

CPCCBC4018A

APPLY SITE SURVEYS AND SET-OUT PROCEDURES TO BUILDING AND CONSTRUCTION PROJECTS

THEORY EXAM INSTRUCTIONS

- This exam will occur under standard assessment conditions.
 - An oral examination may be allowed under certain circumstances. Answers will be documented and FT003 (Oral examination declaration form) must be completed.
- Participants must provide enough detail in their responses to demonstrate their knowledge and skills.
- Please fill in the details below, providing your name, signature and date of assessment.
 - Your signature acknowledges that this is your own work.
- If a participant initially answers a question incorrectly but modifies their response, they must follow the instructions below:
 - If a participant changes their response in writing, they must put their initials next to the written change.
 - If a participant changes their response verbally, this must be noted on the exam paper by the assessor.

Participant name _____

Participant signature _____

Assessor name _____

Assessor signature _____

Date _____

Number of questions	Number of questions answered correctly	Satisfactory?	
		Yes	No
39			





Q1. In the context of site set out and levelling, what is a key attribute for a licensed builder to have and demonstrate? Explain its importance.

Answer

A key attribute required of a licensed builder is accuracy. It is important that the preparation, construction and finishes of a construction project are correct and this especially applies when it comes to site surveys and set-out procedures. Accuracy is reliant on ensuring that the conduct for basic measuring and levelling techniques as part of the set-out procedures performed for building projects is correct every time, all the time.



Q2. Why is a grid a useful device for expressing design rules about the placement of elements on a plan or over the surface of land?

Answer

By expressing positioning rules of elements on a grid, a designer or architect or builder can make decisions for laying out a design problem systematically. Grids and placement rules offer a discipline that can assist with laying out the designs from plans of a building on to a construction site for its future development.



Q3. In terms of site surveying what does 'off-set' mean?

Answer

The use of the term off-set in surveying is that it is a short distance measured perpendicularly from a main survey line known as an off-set line and it is a line which is a short distance from and parallel to a main survey line. One method that surveyors use to measure the area of an irregular block of land is an offset survey which is also known as a traverse survey. The surveyor chooses a diagonal of the field to be the "traverse line" (traverse meaning 'to cross') and then measures the offsets (perpendicular distances) from the traverse line in stages creating the lines of contour reaching out to each corner of the block or the known boundaries. This in turn will create incremental rise and fall of land which is above and below the traverse line and/or measured from a known datum.



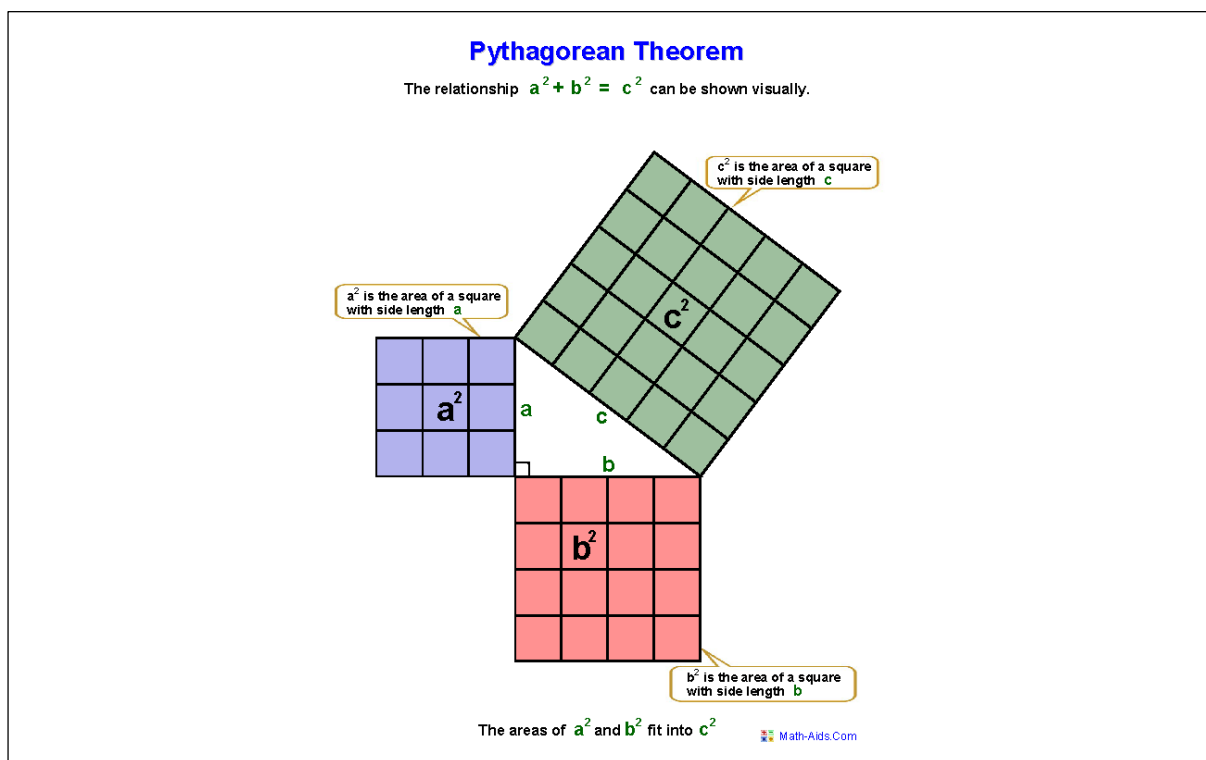
Q4. How would you set out a right angled corner on a building site?

Answer

A right-angled triangle is a triangle in which has one angle which is a right angle (i.e. a 90° angle). The relation between the sides and angles of a right angled triangle is the basis for trigonometry. Construction projects often need to have precise 90° or “square” angles but often the available tools are too small to guarantee the accuracy needed for large projects such as laying out the foundation of a house. In these cases where we may not have access to levelling and laser tools we can use Pythagoras’ Theorem which is in the ratio of base to height to hypotenuse of the triangle where one side is a factor of 3 another side is a factor of 4 and the hypotenuse a factor of 5. It is written as an equation 3:4:5 (3 is to 4 is to 5) which is the triangulating technique to ensure accurate 90 degree angles are set out.



Q5. Using a diagram explain the Pythagorean Theorem to show how it works and is calculated practically.



Answer

Assessor's discretion





Q6. What is a set-out survey used for?

Answer

A set-out survey is used to set out the exact position of a proposed structure within the legal boundaries of a piece of land. This kind of survey is very important when preparing for any type of construction work for sites including low rise commercial construction and residential developments. Basically a set-out survey involves transferring a building design onto the land itself so the builders can follow it during construction. During the process, key points are established and markers used to guide the building process and ensure accuracy. For large scale projects, such as high rise buildings and developments, multiple set-out surveys may be needed as the construction progresses. Examples of this would be for the earthworks, roads, car parks, sewerage, water and the actual building/s themselves.



Q7. Why are set-out procedures important?

Answer

These surveys are important for several reasons and they allow for the construction to be done within the legal boundaries which is vital to ensure no boundary disputes later on with neighbouring properties and they enable the construction team to build exactly to plan as the markers are physically laid out in front of them to work from.



Q8. When are set-out surveys needed?

Answer

When building anything from a small dwelling to major commercial building or high rise and when building roads, bridges, tunnels etc. and when doing any extensions to existing buildings.



Q9. What are some of the errors that can be encountered in the site set out process?

