paris in 1879.

Kites, Pigeons and Rockets

Gradually, improvements in photographic technology made it easier to take cameras into the skies. Besides hot air balloons, early pioneers also used kites, pigeons and rockets to carry their cameras aloft.

The English meteorologist E. D. Archibald was among the first to take successful photographs from kites in 1882. He used a string of kites, with the camera being attached to the last. In France, Arthur Batut took aerial photographs from a kite in 1889, in Labruguiere, France. He suspended his still rather large camera from a single kite, and sot an automatically timed exposure. A slow burning fuse, responding to a rubber band driven device, triggered the shutter within a few moments of the kite being launched. Batut's first aerial photograph was taken in May 1888.

In California, the devastation of San Francisco after the 1906 earthquake and fire was captured by George R. Lawrence, using a camera attached to a string of kites high above the city. His specially designed large-format camera had a curved film plate to provide panoramic images, which remain some of the largest aerial exposures ever taken. The camera, which was large and extremely heavy, took as many as 17 kites to lift it 7,000 feet into the air. Lawrence also used ladders and high towers to capture lower level "aerial" photographs.

GLOSSARY

Accuracy
Absorption
Adjustment/ adjustment standard
Accuracy
Aerial mosaic
Aerophotogrammetry
Aerotriangulation
Alidade
Alignment
Altimeter/Altimetry/Altitude
Azimuth
Application
Approximation
Archipelago
Array
Arc

Bathymetry
Bench mark
Boundary survey
Buffer

Cadastre/ Cadastral survey
Cartography/Cartographic representation
Chart aeronautical/ nautical/bathymetric
Compilation
Contour
Control mapping

Datum (pl. datums)
Depth curve
Declination
Dike
Dimensions
Dissolve
Distortion

Elevation
Ellipsoid
Erosion
Error
Estuary

Feature separation
Formlines

Geoid/Geodetic station
Geocoding
Graticule
Grid/ grid system

Hachure
Halftone
Hydrographic survey/hydrography
Hypsography
Hypsometry

Imagery
Intersection
Isthmus
Isogonic chart/isogonic line

Landmark
Latitude/longitude/ prime meridian
Legend
Levee
Leveling

map, base
map, bathymetric
map, cadastral
map, choropleth
map, engineering
map, flood control
map, forestry
map, geologic
map, hypsographic
map, hypsometric

map, isopleth
map, land use
map, planimetric
map, slope (clinometric map)
map, soil
map, storm evacuation.
map, thematic .
map, topographic
Mapping
Map projections
Mete
Mosaic, aerial

Neatline
Node

Occident/Occidental
Optical axis
Orient/Oriental/orientation
Orthophotoquad
Orthophotoscope
Overedge
Overlay

Photogrammetry
Peninsula
Pixel
Planetable
Planimetry
Plat
Plotting
Prairie
Prime meridian
Projection

Raster
Rectification simple
Rectification differential
Relief/relief shading
Remote sensing
Reproduction

Satellite
Scale
Scattering
Spatial resolution
Spot elevation
Stadia
Stereocompilation
Stereoplotter
Stereoscopic/stereoscopy
Strait
Subsidence
Survey

Tachometer (tachymeter)
Theodolite
Topography/topographic map
Traverse
Triangulation
Trilateration

Vector

Wavelength

Definitions

1. accuracy Degree of conformity with a standard. Accuracy relates to the quality of a result and is distinguished from precision which relates to the quality of the operation by which the result is obtained.
2. adjustment Process designed to remove inconsistencies in measured or computed quantities by applying derived corrections to compensate for random or accidental errors.
3. adjustment, land- line Positioning land lines on a map to indicate their true, theoretical, or approximate location relative to the adjacent terrain and culture, by reconciling the information shown on Bureau of Land Management plats and field records with the ground evidence of the location of the lines.
4. adjustment, standard accuracy Adjustment of a survey resulting in values for positions and (or) elevations that comply with the National Map Accuracy Standards.
5. aerotriangulation The process of developing a network of horizontal and or vertical positions from a group of known positions using direct or indirect measurements from aerial photographs and mathematical computations.
6. alidade Instrument, or part of an instrument , for determining direction , either horizontal or vertical . In its simplest form, a peepsight or telescope mounted on a straightedge and used for plotting directions graphically. In such instruments as transits and theodolites, the alidade is the part containing the telescope and its attachments.
7. altimeter Instrument for measuring altitudes or elevations with respect to a reference level, usually mean sea level. The most common type is an aneroid barometer.
8. azimuth Horizontal direction reckoned clockwise from the meridian plane.
9. bathymetry Science of measuring water depths (usually in the ocean) to determine bottom topography.
10. bench mark Relatively permanent material object, natural or artificial, bearing a marked point whose elevation above or below an adopted datum is known.
11. boundary survey Survey made to establish or to reestablish a boundary line on the ground, or to obtain data for constructing a map or plat showing a boundary line.

