PRACTICE EXAM 7: 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 replacement reservoir outlet structure will remove several existing monuments near the excavation. Which control arrangement best supports the entire construction period?

A. Place the primary marks on the concrete scheduled for demolition
B. Allow each subcontractor to create an unrelated working coordinate system
C. Use only machine-control points because physical monuments are unnecessary
D. Establish redundant primary control on stable ground beyond excavation and settlement influence

2. A flood-control project combines an older survey on an assumed benchmark elevation with new observations tied to NAVD 88. What must be established before elevations are merged?

A. The average of all old and new elevations, regardless of benchmark identity
B. A documented vertical relationship between the assumed datum and NAVD 88 using reliable common control
C. A new label calling both files NAVD 88 without changing their numeric values
D. Separate grade systems for structures and drainage with no transformation between them

3. A monitoring network must distinguish movement of about 0.010 ft from observation noise. Which requirement should drive the survey method selection?

A. Expected measurement uncertainty should be substantially smaller than 0.010 ft and supported by repeatable checks

B. The instrument display should show at least four decimal places even if field uncertainty is larger

C. Only one observation should be taken so repeated measurements do not mask movement

D. The instrument should have the greatest advertised range, regardless of precision at the site

4. A steep canyon corridor needs one-foot contours, but many slopes are inaccessible from the ground. Which planning approach best addresses coverage and terrain definition?

A. Collect only road-centerline shots and interpolate every inaccessible slope from them

B. Use a small-scale existing map as the sole source because the terrain is difficult to occupy

C. Use aerial or lidar acquisition tied to control, with supplemental ground observations for obscured critical features

D. Eliminate breaklines so the surface model can smooth across cliffs and drainage channels

5. Before a long utility-relocation survey begins, what reconnaissance result is most useful for choosing the horizontal-control scheme?

A. A list of the contractor's preferred drawing colors

B. The expected number of pages in the final plan set

C. A decision to use the fewest possible control points regardless of terrain

D. Knowledge of access, intervisibility, GNSS obstruction, disturbance risk, and durable monument locations along the corridor

6. A design team requests a drone surface for earthwork quantities. Which scope statement is most important before flight planning?

A. Define survey limits, required accuracy, ground-surface detail, breaklines, datum, checkpoints, and deliverable format

B. Select the drone brand before defining the accuracy required

C. Specify only the final contour color and sheet size

D. Assume the imagery alone will establish the project datum without surveyed control

7. An industrial expansion uses a local grid rotated from state plane. What should the project control report include so another surveyor can reconstruct it later?

A. Only the northing and easting of one temporary point
B. Origin, orientation, units, scale basis, defining monuments, and any transformation or ties to external control
C. A statement that future crews may choose any convenient rotation
D. Only the coordinate precision shown in the CAD file

8. Record utility plans place a gas line near a proposed retaining-wall footing, but no accuracy statement accompanies the linework. How should the planned survey treat that position?

A. As controlling survey evidence because it appears on an agency drawing
B. As a property boundary that must be held without further investigation
C. As approximate information requiring field verification when the consequence of conflict is significant
D. As exact after the drawing is enlarged to a larger plotting scale

9. A short tunnel blocks all satellite reception beyond its portal. Which control concept should be planned for interior alignment work?

A. A redundant terrestrial traverse or similar line-of-sight network tied to stable portal control
B. Standalone GNSS occupations inside the tunnel with longer observation times
C. Independent arbitrary coordinates at each setup with no common orientation
D. Estimated positions from painted station numbers without geometric ties

10. A design baseline is 3,275.00 ft on the ground. The documented ground-to-grid combined factor is 0.999684. What grid distance should be used?

A. 3,276.04 ft
B. 3,275.00 ft
C. 3,273.97 ft

D. 3,276.03 ft

11. A transportation design team needs a common survey framework for a freeway expansion, including alignment geometry, profiles, section data, drainage crossings, and eventual stakeout. Which classification best fits that surveying assignment?