Answer

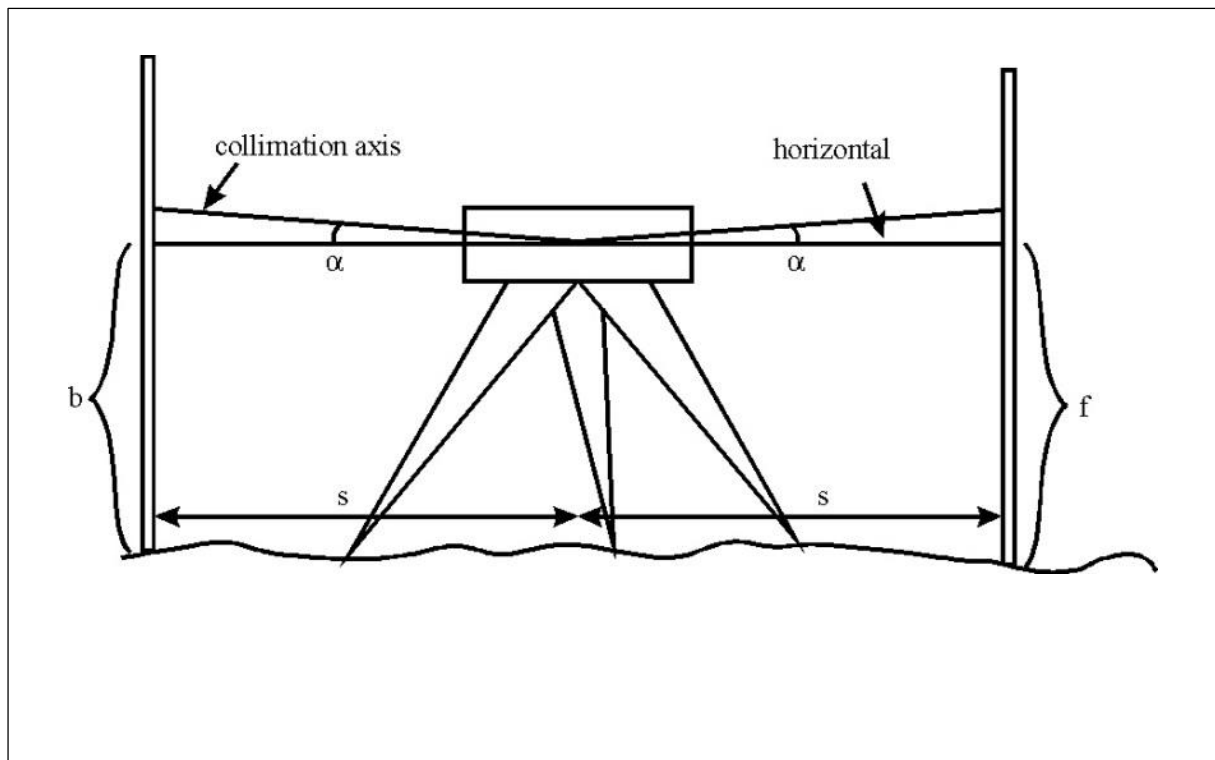
As with calculating any measurement, whether it is from building estimation prices to ordering material quantities, there is always a chance of errors occurring. Some of the most common errors involved in site measurement and set out include instrument and personal errors, collimation errors, errors due to curvature & refraction and other errors like misreading plans and drawings for example.



Q10. How does error of collimation happen? Draw a diagram to support your response.

Answer

Collimation error occurs when the collimation axis is not truly horizontal when the levelling instrument being used is not level. The effect is illustrated in the sketch below, where the collimation axis is tilted with respect to the horizontal by an angle.



Q11. What is cut and fill?

Answer

When planning the design and construction of a building, architects and engineers must first consider the existing conditions of the site. More often than not, the building site will not be level and must be modified before any construction can begin. Some areas of a building lot will be too high above the datum so you will need to cut the ground down to the correct elevation; the same goes for other areas that are too low then we have to fill those areas in order to raise the elevations to the set datum.



Q12. What do cut and fill calculations include?

Answer

Cut and fill calculations include:

- area and volume of land to be levelled; and
 - area of land to be filled; and
 - use of appropriate software; and
 - volume of fill required.
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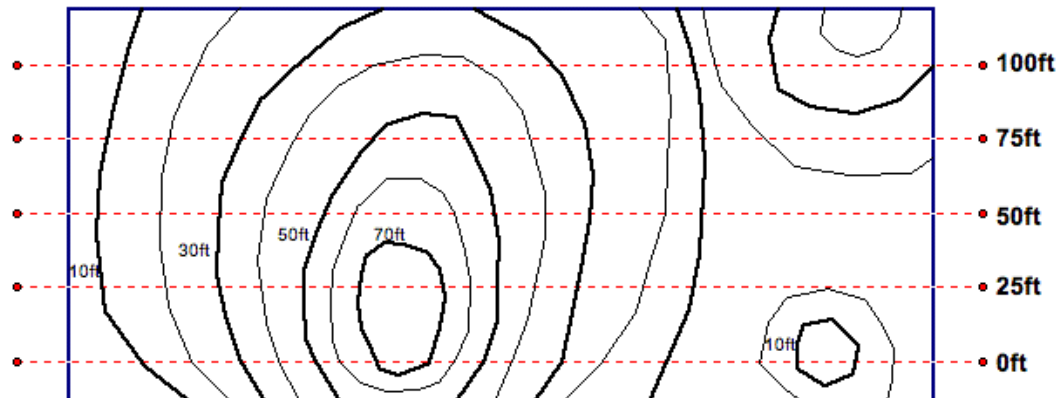
Q13. How do you calculate cut and fill?

Answer

Without computer software to determine the amount of soil to be added or removed, you can do simple calculations to estimate the cut and fill volume of any site. First, the site is divided into sections or "sliced" into segments of land, at a specified fixed distance apart, so you can look at each segment individually. Section cuts are drawn based on the topography of the land in order to accurately represent the land that is being evaluated.



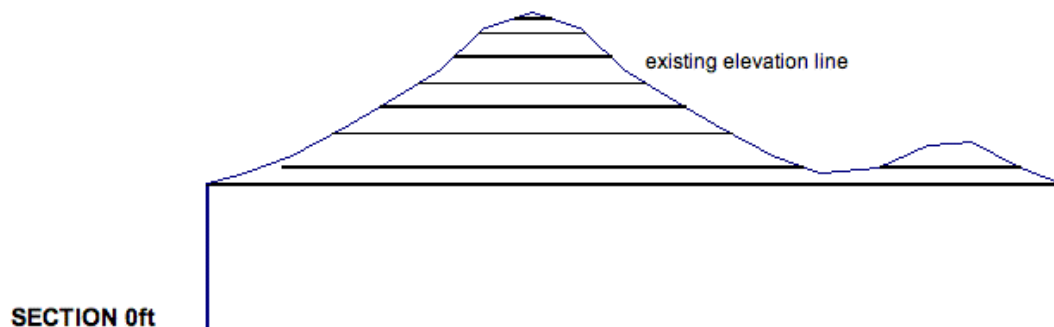
Q14. Using sketch diagrams explain how you would determine cut and fill requirements from the contour map shown below.