12. cadastral survey Survey relating to land boundaries, made to create units suitable for title transfer or to define the limitations of title. Derived from "cadastre" meaning a register of land quantities, values, and ownership used levying taxes, the term may properly be applied to surveys of a similar nature outside the public lands, such surveys are more commonly called "land surveys" or "property surveys."

13. cartography Science and art of making maps and charts.

14. chart Special-purpose map designed for navigation or to present specific data or information. The term "chart" is applied chiefly to maps made primarily for nautical and aeronautical navigation, and to maps of the heavens, although the term is sometimes used to describe other special-purpose maps.

15. chart, aeronautical Charts designed to meet requirements of aerial navigating, produced in several series, each on a specified map projection and differing in scale, format, and content, for use as dictated by type of aircraft and whether flight is to be conducted under visual or instrument flight rules.

16. chart, nautical Representation of a portion of the navigable waters of the Earth and adjacent coastal areas on a specified map projection and designed specifically to meet requirements for marine navigation.

17. compilation Preparation of a new or revised map or chart, or portion thereof, from existing maps, aerial photographs, field surveys, and other sources.

18. control mapping Points of established position or elevation, or both, which are used to fix references in positioning and correlating map features.

19. control station Point on the ground whose position (horizontal or vertical) is known and can be used as a base for additional survey work.

20. coordinates Linear and (or) angular quantities that designate the position of a point in relation to a given reference frame.

21. coordinates, origin of Points in a system of coordinates which serves as a zero point in computing the system's elements or in prescribing its use.

22. datum (pl. datums) In surveying, a reference system for computing or correlating the results of surveys.

23. declination In astronomy, the angular distance of a celestial body above (north, plus) or below (south, minus) the celestial Equator.

24. depth curve Line on a map or chart connecting points of equal depth below the datum.

25. diazo process Rapid method for copying documents in which the image is developed by exposure to ammonia.

26. Dike Bank of earth or stone used to form a barrier, frequently and confusingly interchanged with levee. A dike restrains water within an area that normally is flooded. See levee.

27. elevation Vertical distance of a point above or below a reference surface or datum.

28. formlines Lines, resembling contour lines, drawn to present a conception of the shape of the terrain without regard to a true datum or regular spacing

29. geodesy Science concerned with the measurement and mathematical description of the size and shape of the earth and its gravitational fields.

30. geoid Figure of the Earth visualized as a mean sea level surface extended continuously through the continents. It is a theoretically continuous surface that is perpendicular at every point to the direction of gravity (the plumbline).

31. graticule Network of parallels and meridians on a map or chart.

32. graticule, geographic System of coordinates of latitude and longitude used to define the position of a point on the surface of the Earth with respect to the reference spheroid.

33. grid Network of uniformly spaced parallel lines intersecting at right angles.

34. hachure Any series of lines used on a map to indicate the general direction and steepness of slopes.

35. hydrographic survey Survey of water area, with particular reference to submarine relief, and any adjacent land. See: oceanographic survey

36. hydrography Science that deals with the measurement and description of the physical features of the oceans, seas, lakes, rivers, and their adjoining coastal areas, with particular reference to their use for navigation.

37. hydrology Scientific study of the waters of the Earth, especially with relation to the effects of precipitation and evaporation upon the occurrence and character of ground water.

38. hypsography Topography referred to the national geodetic vertical datum of

1929. The science or art of describing heights of land surfaces with reference to this datum.

39. hypsometry Science or art of determining terrain relief, by any method.

40. infrared scanner (thermal mapper) Instrument that detects infrared radiation and converts the detected energy to an electrical signal for recording on photographic film or magnetic tape.

41. isogonic chart Chart showing isogonic lines properly labeled with their magnetic declination.

42. isogonic line Line joining points on the Earth's surface having equal magnetic declination as of a given date.

43. land use classification system Coding system of categories and subcategories designed for use on a map to designate land or water use.

44. landmark Monument of material mark or fixed object used to designate a land boundary on the ground: any prominent object on land that may be used to determine a location or a direction in navigation or surveying.

45. latitude Angular distance, in degrees, minutes, and seconds of a point north or south of the Equator.

