PRACTICE EXAM 5: CALIFORNIA CIVIL ENGINEERING SURVEYING (100 QUESTIONS)

This 100-question practice exam is weighted to the current BPELSG Civil Engineering Surveying Job Analysis: 25% Survey Planning, 15% Field Data Collection, 30% Data Analysis and Evaluation, 10% Mapping, and 20% Construction Surveying. The official California Civil Engineering Surveying examination is computer-based and provides 2.5 hours of testing time. Use this set as a timed simulation and select the single best answer for each question.

1. A freeway interchange reconstruction will remove several existing monuments near the ramps. Which control plan best supports construction through all phases?

A. Use only the monuments inside the first excavation because they are closest to the work

B. Create separate assumed coordinate systems for each contractor and reconcile them after construction

C. Rely on machine-control coordinates without preserving any independent physical monuments

D. Establish redundant stable control outside disturbance and tie it to the project datum before demolition

2. A flood-control project combines new GNSS control with legacy elevations labeled only as 'City Datum.' What should be resolved before using both datasets for design?

A. Determine and document the vertical datum relationship with verified common points or benchmark ties

B. Average the two elevation sets so the combined surface is smoother

C. Rename the legacy elevations to match the GNSS datum without changing values

D. Use the legacy elevations for contours and GNSS elevations for structures without a transformation

3. Three independent distance sets agree within 0.01 ft, but all are about 0.18 ft longer than a calibrated baseline. The observations are best described as:

A. Accurate but imprecise because the readings are widely scattered
B. Precise but not accurate because a systematic bias is present
C. Both accurate and precise because repeated measurements agree with one another
D. Neither accurate nor precise because any nonzero discrepancy proves random error

4. A steep open-pit mine requires a dense three-dimensional surface for monthly volume comparisons, including inaccessible faces. Which primary method is most suitable?

A. A single differential-level line through the pit floor only
B. Manual taping between a small number of accessible grade stakes
C. Terrestrial or mobile laser scanning tied to project control and independent checks
D. One handheld GNSS position at the approximate center of each bench

5. A control network for a water-treatment plant is being designed. Which feature most improves the ability to discover a single bad observation during adjustment?

A. Exactly the minimum observations needed to solve every unknown
B. Redundant measurements that create independent geometric closures
C. Rounding all distances and angles before the adjustment begins
D. Using one occupied station for every observation so no closure is formed

6. A topographic survey will support design of a detention basin. Which scope item should be defined before choosing the field method?

A. Required limits, surface detail, vertical accuracy, breaklines, and final deliverable format
B. The preferred color of field vests for the survey crew
C. The contractor's future choice of excavation equipment
D. The order in which office staff will archive unrelated project emails

7. A remote solar facility will use an assumed local coordinate system because no outside mapping will be combined with the project. What documentation is most important?

A. Only the project filename and the date the first coordinate was created
B. A statement that local coordinates never require physical monuments
C. Instructions allowing crews to rotate the system whenever a setup is inconvenient
D. Origin, orientation, units, scale basis, control descriptions, and any ties to external references

8. An airport GIS shows underground fuel lines compiled from record plans and utility-owner sketches. Before staking a new duct bank near them, the GIS linework should be treated as:

A. Survey-grade evidence that controls construction whenever it appears on the screen
B. A legal boundary record that supersedes observed field conditions
C. Planning information whose positional reliability must be evaluated and field-verified as risk warrants
D. A substitute for utility locating because multiple source layers were combined

9. A survey must establish control inside a long concrete tunnel where satellite signals are unavailable. Which planning approach is most appropriate?

A. Continue using standalone GNSS because longer occupations overcome complete signal blockage
B. Adopt a new arbitrary coordinate system at every tunnel setup
C. Use a terrestrial traverse or other line-of-sight control method tied to accessible project control
D. Estimate station positions from tunnel-chainage markings without any angular observations

10. Several consultants will exchange survey and design coordinates for a port expansion. Which project note best reduces coordinate-system mistakes?

A. State the datum, projection or local system, units, epoch if relevant, and any grid-to-ground transformation
B. Require every file to display at least four decimal places regardless of its reference system
C. Let each discipline choose its own coordinate basis as long as the drawings look aligned
D. Convert all coordinates to station-offset notation and discard the original reference information

11. A proposed light-rail extension needs centerline geometry, profiles, and corridor topography for design. Which survey classification most directly describes the overall effort?

A. A boundary retracement whose primary purpose is ownership determination
B. A route survey supported by horizontal and vertical control
C. A deformation survey intended to measure structural movement over time
D. A hydrographic survey focused on submerged bottom elevations and water depths

12. A precision settlement program requires repeated elevation differences across a manufacturing floor. Which equipment characteristic matters most during method selection?

A. Maximum advertised reflectorless range for horizontal distance measurements
B. The number of point codes stored in a GNSS data collector
C. Whether the tripod and rod use the same manufacturer brand
D. Expected vertical precision and the ability to control or detect leveling-system errors

13. A two-year bridge replacement needs project benchmarks that will remain usable after approach grading begins. Which location is best?

A. On the temporary embankment so the benchmark follows the new approach grade
B. On a form board scheduled for removal after the first concrete placement
C. At the excavation edge where it is easiest to reach from heavy equipment
D. Stable ground beyond expected settlement and construction disturbance, with safe access

14. Drone photogrammetry is proposed for a reservoir shoreline containing broad areas of smooth water. What limitation should the survey plan address?

A. Photogrammetry cannot determine any horizontal position near a shoreline
B. Open water automatically creates survey-grade elevations because its surface is level
C. Water surfaces may provide poor or misleading image matching, requiring supplemental observations or exclusions
D. Ground control becomes unnecessary because water provides a continuous reference plane

15. A pipeline alignment crosses rugged terrain and several roadways. Which sequence is most efficient before final construction staking?

A. Reconnaissance, establish control, collect route/topographic data, finalize design geometry, then stake construction

B. Stake final pipe bends first and decide the alignment after excavation begins

C. Collect random detail points before defining any project control framework

D. Compute final earthwork quantities before obtaining terrain or profile information

16. Under California Business and Professions Code section 6731.1, which statement about survey-data accuracy is within the civil engineering surveying scope described there?

A. A civil engineer may certify title ownership whenever survey coordinates are included on a map

B. A civil engineer may render a statement regarding the accuracy of maps or measured survey data for the activities listed in that section

C. Every accuracy statement automatically authorizes unrestricted private-boundary retracement

D. Accuracy statements are excluded from civil engineering surveying and may never accompany fixed-work surveys

17. A California civil engineer is not personally authorized to perform land surveying outside the engineering-surveying scope. What does section 6731.2 allow for incidental land-surveying work?

A. The engineer may personally perform it without restriction whenever the client calls it incidental

B. Any experienced technician may perform it independently if the engineer later reviews the map

C. The work may be performed without identifying responsible charge when it supports a civil project

D. The engineer may offer or procure it if the work is performed by or under an appropriately authorized survey professional

18. A precast beam has only 0.08 ft of allowable positional clearance to an existing column. How should the survey method be planned?

A. Use any method whose stated accuracy is approximately equal to the entire 0.08-ft clearance

B. Round field measurements to the nearest tenth before comparing the beam and column

C. Use a survey uncertainty substantially smaller than 0.08 ft and provide an independent check

D. Assume repeated observations eliminate all systematic errors even without calibration or control checks

19. A proposed storm drain passes close to a fiber-optic line whose mapped position is uncertain. What should the survey plan include before final conflict decisions?