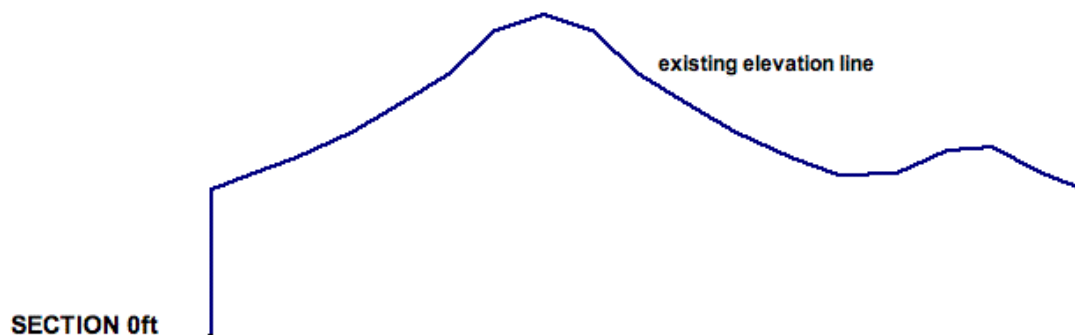
topography map

The map describes the existing slopes of the land, and will allow us to draw site elevations in our section cuts with a change in elevation every 10 feet or in metric about every 3 metres.

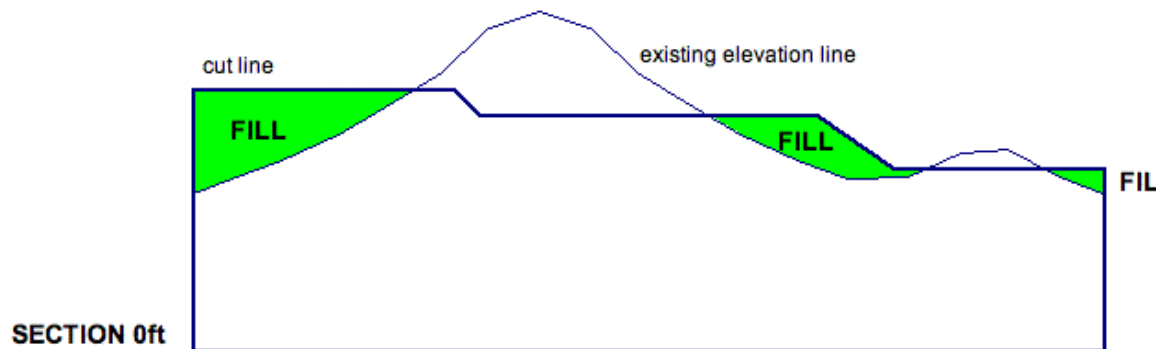
The section at 0ft (the red dashed line in the contour/topography image) would look like this in elevation



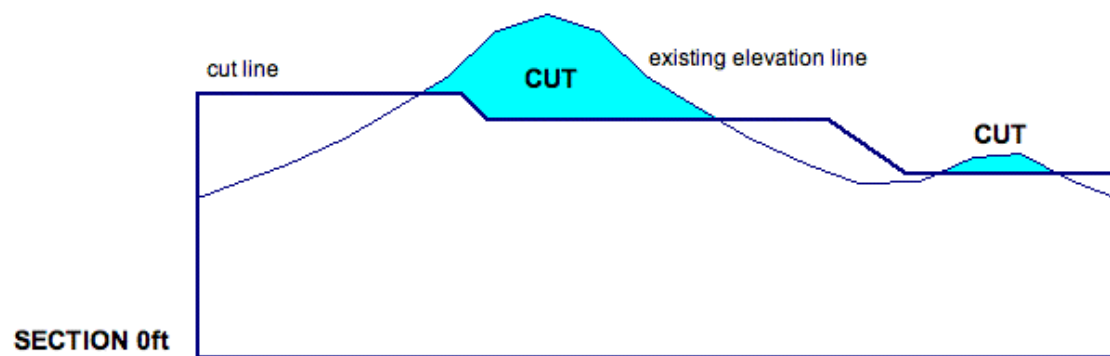
Then, by removing the elevation lines, we get the following section for site elevation



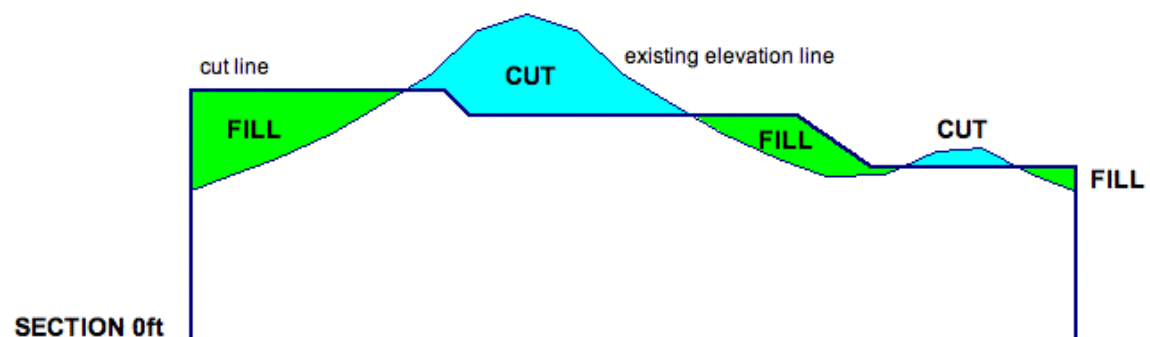
The area between the existing elevation line and the cut line is established and first we add the land that must be *added* to the site to achieve the desired land topography which is marked "fill."



Next the land that must be removed from the site to achieve our desired land topography is marked "cut."



By combining the two diagrams, the land area can be estimated for cut and fill in the site to level the site ready for construction.



Answer Assessor's discretion





Q15. Explain the terms listed in the table below.

Answer

Term	Definition
Vertical line	A line that follows the direction of gravity as indicated by a plumb line.
Horizontal plane	A plane perpendicular to the direction of gravity.
Datum	Any level surface to which elevations are referred. For example: mean sea level.
Mean Sea Level (MSL)	The average height of the sea's surface for all stages of the tide over a 19-year period.
National Geodetic Vertical Datum (NGVD 29)	Nationwide reference of surface elevations throughout the United States. Incorporated all first order levelling that had been completed up to 1929. 1,000,000 Km of levelling lines. 500,000 Bench Marks.
Elevation	The vertical distance from a datum to a point. Usually pertains to height of a point above sea level. This point could be used to describe the height of a piece of property above sea level or the main floor level of a new house.
Bench Mark (BM)	A Bench Mark is a point of reference by which something can be measured. It is a post or other permanent mark or plate established at a known elevation that is then used as the basis for measuring the elevation of other topographical points in any direction from the Bench Mark position.





Q16. Explain the functions of levelling. What is its purpose to set out a construction site?

Answer

Levelling involves measuring vertical heights at distances with reference to a horizontal plane or surface from a known bench mark or datum point. To do this, a levelling staff with vertical measurements upon it is needed to measure vertical heights with an instrument known as a level which is required to define the horizontal plane above or below the datum point.



Q17. Name some levelling devices used in the building and construction and civil construction industries.

Answer

Levelling devices include:

1. Electronic distance measuring (EDM) equipment
2. Laser level
3. Optical plummets
4. Theodolite



Q18. What is the fundamental principle of levelling?

Answer

The fundamental principle of levelling lies in determining the separation of horizontal level lines passing above or below a point of known elevation (The Bench Mark) through to new point/s of locations whose elevation needs to be determined and which may be above or below the known bench mark (ground zero). The objective of levelling is to find these rise and fall measurements of elevation for any given point/s in distance from the bench mark with respect to these new reference points identified from maps, plans and drawings and to then establish new height positions at these defined points to then determine for example cut and fill requirements, foundation and pier locations, wall positions of a building in relation to its land boundaries and other physical things and buildings, etc.