46. lead line Line weighted with lead for making depth soundings in water.

47. levee Artificial bank confining a stream channel or limiting adjacent areas subject to flooding; an embankment bordering a submarine canyon or channel, usually occurring along the outer edge of a curve.

48. level surface Surface which at every point is perpendicular to the plumbline or the direction in which gravity acts.

49. leveling Surveying operation in which heights of objects and points are determined relative to a specified datum.

50. line copy (line drawing) Map copy suitable for reproduction without the use of a screen; a drawing composed of lines as distinguished from continuous-tone copy.

51. longitude Angular distance, in degrees, minutes, and seconds, of a point east or west of the Greenwich meridian.

- map, base Map on which information may be placed for purposes of comparison or geographical correlation.
- map, bathymetric Maps delineating the form of the

bottom of a body of water, or a portion thereof, by the use of depth contours (isobaths).

- map, cadastral Map showing the boundaries of subdivisions of land, often with the bearings and lengths thereof and the areas of individual tracts, for purposes of describing and recording ownership.
- map, choropleth Thematic map in which areas are colored, shaded, dotted, or hatched to create darker or lighter areas in proportion to the density of distribution of the theme subject.
- map digitization Conversion of map data from graphic to digital form.
- map, flood control Map designed for studying and planning control projects in areas subject to flooding.
- map, forestry Map prepared principally to show the size, density, kind, and value of trees in a designated area.
- map, geologic Map showing the structure and composition of geologic features.
- map hypsographic Map showing relief with elevations referred to the national geodetic vertical datum of 1929.
- map, hypsometric Map showing relief by any convention, such as contours, hachures, shading, or tinting.
- map, isopleth Map consisting of lines connecting places of equal value of distribution for a given theme such as rainfall or temperature.
- map, land use Map showing by means of a coding system the various purposes for which parcels of land are being used by man.
- map, planimetric Map that presents only the horizontal positions for features represented.
- map projection
- map, slope (clinometric map) Map showing the degree of steepness of the Earth's surface by the use of various colors or shading for critical ranges of slope.
- map, storm evacuation Map designed to identify coastal areas subject to flooding, to indicate recommended areas of refuge, and to emphasize available evacuation routes.
- map, thematic Map designed to provide information on a single topic, such as geology, rainfall, population.

52. meridian Great circle on the surface of the Earth passing through the geographical poles and any given point on the Earth's surface. All points on a

given meridian have the same longitude.

53. mosaic, aerial Assembly of aerial photographs whose edges usually have been torn or cut selectively and matched to the imagery on adjoining photographs to form a continuous representation of a portion of the Earth's surface.
54. orientation Establishing correct relationship in direction with reference to points of the compass; the state of being in correct relationship in direction with reference to the points of the compass.
55. origin of coordinates Point in a system of coordinates that serves as a zero point in computing the system's elements or in prescribing its use.
56. orthophotograph Photograph having the properties of an orthographic projection.
57. orthophotographic map Map produced by assembling orthophotographs at a specified uniform scale in a map format.
58. orthophotomap Orthophotographic map with contours and cartographic treatment, presented in a standard format, and related to standard reference systems.
59. orthophotoquad Monocolor orthophotgraphic map presented in a standard quadrangle format and related to standard reference systems. It has no contours and little or cartographic treatment.
60. orthophotoscope Photomechanical device used in conjunction with a double-projection stereoplotter for producing orthophotograph.
61. overlay Printing or drawing on a transparent or translucent medium intended to be placed in register on a map or other graphic and which shows details not appearing or requiring special emphasis on the base material.
62. overprint New material printed on a map or chart to show data of importance or special use, in addition to those data originally printed.
63. parallel of latitude A circle, or approximation of a circle, on the surface of the Earth, parallel tot he Equator, and connecting points of equal latitude; a circle of the celestial sphere parallel to the ecliptic, and connecting points of equal celestial latitude.
64. photogrammetry Science or art of obtaining reliable measurements or information from photographs or other sensing systems.
65. photomap (photographic map) Map made by adding marginal information, descriptive data, and a reference system to a

photograph or assembly of photographs.

