GATE Geomatics Engineering

Sample Paper – 9

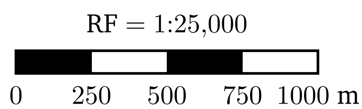
Duration: 128 Minutes **Maximum Marks: 72**

Instructions

- This paper contains **46 questions** covering the core **Geomatics Engineering** subject of the GATE paper conducted by the IITs and IISc (General Aptitude and Engineering Mathematics are provided as separate papers).
- **Q1–Q20 carry 1 mark each** and **Q21–Q46 carry 2 marks each**, for a total of **72 marks**.
- Each question carries **negative marking of one-third of its allotted marks**: a wrong 1-mark question costs **0.33** and a wrong 2-mark question costs **0.67**. Unattempted questions carry no penalty.
- Every question here is a single-correct **MCQ**. The real GATE paper also has Multiple Select (MSQ) and Numerical Answer Type (NAT) questions, and **those carry no negative marking**.
- Attempt this paper in one timed sitting of about **128 minutes**, the share this core subject earns at GATE's overall pace of 180 minutes for 65 questions. Unless stated otherwise take the speed of light $c = 3 \times 10^8$ m/s and the coefficient of thermal expansion of steel $\alpha = 11.7 \times 10^{-6}\ ^{\circ}\mathrm{C}^{-1}$.

Principles of Surveying and Error Theory

Q1. A topographic map is drawn to a representative fraction of $1/25{,}000$, as marked on the scale bar below. A road measures 6 cm on this map. The corresponding ground length is: **[1 mark]**



(A) 150 m

(B) 15 km

(C) 15 m

(D) 1.5 km

Q2. The standard deviation of a large set of equally reliable observations of a length is ± 0.30 m. Taking the probable error of a single observation as $0.6745\,\sigma$, the probable error of a single observation is nearest to: **[1 mark]**

(A) ± 0.30 m

(B) ± 0.45 m

(C) ± 0.20 m

(D) ± 0.10 m

Q3. Two independent tape measurements have standard errors of ± 6 mm and ± 8 mm. Taking the errors as combining in quadrature, the standard error of their sum is: **[1 mark]**

(A) ± 10 mm

(B) ± 14 mm

(C) ± 2 mm

(D) ± 100 mm

Q4. In which class of surveying is the curvature of the Earth's surface taken into account, so that the survey lines are treated as arcs rather than straight lines? **[1 mark]**

(A) plane surveying

(B) chain surveying

(C) geodetic surveying

(D) plane-table surveying

Q5. A horizontal distance is measured 9 times, each single measurement carrying a standard error of ± 12 mm. The standard error of the arithmetic mean of the nine measurements is: **[1 mark]**

(A) ± 12 mm

(B) ± 36 mm

(C) ± 1.33 mm

(D) ± 4 mm

Q6. In levelling, small unpredictable fluctuations in an observer's estimate of the staff reading, sometimes a little high and sometimes a little low, produce an error that is best classified as a: **[1 mark]**

(A) random (accidental) error

(B) systematic (cumulative) error

(C) constant instrumental error

(D) gross mistake or blunder

Distance Measurement, Levelling and Contouring

Q7. A nominal 30 m steel tape is standardized and found to be actually 30.008 m long (too long). A line measured with this tape reads 600 m. The corrected (true) length of the line is: **[1 mark]**

(A) 599.84 m

(B) 600.00 m

(C) 600.08 m

(D) 600.16 m

Q8. A distance of 200 m is measured along a slope, the two ends differing in level by 8 m. Using the approximate slope correction $-\dfrac{h^2}{2L}$, the correction to reduce the length to the horizontal is: **[1 mark]**

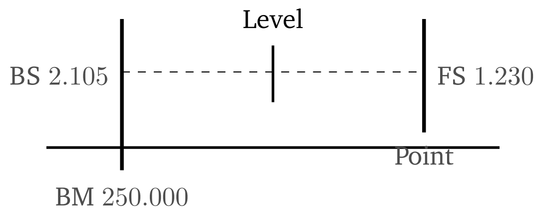
(A) -0.32 m

(B) -0.16 m

(C) -0.08 m

(D) -0.04 m

Q9. In the differential-levelling set-up shown, the backsight on a benchmark of RL 250.000 m is 2.105 m and the foresight to the next point is 1.230 m. The reduced level of the forepoint is: **[1 mark]**



(A) 253.335 m

(B) 250.875 m

(C) 249.125 m

(D) 251.230 m

Q10. A precise levelling loop begins and closes back on the same benchmark. The sum of all backsights is 12.455 m and the sum of all foresights is 12.470 m. The misclosure of the circuit is: **[1 mark]**

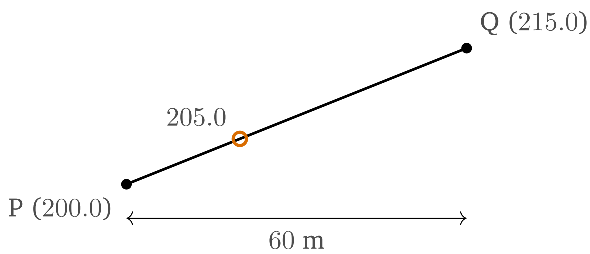
(A) 15 mm

(B) 25 mm

(C) 5 mm

(D) 0 mm

Q11. Points P and Q lie 60 m apart on a uniform slope. P has RL 200.0 m and Q has RL 215.0 m, as shown. By linear interpolation the horizontal distance from P to the point where the 205.0 m contour crosses PQ is: **[1 mark]**



(A) 20 m

(B) 30 m

(C) 12 m

(D) 40 m

Q12. A uniform gradient of 1 in 25 is to be set out from a road junction. Over a horizontal distance of 200 m, the total rise in level along this gradient is: **[1 mark]**

(A) 5 m

(B) 25 m

(C) 2 m

(D) 8 m

Theodolite, Traverse and Triangulation

Q13. The fore bearing (whole-circle bearing) of a line PQ is $200°15'$. The back bearing of the line is: **[1 mark]**