A. A hydrographic survey focused primarily on submerged bottom elevations
B. A route survey supported by horizontal and vertical control
C. A deformation survey intended mainly to detect structural movement
D. A cadastral retracement whose principal objective is ownership determination

12. A project specification requires a traverse to achieve at least 1:30,000 relative closure over a planned 9,600-ft loop. What maximum linear misclosure corresponds to that ratio?

A. 0.03 ft
B. 3.20 ft
C. 0.96 ft
D. 0.32 ft

13. Benchmark control must remain usable throughout a three-year bridge replacement. Which proposed monument location offers the best long-term stability?

A. A fresh embankment that is expected to consolidate during construction
B. A stable monument or structure outside excavation, surcharge fill, and likely equipment disturbance
C. A form board that will be stripped after the first placement
D. A paint mark on a barrier scheduled to move with traffic stages

14. A photogrammetric survey will map a large white concrete apron with very little visual texture. Which planning measure best reduces matching risk?

A. Fly faster so fewer images cover the apron

B. Remove checkpoints because the slab is assumed to be perfectly planar
C. Avoid all ground control because targets interfere with automated processing
D. Add well-distributed targets or supplemental observations where natural image texture is inadequate

15. Which sequence best describes a defensible engineering-survey workflow for a new rail spur?

A. Reconnaissance, establish control, collect design survey data, finalize geometry, then perform construction staking
B. Stake final track points first, then establish control after grading begins
C. Calculate final quantities before collecting terrain and profile data
D. Create separate unrelated grids for each obstruction and reconcile them after construction

16. Under California Business and Professions Code section 6731.1, a civil engineer determines the contour of the earth's surface for a fixed-work design and states the accuracy of the resulting measured data. How is that activity characterized?

A. It automatically becomes an unrestricted cadastral boundary survey
B. It is prohibited unless every adjoining parcel corner is retraced
C. It is included within civil engineering surveying for the fixed-work activities described in the statute
D. It guarantees the location of all concealed utilities shown on the map

17. A California civil engineering firm must procure incidental land-surveying work that the civil engineer in responsible charge is not personally authorized to perform. What arrangement is permitted by section 6731.2?

A. The civil engineer may personally perform any boundary service whenever it is incidental to a civil contract
B. An unlicensed technician may independently complete the survey if a civil engineer later signs the map
C. The firm may procure it if the land surveying is performed by or under the direction of an appropriately authorized survey professional
D. Responsible direction is unnecessary because the surveying is part of a larger engineering project

18. A prefabricated equipment skid must fit between existing anchor bolts with only 0.05 ft of positional tolerance. Which survey-control strategy is most appropriate?

A. Use a method whose expected uncertainty is well below 0.05 ft and verify the result independently
B. Accept uncertainty equal to the full 0.05-ft tolerance
C. Round all offsets to the nearest tenth before checking fit
D. Rely only on repeated observations because repetition removes all systematic error

19. Design clearance is tight where a new storm drain passes below an existing fiber duct bank, but the duct-bank depth comes only from uncertain records. What should be included before the crossing elevation is finalized?

A. A larger plotted scale only, because enlargement improves true utility accuracy
B. Removal of uncertain utility linework from the base map
C. A decision to wait until trench excavation reaches the crossing before checking clearance
D. Targeted locating and, where risk warrants, direct exposure tied to project horizontal and vertical control

20. The project scale convention states grid = ground x 0.999735. A coordinate baseline measures 5,120.00 ft on the grid. Determine the corresponding ground length.

A. 5,118.64 ft
B. 5,121.36 ft
C. 5,120.00 ft
D. 5,123.36 ft

21. A new control point is proposed beside reflective glass curtain walls and under a partial tree canopy. What is the best GNSS planning response?

A. Keep the point because reflective surfaces strengthen satellite geometry
B. Accept any displayed fixed coordinate without independent checks

C. Relocate or supplement the point to improve sky visibility and reduce multipath, then verify it independently
D. Raise the antenna indefinitely because height alone eliminates multipath

22. A precision plant-layout project will use several reflector types. Which setup item should be explicitly controlled in the field procedure?