Q19. Define 'levelling'.**Answer**

Levelling is the art of determining the relative height of different points on, above or below the surface.

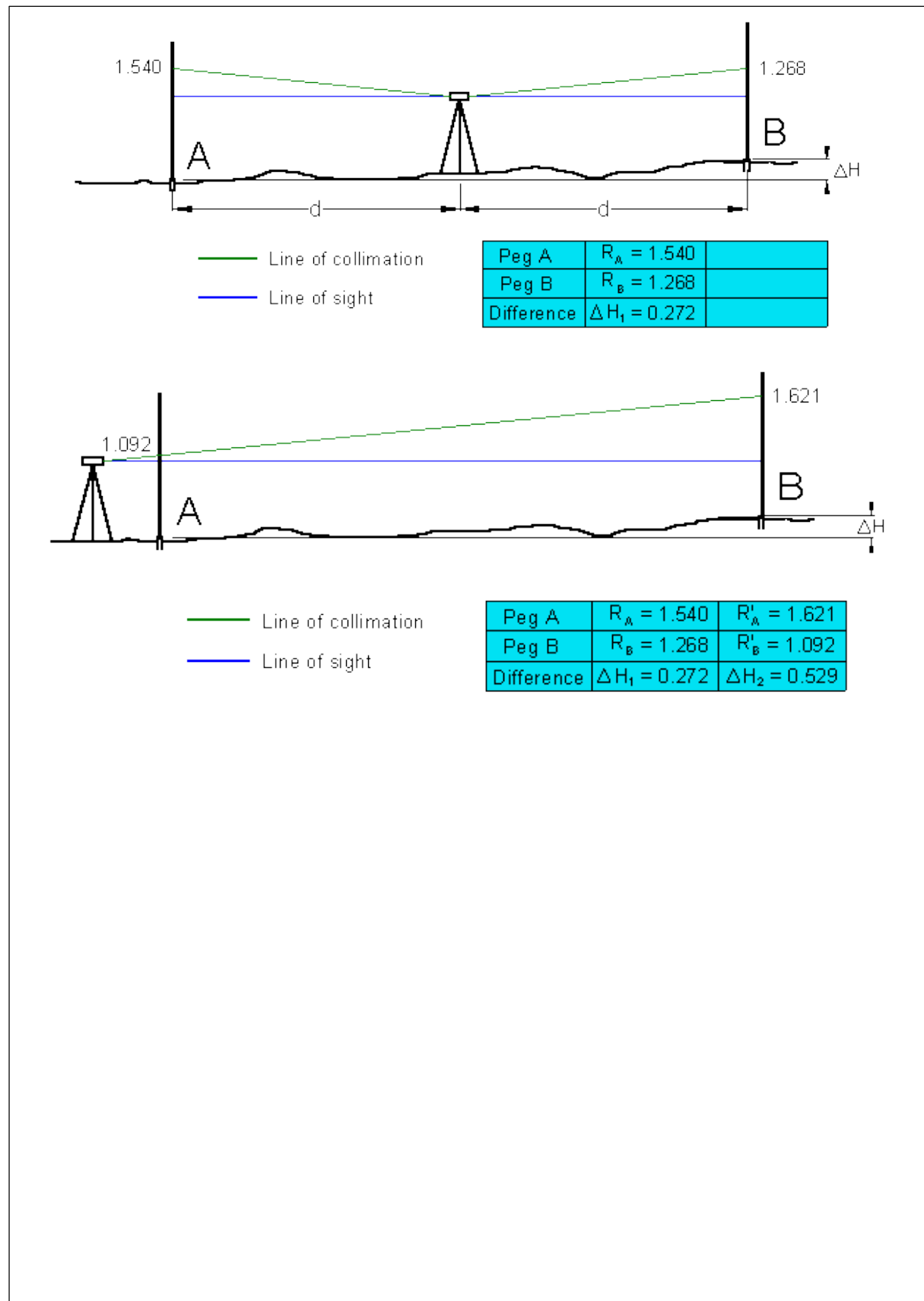
**Q20. Explain a two peg test of a levelling instrument.****Answer**

The Two Peg Test is a quick way to check that an automatic level or laser level is giving accurate readings. Before starting a project work the first task should be to carry out a two peg test to ensure the levelling instrument is properly calibrated and functioning within the calibration limits. To check the instrument's calibration setting is within the tolerance range the following is done:-



1. Set out and mark on the ground two wooden pegs driven into the earth, some 40 metres apart. Set up the level exactly mid-way (within half a metre) between them.
 2. Take measurements of backsight and foresight from this positional set up. The height difference will be free of the effects of collimation error.
 3. Next, move the level to a position just beyond the fore staff position (about 5m).
 4. The difference between the readings of the two level positions should be zero. If more than 5 mm the instrument will need to be calibrated.
-
-
-
-
-

Q21. Provide sketches of how a two peg test of a levelling instrument would be set up and achieved.



Q22. Explain a 'traverse' in levelling. Name the two methods of levelling used.

Answer

To determine the difference in level between points on the surface of the ground a 'series' of levels will need to be carried out; this is called a level traverse or level run.

There are two methods of levelling:

1. Rise & Fall method; and
2. Height of collimation (height of instrument) method.

Q23. Using the data from the survey information presented below plot the rise and fall profile on graph paper using a suitable scale.

B.S. (m)	F.S. (m)	Rise (m)	Fall (m)	Elevation (m)	Remark
1.205				150.485	B.M.
0.125	1.860		0.655	149.830	
0.395	1.915		1.7290	148.040	
0.880	2.615		2.220	145.820	
1.960	1.760		0.880	144.940	
2.595	0.920	1.040		145.980	
2.255	0.915	1.680		147.660	
2.305	0.515	1.740		149.450	
	1.170	1.135		150.535	B.M.

Answer

Assessor's discretion

Q24. What is direct levelling? Identify the common methods used.

Answer

Direct levelling require direct precise measurements:

1. Simple levelling: One set up of level to find elevation
2. Differential levelling: Used over vast distances where a number of set-ups are required
3. Fly levelling: Low precision, to find/check approximate level for reconnaissance survey.
4. Precise levelling: Precise form of differential levelling.
5. Profile levelling: Elevation is found along a line and its cross section.
6. Reciprocal levelling: Along a river or pond. Two levels simultaneously used, one at either end.