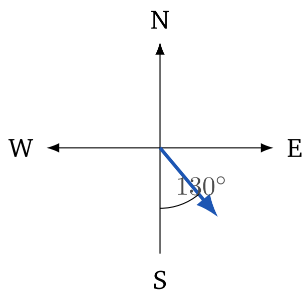
(A) $200°15'$

(B) $380°15'$

(C) $160°15'$

(D) $20°15'$

Q14. The whole-circle bearing of a survey line is $130°$, as shown on the compass diagram. Its reduced (quadrantal) bearing is: **[1 mark]**



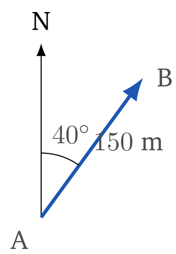
(A) N50°E

(B) N50°W

(C) S50°E

(D) S50°W

Q15. A traverse line AB of length 150 m has a whole-circle bearing of $40°$, as shown. Its latitude ($L\cos\theta$) and departure ($L\sin\theta$) are respectively: **[1 mark]**



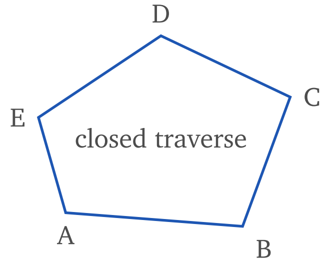
(A) 96.4 m N, 114.9 m E

(B) 114.9 m N, 150 m E

(C) 114.9 m N, 96.4 m E

(D) 96.4 m N, 96.4 m E

Q16. A closed traverse (shown schematically) has a total latitude misclosure of $+0.6$ m and a total departure misclosure of -0.8 m. The linear closing error of the traverse is: **[1 mark]**



(A) 1.4 m

(B) 1.0 m

(C) 0.2 m

(D) 0.7 m

Q17. For a closed polygon traverse having 5 sides, the theoretical sum of the interior angles, given by $(2n-4)\times 90°$, is: **[1 mark]**

(A) 540°

(B) 720°

(C) 360°

(D) 900°

Q18. In triangulation a "well-conditioned" triangle avoids angles smaller than about 30° mainly because: **[1 mark]**

(A) it forces every triangle to be exactly equilateral

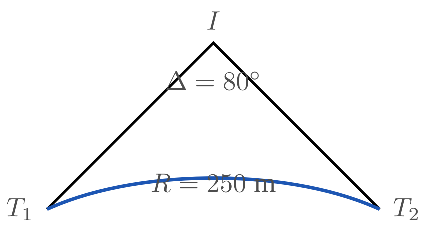
(B) it reduces the total number of triangulation stations

(C) it removes the need to measure any base line

(D) small angles make the computed side lengths highly sensitive to errors in the observed angles

Curves, Tacheometry and Field Astronomy

Q19. A simple circular curve of radius $R = 250$ m has a deflection angle $\Delta = 80^\circ$ between its tangents, as shown. The tangent length ($T = R\tan(\Delta/2)$) is: **[1 mark]**



(A) 209.8 m

(B) 250 m

(C) 300 m

(D) 105.0 m

Q20. A simple circular curve of radius 180 m subtends a deflection angle of 40°. The length of the curve, $L = \dfrac{\pi R \Delta}{180^\circ}$, is nearest to: **[1 mark]**

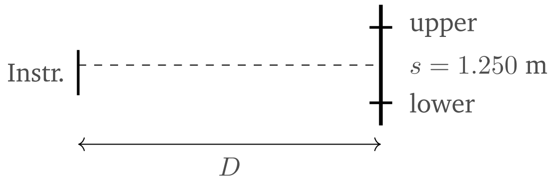
(A) 62.8 m

(B) 251.3 m

(C) 125.7 m

(D) 180 m

Q21. In a tacheometric observation with an anallactic telescope (multiplying constant $k = 100$, additive constant $C = 0$) the staff intercept is 1.250 m with the line of sight horizontal, as shown. The horizontal distance to the staff is: **[2 marks]**



(A) 125 m

(B) 12.5 m

(C) 1250 m

(D) 100 m

Q22. A subtense bar of length $S = 2$ m is held horizontally at right angles to the line of sight, and the theodolite measures the horizontal angle subtended by its targets as $0°20'00''$. Using $D = \frac{S}{2}\cot\left(\frac{\beta}{2}\right)$, the horizontal distance to the bar is nearest to: **[2 marks]**

(A) 200.0 m

(B) 171.9 m

(C) 687.5 m

(D) 343.8 m

Q23. At an observing station of latitude $40°$N, the altitude of the celestial equator above the horizon (which equals $90°$ minus the latitude) is: **[2 marks]**

(A) $40°$

(B) $90°$

(C) 130°

(D) 50°

Q24. A tacheometer ($k = 100$, $C = 0$) reads a staff intercept of 1.500 m with the line of sight inclined at 6° to the horizontal. The horizontal distance, $D = k\,s\cos^2\theta$, is nearest to: **[2 marks]**

(A) 148.4 m

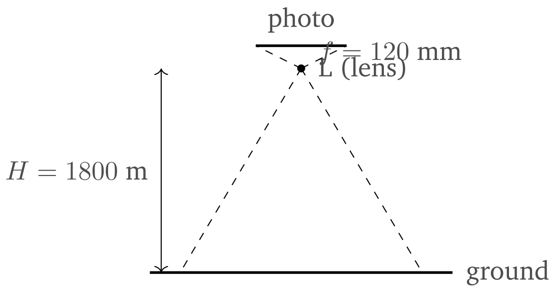
(B) 150.0 m

(C) 145.0 m

(D) 130.5 m

Photogrammetry

Q25. A vertical aerial photograph is taken with a camera of focal length 120 mm from a flying height of 1800 m above flat ground, as shown. The scale of the photograph (f/H) is: **[2 marks]**



(A) $1{:}10{,}000$

(B) $1{:}15{,}000$

(C) $1{:}1500$

(D) $1{:}150{,}000$

Q26. A vertical photograph has a scale of $1{:}12{,}000$ and was taken with a camera of focal length 150 mm. The flying height above the ground datum is: **[2 marks]**