A. Targeted utility locating and, where warranted, direct exposure tied to project control

B. A larger plotting scale only, because enlargement improves the utility's actual positional accuracy

C. A requirement that the contractor excavate first and survey the conflict only after damage occurs

D. Deletion of the uncertain utility from the base map so the proposed profile remains uncluttered

20. A campus project is designed on State Plane grid coordinates, but precise layout distances will be measured on the ground. What should be defined before stakeout files are issued?

A. A rule that grid and ground distances are interchangeable at all project locations

B. A separate assumed benchmark for each trade so vertical work is independent

C. The project grid-to-ground conversion, including scale, rotation, origin, and units if applicable

D. A magnetic declination value to replace the coordinate-system orientation

21. A long EDM control line will be observed during large afternoon temperature changes. Which planning item is most relevant to high-precision distance work?

A. Select a larger contour interval so distance errors are less visible on the plan

B. Record and apply the atmospheric inputs required by the instrument or procedure

C. Use a prism with a brighter housing color rather than checking atmospheric conditions

D. Convert the distance to a bearing before applying any environmental correction

22. Two proposed control stations form a very narrow intersection angle to an important structure point. What is the main planning concern?

A. Weak geometry can amplify small angular or centering errors in the computed position

B. Narrow intersections automatically improve positional accuracy because the rays nearly agree

C. The only effect is on vertical elevation, not horizontal coordinates

D. Geometry is irrelevant if the instrument displays angles to one arc-second

23. A buried valve cluster will be covered immediately after installation. When should the as-built survey be scheduled?

A. Before installation, using only the proposed design coordinates as the final as-built record

B. After backfill, reconstructing the underground locations from crew memory and photographs

C. At project closeout only, when the surface finish has hidden all underground geometry

D. After installation is complete but before the valves and fittings are concealed

24. A mobile-mapping point cloud will be used for curb-ramp design. Which validation element provides the strongest independent accuracy check?

A. Additional points that are all used to fit the same point-cloud transformation

B. Surveyed check points distributed across the project and withheld from the mapping adjustment

C. A larger point-symbol size on the final plan to make discrepancies less visible

D. Contours generated from the point cloud and compared only with the same point cloud

25. A retaining wall will be monitored for lateral movement over several years. Which practice best supports meaningful comparison between survey epochs?

A. Reset the project coordinate origin at each visit so reported coordinates remain small

B. Replace reference monuments whenever a new crew finds a more convenient location

C. Round each epoch to the nearest tenth before calculating displacement trends

D. Use stable external references, consistent procedures, and documented observation conditions for every epoch

26. During three-wire differential leveling, the upper stadia hair reads 4.882 ft and the lower hair reads 4.590 ft. What middle-hair reading would satisfy the usual arithmetic symmetry check?

A. 4.590 ft
B. 4.736 ft
C. 4.882 ft
D. 4.646 ft

27. A level setup has a height of instrument of 691.34 ft. What rod reading should be observed on a point whose known elevation is 687.96 ft?

A. 3.38 ft
B. 2.96 ft
C. 4.16 ft
D. 5.20 ft

28. A total station occupies a point at elevation 950.00 ft with instrument height 5.20 ft. It measures 210.00 ft at a +4°00' vertical angle to a prism 6.00 ft above the target point. What is the target-point elevation, nearest 0.01 ft?

A. 958.65 ft
B. 969.85 ft
C. 963.85 ft
D. 964.65 ft

29. A direction is observed as 84°12'20" in face I and 264°12'40" in face II. After reducing the face-II direction by 180°, what is the mean direction?

A. 84°12'10"
B. 84°12'20"
C. 84°12'30"
D. 84°12'40"

30. At a total-station setup, the occupied point coordinates are known and a backsight point is also known. What is the primary purpose of observing the backsight?

A. Orient the instrument to a known project direction before measuring or staking other points
B. Determine atmospheric pressure automatically from the known point coordinates
C. Replace the need to enter the occupied-station coordinates
D. Establish a vertical benchmark elevation without any measured height information

31. Why are backsight and foresight distances commonly kept approximately equal during precise differential leveling?

A. To force every turning point to have the same elevation as the benchmark
B. To eliminate the need for stable turning points between setups
C. To make rod graduation errors cancel regardless of where the rod is held
D. To reduce the effect of line-of-sight collimation error by balancing sight lengths

32. A level loop starts at elevation 500.00 ft. Total backsights are 36.84 ft and total foresights are 36.91 ft. What computed elevation is obtained at the closing point?

A. 500.07 ft
B. 499.93 ft
C. 500.00 ft
D. 499.07 ft

33. A prism pole is actually 5.00 ft high, but 5.35 ft is entered in the data collector. Assuming other inputs are correct, how are reduced ground elevations affected?

A. They are 0.35 ft too high
B. They are 5.00 ft too low
C. They are unaffected because prism height changes only horizontal position

D. They are 0.35 ft too low

34. A GNSS rover antenna height is measured as 2.000 m, but the controller is mistakenly set to 1.800 m. What is the primary consequence if the software expects vertical antenna height?

A. Computed ground elevations will be about 0.200 m too low
B. Only horizontal coordinates will change by 0.200 m
C. Computed ground elevations will be about 0.200 m too high
D. No coordinate will change because antenna height is used only for signal tracking

35. What is a principal benefit of observing a precise horizontal angle in both telescope faces?

A. Some instrumental angular errors reverse and can be reduced or detected when the observations are combined
B. It removes every centering and pointing error regardless of field procedure
C. It converts the angle automatically from grid north to magnetic north
D. It eliminates the need to identify the occupied and backsight points correctly

36. A reflectorless EDM shot is taken to a dark, wet wall at a shallow incidence angle. What field concern is most appropriate?

A. The surface guarantees a stronger return than a clean prism at normal incidence
B. Weak or irregular signal return may reduce range reliability, so the shot should be evaluated or independently checked
C. Reflectorless distance is independent of target material and incidence angle
D. Only the horizontal angle can be affected; the measured distance cannot change

37. A total station reports a slope distance of 286.40 ft and a zenith angle of 92°15'. What is the horizontal component, nearest 0.01 ft?

A. 11.24 ft

B. -11.24 ft
C. 286.18 ft
D. 286.40 ft

38. From a setup at N=5000.00 ft, E=2000.00 ft, a point is observed 120.00 ft at azimuth 30°00'. What is the point's easting, nearest 0.01 ft?

A. 2103.92 ft
B. 2060.00 ft
C. 1940.00 ft
D. 2030.00 ft

39. A level run starts on BM A elevation 742.18 ft and closes on BM B whose published elevation is 735.62 ft. The field sums are ΣBS=28.44 ft and ΣFS=34.96 ft. What is the vertical misclosure?

A. -0.04 ft
B. -6.52 ft
C. +6.56 ft
D. +0.04 ft

40. During roadway field collection, the measured edge of a proposed excavation appears within one foot of a marked gas line. What is the best immediate survey action?

A. Document and independently verify the apparent conflict, then escalate it before staking or excavation proceeds
B. Shift the gas-line shot in the data collector until the conflict disappears
C. Ignore the discrepancy because painted utility marks are never part of survey field work
D. Stake the excavation as designed and let construction personnel decide after digging begins

41. A traverse course is 250.00 ft long at azimuth 40°00'. What is its latitude (northing change), nearest 0.01 ft?

A. 160.70 ft
B. -191.51 ft
C. 191.51 ft
D. -160.70 ft

42. For the same 250.00-ft course at azimuth 40°00', what is the departure (easting change), nearest 0.01 ft?

A. 191.51 ft
B. -160.70 ft
C. -191.51 ft
D. 160.70 ft

43. A closed traverse should return to N=10,000.00 ft, E=5,000.00 ft, but the computed closing coordinates are N=10,000.06 ft, E=4,999.92 ft. What is the linear position misclosure?