A. Extend every tripod leg to exactly the same length
B. Confirm that the prism constant entered in the instrument matches the reflector actually being used
C. Use the same screen brightness on every data collector
D. Assign drawing layer colors before any measurements are taken

23. A 14-mile transmission-water corridor needs primary control. Which network concept is preferable to one completely open chain of setups?

A. A separate assumed bearing for each mile
B. Temporary side shots from construction stakes as the only control
C. An unclosed traverse with no external ties because it minimizes observation time
D. Periodic ties, loops, or independent checks that provide meaningful closure along the corridor

24. A drainage design must use elevations compatible with an agency's published orthometric-height system. What should be established before topographic collection?

A. Project benchmarks tied to the specified vertical datum or a documented transformation to it
B. An arbitrary elevation of 100.00 ft relabeled with the datum name
C. A decision to use ellipsoid heights directly as orthometric heights
D. A plan to choose the vertical datum after grading quantities are computed

25. A site reconnaissance finds primary control proposed on a newly constructed retaining-wall backfill that is still consolidating. What should the surveyor do?

A. Keep the point because new construction is always more stable than natural ground
B. Use it as the only project benchmark and ignore future elevation changes
C. Assign it an exact elevation so any physical movement is mathematically prevented
D. Select a more stable monument location outside anticipated settlement or establish redundant control that can reveal movement

26. A reflector is observed along a 684.35-ft inclined line that is 7°35' above the horizontal. After reducing the observation to the horizontal plane and neglecting curvature and refraction, what distance should be used?

A. 90.31 ft
B. 684.35 ft
C. 678.36 ft
D. 690.39 ft

27. A setup point has elevation 438.22 ft. The instrument axis is 5.31 ft above it, and a 4.85-ft prism is observed 512.60 ft away at +3°50'. Compute the ground elevation beneath the prism.

A. 472.95 ft
B. 472.49 ft
C. 404.41 ft
D. 950.13 ft

28. Using the height-of-instrument method, start from BM A at elevation 642.18 ft with BS = 5.44 ft. The next reading to TP 1 is FS = 7.12 ft. Which elevation should be assigned to TP 1?

A. 643.86 ft
B. 640.50 ft
C. 654.74 ft
D. 629.62 ft

29. A two-peg style check indicates a +0.028-ft leveling error when the backsight and foresight lengths differ by 140 ft. If the effect is proportional to sight-length imbalance, what error is expected for a 60-ft imbalance?

A. +0.006 ft
B. +0.028 ft
C. +0.065 ft
D. +0.012 ft

30. From an occupied control point at N 7,800.00 ft, E 4,150.00 ft, stakeout software targets N 8,024.00 ft, E 3,898.00 ft. How long is the plan-distance line between the two coordinates?

A. 337.16 ft
B. 224.00 ft
C. 252.00 ft
D. 476.00 ft

31. A 100.00-ft steel tape standardized at 68°F is used at 40°F. Using a thermal coefficient of 0.00000645 per °F, what temperature correction applies to one full tape length?

A. +0.0181 ft
B. -0.1806 ft
C. -0.0181 ft
D. +0.0018 ft

32. Face-left and face-right observations of the same horizontal angle, reduced to the same sense, are 63°42'18" and 63°42'30". What mean angle should be recorded?

A. 63°42'18"
B. 63°42'24"
C. 63°42'30"
D. 63°43'00"

33. Only the proportional term of an EDM accuracy specification is being evaluated. If that term is 2.5 ppm, how many feet does it contribute over a measured length of 3,150 ft?

A. 0.0008 ft
B. 0.0788 ft
C. 0.0079 ft
D. 0.7875 ft

34. A prism with an actual constant of +17.5 mm is used while the total station is set for 0 mm. What type of field effect is most likely?

A. Only random angular scatter with no distance effect
B. A systematic distance bias affecting reflector observations
C. A change in the vertical datum of all benchmarks
D. No effect unless the line exceeds one mile

35. During RTK work near a steel-framed building, the rover loses its fixed ambiguity solution and reports float. What should be done for a precision control point?