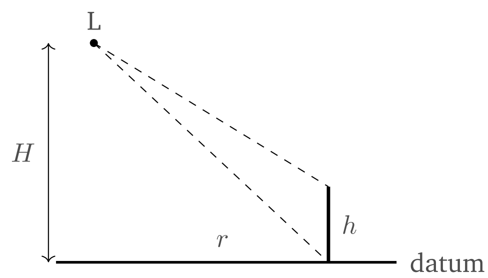
(A) 900 m

(B) 1800 m

(C) 8000 m

(D) 12,000 m

Q27. On a vertical photograph the relief displacement of the top of a vertical object is $d = \dfrac{r\,h}{H}$. For radial distance $r = 100$ mm, object height $h = 50$ m and flying height $H = 2500$ m (see figure), the relief displacement is: **[2 marks]**



(A) 2 mm

(B) 4 mm

(C) 1 mm

(D) 8 mm

Q28. The six elements of exterior orientation of an aerial photograph, used in analytical photogrammetry, consist of: **[2 marks]**

(A) three rotation angles only

(B) the three coordinates of the camera perspective centre together with three rotation angles

(C) the focal length and five fiducial marks

(D) two scale factors and four tie points

Q29. The collinearity condition, which is the basis of analytical photogrammetry, states that: **[2 marks]**

(A) all ground control points must lie on one straight line

(B) successive flight lines must be exactly parallel

(C) the exposure (perspective) centre, the image point and the corresponding ground point all lie on a single straight line

(D) meridians and parallels must intersect at right angles

Q30. A vertical photograph of scale $1{:}10{,}000$ shows a rectangular field measuring 50 mm $\times$ 40 mm on the print. The ground area of the field is: **[2 marks]**

(A) 2 ha

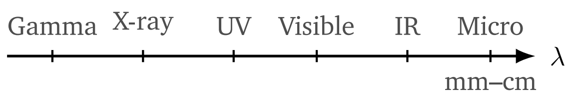
(B) 20 ha

(C) 200 ha

(D) 8 ha

Remote Sensing

Q31. Electromagnetic radiation of frequency 3×10^{10} Hz travels in vacuum at $c = 3 \times 10^8$ m/s. Its wavelength ($\lambda = c/f$), located on the spectrum below, is: **[2 marks]**



(A) 1 mm

(B) 1 m

(C) 1 cm

(D) 1 μm

Q32. The 8–14 μm atmospheric window is exploited in remote sensing mainly to measure: **[2 marks]**

(A) reflected visible light

(B) thermal (emitted) infrared radiation and surface temperature

(C) microwave backscatter from the ground

(D) ultraviolet radiation

Q33. In post-classification change detection between two dates, the changes are identified by: **[2 marks]**

(A) averaging the two raw images into one

(B) independently classifying each date and comparing the two thematic maps pixel by pixel

(C) applying a single buffer to one of the images

(D) resampling one image to a coarser grid

Q34. In the accuracy assessment of a classified image, the overall accuracy is computed from the error (confusion) matrix as: **[2 marks]**

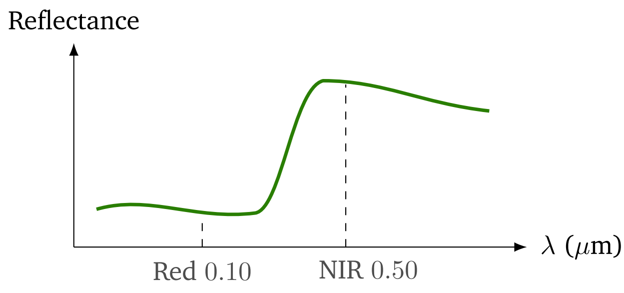
(A) the sum of the diagonal (correctly classified) pixels divided by the total number of reference pixels

(B) the single largest off-diagonal value in the matrix

(C) the number of classes divided by the number of pixels

(D) the ratio of the number of image bands to the number of classes

Q35. The Normalized Difference Vegetation Index is NDVI $= \dfrac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}}$. For a pixel with near-infrared reflectance 0.50 and red reflectance 0.10 (see spectral plot), the NDVI is nearest to: **[2 marks]**



(A) 0.40

(B) 0.20

(C) 0.60

(D) 0.67

Q36. A satellite sensor records each pixel with 10 bits of data. The number of discrete grey levels (radiometric resolution) it can represent is: **[2 marks]**

(A) 256

(B) 512

(C) 1024

(D) 2048

Geographic Information Systems

Q37. In a Digital Elevation Model, the slope of a cell is derived from the elevation difference to a neighbouring cell and the cell spacing. Two adjacent cells (shown below) are 30 m apart and differ in elevation by 15 m. The ground slope, expressed as a percentage (rise/run $\times 100$), is: **[2 marks]**

40	45	55	70
35	40	50	65

$\Delta h = 15$ m

$\longleftrightarrow$
30 m

(A) 50%

(B) 15%

(C) 100%

(D) 25%

Q38. In terrain analysis derived from a DEM, the "aspect" of a cell represents: **[2 marks]**

(A) the absolute elevation of the cell

(B) the horizontal ground area covered by the cell

(C) the number of neighbouring cells surrounding it

(D) the compass direction that the steepest downhill slope faces

Q39. A single-band DEM has 2000 rows and 2000 columns, with each cell stored as 2 bytes. The uncompressed storage size of the layer is nearest to: **[2 marks]**

(A) 4 MB

(B) 2 MB

(C) 8 MB

(D) 16 MB

Q40. A Triangulated Irregular Network (TIN) represents a terrain surface in a GIS as: **[2 marks]**

(A) a regular grid of equal-size square cells

(B) a set of contiguous, non-overlapping triangles joining irregularly spaced elevation points

(C) a single best-fit horizontal plane

(D) a network of road centrelines and junctions

Q41. Contour lines can be generated automatically from a DEM by: **[2 marks]**

(A) joining interpolated points of equal elevation across the grid

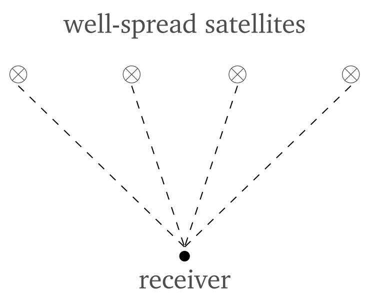
(B) buffering the single highest cell of the grid