A. 0.02 ft
B. 0.10 ft
C. 0.14 ft
D. 0.48 ft

44. A traverse has a total length of 5,280 ft and a linear error of closure of 0.24 ft. What is the approximate relative precision?

A. 1:22,000
B. 1:1,267
C. 1:5,280
D. 1:126,720

45. Using the Bowditch rule, a 400-ft traverse course is part of a 2,000-ft traverse with latitude misclosure +0.10 ft. What latitude correction is applied to that course?

A. +0.020 ft
B. -0.020 ft
C. -0.050 ft
D. +0.050 ft

46. An azimuth is 214°30'. What is the equivalent quadrant bearing?

A. S 34°30' W
B. N 34°30' E
C. S 55°30' W
D. N 55°30' W

47. A line has forward azimuth 128°20'. What is its back azimuth?

A. 51°40'
B. 231°40'
C. 128°20'
D. 308°20'

48. A line has horizontal distance 360.00 ft and rises 27.00 ft. What is its vertical angle above horizontal, nearest 0.01°?

A. 85.71°
B. 3.75°
C. 4.29°
D. 7.50°

49. A proposed tangent must rise 7.50 ft at a constant grade of +1.50%. What horizontal distance is required for that elevation change?

A. 112.5 ft

B. 750 ft
C. 500 ft
D. 50 ft

50. At station 22+50, a descending tangent has elevation 506.25 ft and grade -1.60%. What was the tangent elevation at station 20+00?

A. 510.25 ft
B. 502.25 ft
C. 506.65 ft
D. 509.85 ft

51. A simple circular curve has total central angle 36°00' and tangent length 194.95 ft. What is the radius, nearest foot?

A. 300 ft
B. 377 ft
C. 540 ft
D. 600 ft

52. For the curve in Question 51, use $R = 600$ ft and $\Delta = 36°00'$. What is the arc length, nearest 0.01 ft?

A. 194.95 ft
B. 376.99 ft
C. 370.82 ft
D. 600.00 ft

53. For the same $R = 600$ ft, $\Delta = 36°00'$ curve, what is the external distance E, nearest 0.01 ft? Use $E = R(\sec(\Delta/2)-1)$.

A. 18.57 ft

B. 194.95 ft
C. 370.82 ft
D. 30.88 ft

54. The PI station for the curve in Questions 51-53 is 47+80.00 and T = 194.95 ft. What is the PC station?

A. 49+74.95
B. 45+85.05
C. 45+80.00
D. 43+90.10

55. If the PC is station 45+85.05 and the arc length is 376.99 ft, what is the PT station?

A. 49+62.04
B. 47+80.00
C. 42+08.06
D. 49+74.95

56. On a circular curve of radius 700 ft, what chord subtends a central angle of 18°00', nearest 0.01 ft?

A. 109.84 ft
B. 1099.56 ft
C. 219.01 ft
D. 221.99 ft

57. A 600-ft vertical curve connects g1 = +2.0% and g2 = -1.0%. What is the K value, defined as curve length divided by the absolute algebraic grade difference in percent?

A. 6 ft/%
B. 1,800 ft/%

C. 200 ft/%

D. 0.50 ft/%

58. A 400-ft parabolic vertical curve starts at elevation 700.00 ft with g1 = +1.0% and ends with g2 = -3.0%. What is the curve elevation 200 ft from the PVC? Use $y = y0 + g1\ x + (g2-g1)x^2/(2L)$, with grades as decimals.

A. 702.00 ft

B. 700.00 ft

C. 698.00 ft

D. 699.00 ft

59. For the vertical curve in Question 58, at what distance from the PVC does the high point occur?

A. 200 ft

B. 300 ft

C. 400 ft

D. 100 ft

60. A point has coordinates N=1120 ft, E=940 ft. A straight alignment runs east-west along N=1100 ft. What is the perpendicular offset magnitude from the alignment?

A. 20 ft

B. 40 ft

C. 60 ft

D. 180 ft

61. A four-sided site has coordinates (E,N) in feet: (0,0), (300,0), (240,160), and (0,160). What is its area?

A. 48,000 sq ft

B. 38,400 sq ft
C. 43,200 sq ft
D. 86,400 sq ft

62. Two end areas 100 ft apart are 820 sq ft and 1,060 sq ft, and the midpoint area is 950 sq ft. Using the prismoidal formula V=L(A1+4Am+A2)/6, what is the volume in cubic yards?

A. 3,481.48 cu yd
B. 1,753.09 cu yd
C. 94,666.67 cu yd
D. 3,506.17 cu yd

63. A stockpile volume is 18,500 cu yd in bank condition. If the material swells 18% when excavated, what loose volume should be expected?

A. 15,170 cu yd
B. 21,830 cu yd
C. 18,518 cu yd
D. 22,570 cu yd

64. A level line is 2,400 ft long and has an allowable misclosure of $\pm 0.04\sqrt{K}$ ft, where K is distance in miles. What is the allowable magnitude, nearest 0.001 ft?

A. 0.027 ft
B. 0.019 ft
C. 0.040 ft
D. 0.061 ft

65. A measured horizontal ground distance is 1,250.00 ft. The project grid factor is 0.99985. What corresponding grid distance is obtained by multiplying ground distance by the factor?

A. 1,250.19 ft
B. 1,248.13 ft
C. 1,249.81 ft
D. 1,250.00 ft

66. A local coordinate point (x,y) = (30, 50) ft is rotated 90° counterclockwise about the origin with no scale or translation. What are the new coordinates?

A. (50, -30) ft
B. (-50, 30) ft
C. (30, -50) ft
D. (-30, 50) ft

67. A straight grade rises uniformly from elevation 410.20 ft at station 5+00 to 418.20 ft at station 9+00. What is the elevation at station 7+50?

A. 414.20 ft
B. 416.20 ft
C. 413.70 ft
D. 415.20 ft

68. On a topographic map, contour spacing becomes much tighter along a hillside while the contour interval remains unchanged. What does that indicate?

A. The ground slope is becoming steeper
B. The ground slope is becoming flatter
C. The map scale has automatically changed in that area
D. The vertical datum has shifted only where the contours are close together

69. Point A is N=1000 ft, E=1000 ft and Point B is N=1120 ft, E=1090 ft. What is the azimuth from A to B, nearest 0.1°?

A. 53.1°
B. 216.9°
C. 323.1°
D. 36.9°

70. A benchmark is published at elevation 850.00 ft. A closed level loop computes 850.05 ft at that benchmark after 10 equal-length setups. If the misclosure is distributed equally by setup, what correction is applied to the cumulative elevation after setup 6?

A. -0.030 ft
B. +0.030 ft
C. -0.005 ft
D. -0.050 ft

71. Along a straight line between spot elevations 412.0 ft and 420.0 ft, the points are 80 ft apart. Where is the 416-ft contour located from the 412-ft point, assuming linear interpolation?

A. 20 ft
B. 60 ft
C. 40 ft
D. 80 ft

72. A utility profile is plotted at a horizontal scale of 1 inch = 40 ft. How many inches on the sheet represent 430 ft of alignment?

A. 17.20 in
B. 10.75 in
C. 1.075 in
D. 4.30 in

73. Which information is essential when plotting a roadway profile from survey data?

A. Only northing coordinates, with all elevation information omitted
B. Station or horizontal distance along the alignment paired with corresponding elevations
C. Parcel-owner names arranged in alphabetical order instead of stationing
D. Aerial image pixel colors without any relation to alignment distance

74. A topographic map shows several closed contour loops with short hachure marks pointing toward the centers. What terrain feature is represented?