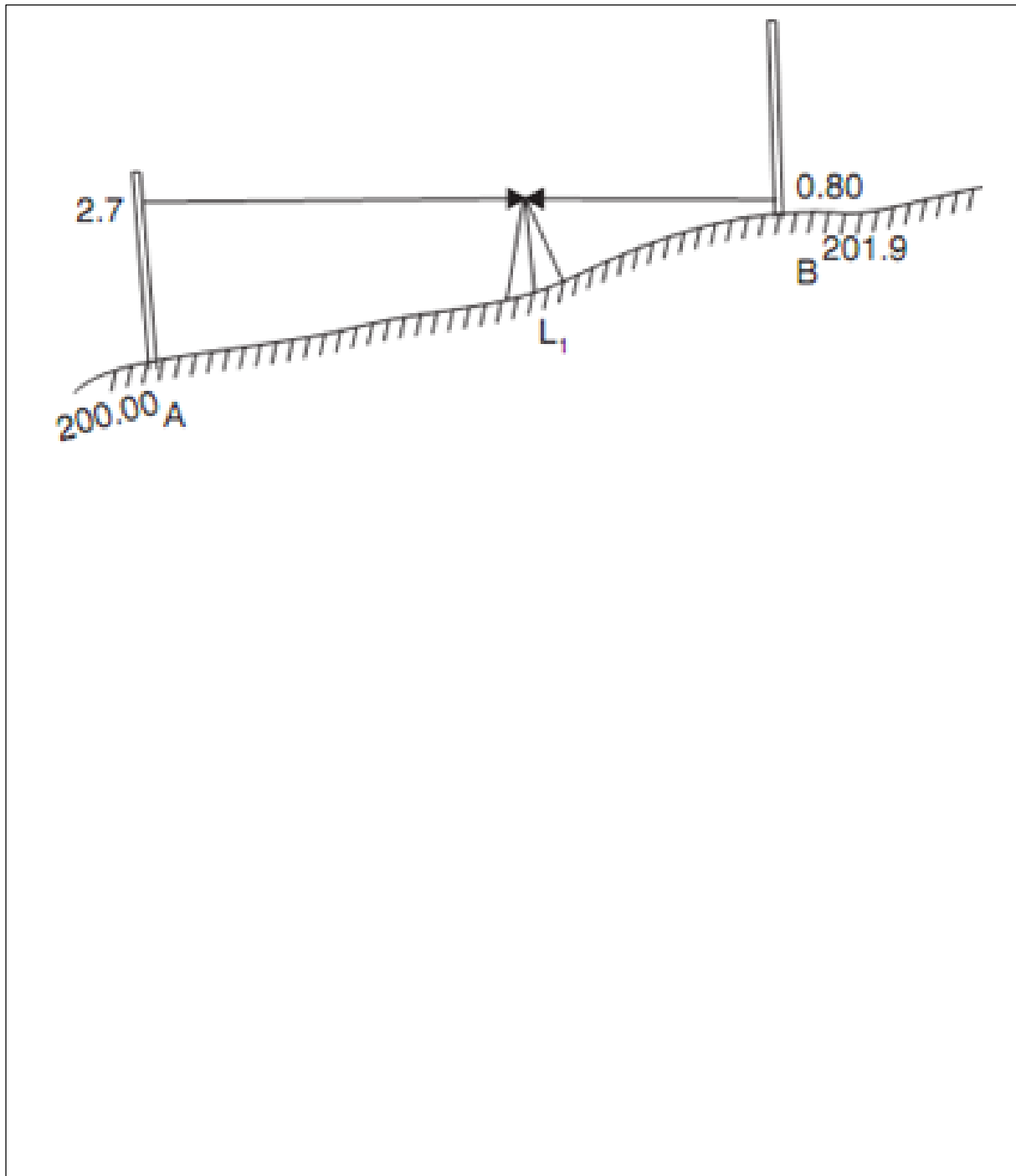
Q25. Explain the simple levelling technique.
Provide a sketch to support your response.

Answer

Simple levelling is one set up of the Levelling Instrument to find elevation.



It is the simplest method used, when it is required to find the difference in elevation between 2 points.



Q26. Explain the concept 'differential levelling technique'.

Answer

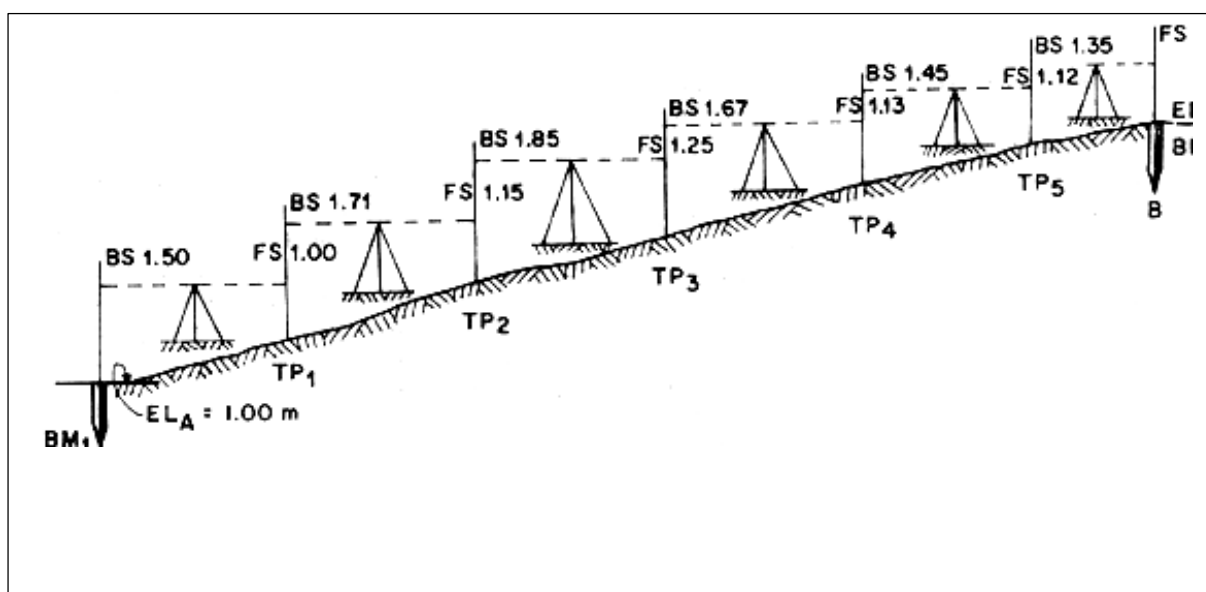
Differential levelling is used over vast distances where numbers of set-ups are required. Consider a Station B whose elevation is to be established with reference to a Bench Mark at Station A, quite a distant apart. To establish Station B, differential levelling is carried out starting from A and terminating at B. In order to carry out the levelling, the instrument is set up at a location where the backsight reading taken on A can be read clearly. The staff man then moves towards B and chooses a point, which is firm and stable roughly the same distance that was taken from A, the staff is held to take the foresight reading for this instrument set up and then backsight readings are taken, terminal at point B.



Q27. Explain the Fly Levelling technique. Provide a sketch to support your response.

Answer

Fly levelling is just like differential levelling carried out to check the accuracy of levelling work. In Fly levelling only back site and forward sights are taken.



Q28. What is precise levelling?

Answer

Precise levelling is used for establishing bench marks for future public use.