(C) computing the arithmetic mean of all cell values

(D) counting the number of cells in each elevation class

GNSS, Cartography and Map Projections

Q42. In GNSS positioning, a low value of the Position Dilution of Precision (PDOP), associated with the widely spread satellite geometry sketched below, indicates: **[2 marks]**



(A) that too few satellites are visible to fix a position

(B) that the tracked satellites are clustered close together in the sky

(C) a well-distributed satellite geometry giving better positioning accuracy

(D) that the receiver clock has failed

Q43. In Real-Time Kinematic (RTK) GNSS surveying, centimetre-level positioning is achieved mainly by: [2 marks]

(A) averaging code pseudoranges over several hours

(B) resolving the carrier-phase integer ambiguities using real-time corrections broadcast from a base (reference) station

(C) tracking a single satellite for a long period

(D) ignoring the ionospheric delay altogether

Q44. In a Network RTK service (for example, a Virtual Reference Station system), the rover obtains its differential corrections from: [2 marks]

(A) a single nearby base station only

(B) the broadcast satellite navigation message alone

(C) its own internal quartz clock

(D) a network of continuously operating reference stations that models the errors across the region

Q45. A map projection that keeps the relative sizes of regions correct, so that any area on the map is proportional to the true area on the ground, is described as: [2 marks]

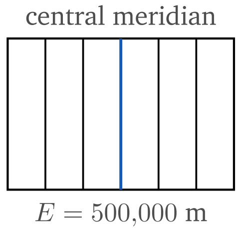
(A) a conformal (orthomorphic) projection

(B) an azimuthal (zenithal) projection

(C) an equal-area (equivalent) projection

(D) a gnomonic projection

Q46. In the UTM system (graticule shown), the central meridian of each zone is assigned a false easting of 500,000 m mainly to: [2 marks]



(A) increase the scale factor along the central meridian

(B) avoid negative easting values anywhere within the zone

(C) rotate the grid to true north

(D) convert longitudes directly into metres

Detailed Solutions

Q1.

Solution

Concept – ground distance from a representative fraction: The RF is the ratio of a map distance to the corresponding ground distance in the same unit, so ground distance $=$ map distance $\times$ scale denominator.

Step 1 – write the RF as a scale factor: $\text{RF} = \dfrac{1}{25{,}000}$, so 1 map unit $= 25{,}000$ ground units.

Step 2 – multiply the map length by the denominator: ground length $= 6\text{ cm} \times 25{,}000$

ground length $= 150{,}000\text{ cm}$

Step 3 – convert centimetres to metres: $150{,}000\text{ cm} = \dfrac{150{,}000}{100}\text{ m} = 1500\text{ m}$

Step 4 – express in kilometres: $1500\text{ m} = 1.5\text{ km}$

Final Answer: $1.5\text{ km} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q1

Q2.

Solution

Concept – probable error of a single observation: The probable error is $E_s = 0.6745\,\sigma$, where σ is the standard deviation of the observations.

Step 1 – list the data: $\sigma = 0.30\text{ m}$ and the factor is 0.6745.

Step 2 – multiply the factor by the standard deviation: $E_s = 0.6745 \times 0.30$

Step 3 – evaluate: $E_s = 0.2024\text{ m}$

Step 4 – round to the given precision: $E_s \approx \pm 0.20\text{ m}$

Final Answer: $E_s \approx \pm 0.20\text{ m} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q2

Q3.

Solution

Concept – propagation of error in a sum: For independent quantities added together, the standard errors combine in quadrature: $\sigma = \sqrt{\sigma_1^2 + \sigma_2^2}$.

Step 1 – square each component error: $\sigma_1^2 = 6^2 = 36$

$\sigma_2^2 = 8^2 = 64$

Step 2 – add the squares: $36 + 64 = 100$

Step 3 – take the square root: $\sigma = \sqrt{100}$

$\sigma = 10$ mm

Final Answer: $\sigma = \pm 10$ mm $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept – plane versus geodetic surveying: The distinguishing feature is whether the Earth's curvature is accounted for.

Step 1 – recall plane surveying: Plane surveying treats the survey area as flat and ignores curvature; it is valid only over small areas.

Step 2 – recall geodetic surveying: Geodetic surveying covers large areas and treats survey lines as arcs on the curved (ellipsoidal) Earth, so curvature is taken into account.

Why the other options are wrong:

- A: plane surveying assumes a flat Earth by definition.
- B and D: chain and plane-table surveying are field methods, both normally carried out as plane surveys.

Final Answer: geodetic surveying $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q4

Q5.

Solution

Concept – standard error of the mean: Averaging n independent measurements reduces the standard error by a factor $\sqrt{n}$: $\sigma_{\bar{x}} = \dfrac{\sigma}{\sqrt{n}}$.

Step 1 – list the data: $\sigma = 12$ mm and $n = 9$.

Step 2 – take the square root of the number of measurements: $\sqrt{9} = 3$

Step 3 – divide the single-observation error by this: $\sigma_{\bar{x}} = \dfrac{12}{3}$

Step 4 – evaluate: $\sigma_{\bar{x}} = 4$ mm

Final Answer: $\sigma_{\bar{x}} = \pm 4$ mm $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q5

Q6.

Solution

Concept – random (accidental) errors: An error that is equally likely to be positive or negative, varies unpredictably from reading to reading and tends to cancel on averaging, is a random error.

Step 1 – read the description: The staff estimate is sometimes a little high and sometimes a little low, with no fixed pattern.

Step 2 – test the sign behaviour: Because the sign changes at random and the errors partly cancel, the fault is not systematic.

Step 3 – name the class: An unpredictable, sign-changing error of this kind is a random (accidental) error.

Why the other options are wrong:

- B and C: systematic and constant errors keep the same sign and do not cancel.
- D: a blunder is an isolated gross mistake, not small unpredictable scatter.

Final Answer: random (accidental) error $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q6

Q7.

Solution

Concept – correction for a tape of wrong length: $\text{true length} = \text{measured length} \times \dfrac{\text{actual tape length}}{\text{nominal tape length}}$. A tape that is too long makes the measured length read short, so the correction is positive.

Step 1 – find the error per tape length: $30.008 - 30.000 = 0.008$ m too long.