A. A ridge crest with elevations increasing along its centerline
B. A hilltop with elevations increasing toward the center
C. A depression with elevations decreasing toward the center
D. A uniform planar slope with no local high or low point

75. A map has a 2-ft contour interval and every fifth contour is drawn as an index contour. What is the elevation difference between adjacent index contours?

A. 10 ft
B. 5 ft
C. 2 ft
D. 20 ft

76. Which statement best distinguishes a planimetric map from a topographic map?

A. A planimetric map shows only property ownership, while a topographic map never shows fixed features
B. A planimetric map must use satellite coordinates, while a topographic map must use assumed coordinates
C. A planimetric map is always larger scale than every topographic map regardless of purpose
D. A planimetric map emphasizes horizontal feature positions, while a topographic map also represents relief or elevation

77. A plotting tolerance is 0.02 inch on a map at 1 inch = 100 ft. What ground distance corresponds to that plotting tolerance?

A. 2.0 ft
B. 0.2 ft
C. 5.0 ft
D. 20.0 ft

78. A straight TIN edge connects elevations 255.0 ft and 263.0 ft over 64 ft. How far from the 255.0-ft end is elevation 260.0 ft, assuming linear interpolation?

A. 24 ft
B. 32 ft
C. 40 ft
D. 50 ft

79. A profile uses a horizontal scale of 1 in = 100 ft and a vertical scale of 1 in = 10 ft. What is the vertical exaggeration?

A. 1:10
B. 5:1
C. 100:1
D. 10:1

80. Before issuing a topographic base map assembled from several surveys, which map note is most important for downstream users?

A. State only the plotting software version because it determines every feature's true position
B. Identify the coordinate and vertical reference systems, units, source dates, and relevant accuracy limitations
C. Omit source dates so users do not question older data
D. Remove datum information once the drawing has been converted to PDF

81. A stake is at station 23+45.00. A second point is 185.50 ft ahead along the same stationing. What is the second station?

A. 21+59.50
B. 25+30.50
C. 23+30.50
D. 25+45.00

82. A design point is N=4200.00 ft, E=3150.00 ft. A 15.00-ft offset stake is placed due west of the design point. What are the stake coordinates?

A. N=4185.00 ft, E=3150.00 ft
B. N=4200.00 ft, E=3165.00 ft
C. N=4200.00 ft, E=3135.00 ft
D. N=4215.00 ft, E=3150.00 ft

83. Existing ground at a proposed footing is elevation 612.35 ft and design subgrade is 609.90 ft. What cut is required?

A. 2.45 ft fill
B. 1.55 ft cut
C. 3.45 ft cut
D. 2.45 ft cut

84. After a roadway catch point is located, why is a reference or offset stake often set beyond the planned grading disturbance?

A. To preserve a recoverable record of the catch location and cut/fill information after earthwork removes the original point
B. To redefine the roadway centerline independently of the project control system

C. To convert the catch point into a permanent legal property monument
D. To eliminate the need for any future grade checks during earthwork

85. A grade stake is marked 'C 1.25' for a proposed pavement subgrade point. Under the stated convention C = cut. What does the mark mean?

A. Existing ground is 1.25 ft below design grade and should be filled that amount
B. The stake is 1.25 ft horizontally from centerline with no elevation meaning
C. The proposed grade must be raised 1.25 ft above the design elevation
D. Existing ground is 1.25 ft above design grade and should be cut down that amount

86. For a simple circular curve, the total central angle is 36°00'. What is the deflection angle from the tangent at the PC to the PT chord?

A. 18°00'
B. 9°00'
C. 36°00'
D. 72°00'

87. A curve PC is at station 60+40.00. A point lies 175.00 ft along the curve from the PC. What is the station of that point?

A. 58+65.00
B. 60+15.00
C. 62+15.00
D. 61+75.00

88. A sanitary sewer invert is elevation 488.60 ft at station 10+00 and the pipe falls at 0.80%. What is the invert elevation at station 12+75?

A. 490.80 ft

B. 486.40 ft
C. 488.38 ft
D. 486.80 ft

89. A column grid point at N=8000.00 ft, E=5000.00 ft must be offset 20.00 ft at azimuth 135°00'. What is the offset point easting, nearest 0.01 ft?

A. 4985.86 ft
B. 5010.00 ft
C. 5020.00 ft
D. 5014.14 ft

90. What is the primary surveying purpose of batter boards for a small foundation excavation?

A. Provide durable offset references for building lines and elevations after the excavation removes center stakes
B. Replace all project control monuments with temporary lumber around the excavation
C. Establish legal property boundaries without any boundary survey evidence
D. Measure concrete strength by comparing board deflection before and after placement

91. A curb flow line rises 2.40 ft at a constant grade of +1.20%. What horizontal distance corresponds to that rise?

A. 120 ft
B. 288 ft
C. 200 ft
D. 20 ft

92. At a roadway hinge point, design elevation is 510.0 ft. Existing ground at the projected catch is 504.0 ft. For a 2H:1V fill slope on level cross-section geometry, what horizontal distance from the hinge is required?

A. 3 ft
B. 6 ft
C. 12 ft
D. 18 ft

93. A design point is 80.00 ft horizontally from the instrument and 6.00 ft higher than the instrument axis. What slope distance should be used to reach the design point, nearest 0.01 ft?

A. 74.00 ft
B. 80.22 ft
C. 86.00 ft
D. 80.00 ft

94. A grading contractor uses machine-control models for earthwork. What survey practice is still important before relying on the model for production?

A. Assume the digital model is self-verifying because it was exported from design software
B. Remove physical control so machines cannot accidentally compare against a different system
C. Allow each machine to use a separate origin as long as the displayed cut and fill values look reasonable
D. Verify site control and check representative model points or surfaces independently in the field

95. Bridge bearing seats are being staked from two control stations. Which procedure best protects against a setup or orientation blunder?

A. Stake every bearing from one setup only and skip any closure because the coordinates are known
B. Check the staked positions from independent control or a different setup before release
C. Use longer prism poles so angular centering errors become less important
D. Round the design coordinates to the nearest foot before field stakeout

96. A wall design line is at easting 2500.00 ft. An as-built point on the wall measures easting 2500.07 ft, and east is defined as positive offset. What is the as-built horizontal offset from design?

A. +0.07 ft
B. -0.07 ft
C. +7.00 ft
D. 0.00 ft

97. A rectangular building grid is 120.00 ft by 90.00 ft. What diagonal length should be checked between opposite corners, nearest 0.01 ft?

A. 210.00 ft
B. 30.00 ft
C. 150.00 ft
D. 147.65 ft

98. A 300-ft parabolic vertical curve begins at elevation 250.00 ft with g1=+2.0% and ends with g2=-1.0%. What design elevation should be staked 150 ft from the PVC? Use $y = y0 + g1x + (g2-g1)x^2/(2L)$.

A. 253.00 ft
B. 251.88 ft
C. 250.75 ft
D. 251.50 ft

99. A station equation is 100+00 back = 100+25 ahead. A point is 175 ft physically ahead of station 99+50 back and crosses the equation. What is its ahead station?

A. 101+50
B. 101+25
C. 101+75
D. 100+25

100. A curb stake is destroyed before grading, but two nearby project control points remain undisturbed and the design coordinate is known. What is the best way to replace the stake?