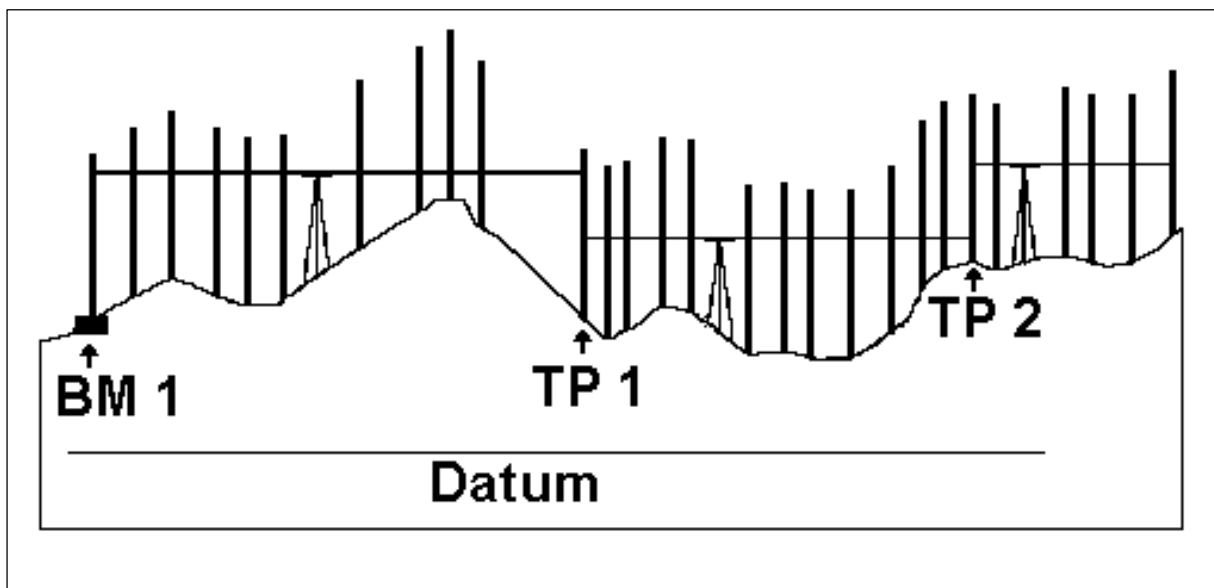


It is carried out with a very high degree of accuracy using advanced instruments and is more generally used to determine and establish bench marks and datum points.

Q29. What is profile levelling? Provide a sketch to support your response.

Answer

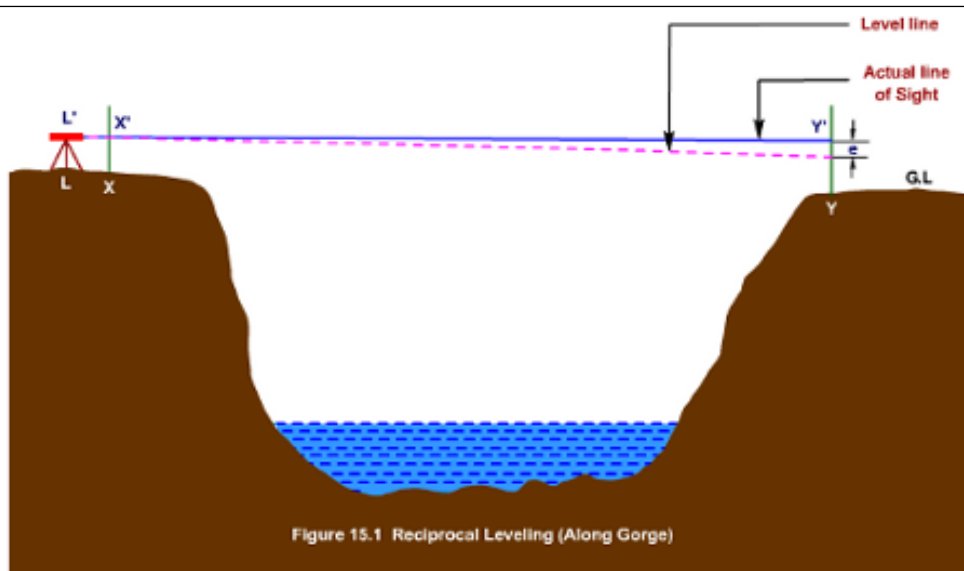
Profile levelling is used for taking levels along the centre line of any alignment like a road, a railway line, a man-made canal etc. The object is to determine the undulations of the ground surface along the alignment.



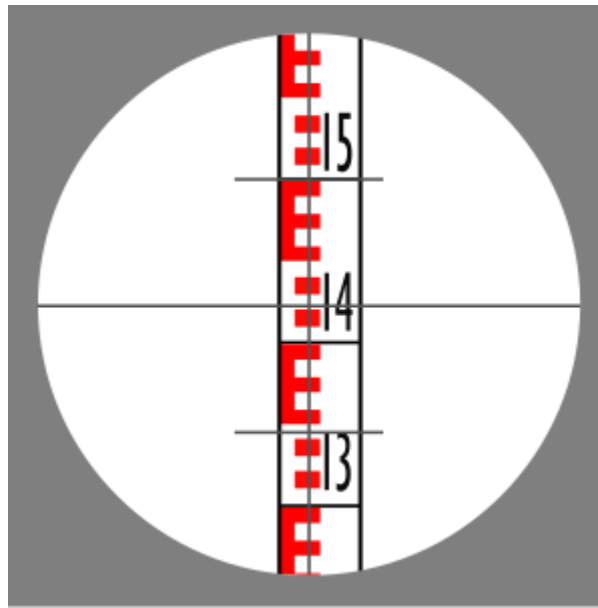
Q30. Explain reciprocal levelling. Provide a sketch to support your response.

Answer

Reciprocal levelling is used for taking levels along the centre line of any alignment like a road, a railway, a canal, etc. The object is to determine the undulations of the ground surface along the alignment.



Q31. Explain Stadia levelling. Describe what you see in the image below.



Answer

A typical surveyor's instrument reticule (which is the net of fine lines or fibres in the eyepiece of a sighting device) has two pairs of stadia marks. One pair is on the horizontal centreline and the other on the vertical cross hair. Each functions in the same manner and are placed for measuring on either axis. The stadia marks are set a specific distance apart. The distance is chosen so that there is a fixed, integer ratio between the distance observed between the marks and the distance from the telescope to the measuring device observed. This is known as the stadia constant or stadia interval factor. A typical stadia mark pair is set so that the ratio is 100.

In the image above, the upper stadia mark is at 1.5M and the lower at 1.345M. The difference is 0.155M. Thus the distance from the instrument to the levelling rod is: $0.155 \times 100 = 15.5\text{M}$.