Step 2 – form the ratio of actual to nominal length: $\dfrac{30.008}{30.000} = 1.0002667$

Step 3 – multiply the measured length by this ratio: $\text{true length} = 600 \times 1.0002667$

Step 4 – evaluate: $\text{true length} = 600.16$ m

Step 5 – check the size of the correction: $\text{Correction} = \dfrac{0.008}{30} \times 600 = +0.16$ m, confirming the result.

Final Answer: 600.16 m $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q7

Q8.

Solution

Concept – slope (reduction to horizontal) correction: For a small height difference the correction is $C_s = -\dfrac{h^2}{2L}$, always subtractive.

Step 1 – square the height difference: $h^2 = 8^2 = 64$

Step 2 – form the denominator: $2L = 2 \times 200 = 400$

Step 3 – divide: $\dfrac{h^2}{2L} = \dfrac{64}{400}$

$\dfrac{h^2}{2L} = 0.16$

Step 4 – apply the negative sign: $C_s = -0.16$ m

Final Answer: $C_s = -0.16$ m $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q8

Q9.

Solution

Concept – reduced level by the height-of-instrument method: RL of forepoint = RL of BM + BS − FS.

Step 1 – add the backsight to the benchmark RL (gives the line of collimation): $250.000 + 2.105 = 252.105$ m

Step 2 – subtract the foresight: $252.105 - 1.230 = 250.875$ m

Step 3 – interpret: The foresight (1.230) is smaller than the backsight (2.105), so the ground has risen; $250.875 > 250.000$, which is consistent.

Final Answer: $\text{RL} = 250.875 \text{ m} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q9

Q10.

Solution

Concept – misclosure of a closed levelling loop: When a circuit starts and ends on the same point the rises and falls must cancel, so ideally $\sum \text{BS} = \sum \text{FS}$. Any difference is the misclosure.

Step 1 – write the two sums: $\sum \text{BS} = 12.455$ m, $\sum \text{FS} = 12.470$ m.

Step 2 – subtract to get the closing difference: $\sum \text{BS} - \sum \text{FS} = 12.455 - 12.470$

$= -0.015$ m

Step 3 – take the magnitude and convert to millimetres: $|-0.015 \text{ m}| = 0.015 \text{ m} = 15 \text{ mm}$

Final Answer: $\text{misclosure} = 15 \text{ mm} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q10

Q11.

Solution

Concept – linear interpolation of a contour on a uniform slope: The horizontal distance to a given level is proportional to its height above the lower point.

Step 1 – total rise from P to Q: $215.0 - 200.0 = 15.0$ m

Step 2 – rise from P up to the contour: $205.0 - 200.0 = 5.0$ m

Step 3 – form the proportion of the total distance: $\dfrac{5.0}{15.0} = \dfrac{1}{3}$

Step 4 – multiply by the horizontal distance PQ: $d = \frac{1}{3} \times 60$

$d = 20$ m

Final Answer: $d = 20$ m from P $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q11

Q12.

Solution

Concept – rise on a stated gradient: A gradient of 1 in n means a rise of 1 unit for every n units of horizontal distance, so rise $= \frac{\text{horizontal distance}}{n}$.

Step 1 – identify the gradient denominator: 1 in 25 gives $n = 25$.

Step 2 – divide the horizontal distance by the denominator: rise $= \frac{200}{25}$

Step 3 – evaluate: rise $= 8$ m

Final Answer: rise $= 8$ m $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept – back bearing from fore bearing: Back bearing = fore bearing $\pm 180°$; subtract $180°$ when the fore bearing exceeds $180°$.

Step 1 – note the fore bearing: FB $= 200°15'$

Step 2 – since it is greater than $180°$**, subtract** $180°$**:** BB $= 200°15' - 180°$

Step 3 – evaluate: BB $= 20°15'$

Final Answer: BB $= 20°15' \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q13

Q14.

Solution

Concept – whole-circle to reduced bearing: A WCB between $90°$ and $180°$ lies in the second (south-east) quadrant, with RB $= 180° -$ WCB measured from south towards east.

Step 1 – identify the quadrant: $130°$ is between $90°$ and $180°$, i.e. the SE quadrant.

Step 2 – subtract from $180°$**:** $180° - 130° = 50°$

Step 3 – attach the quadrant letters: Measured from south towards east, the bearing is S50°E.

Final Answer: S50°E $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q14

Q15.

Solution

Concept – latitude and departure of a line: Latitude $= L\cos\theta$ (N–S component) and Departure $= L\sin\theta$ (E–W component), with θ measured from north.

Step 1 – compute the latitude: Lat $= 150\cos 40°$

Lat $= 150 \times 0.7660$

Lat $= 114.9$ m (northerly)

Step 2 – compute the departure: Dep $= 150\sin 40°$

Dep $= 150 \times 0.6428$

Dep $= 96.4$ m (easterly)

Final Answer: 114.9 m N, 96.4 m E $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept – linear closing error of a traverse: $e = \sqrt{(\sum L)^2 + (\sum D)^2}$, where $\sum L$ and $\sum D$ are the total latitude and departure misclosures.

Step 1 – square the latitude misclosure: $(\sum L)^2 = (0.6)^2 = 0.36$

Step 2 – square the departure misclosure: $(\sum D)^2 = (-0.8)^2 = 0.64$

Step 3 – add: $0.36 + 0.64 = 1.00$

Step 4 – take the square root: $e = \sqrt{1.00}$

$e = 1.0$ m

Final Answer: $e = 1.0$ m $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q16

Q17.

Solution

Concept – sum of interior angles of a closed polygon: For a closed traverse of n sides the interior angles sum to $(2n - 4) \times 90°$.

Step 1 – substitute $n = 5$: $(2 \times 5 - 4) \times 90°$

Step 2 – simplify inside the bracket: $(10 - 4) = 6$

Step 3 – multiply: $6 \times 90° = 540°$

Final Answer: $540° \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept – well-conditioned triangle in triangulation: Computed sides are found from the base and the observed angles through the sine rule, in which a side is proportional to $\sin(\text{angle})$.

Step 1 – note how errors enter: Near $0°$ (or $180°$) the sine changes very rapidly with the angle, so a small angular error produces a large error in the computed side.

Step 2 – give the safe range: Keeping every angle between about $30°$ and $120°$ keeps the sines in a stable range, minimising the effect of observational errors; such a triangle is "well conditioned".