A. Reject the float result for precision control; restore fixed RTK or use another checked method
B. Average the float coordinates briefly and relabel the result as fixed
C. Keep the point if enough decimal places appear on the display
D. Ignore solution status because nearby steel improves satellite ambiguity resolution

36. After occupying a known point and orienting to a backsight, which check should be made before staking dozens of points?

A. Change the datum if the first stake does not fit existing work
B. Assume the setup is correct because the data collector accepted it
C. Delay all checking until the end of the shift

D. Reobserve the backsight or another known control point and compare measured direction and distance with known values

37. A differential-level circuit begins at elevation 510.455 ft. With total BS = 28.644 ft and total FS = 41.327 ft, the computed closing elevation is compared with a published closing benchmark of 497.780 ft. What misclosure results?

A. +0.008 ft
B. -0.008 ft
C. -12.683 ft
D. 497.772 ft

38. For an inclined sight measuring 588.40 ft, the target is 5°10' below the instrument horizontal. Determine the signed vertical component of that measured line.

A. +52.99 ft
B. 586.01 ft
C. -5.17 ft
D. -52.99 ft

39. The line of sight for a level setup has elevation 704.665 ft. A rod on a proposed grade hub reads 5.825 ft. Which elevation belongs to the hub?

A. 710.490 ft
B. 698.250 ft
C. 698.840 ft
D. 704.083 ft

40. A crew must make precise observations across a sun-heated parking deck producing visible shimmer. Which field practice is most appropriate?

A. Use shorter and balanced sight lengths where possible and observe during more stable atmospheric conditions if required
B. Use the longest possible sights so refraction averages out
C. Keep the line of sight as close to the hot deck as possible
D. Assume repeated readings automatically remove a persistent thermal gradient

41. A traverse course is 472.60 ft long with azimuth 128°25'. What change in northing occurs from the beginning to the end of the course?

A. +370.29 ft
B. +293.66 ft
C. -370.29 ft
D. -293.66 ft

42. A 472.60-ft traverse course is directed on azimuth 128°25'. Calculate the course's signed easting component.

A. -293.66 ft
B. -370.29 ft
C. +370.29 ft
D. +293.66 ft

43. Starting coordinates are N 9,440.00 ft and E 2,175.00 ft. One traverse leg contributes latitude +186.75 ft and departure -243.20 ft. Which coordinate pair results at the forward station?

A. N 9,626.75 ft, E 1,931.80 ft
B. N 9,253.25 ft, E 2,418.20 ft
C. N 9,626.75 ft, E 2,418.20 ft
D. N 9,253.25 ft, E 1,931.80 ft

44. A closed control loop is 8,950 ft in total length and its horizontal closure vector has magnitude 0.24 ft. Express the achieved closure as an approximate 1:N relative precision.

A. 1:3,730
B. 1:37,300
C. 1:8,950
D. 1:24,000

45. For Bowditch adjustment, a traverse totaling 3,200 ft is +0.48 ft out in easting. An 800-ft leg represents one-fourth of the perimeter. What easting correction belongs to that leg?

A. +0.12 ft
B. -0.12 ft
C. -0.48 ft
D. +0.48 ft

46. A CAD file stores the direction of a line as azimuth 301°40'. Which quadrant bearing represents the same direction?

A. N 58°20' W
B. N 31°40' W
C. S 58°20' E
D. S 31°40' W

47. Field notes give a bearing S 41°15' E. What clockwise azimuth from north represents that direction?

A. 41°15'
B. 221°15'
C. 138°45'
D. 318°45'

48. Seven measured interior angles sum to 900°01'03". If a simple equal-angle adjustment is required, how many seconds, with sign, should be added to each observation?

A. +9"
B. -63"
C. +63"
D. -9"

49. An irregular equipment pad is defined by the coordinate sequence (0,0), (210,0), (245,120), (110,185), and (20,95) ft. Using coordinate area, what is its approximate acreage?