66. plain Region of uniform general slope, comparatively level, of considerable extent, and not broken by marked elevations and depressions (it may be an extensive valley floor or a plateau summit); an extent of level or nearly level land; a flat, gently sloping, or nearly level region of the sea floor.
67. planetable Instrument consisting essentially of a drawing board on a tripod and some type of sighting device (alidade) with attached straightedge, used for plotting the lines of survey directly from observation in the field.
68. planimetry Plan details of a map - those having no indication of relief or contour.
69. plat Diagram drawn to scale showing all essential data pertaining to the boundaries and subdivisions of a tract of land, as determined by survey or protraction.
70. prime meridian Meridian of longitude 0 degrees, used as the origin for measurements of longitude. The meridian of Greenwich, England, is the internationally accepted prime meridian on most charts. However, local or national prime meridians are occasionally used.
71. public land system Public lands are subdivided by a rectangular system of surveys established and regulated by the Bureau of Land Management.
72. quad-centered photograph Middle exposure of a phototriplet (three consecutive aerial photographs) take so that the middle photograph is exposed directly above the center of the quadrangle and the preceding and following photographs are exposed directly above the boundaries of the quadrangle.
73. quadrangle Four-sided area, bounded by parallels of latitude and meridians of longitude used as an area unit in mapping (dimensions are not necessarily the same in both directions).
74. radial-line plotting Determination of the location of points by the successive intersection and resection of direction lines radiating from the radial centers of overlapping aerial photographs.
75. rectification, differential The process of scanning and reprojecting a photograph onto a horizontal plane in differential elements to remove displacements caused by tilt and relief. The process may be accomplished by any one of a number of instruments developed specifically for the purpose.

76. rectification, simple Projection of an aerial photograph (mathematically, graphically, or photographically) from its plane onto a horizontal plane by translation, rotation, and (or) scale change to remove displacement due to tilt of the camera.
77. relief Elevations and depressions of the land or sea bottom.
78. relief shading Technique for making hypsography on a map appear three dimensional by the use of graded shadow effects. Generally, the features are shaded as though illuminated from the northwest.
79. remote sensing Process of detecting and (or) monitoring chemical or physical properties of an area by measuring its reflected and emitted radiation.
80. representational fraction Scale of a map or chart expressed as a fraction or ratio that relates unit distance on the map to distance measured in the same unit on the ground.
81. reproduction Summation of all processes involved in printing copies from an original drawing. A printed copy of an original drawing made by the processes of reproduction
82. scale Relationship existing between a distance on a map, chart, or photograph and the corresponding distance on the Earth.
83. spheroid Mathematical figure closely approaching the geoid in form and size and used as a surface of reference for geodetic surveys. A reference spheroid or ellipsoid is a spheroid determined by revolving an ellipse about its shorter (polar) axis and used as a base for geodetic surveys of a large section of the Earth (such as the Clarke spheroid of 1866 which is used for geodetic surveys in the United States).
84. spot elevation Point on a map or chart whose height above a specified datum is noted, usually by a dot or a small sawbuck and elevation value. Elevations are shown, on a selective basis, for road forks and intersections, grade crossings summit of hills, mountain
85. stadia Technique of distance measurement wherein the observer reads the intercept subtended on a graduated rod between two marks on the reticle of the telescope.
86. state plane coordinate system Coordinate systems established by the U.S. Coast and Geodetic Survey (now the National Ocean Survey), usually one for each state, for use in defining positions of points in

terms of plane rectangular (x,y) coordinates.

87. stereocompilation Production of a map or chart manuscript from aerial photographs and geodetic control data by means of photogrammetric instruments.
88. stereoplotter Instrument for plotting a map by observation of stereomodels formed by pairs of photographs.
89. stereoscopic Pertaining to the use of binocular vision for observation of a pair of overlapping photographs or other perspective views, giving impression of depth.
90. subsidence Decrease in the elevation of land surface due to tectonic, seismic, or artificial forces, without removal of surface material.
91. survey Orderly process of determining data relating to any physical or chemical characteristics of the Earth. The associated data obtained in a survey. An organization engaged in making a survey.
92. tacheometer (tachymeter) Surveying instrument designed for use in the rapid determination of distance, direction, and difference of elevation from a single observation, using a short base which may be an intergraph part of the instrument.
93. theodolite Precision surveying instrument for measuring horizontal and vertical angles.
94. traverse Sequence of lengths and directions of lines connecting a series of stations, obtained from field measurements, and used in determining positions of the stations.
95. triangulation Method of extending horizontal position on the surface of the Earth by measuring the angles of triangles and the included sides of selected triangles.
96. trilateration Method of surveying wherein the lengths of the triangle sides are measured, usually by electronic methods, and the angles are computed from the measured lengths. Compare with triangulation.
97. zenith telescope Instrument for observing starts near the zenith (a point on the celestial sphere directly above the observer's position).

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http://wiki.gis.com/wiki/index.php/GIS_Glossary