Why the other options are wrong:

- A: an equilateral shape is ideal but not required; a range of angles is acceptable.
- B: conditioning is about accuracy of the computed sides, not the number of stations.
- C: a measured base line is always needed to give the triangulation its scale.

Final Answer: small angles make computed sides very sensitive to angular error $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q18

Q19.

Solution

Concept – tangent length of a simple circular curve: $T = R\tan\left(\dfrac{\Delta}{2}\right)$.

Step 1 – halve the deflection angle: $\dfrac{\Delta}{2} = \dfrac{80^\circ}{2} = 40^\circ$

Step 2 – take the tangent of the half-angle: $\tan 40^\circ = 0.8391$

Step 3 – multiply by the radius: $T = 250 \times 0.8391$

Step 4 – evaluate: $T = 209.8$ m

Final Answer: $T \approx 209.8 \text{ m} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q19

Q20.

Solution

Concept – length of a circular curve: $L = \dfrac{\pi R \Delta}{180^\circ}$ with Δ in degrees.

Step 1 – form the ratio $\Delta/180^\circ$: $\dfrac{40^\circ}{180^\circ} = 0.2222$

Step 2 – multiply by πR: $L = \pi \times 180 \times 0.2222$

Step 3 – simplify $R \times \Delta/180$: $180 \times 0.2222 = 40$, so $L = 40\pi$

Step 4 – evaluate with $\pi = 3.1416$: $L = 125.66 \text{ m} \approx 125.7$ m

Final Answer: $L \approx 125.7 \text{ m} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q20

Q21.

Solution

Concept – horizontal-sight tacheometry (stadia formula): $D = k\,s + C$, where k is the multiplying constant, s the staff intercept and C the additive constant.

Step 1 – list the data: $k = 100$, $s = 1.250$ m, $C = 0$.

Step 2 – multiply the constant by the intercept: $k\,s = 100 \times 1.250$

$k\,s = 125.0$

Step 3 – add the additive constant: $D = 125.0 + 0$

$D = 125.0$ m

Final Answer: $D = 125 \text{ m} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept – subtense-bar distance: For a horizontal subtense bar of length S subtending an angle β at the instrument, $D = \frac{S}{2}\cot\left(\frac{\beta}{2}\right)$.

Step 1 – halve the subtended angle: $\frac{\beta}{2} = \frac{0°20'00''}{2} = 0°10'00''$

Step 2 – express the half-angle in degrees: $0°10'00'' = \frac{10°}{60} = 0.16667°$

Step 3 – take the cotangent: $\cot(0.16667°) = \frac{1}{\tan(0.16667°)} = \frac{1}{0.0029089}$

$\cot(0.16667°) = 343.77$

Step 4 – multiply by $S/2$: $D = \frac{2}{2} \times 343.77 = 1 \times 343.77$

Step 5 – evaluate: $D = 343.8$ m

Final Answer: $D \approx 343.8$ m $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q22

Q23.

Solution

Concept – altitude of the celestial equator: At any station the celestial equator crosses the meridian at an altitude equal to the co-latitude, $90° - \phi$, where ϕ is the observer's latitude.

Step 1 – state the relation: altitude of celestial equator $= 90° - \phi$

Step 2 – substitute the latitude: $= 90° - 40°$

Step 3 – evaluate: $= 50°$

Why the other options are wrong:

- A, $40°$: is the altitude of the celestial pole, which equals the latitude, not the equator.
- B, $90°$: the equator passes overhead only at latitude $0°$.
- C, $130°$: exceeds $90°$ and cannot be an altitude above the horizon.

Final Answer: altitude $= 50° \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q23

Q24.

Solution

Concept – inclined-sight tacheometry: For an inclined line of sight the horizontal distance is $D = k\,s\cos^2\theta$ (with $C = 0$).

Step 1 – compute the stadia distance along the sight: $k\,s = 100 \times 1.500 = 150$

Step 2 – take the cosine of the vertical angle: $\cos 6^\circ = 0.9945$

Step 3 – square it: $\cos^2 6^\circ = (0.9945)^2 = 0.9891$

Step 4 – multiply: $D = 150 \times 0.9891$

$D = 148.36\text{ m} \approx 148.4\text{ m}$

Final Answer: $D \approx 148.4\text{ m} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q24

Q25.

Solution

Concept – scale of a vertical photograph: Scale $= \dfrac{f}{H}$, with f the focal length and H the flying height above the ground, in the same unit.

Step 1 – convert the focal length to metres: $f = 120\text{ mm} = 0.120\text{ m}$

Step 2 – form the ratio: Scale $= \dfrac{0.120}{1800}$

Step 3 – simplify by dividing: $\dfrac{0.120}{1800} = \dfrac{1}{15{,}000}$

Final Answer: scale $= 1{:}15{,}000 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q25

Q26.

Solution

Concept – flying height from photo scale: From Scale $= f/H$ we get $H = f \times (\text{scale denominator})$.

Step 1 – convert the focal length: $f = 150\text{ mm} = 0.150\text{ m}$

Step 2 – multiply by the scale denominator: $H = 0.150 \times 12{,}000$

Step 3 – evaluate: $H = 1800\text{ m}$

Final Answer: $H = 1800\text{ m} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept – relief displacement on a vertical photograph: $d = \dfrac{r\,h}{H}$, where r is the radial distance of the image from the principal point.

Step 1 – multiply the radial distance by the object height: $r\,h = 100 \times 50$

$r\,h = 5000$

Step 2 – divide by the flying height: $d = \dfrac{5000}{2500}$

Step 3 – evaluate (units of r, i.e. mm): $d = 2$ mm

Final Answer: $d = 2$ mm $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q27

Q28.

Solution

Concept – exterior orientation of a photograph: Exterior orientation fixes where the camera was and how it was tilted at the instant of exposure.

Step 1 – count the position parameters: The perspective (exposure) centre has three coordinates X_0, Y_0, Z_0.

Step 2 – count the attitude parameters: The camera axis orientation is given by three rotation angles ω, ϕ, κ.

Step 3 – total: $3 + 3 = 6$ exterior-orientation elements.