A. 0.735 acre
B. 0.367 acre
C. 0.815 acre
D. 3.204 acres

50. At the PI of a simple circular curve, R = 760 ft and Δ = 36°. What is the tangent length from PI to PC?

A. 477.52 ft
B. 469.71 ft
C. 246.94 ft
D. 234.85 ft

51. A 760-ft-radius roadway arc turns through 36°. Determine the distance measured along the circular arc from PC to PT.

A. 246.94 ft
B. 477.52 ft
C. 469.71 ft
D. 493.88 ft

52. Two endpoints of a 760-ft-radius, 36° circular arc are to be connected directly by a straight survey line. What is the length of that PC-to-PT chord?

A. 477.52 ft
B. 246.94 ft
C. 493.88 ft
D. 469.71 ft

53. The PI is stationed 63+25.00 on a simple curve, and the computed tangent distance back to PC is 246.94 ft. Which station identifies the PC?

A. 65+71.94
B. 63+25.00
C. 58+47.48
D. 60+78.06

54. After locating PC at station 60+78.06, stationing must advance 477.52 ft along the designed arc to PT. What station should be assigned at PT?

A. 65+47.77
B. 63+25.00
C. 65+55.58
D. 60+78.06

55. A 500-ft sag vertical curve starts at elevation 816.40 ft on a -1.2% grade and leaves on +1.8%. Using the parabolic curve, determine elevation 200 ft beyond the PVC.

A. 814.00 ft
B. 815.20 ft
C. 820.00 ft
D. 817.60 ft

56. For that 500-ft sag curve from -1.2% to +1.8%, how far from the PVC is the low point?

A. 200 ft
B. 300 ft
C. 250 ft
D. 500 ft

57. Existing ground is elevation 244.72 ft and proposed subgrade is 246.05 ft. Using fill as positive when proposed is above existing, what fill is required?

A. 1.33 ft cut
B. 490.77 ft fill
C. 0.75 ft fill
D. 1.33 ft fill

58. A tangent falls 2.4 ft over 160 ft of horizontal run. What signed percent grade applies in the direction of increasing station?

A. -1.50%
B. +1.50%
C. -0.67%
D. -15.0%

59. The endpoints of a control segment are A(N 2,840.00, E 7,120.00) and B(N 3,260.00, E 6,760.00). Which coordinate pair locates the point halfway along the segment?

A. N 3,260.00 ft, E 6,940.00 ft
B. N 3,050.00 ft, E 6,940.00 ft
C. N 3,050.00 ft, E 7,120.00 ft
D. N 210.00 ft, E -180.00 ft

60. Moving from one control point to another changes northing by +420 ft and easting by -360 ft. Convert that rectangular direction to an approximate quadrant bearing.

A. N 49°24' E
B. S 40°36' W
C. N 40°36' W
D. N 49°24' W

61. A triangular borrow-stockpile footprint has a 410-ft baseline and a 275-ft perpendicular altitude. Convert its plan area to acres.

A. 0.647 acre
B. 1.294 acres
C. 5.638 acres
D. 56,375 acres

62. Earthwork sections 60 ft apart enclose 138 sq ft and 204 sq ft of cut. Under the average-end-area method, how many cubic yards are represented between the sections?

A. 171.00 cu yd
B. 760.00 cu yd
C. 380.00 cu yd
D. 10260.00 cu yd

63. Excavation is modeled as a constant rectangular prism 5.5 ft wide, 4.0 ft deep, and 450 ft long. With no allowance for side slopes or overbreak, compute the quantity in cubic yards.

A. 733.33 cu yd
B. 9,900.00 cu yd
C. 183.33 cu yd
D. 366.67 cu yd

64. Project coordinates use a ground-to-grid multiplier of 0.999910. Reduce a 4,460.00-ft ground measurement to its grid-equivalent distance.

A. 4,459.60 ft
B. 4,460.40 ft
C. 4,460.00 ft
D. 4,459.10 ft

65. A 3.6-mile leveling circuit finishes 0.027 ft high. If the opposite correction is accumulated in direct proportion to route length, what correction applies 1.2 miles from the starting benchmark?

A. +0.009 ft
B. -0.009 ft
C. -0.018 ft
D. +0.027 ft

66. Contours become widely spaced on a hillside while the contour interval remains constant. What does that generally indicate?