A. Estimate its location from tire tracks and the memory of the previous staking crew
B. Create a new arbitrary coordinate origin at the nearest surviving lath
C. Shift the design point to match the contractor's current excavation edge
D. Reestablish it from verified project control and document the replacement check

Practice Exam 5: Answer Key and Explanations

1. D — Long-duration construction control must survive demolition, grading, paving, and changing access. Redundant stable monuments outside likely disturbance preserve a common project reference and allow recovery if one point is lost. Control inside excavation is vulnerable, separate coordinate systems invite systematic offsets, and machine files alone do not provide an independent physical reference framework.

2. A — Elevation values are meaningful only within a defined vertical reference system. A verified tie through common benchmarks or other defensible transformation establishes the offset and confirms whether the systems are compatible. Averaging, relabeling, or mixing datums by task can create hidden systematic grade errors even when each individual dataset appears internally consistent.

3. B — The measurements cluster tightly, so their repeatability indicates good precision. Their common 0.18-ft displacement from the calibrated value shows poor accuracy caused by a likely systematic effect. Precision describes agreement among repeated observations, while accuracy describes agreement with the accepted value. Repetition alone cannot remove a bias that affects each reading similarly.

4. C — Laser scanning can collect dense three-dimensional point coverage rapidly across complex and partly inaccessible surfaces. Tying the scans to reliable control and validating them with independent points supports repeatable volume comparisons. A single level line, sparse manual measurements, or isolated navigation-grade positions cannot adequately represent irregular bench faces and changing mine geometry.

5. B — Redundancy provides more observations than the minimum mathematical solution requires. Those extra measurements create closures and residuals that expose inconsistencies and allow a blunder to be isolated. A minimally determined network can absorb a bad observation without revealing it, while early rounding and single-station geometry reduce the information available for quality control.

6. A — Field methods should be selected from the information the design actually requires. Survey limits, needed breaklines, vertical accuracy, terrain detail, and deliverable format determine point density, equipment, control, and checking procedures. Crew clothing, future excavation machinery, and unrelated office practices do not establish whether the resulting surface will support detention-basin grading and drainage design.

7. D — An assumed local system can work well when it is reproducible. Recording the origin, orientation, units, scale basis, monument descriptions, and external ties explains how coordinates relate to the site and permits future recovery. A filename alone is insufficient, physical control still matters, and changing orientation between crews destroys consistency even if individual measurements are precise.

8. C — GIS linework may combine sources with different ages, datums, scales, and positional accuracies. Near a critical conflict, the project team should review metadata and use appropriate field locating, survey ties, or direct exposure. Screen display precision does not make a layer survey-grade, and combining uncertain sources does not eliminate their underlying uncertainty.

9. C — GNSS requires usable satellite signals, so a tunnel normally calls for terrestrial control methods such as a carefully designed total-station traverse, gyroscopic orientation where appropriate, or other suitable underground techniques. Longer occupation cannot solve complete signal blockage. Independent arbitrary systems and chainage-only estimates would not preserve the project coordinate framework through the tunnel.

10. A — Coordinate exchange is reliable only when the reference framework is explicit. Datum, projection or local basis, units, epoch where relevant, and any ground transformation explain what the numbers mean. Decimal precision does not identify a system, visual alignment can hide large systematic errors, and discarding source reference information makes later verification much harder.

11. B — Route surveying supports linear projects by establishing or using an alignment, collecting corridor topography, and developing profiles and cross-sections for design. Control provides the reference framework for those tasks. Boundary retracement, deformation monitoring, and hydrographic work have different primary purposes even though individual surveying techniques may overlap with a transportation corridor project.

12. D — Settlement monitoring depends on detecting small vertical changes, so equipment and procedures must provide uncertainty comfortably below the movement threshold and allow systematic effects to be controlled. Reflectorless range, coding capacity, and matching brand names do not establish vertical performance. The selected method should support repeatable setups, stable references, and independent checks across monitoring epochs.

13. D — A project benchmark must remain stable relative to the work being measured. Placing it beyond expected settlement and disturbance, while maintaining safe access, makes repeated elevation transfer more reliable. Marks on embankments, removable forms, or excavation edges may move or disappear, which can make apparent construction elevation changes indistinguishable from movement of the reference itself.

14. C — Photogrammetric surface reconstruction depends on identifiable image texture and reliable matching. Smooth, reflective, or changing water can produce weak, absent, or erroneous points, so the plan should supplement or exclude those areas as appropriate. Shoreline proximity does not eliminate horizontal positioning, and water does not replace surveyed control or independent model validation.

15. A — Efficient linear-project surveying progresses from reconnaissance and control to design-support data, then to construction staking after the alignment is defined. Staking before design creates rework, random detail without control is difficult to integrate, and earthwork quantities require terrain and design information. Sequencing the work this way also preserves traceability from design coordinates to field layout.

16. B — California section 6731.1 expressly includes rendering a statement regarding the accuracy of maps or measured survey data when connected with the engineering-surveying activities described in the section. That provision does not create unrestricted authority over title or every boundary matter. The accuracy statement remains tied to the authorized fixed-work, surface-configuration, fixed-object, and related data activities.

17. D — Section 6731.2 allows a registered civil engineer to offer, procure, or offer to procure land-surveying work incidental to civil engineering practice even when the engineer is not personally authorized to perform it. The condition is that the surveying be performed by or under the direction of a licensed land surveyor or appropriately authorized civil engineer.

18. C — When available clearance is small, survey uncertainty should consume only a controlled fraction of that tolerance. A method with uncertainty near the full 0.08 ft cannot reliably distinguish acceptable from conflicting positions. Early rounding loses information, and repetition does not remove systematic bias. Better geometry, equipment, calibration, and independent checks may be required.

19. A — Critical utility conflicts should be investigated with methods appropriate to the risk. Locating, survey ties, and direct exposure such as potholing can establish the actual relationship before design or excavation decisions are locked. Enlarging graphics cannot improve source accuracy, and deleting uncertain information or waiting for excavation transfers rather than manages the conflict risk.

20. C — Projected grid distances and ground distances can differ because of projection scale and elevation effects, and a localized construction system may add rotation or translation. The relationship must be documented before stakeout. Silently mixing the two can introduce systematic position errors across the site even when field measurements themselves are precise and internally consistent.

21. B — Electromagnetic distance measurement depends on signal propagation through the atmosphere, so temperature, pressure, and other specified environmental inputs can affect precise results. The crew should follow the instrument and project procedure for corrections. Contour interval, prism housing color, and bearing conversion do not compensate for an incorrect atmospheric model applied to the measured distance.

22. A — Intersection geometry controls how observation errors propagate into a computed point. Very narrow or nearly collinear rays can make small angular, pointing, or centering errors create much larger positional uncertainty. Instrument resolution alone does not overcome poor geometry, and the effect is fundamentally horizontal for an intersection. Better station placement or added observations strengthens the solution.

23. D — As-built surveying should capture the constructed condition while critical features remain directly observable. Surveying after installation but before concealment allows valve centers, fittings, inverts, and offsets to be tied to project control. Design coordinates are not as-built evidence, and post-backfill reconstruction relies on indirect information with greater positional uncertainty and less defensible verification.

24. B — Independent check points test the final mapping without being used to force the solution to agree. Their residuals therefore provide evidence of external positional accuracy. Points used in the adjustment are not independent, and changing symbol size does not change accuracy. Comparing a derived product only against its own source also cannot provide an external validation.

25. D — Deformation monitoring depends on comparing like measurements through time. Stable external references, consistent procedures, and documented conditions help separate actual movement from changes in method or control. Resetting origins or replacing references can mimic displacement, while premature rounding can hide small trends. Periodic checks of the reference network are also necessary to confirm its stability.