Why the other options are wrong:

- A: three rotations alone omit the camera position.
- C: focal length and fiducial marks are interior-orientation elements.
- D: scale factors and tie points are not the exterior-orientation set.

Final Answer: three perspective-centre coordinates plus three rotation angles $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q28

Q29.

Solution

Concept – collinearity condition: It is the geometric statement underlying the collinearity equations used in analytical photogrammetry.

Step 1 – state the geometry: The light ray from a ground point passes through the camera lens (perspective centre) to form the image point.

Step 2 – identify the three collinear entities: The object (ground) point, the perspective centre and the image point all lie on that single straight ray.

Why the other options are wrong:

- A: ground control points need not be collinear.
- B: parallel flight lines relate to mission planning, not the collinearity condition.
- D: right-angle graticule intersection is a map-projection property.

Final Answer: perspective centre, image point and ground point lie on one straight line $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q29

Q30.

Solution

Concept – ground area from a photograph: Convert each photo dimension to a ground dimension using the scale, then multiply.

Step 1 – ground length of the first side: $50 \text{ mm} \times 10{,}000 = 500{,}000 \text{ mm} = 500 \text{ m}$

Step 2 – ground length of the second side: $40 \text{ mm} \times 10{,}000 = 400{,}000 \text{ mm} = 400$ m

Step 3 – multiply for the area: $A = 500 \times 400$

$A = 200{,}000 \text{ m}^2$

Step 4 – convert to hectares (1 ha = 10,000 m^2): $A = \dfrac{200{,}000}{10{,}000} = 20 \text{ ha}$

Final Answer: $A = 20 \text{ ha} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q30

Q31.

Solution

Concept – wavelength from frequency: $\lambda = \dfrac{c}{f}$.

Step 1 – substitute the values: $\lambda = \dfrac{3 \times 10^{8}}{3 \times 10^{10}}$

Step 2 – divide the mantissas: $\dfrac{3}{3} = 1$

Step 3 – subtract the exponents: $10^{8-10} = 10^{-2}$

Step 4 – combine: $\lambda = 1 \times 10^{-2}$ m

Step 5 – convert to centimetres: 10^{-2} m $= 1$ cm (microwave region)

Final Answer: $\lambda = 1$ cm $\Rightarrow \boxed{\text{C}}$

$\boxed{\text{Answer: (C)}}$ Go Back to Q31

Q32.

Solution

Concept – thermal infrared window: The 8–14 μm band is an atmospheric window in which the Earth's own emitted (thermal) radiation passes to the sensor.

Step 1 – recall what dominates at these wavelengths: At normal Earth temperatures the peak of emitted radiation lies in the thermal infrared, near 8–14 μm.

Step 2 – state the use: Sensing this band gives surface temperature and other thermal information.

Why the other options are wrong:

- A: reflected visible light is at 0.4–0.7 μm.
- C: microwave backscatter is at millimetre-to-centimetre wavelengths.
- D: ultraviolet lies below 0.4 μm.

Final Answer: thermal (emitted) infrared radiation $\Rightarrow \boxed{\text{B}}$

$\boxed{\text{Answer: (B)}}$ Go Back to Q32

Q33.

Solution

Concept – post-classification change detection: Each date's image is first turned into a thematic (class) map, and change is found by comparing the maps.

Step 1 – classify each date separately: Image of date 1 $\rightarrow$ classified map 1; image of date 2 $\rightarrow$ classified map 2.

Step 2 – compare cell by cell: Overlaying the two maps and comparing each pixel's class reveals where and how the class has changed (a "from–to" change matrix).

Why the other options are wrong:

- A: averaging the raw images erases the change information.
- C: a buffer is a proximity operation, not change detection.
- D: resampling only changes grid resolution.

Final Answer: classify each date and compare the two thematic maps pixel by pixel $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q33

Q34.

Solution

Concept – overall accuracy from the error matrix: The confusion (error) matrix compares classified pixels against reference (ground-truth) pixels; correctly classified pixels lie on the main diagonal.

Step 1 – identify the correctly classified pixels: These are the diagonal entries, where the classified class matches the reference class.

Step 2 – form the overall accuracy: Overall accuracy $= \dfrac{\sum(\text{diagonal pixels})}{\text{total number of reference pixels}}$

Why the other options are wrong:

- B: off-diagonal entries are misclassifications, not correct ones.
- C and D: neither ratio has any accuracy meaning.

Final Answer: sum of diagonal pixels divided by total sample pixels $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q34

Q35.

Solution

Concept – Normalized Difference Vegetation Index: $\text{NDVI} = \dfrac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}}$.

Step 1 – form the numerator: $\text{NIR} - \text{Red} = 0.50 - 0.10 = 0.40$

Step 2 – form the denominator: $\text{NIR} + \text{Red} = 0.50 + 0.10 = 0.60$

Step 3 – divide: $\text{NDVI} = \dfrac{0.40}{0.60}$

Step 4 – evaluate: $\text{NDVI} = 0.667 \approx 0.67$

Final Answer: $\text{NDVI} \approx 0.67 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q35

Q36.

Solution

Concept – radiometric resolution: With b bits per pixel the number of grey levels is 2^b.

Step 1 – substitute $b = 10$: levels $= 2^{10}$

Step 2 – expand the power: $2^{10} = 1024$

Final Answer: 1024 grey levels $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q36

Q37.

Solution

Concept – slope as a percentage from a DEM: $\text{slope}(\%) = \dfrac{\text{rise}}{\text{run}} \times 100$, where the rise is the elevation difference and the run is the horizontal spacing.

Step 1 – identify the rise and run: Rise $= \Delta h = 15$ m; run $=$ cell spacing $= 30$ m.

Step 2 – form the ratio: $\dfrac{15}{30} = 0.5$

Step 3 – convert to a percentage: $0.5 \times 100 = 50\%$

Final Answer: slope $= 50\% \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q37

Q38.

Solution

Concept – aspect in terrain analysis: Aspect describes the orientation of a slope, i.e. the direction it faces.

Step 1 – recall the definition: For each cell, aspect is the compass direction of the steepest downhill gradient (measured clockwise from north).

Step 2 – note its use: Aspect indicates, for example, which slopes receive more sunlight (south-facing in the northern hemisphere).