A. A relatively gentle slope because the same elevation change occurs over a longer horizontal distance
B. A very steep slope because the contours are far apart
C. A mandatory change in vertical datum
D. A depression regardless of contour labels or hachures

67. In a local rectangular frame, a feature lies 47 ft east and 63 ft north of the origin. What straight-line polar distance separates the feature from the origin?

A. 110.00 ft
B. 16.00 ft
C. 78.60 ft
D. 55.00 ft

68. Take P1=(N 0,E 0) and P2=(N 500,E 200) as an infinite reference line. Point Q is at (N 170,E 310). What is Q's shortest perpendicular distance to that line?

A. 140.00 ft
B. 310.00 ft
C. 538.52 ft
D. 224.69 ft

69. At station 20+00 a tangent profile is elevation 352.60 ft and continues upward at 1.25%. At which station does the tangent first reach elevation 357.10 ft?

A. 22+80
B. 23+60
C. 24+50
D. 23+25

70. The established direction from A to B is azimuth 214°20'. If the instrument occupies B and backsights A, what azimuth should be used for B-to-A?

A. 34°20'
B. 145°40'
C. 214°20'
D. 325°40'

71. A utility easement measures 4.25 inches on a plan plotted at 1 inch = 60 ft. What ground length does that represent?

A. 70.8 ft
B. 141.7 ft
C. 255 ft
D. 360 ft

72. Along one straight map line, the 525-ft and 529-ft contours are 80 ft apart. Under linear interpolation, locate elevation 528 ft by distance measured from the 525-ft contour.

A. 20 ft
B. 60 ft
C. 40 ft
D. 75 ft

73. Index contours occur every fifth line. Two consecutive index contours carry elevations 640 ft and 650 ft. What elevation increment separates ordinary adjacent contours?

A. 1 ft
B. 5 ft
C. 10 ft
D. 2 ft

74. Following increasing station on a profile, existing terrain begins below design grade and later passes above it. At their intersection, which earthwork condition changes to which?

A. The horizontal alignment automatically becomes a circular curve
B. The map scale changes at the intersection
C. The work changes from fill to cut
D. The vertical datum changes from local to geodetic

75. A plan is plotted at 1 inch = 30 ft. A manhole is 72 ft from the reference alignment. How far should that offset plot on the sheet?

A. 0.42 in
B. 1.80 in
C. 30.00 in
D. 2.40 in

76. Why should the top and toe of a sharp embankment be encoded as breaklines in a terrain model?

A. They preserve abrupt slope changes so triangulation does not incorrectly smooth across the embankment

B. They force every nearby contour to become an index contour

C. They change the horizontal datum to the embankment alignment

D. They eliminate the need for elevation observations along the feature

77. A topographic surface shows an ordinary closed 744-ft contour with no hachures, yet a surveyed spot inside it is 742.3 ft. Which part of that mapping relationship deserves immediate verification?

A. The internal consistency of the spot elevation and contour representation

B. The contour must be a vertical wall

C. The contour interval must change inside the loop

D. The spot elevation proves every surrounding contour is wrong

78. A plotting requirement permits 0.015 inch of positional error at a map scale of 1 inch = 200 ft. What ground distance does that paper tolerance represent?

A. 0.3 ft

B. 13.3 ft

C. 30 ft

D. 3.0 ft

79. Why must grid north and true north be distinguished when directions are transferred between a coordinate map and geodetic observations?

A. Grid convergence changes every distance by the same number of feet

B. True north affects elevations but never horizontal direction

C. Directions referenced to the two north bases can differ by grid convergence and must be converted consistently

D. The distinction matters only when plotting property boundaries

80. When preparing a transverse roadway section, the source data consist of lateral offsets from centerline and corresponding elevations. How should the two axes be assigned to preserve the measured shape?

A. Plot station as the vertical coordinate and ignore offsets
B. Plot horizontal offset on the section axis and elevation on the vertical axis at the stated scales
C. Use raw plan northings and eastings without section transformation
D. Place all section points at equal horizontal spacing for readability

81. Construction notes call for a curb inlet at Sta. 18+75, 22 ft LT. In that notation, what geometric quantity is communicated by '22 ft LT'?