26. B — For a symmetric three-wire reading, the middle hair should equal the average of the upper and lower hair readings. The mean is (4.882 + 4.590)/2 = 4.736 ft. A materially different middle reading may indicate a reading or transcription problem. The check does not replace proper rod plumbing, focus, or stable instrument setup.

27. A — A foresight or check reading equals height of instrument minus the known point elevation when both are in the same vertical datum. Here 691.34 - 687.96 = 3.38 ft. Adding the values or reversing the subtraction does not represent the rod geometry. Comparing the observed reading with this expected value provides a direct field check.

28. C — The prism-center elevation equals occupied elevation plus instrument height plus the vertical component of the sight. The vertical component is 210 sin 4° = 14.65 ft. Subtracting the 6.00-ft prism height gives 950.00 + 5.20 + 14.65 - 6.00 = 963.85 ft. Omitting a height term produces the distractors. Check the angle sign carefully.

29. C — Reduce the face-II reading by 180° to place both observations on the same directional basis: 264°12'40" becomes 84°12'40". Averaging that with 84°12'20" gives 84°12'30". The mean helps reduce certain face-dependent instrumental effects, but careful pointing, centering, and station identification are still required for precise angular work. The two-face comparison is also a useful diagnostic for angular consistency.

30. A — The occupied station fixes the instrument position, while the backsight provides a known direction for orientation. Once oriented, measured horizontal angles can be related to project azimuths, bearings, or coordinates. A backsight does not supply atmospheric data, replace the occupation coordinates, or independently establish an elevation without the required vertical observations and height information.

31. D — A small collimation error produces a sight-length-dependent vertical effect. Keeping backsight and foresight distances approximately equal causes much of that effect to cancel within each setup. Balanced sights do not make elevations equal, eliminate the need for stable turning points, or correct every possible rod error. Careful setup geometry still supports precise leveling.

32. B — The net elevation change equals total backsights minus total foresights: 36.84 - 36.91 = -0.07 ft. Applying that change to 500.00 ft gives 499.93 ft. Reversing the subtraction gives 500.07 ft, while assuming exact closure ignores the observed difference recorded in the level notes. An independent repeat or closure is still valuable before accepting the field result.

33. D — The data collector subtracts the entered target height when reducing prism-center elevation to the ground point. Entering 5.35 ft instead of the actual 5.00 ft subtracts an extra 0.35 ft, making ground elevations 0.35 ft too low. The error equals the height-entry difference, not the full prism height. Use the documented project convention.

34. C — The receiver determines the antenna reference-point position, then applies the entered antenna height to derive the ground mark. If 1.800 m is entered instead of the actual 2.000 m, the software subtracts 0.200 m too little, so the ground elevation is approximately 0.200 m too high. Antenna-height errors directly affect the vertical reduction.

35. A — Face-left and face-right observations reverse portions of the instrument geometry, allowing certain systematic angular errors to cancel or become visible when combined. They do not eliminate centering, pointing, identification, or setup mistakes. Accurate angle work still depends on stable stations, careful targets, correct orientation, and appropriate repetitions or closures for the required precision.

36. B — Reflectorless EDM performance depends on the target's reflectivity, texture, range, and angle of incidence. Dark, wet, rough, or oblique surfaces can return weaker or less reliable signals. The crew should evaluate instrument limits and repeat or check critical shots. Reflectorless capability does not make target characteristics irrelevant to measured distance quality.

37. C — A zenith angle is measured from the upward vertical, so the horizontal component is slope distance times sine of the zenith angle. Using 286.40 sin 92.25° gives 286.18 ft. The small cosine component is vertical and negative because the sight is slightly below horizontal. The horizontal projection remains slightly shorter than the slope distance.

38. B — For azimuth measured clockwise from north, departure or easting change equals distance times sine of azimuth. Thus 120.00 sin 30° = 60.00 ft east, and 2000.00 + 60.00 = 2060.00 ft. Using cosine would compute the northing component, while subtracting the departure would place the point west of the setup.

39. D — The observed elevation change is 28.44 - 34.96 = -6.52 ft, giving a computed closing elevation of 735.66 ft. Comparing that with the published 735.62 ft gives a misclosure of +0.04 ft. The sign depends on computed minus known closing elevation, so the project convention should be stated and used consistently.

40. A — A potential utility conflict is a safety- and design-significant observation. The crew should document the evidence, verify positions and control as appropriate, and communicate the conflict before work proceeds. Editing data to remove the discrepancy destroys evidence, while ignoring or deferring the issue until excavation can turn a detectable conflict into a construction incident.

41. C — Latitude is the north-south component of a traverse course. For azimuth measured clockwise from north, latitude equals distance times cosine of azimuth: 250.00 cos 40° = 191.51 ft north. The sine gives the departure, and negative signs would place the course in a southern quadrant inconsistent with the stated 40° azimuth.

42. D — Departure is the east-west component. With azimuth measured clockwise from north, departure equals distance times sine of azimuth: 250.00 sin 40° = 160.70 ft east. Cosine gives the latitude. Because 40° lies in the northeast quadrant, both latitude and departure are positive under the conventional north-positive, east-positive coordinate system. Use the documented project convention.

43. B — The closing coordinate differences are +0.06 ft in northing and -0.08 ft in easting. The linear misclosure is their vector magnitude: sqrt(0.06^2 + 0.08^2) = 0.10 ft. Adding signed components or absolute components does not give the two-dimensional distance between the computed and required closing positions. The closure vector should be assessed against the project's required positional standard.

44. A — Relative precision is total traverse length divided by linear error of closure. Here 5280 / 0.24 = 22,000, so the closure is approximately 1:22,000. Dividing in the opposite direction produces a small decimal rather than the conventional ratio. The result should be evaluated against the project's required survey accuracy and network purpose.

45. B — The Bowditch correction is proportional to course length and opposite the total misclosure. The length fraction is 400/2000 = 0.20, so the latitude correction is -(0.10)(0.20) = -0.020 ft. A positive correction would increase the existing positive misclosure, while 0.050 ft uses the wrong length proportion. A quick sign and magnitude check helps catch common reduction errors before use.

46. A — An azimuth between 180° and 270° lies in the southwest quadrant. Subtract 180° from 214°30' to obtain 34°30', giving S 34°30' W. Using 270° as the reference produces 55°30', while north-based bearings would place the line in the wrong quadrant. Always identify the quadrant before converting the angle. Use the documented project convention.

47. D — The back azimuth differs from the forward azimuth by 180°. Because 128°20' is less than 180°, add 180° to obtain 308°20'. Subtracting from 180° gives 51°40', which is a related quadrant angle but not the back azimuth. The forward and back directions must be exactly opposite on the full circle.

48. C — The vertical angle above horizontal satisfies tan(theta) = vertical difference divided by horizontal distance. Thus theta = arctan(27/360) = 4.29°. The complementary 85.71° is a zenith-related angle, while 3.75° results from treating the ratio as degrees without applying the inverse tangent. The positive rise confirms a positive vertical angle. Check the sign for slopes.

49. C — Grade as a decimal equals elevation change divided by horizontal distance. Rearranging gives distance = 7.50/0.015 = 500 ft. Multiplying the rise by the percent, or using 1.50 instead of 0.015, produces incorrect scales. The positive sign only indicates that elevation increases in the forward station direction. This rearranged grade relationship is common when solving profile spacing from elevation constraints.

50. A — The stations are 250 ft apart. At -1.60%, the forward elevation change is -0.016 x 250 = -4.00 ft. Therefore the earlier elevation must be 4.00 ft higher than 506.25 ft, giving 510.25 ft. Applying the grade in the wrong direction or using 25 ft instead of 250 ft produces the other values.