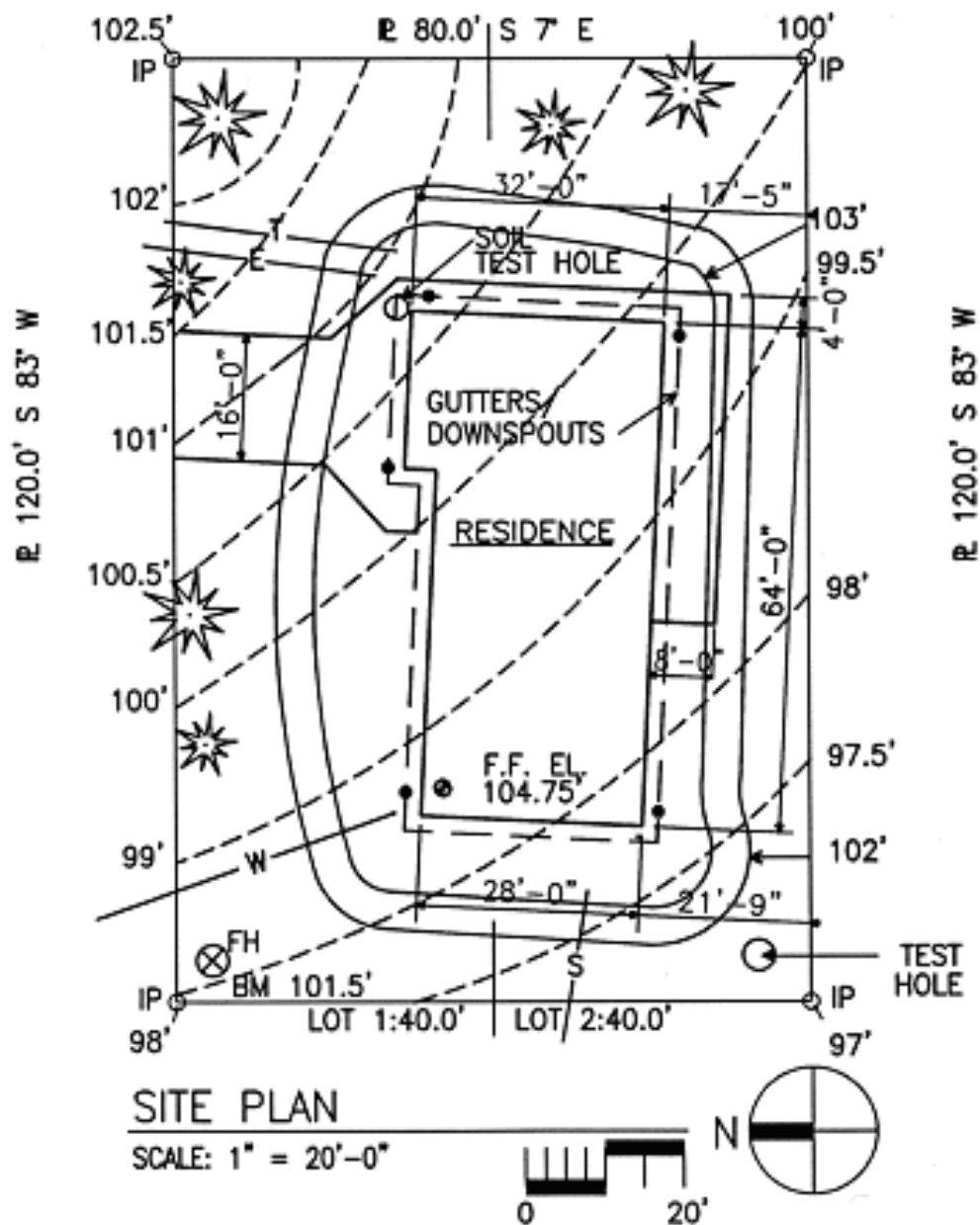
Q32. What is a contour plan?

Answer

A Contour plan is a graphical representation of the lay of the land. It shows the degree of slope on a site and relates back to a site datum.



Q33. Using the information on the contour drawing below, provide a brief explanation of the block of land's topographical surface prior to any cut and fill as represented by the contour lines relative to the BM and North as your points of reference.





Answer

Assessor's discretion



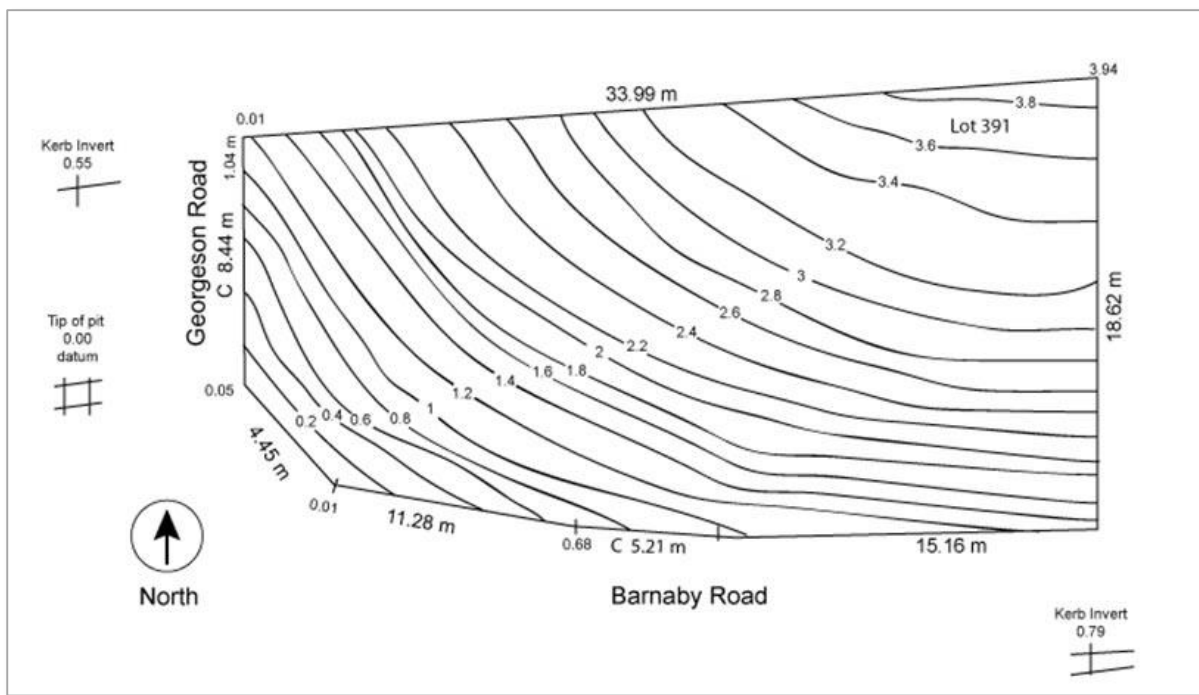
Q34. How would a surveyor you go about creating a contour plan?

Answer

To produce a contour plan a surveyor takes a series of levels over the site at regular grid spacing. The vertical distance separating contour lines gives an indication of the steepness of the slopes. In general gentle slopes are represented by widely spaced contour lines. Steep slopes are represented by closely spaced contour lines. These readings are recorded in a surveyor's log book and converted to RLs (reduced levels), which are plotted onto a grid overlaid on the site plan. A draftsman can then draw lines of best fit between equal RLs.



Q35. In simple terms write an explanation of the contour map shown below.





Answer



Direction North is essentially at right angles to Barnaby Road. The land which is contoured is essentially 33.99 metres in length on the Northern boundary and 18.62M in width across the Eastern boundary. The Southern boundary is adjacent to Barnaby Road and is angular in several directions in each case edging in a north-westerly direction to the western boundary adjacent to Georgeson Road.

The invert level on the southern boundary adjacent to Barnaby Road refers to the flow line in a storm drain or sewer manhole. The invert forms a definite flow line that matches the flow of the storm water (gutter, pipe or sewer) on that boundary and describes an invert of 790mm for Barnaby Road and an invert level at Georgeson Road of 550mm.

The ground across which the contour lines are plotted rises slowly from the corner of Georgeson and Barnaby Roads from 0mm to 3,940mm suggesting a gradual but rising slope of reasonable magnitude. If this land was built upon then significant cut and fill would be required for a level foundation pad and engineered retaining walls and drainage would need to be established.

Q36. Explain the terms listed in the table below.

Answer

Term	Definition
Surveying	A legal description completed by a surveyor of a piece of property. This should include all dimensions, headings, and any recorded easements or right of ways or encroachments.
Legal description	A method of describing a particular parcel of land in such a way that it uniquely describes the particular parcel and no other. A legal description may be a simple reference to a lot as shown on a subdivision plat, or be described by metes and bounds. To be adequate, it should be sufficient to locate the property without oral testimony
Property line	The boundary of a piece property. It is normally noted on a survey with its directional heading and length. When a surveyor comes out to stake out a piece of property, these stakes would determine the actual property lines and boundaries.
Monument	An object placed to mark the physical location of a position. A property corner monument is often a length of iron rod driven vertically into the ground so that the top is at or below natural grade. A cap identifying the registration number of the surveyor responsible for placing the monument may be placed atop the monument.
Set back	The term used in surveying to describe the distance a structure should be from the property lines. These are usually the minimum distances. These distances are part of a city's zoning restrictions or recorded with a subdivisions plat, property lines and boundaries.