Why the other options are wrong:

- A: elevation is the cell value itself, not aspect.
- B: the ground area is the cell size.
- C: neighbour count is a connectivity property, not aspect.

Final Answer: the compass direction the steepest downhill slope faces $\Rightarrow \boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ **Go Back to Q38**

Q39.

Solution

Concept – raster storage size: size $=$ rows $\times$ columns $\times$ bytes per cell.

Step 1 – multiply rows by columns: $2000 \times 2000 = 4{,}000{,}000$ cells

Step 2 – multiply by bytes per cell: $4{,}000{,}000 \times 2 = 8{,}000{,}000$ bytes

Step 3 – convert to megabytes (1 MB $\approx 10^6$ bytes): $8{,}000{,}000$ bytes ≈ 8 MB

Final Answer: about 8 MB $\Rightarrow \boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q39**

Q40.

Solution

Concept – triangulated irregular network (TIN): A TIN is a vector surface model built from irregularly located sample points.

Step 1 – describe the geometry: The sample (mass) points, each with a known elevation, are joined into triangles (usually by Delaunay triangulation).

Step 2 – state the key property: The triangles are contiguous and non-overlapping, and each triangular facet approximates the surface over its area.

Why the other options are wrong:

- A: a regular grid of square cells is a raster DEM, not a TIN.
- C: a single plane cannot represent varied terrain.
- D: a road network is a line feature set, unrelated to surface modelling.

Final Answer: contiguous non-overlapping triangles on irregular points $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q40

Q41.

Solution

Concept – generating contours from a DEM: A contour is a line of constant elevation, so it is built by locating equal-height points across the grid.

Step 1 – fix the contour value: Choose an elevation (say 105 m) to be traced.

Step 2 – interpolate crossings: Between neighbouring cells whose values straddle 105 m, interpolate the exact point where the surface equals 105 m.

Step 3 – join the points: Connecting these equal-elevation points produces the contour line.

Why the other options are wrong:

- B: buffering the highest cell gives a distance zone, not a contour.
- C: a single mean value cannot form a line.
- D: counting cells per class is a histogram, not a contour.

Final Answer: join interpolated points of equal elevation across the grid $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q41

Q42.

Solution

Concept – Dilution of Precision (DOP): DOP is a purely geometric factor: the positioning error equals the measurement error multiplied by the DOP, so a small DOP is desirable.

Step 1 – link geometry to DOP: Satellites spread widely across the sky give strongly intersecting ranges and a low PDOP; satellites clustered together give a high PDOP.

Step 2 – interpret a low PDOP: A low PDOP therefore means a favourable, well-distributed geometry that yields better positioning accuracy.

Why the other options are wrong:

- A: too few satellites would give a high (poor) DOP or no fix.
- B: clustered satellites raise the DOP, not lower it.
- D: DOP is a geometry measure, unrelated to clock failure.

Final Answer: a well-distributed geometry giving better accuracy $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q42

Q43.

Solution

Concept – Real-Time Kinematic (RTK) positioning: RTK relies on the very precise carrier-phase observable rather than the coarse code pseudorange.

Step 1 – identify the precise observable: The carrier wavelength is only about 19 cm, so measuring its phase gives millimetre-level range once the integer number of whole cycles (the ambiguity) is known.

Step 2 – describe how the ambiguity is fixed: A base station on a known point transmits real-time corrections to the rover; combining base and rover data lets the receiver resolve the integer ambiguities on the fly, giving centimetre positions.

Why the other options are wrong:

- A: averaging code ranges gives only metre-level accuracy.
- C: a single satellite cannot fix a position.
- D: ignoring ionospheric delay worsens, not improves, accuracy.

Final Answer: resolving carrier-phase ambiguities using base-station corrections $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q43

Q44.

Solution

Concept – Network RTK (VRS): Network RTK improves on single-base RTK by using many reference stations to model the spatially varying errors.

Step 1 – recall the network set-up: A regional network of continuously operating reference stations (CORS) streams its data to a central server.

Step 2 – describe the correction: The server models the atmospheric and orbit errors across the whole area and generates corrections (for example, a virtual reference station near the rover), which the rover uses for a centimetre-level fix even far from any single base.

Why the other options are wrong:

- A: a single base is ordinary RTK, not network RTK.
- B: the broadcast navigation message alone gives only standard positioning.
- C: the receiver's own clock provides no external correction.

Final Answer: a network of continuously operating reference stations modelling regional errors $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q44

Q45.

Solution

Concept – equal-area (equivalent) projection: Map projections are classified by the property they preserve; one that preserves area is called equal-area.

Step 1 – match the property to the name: Keeping every mapped region proportional to its true ground area is the defining property of an equal-area (equivalent) projection.

Why the other options are wrong:

- A: a conformal projection preserves angles and shapes, not area (Mercator badly distorts area).
- B: azimuthal describes the developable surface (a plane), not what is preserved.
- D: the gnomonic projection shows great circles as straight lines; it is not area-true.

Final Answer: an equal-area (equivalent) projection $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q45

Q46.

Solution

Concept – false easting in UTM: Eastings are measured from the central meridian of each zone; without an offset, points west of it would have negative coordinates.

Step 1 – note the natural origin: If the central meridian were assigned easting 0, every point to its west would take a negative easting.

Step 2 – apply the false easting: Assigning the central meridian a value of $500{,}000$ m shifts the whole grid so that all points within the $6°$-wide zone keep positive eastings.

Why the other options are wrong:

- A: the scale factor (0.9996 on the central meridian) is set separately and is unaffected by the false easting.
- C: the false easting is a translation, not a rotation of the grid.
- D: it does not convert degrees to metres; that is done by the projection equations.

Final Answer: to avoid negative easting values within the zone $\Rightarrow \boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ Go Back to Q46

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	D	2	C	3	A	4	C	5	D
6	A	7	D	8	B	9	B	10	A
11	A	12	D	13	D	14	C	15	C
16	B	17	A	18	D	19	A	20	C
21	A	22	D	23	D	24	A	25	B
26	B	27	A	28	B	29	C	30	B
31	C	32	B	33	B	34	A	35	D
36	C	37	A	38	D	39	C	40	B
41	A	42	C	43	B	44	D	45	C
46	B								