51. D — For a simple curve, T = R tan(Delta/2), so R = T/tan(Delta/2). With T = 194.95 ft and Delta/2 = 18°, the radius is approximately 599.99 ft, which rounds to 600 ft. Using arc length or the full central angle in the tangent formula produces substantially different values. Use the half-angle in this formula.

52. B — Arc length equals radius times the central angle in radians: L = pi(600)(36/180) = 376.99 ft. The 194.95-ft value is the tangent length, while 370.82 ft is the long chord. Arc and chord are close for modest angles but are not interchangeable because one follows the circle and one is straight.

53. D — The external distance is E = R(sec(Delta/2) - 1). With Delta/2 = 18°, sec 18° is about 1.05146, so E = 600(0.05146) = 30.88 ft. Tangent length and long chord are different curve elements. The external distance is measured from the PI toward the curve midpoint along the angle bisector.

54. B — The PC lies one tangent length before the PI along the stationing. Convert station 47+80.00 to 4780.00 ft and subtract 194.95 ft to obtain 4585.05 ft, or station 45+85.05. Adding the tangent places a point ahead of the PI, while subtracting twice the tangent moves too far back. Converting station notation to total feet first reduces station arithmetic errors.

55. A — Stationing along the alignment advances by the arc length from PC to PT. Adding 376.99 ft to 4585.05 ft gives 4962.04 ft, or station 49+62.04. The PI station is not obtained by simply taking the station midpoint, and adding tangent length instead of arc length would place the PT too far ahead.

56. C — A chord for central angle Delta is C = 2R sin(Delta/2). With R = 700 ft and Delta = 18°, C = 1400 sin 9° = 219.01 ft. Using only R sin(Delta/2) halves the chord, while arc length would be slightly longer than the chord for the same central angle.

57. C — The absolute algebraic grade difference is |g2 - g1| = |-1.0 - 2.0| = 3.0%. By the stated definition, K = L/A = 600/3.0 = 200 ft per percent. The value describes horizontal curve length provided for each one-percent change in grade and is distinct from the grade-change rate per station.

58. B — Substitute x = 200 ft, L = 400 ft, g1 = 0.01, and g2 - g1 = -0.04. The tangent rise is 2.00 ft, while the parabolic term is -2.00 ft, so the curve elevation remains 700.00 ft. Using only the entering tangent would give 702.00 ft and omit curvature.

59. D — The grade along a parabolic vertical curve is g(x) = g1 + (g2-g1)x/L. At the high point the grade is zero. Solving 0 = 0.01 + (-0.04)x/400 gives x = 100 ft from the PVC. The midpoint is not automatically the high point unless the entering and exiting grades are equal in magnitude.

60. A — An east-west alignment has constant northing, so the perpendicular offset is the difference in northing between the point and the line. The magnitude is |1120 - 1100| = 20 ft. The easting does not affect perpendicular distance to an infinite east-west line. Larger choices mix coordinate components that are not normal to the alignment.

61. C — The coordinates form a trapezoid with parallel bases 300 ft and 240 ft separated by 160 ft. Its area is (300 + 240)/2 x 160 = 43,200 square feet. The shoelace coordinate-area method gives the same result. Using 300 x 160 treats the sloping side as if the site were rectangular.

62. D — The prismoidal formula uses the midpoint area with four times its weight: V = 100(820 + 4(950) + 1060)/6 = 94,666.67 cubic feet. Dividing by 27 gives 3,506.17 cubic yards. The average-end-area result is slightly different because it does not use the measured midpoint section in the volume model. Keep volume units consistent.

63. B — An 18% swell means loose volume equals bank volume multiplied by 1.18. Thus 18,500 x 1.18 = 21,830 cubic yards. Subtracting 18% would represent shrinkage rather than swell, and adding only 18 cubic yards confuses a percentage with an absolute quantity. The swell factor should match the project's defined material-volume convention.

64. A — Convert 2,400 ft to miles: K = 2400/5280 = 0.4545 mile. The allowable magnitude is 0.04 sqrt(0.4545) = about 0.027 ft. Using K directly instead of its square root gives about 0.018 ft, while 0.040 ft ignores the distance term entirely. A quick sign and magnitude check helps catch common reduction errors before use.

65. C — Using the stated convention, grid distance equals ground distance times the grid factor: 1250.00 x 0.99985 = 1249.8125 ft, which rounds to 1249.81 ft. Dividing by the factor would produce a slightly larger value. The question defines the conversion direction, so the factor should not be inverted during reduction. Use the documented project convention.

66. B — A 90° counterclockwise rotation maps (x, y) to (-y, x). Applying that rule to (30, 50) gives (-50, 30). The other pairs represent clockwise rotation, reflection, or sign changes without the required coordinate swap. Rotation preserves distance from the origin even though the coordinate components change. A quick sign and magnitude check helps catch common reduction errors before use.

67. D — The total rise is 8.00 ft over 400 ft, or 0.02 ft per horizontal foot. Station 7+50 is 250 ft beyond station 5+00, so the rise is 0.02 x 250 = 5.00 ft. Adding that to 410.20 gives 415.20 ft. Linear interpolation is valid because the grade is stated as uniform.

68. A — With a constant contour interval, closely spaced contours represent the same vertical change occurring over a shorter horizontal distance, which means a steeper slope. Wider spacing indicates flatter terrain. Local contour spacing does not change the map scale or vertical datum; it reflects how rapidly elevation changes across the mapped surface.

69. D — The coordinate changes are DeltaN = +120 ft and DeltaE = +90 ft, placing the line in the northeast quadrant. Azimuth from north is atan(DeltaE/DeltaN) = atan(90/120) = 36.9°. Using the reciprocal ratio gives 53.1°, while adding 180° or reflecting the angle places the line in another quadrant. Use the documented project convention.

70. A — The loop closes 0.05 ft high, so the total correction at the end must be -0.05 ft. With ten equal-length setups, correction accumulates uniformly at -0.005 ft per setup. After setup 6, the cumulative correction is 6(-0.005) = -0.030 ft. A positive correction would worsen the high closure. Use the documented project convention.

71. C — The 416-ft contour is 4 ft above 412 ft within an 8-ft total elevation change. The fractional position is 4/8 = 0.5, so it lies 0.5 x 80 = 40 ft from the lower point. Linear interpolation assumes the surface changes uniformly along the segment between the two measured elevations.

72. B — At 40 ft per plotted inch, sheet length equals ground distance divided by the scale denominator in feet per inch. Thus 430/40 = 10.75 inches. Multiplying instead of dividing produces an unrealistic sheet length, while shifting the decimal loses a factor of ten. The calculation assumes the printed profile is at its intended scale.

73. B — A profile represents elevation versus distance along an alignment, so each plotted point needs a station or horizontal-distance position and a corresponding elevation. Northing alone does not define alignment distance, ownership information is unrelated to the vertical section, and raw image colors cannot substitute for surveyed positions and elevations tied to the route.

74. C — Hachured closed contours conventionally indicate a depression, and the hachure marks point toward lower ground. Ordinary closed contours without hachures commonly represent a hill when elevations increase toward the center. A ridge or planar slope has a different contour pattern. The surrounding labeled elevations should still be checked when interpreting the mapped landform.

75. A — Index contours occur every fifth contour in this map. With a 2-ft contour interval, five intervals represent 5 x 2 = 10 ft between adjacent index contours. The 2-ft value is the basic contour interval, not the index spacing, while 5 ft incorrectly treats the contour count as an elevation difference.