Flood Plain	A term used to describe the greatest height water has reached during a flood. These heights are kept as matter of record by cities and counties. The recorded heights normally date back 50 to 100 years. They are referred to as a 50 and 100 year flood plain.
Recorded	Refers to the process of recording all legal information pertaining to description of a piece of property. This information is a matter of public record and is kept on file in the parish, county or city where it is located.
Hub and Tack	Used to describe the process of a surveyor determining points by placing wood hubs. Once the hub is driven in the ground, a metal tack is placed in the top of the hub to give a pinpoint location of a point.
Site plan	A plan showing all property lines, dimensions, and proposed or existing improvements. Detailed site plans will show all information pertaining to utilities and site drainage
Foot Print	A surveying term used to refer to the outermost boundaries or perimeter walls of a building. This will include all exterior walls and will help to determine correct placement of the house on the property.
Site heading	Refers to magnetic direction of a property line as related to compass heading.

Utility Easement	The use of a portion of property for some stated purpose (e.g. water, sewerage, power, pedestrians). Easements are not estates in that they do not convey ownership, but rather the use of the property in so far as needed for a stated purpose.
Topography	A mapping that presents the horizontal and vertical positions of the features of the represented piece of property. This type of map is very important in areas in a flood plain.
As built	Survey is performed to obtain horizontal and/or vertical dimensional data so that constructed improvements may be located and delineated.
Tolerance	A mathematical term indicating the allowable variation from a standard or from specified conditions. It is an indication of the accuracy and the precision of a measurement.
Construction survey	Measurements made, while construction is in process, to control elevation, horizontal position and dimensions, and configuration; to determine adequacy of completion; and to obtain essential dimensions for construction pay quantities.
Station	A computed or surveyed point; normally by standard measurement intervals along a defined centreline.



Toe	The lowest or bottom edge of a land bank or slope.
Invert	The flow line in a storm drain or sewer manhole. The invert forms a definite flow line that matches the flow of the storm drain (in a gutter for example) or sewer pipe.
Transit	An instrument used by surveyors to determine the location, heading, and dimensions of a piece of property. From existing benchmarks, surveyors can locate the latitude and longitude location. They can determine the magnetic heading of each property line with its associated length.
Acre or hectare	An area measurement of land. An acre measures 43,560 square feet. A hectare is a metric unit of square measure, equal to 100 acres (2.471 acres or 10,000 square metres).
Right of way	A recorded right to use or travel over a specified area or strip of land. Most commonly it refers to land on which a street, sidewalk or railroad is located. It can also be occupied by utilities, transmission lines, oil or gas pipelines, drainage ways or similar facilities, although pathways for these facilities are more commonly referred to as easements.
Covenants	Rules and regulations recorded as part of a sub-division. These could regulate the style and size of homes to be built. Also, they could regulate fences, sheds, property use, etc.

Plat	A print of lot or subdivision showing buildings, roads, and any present or future improvements.
Zoning	Areas of a city or county can be divided into zones for a particular use. These zones are recorded and a matter of public record. A zoning committee normally governs the rules and regulations of these zones. Zones pertain to commercial, residential, industrial, etc.
Lot	A specific piece of land and is normally a part of recorded sub-division.
Laser	An instrument used to set up points of the same level for a foundation. The level can also be used to determine differences in elevation of points in order to possibly determine slope.
Zero lot line	A term used to describe subdivisions that require no side yard setback.
Encroachment	A structure has been built inside the normal setback or easement.



Variance	Gives the right to do something that is normally not allowed. This could pertain to a building setback or a particular use of property.
Building Code of Australia	The Building Code of Australia (BCA) is Volumes One and Two of the National Construction Code (NCC). The BCA is produced and maintained by the Australian Building Codes Board (ABCB) on behalf of the Australian Government and State and Territory Governments.
Australian Standards	These set out specifications and procedures to ensure that products, services and systems are safe, reliable and consistently perform as intended. They are based on sound industrial, scientific and consumer experience.
Work Health and Safety Act 2011 (Qld)	Provides a framework to protect the health, safety and welfare of all workers at work. It also protects the health and safety of all other people who might be affected by the work.

Q37. You are laying 120 metres of 100mm PVC sewer pipe and your plans nominate a fall of 1:55 which is expressed as 1.8%.

Using the formula below for calculating fall using either ratio or percentage, calculate the fall using the ratio method and then using the percentage method.

Grade as a ratio

$$F = \frac{L}{G}$$

Grade as a percentage

$$F = \frac{L \times G\%}{100}$$

Where:

F = fall in millimetres

L = length of trench (or pipe) in millimetres

G = grade as a percentage (or ratio).

NOTE

Your answers will not necessarily match. Fall is calculated using the following formulae noting there is a slight difference in the formulae depending if the grade is expressed as a percentage or is expressed as a ratio.

Answer

Ratio Method

Fall = Length ÷ ratio

F = (120000 ÷ 55)mm

Fall = 2,181mm

Percentage Method:

Fall = (Length x Grade%) ÷ 100

(120,000 x 1.8) ÷ 100

Fall = 2,160mm

Q38. A sewerage pipe trench is being laid over 340 metres and the fall is expressed as a ratio of 1:90. Calculate the fall of the trench.

Answer

Ratio Method

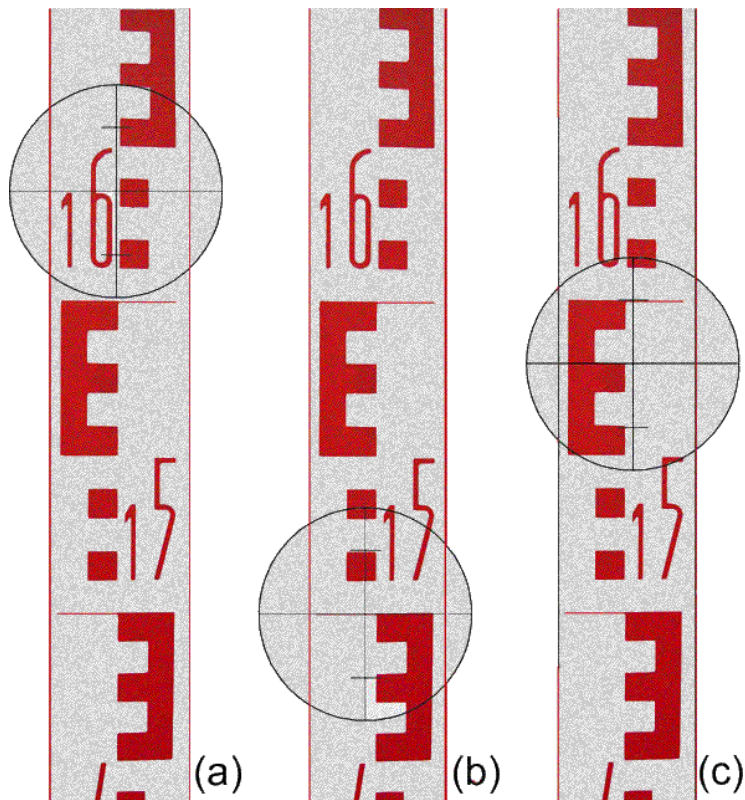
Fall = Length ÷ ratio

F = (340,000 ÷ 90)mm

Fall = 3,777mm



Q39. Give the readings of the staff below:



Answer

a) 1.635

b) 1.500

c) 1.580