76. D — Planimetric mapping primarily shows horizontal positions of visible or mapped features, while topographic mapping adds representation of terrain relief through contours, spot elevations, surfaces, or similar vertical information. Either map may use different coordinate systems or scales, and neither definition is limited to property ownership or a particular positioning technology.

77. A — At 100 ft per inch, a 0.02-inch plotting tolerance corresponds to 0.02 x 100 = 2.0 ft on the ground. A smaller-scale map magnifies the ground distance represented by a small paper displacement. This conversion helps determine whether source survey accuracy is appropriate for the intended plotted scale and use.

78. C — The target elevation is 5 ft above the lower point within an 8-ft total change. The fraction is 5/8 = 0.625, and 0.625 x 64 = 40 ft. The calculation assumes linear variation along that TIN edge. Using half the distance would incorrectly place the target at elevation 259.0 ft.

79. D — Vertical exaggeration compares the horizontal ground distance per plotted inch with the vertical ground distance per plotted inch. Here 100/10 = 10, so the profile is vertically exaggerated 10:1. This makes small grade changes easier to see, but it also makes slopes appear visually steeper than they would at equal horizontal and vertical scales.

80. B — A useful base map communicates not only feature locations but also the reference systems and limitations needed to interpret them. Datum, vertical reference, units, source dates, and accuracy notes help users judge compatibility and suitability. Software version or file format cannot replace that metadata, and removing reference information makes later design coordination more vulnerable to hidden systematic errors.

81. B — Station 23+45.00 represents 2345.00 ft along the alignment. Adding 185.50 ft gives 2530.50 ft, which is station 25+30.50. Subtracting would move backward, while changing only the plus portion without carrying through hundreds produces an incorrect station. Converting stationing to total feet first helps prevent bookkeeping mistakes. That convention lets the staking crew compare design intent with field conditions consistently.

82. C — A due-west offset changes only easting, and west is negative in the conventional east-positive coordinate system. Subtract 15.00 ft from E=3150.00 ft to obtain E=3135.00 ft, while northing remains 4200.00 ft. The other choices move south, east, or north instead of west from the design point. That convention lets the staking crew compare design intent with field conditions consistently.

83. D — Existing ground is above the design subgrade, so material must be removed. The cut magnitude is 612.35 - 609.90 = 2.45 ft. Calling it fill reverses the construction condition, while the other magnitudes come from incorrect subtraction. A clear cut/fill sign convention should be stated on stake notes and used consistently.

84. A — The actual catch point may be destroyed as grading reaches the cut or fill limit. An offset or reference stake outside disturbance preserves the information needed to recover the intended slope intersection and communicate cut, fill, station, or offset data. It does not establish a property boundary, redefine centerline control, or eliminate later construction verification.

85. D — With the stated convention, C means cut and the number gives the vertical amount. A 1.25-ft cut means existing ground is 1.25 ft above the proposed grade at the referenced point. The mark does not describe a horizontal offset or authorize changing design elevation. Stake conventions must be clearly defined before construction uses them.

86. A — For a simple circular curve, the deflection from the tangent at the PC to the chord ending at the PT equals one-half the central angle subtended by that chord. The PT chord subtends the full 36° curve, so the deflection is 18°. Using the full central angle doubles the correct tangent deflection.

87. C — Stationing along an alignment accumulates traveled alignment distance. Convert PC station 60+40.00 to 6040.00 ft and add the 175.00-ft arc distance to obtain 6215.00 ft, or station 62+15.00. Subtracting moves backward, while adding only to the plus portion without proper carrying misstates the station. That convention lets the staking crew compare design intent with field conditions consistently.

88. B — Station 12+75 is 275 ft ahead. At a -0.80% grade, the elevation change is -0.008 x 275 = -2.20 ft. Therefore the invert is 488.60 - 2.20 = 486.40 ft. A positive change reverses the pipe fall, while using 27.5 ft understates the drop by a factor of ten. Use the documented project convention.

89. D — For azimuth measured clockwise from north, the easting change is distance times sine of azimuth. Thus DeltaE = 20 sin 135° = +14.14 ft, and the new easting is 5014.14 ft. The negative option would place the point west, while 10 or 20 ft ignore the trigonometric component of the diagonal offset.

90. A — Batter boards carry stringlines, offsets, or grade references outside the excavation so layout can be recovered after direct stakes are removed. They are tied to project control rather than replacing it. Their function is construction layout, not boundary determination or material testing. Stable placement and clear offset notes make the references reproducible during forming and foundation work.

91. C — Grade equals rise divided by horizontal distance. Rearranging gives distance = 2.40/0.012 = 200 ft. Using 1.20 as a whole number instead of converting percent to decimal produces a much smaller distance, while multiplying rather than dividing gives another incorrect scale. The positive sign simply indicates the flow line rises forward.

92. C — The vertical difference is 510.0 - 504.0 = 6.0 ft of fill. A 2H:1V slope requires two horizontal feet for each vertical foot, so horizontal distance is 2 x 6 = 12 ft. Using 6 ft would apply a 1:1 slope, while 3 ft reverses the ratio. That convention lets the staking crew compare design intent with field conditions consistently.

93. B — Horizontal and vertical components form a right triangle. The required slope distance is sqrt(80^2 + 6^2) = 80.22 ft. Simply adding or subtracting 6 ft does not represent the geometry, and using 80.00 ft ignores the vertical separation. This calculation concerns instrument-axis to target-point geometry before target-height adjustments. Use the documented project convention.

94. D — Machine control depends on the same coordinate, datum, and surface definitions as conventional staking. Independent checks of site control and representative design points help detect wrong files, transformations, antenna settings, or model errors before large quantities are moved. Design-software origin does not make a model self-verifying, and separate machine origins destroy common project control.

95. B — Critical bridge geometry deserves an independent verification path. Checking from another control station or setup can expose occupation, orientation, centering, or coordinate-entry mistakes that one setup might repeat consistently. Longer prism poles do not remove angular or centering error, and rounding design coordinates would intentionally reduce the precision required for bearing-seat construction.

96. A — The design line has easting 2500.00 ft and the as-built point is 0.07 ft farther east. Under the stated east-positive convention, offset is 2500.07 - 2500.00 = +0.07 ft. The negative value reverses the direction, while 7.00 ft is a decimal-place error. The tolerance decision is separate from computing the offset.

97. C — The diagonal of a rectangle is found with the Pythagorean theorem: sqrt(120^2 + 90^2) = 150.00 ft. Comparing measured diagonals with the design value is a useful squareness check after the sides are established. Adding the side lengths gives the perimeter half-sum, while subtracting them gives no diagonal geometry. Use the documented project convention.

98. B — At x = 150 ft, the entering tangent contributes 0.02 x 150 = 3.00 ft. The parabolic term is (-0.03)(150^2)/(2 x 300) = -1.125 ft. Adding both to 250.00 gives 251.875 ft, or 251.88 ft. Using only the tangent would incorrectly give 253.00 ft. That convention lets the staking crew compare design intent with field conditions consistently.

99. A — From 99+50 back to 100+00 back is 50 ft. After crossing the equation, 125 ft of the 175-ft physical distance remains. The ahead station at the equation is 100+25, so adding 125 ft gives 101+50. Ignoring the 25-ft station jump would produce 101+25 instead. That convention lets the staking crew compare design intent with field conditions consistently.

100. D — A destroyed construction stake should be replaced from the same verified project control and design basis used originally. Reestablishing from known control preserves line, grade, and coordinate consistency, while documenting the check supports traceability. Memory, temporary marks, or arbitrary coordinate changes can compound disturbance with a new systematic layout error rather than restore the intended point.