A. A horizontal lateral offset from the reference alignment to the inlet
B. An elevation difference from the project benchmark
C. A correction to the station label
D. A vertical-curve length measured along the profile

82. A footing bottom is designed at elevation 524.86 ft where the current ground is 528.14 ft. If stake notes report positive cut for material removal, what value and action should be marked?

A. 3.28 ft fill
B. 3.28 ft cut
C. 1.64 ft cut
D. 1,053.00 ft cut

83. A roadway hinge is 16 ft from centerline. The design cut slope is 1.5H:1V upward, and level existing ground is 8 ft above the hinge elevation. What centerline offset is the catch point?

A. 12 ft
B. 24 ft
C. 28 ft
D. 32 ft

84. At Sta. 32+00, finished grade is 684.20 ft. The tangent continues downgrade at 0.65% for 450 ft to Sta. 36+50. What finished-grade elevation is required there?

A. 687.13 ft
B. 683.55 ft
C. 680.55 ft
D. 681.28 ft

85. Between Sta. 5+00 and Sta. 11+25, a sanitary sewer invert drops from 412.90 ft to 408.15 ft. Express the downstream fall as a percent of horizontal run.

A. 4.75%
B. 1.31%
C. 0.76%
D. 0.48%

86. A building line will be destroyed by excavation. Where should offset references be established?

A. Directly on the footing centerline inside the excavation
B. On loose spoil piles because they are easy to reach
C. At unrelated convenient points without recording ties to the design line
D. Outside excavation and equipment disturbance, with measured ties that allow the design line to be reconstructed

87. Across a 6.5-ft sidewalk, the design falls away from a building elevation of 226.40 ft at 2.0%. Determine the curb-side edge elevation.

A. 226.53 ft
B. 226.27 ft
C. 225.10 ft

D. 226.38 ft

88. On a building grid, axis A is E=2,500.00 ft and axis 1 is N=7,000.00 ft. Column D5 is defined 90 ft east and 120 ft north of that origin intersection. Which coordinates should be staked?

A. N 7,120.00 ft, E 2,590.00 ft
B. N 7,090.00 ft, E 2,620.00 ft
C. N 6,880.00 ft, E 2,410.00 ft
D. N 7,120.00 ft, E 2,410.00 ft

89. A pile cap layout uses 7 center rows in one direction and 9 in the other, with 10 ft between neighboring centers. What center-to-center dimensions span the two outside rows?

A. 60 ft by 80 ft
B. 70 ft by 90 ft
C. 60 ft by 90 ft
D. 70 ft by 80 ft

90. A fill shoulder hinge lies 24 ft from centerline at elevation 508.00 ft. Beyond it, the design descends at 2.5H:1V to level natural ground at elevation 500.00 ft. At what centerline offset will the design meet the ground?

A. 20 ft
B. 32 ft
C. 52 ft
D. 44 ft

91. A simple curve has radius 700 ft. What central angle is subtended by a 60-ft arc interval?

A. 4°00'00" exactly
B. 9°49'00" approximately

C. 4°54'40" approximately
D. 2°27'00" approximately

92. Two radial lines to a 700-ft-radius circular alignment differ by 4°. What straight-line chord connects the corresponding points on the curve?

A. 48.87 ft
B. 48.86 ft
C. 24.43 ft
D. 97.74 ft

93. A crest vertical curve is 450 ft long, beginning at Sta. 88+00. Its grades change from +2.2% entering to -1.3% exiting. Where, by station, does the grade become zero?

A. 90+25.00
B. 89+80.00
C. 92+50.00
D. 90+82.86

94. An established straight baseline must be reproduced as a wall line everywhere 12.00 ft to its west. Which stakeout construction maintains that constant geometric separation?

A. Subtract 12.00 ft from both northing and easting regardless of baseline orientation
B. Measure 12.00 ft from any convenient point without maintaining perpendicular geometry
C. Compute or set points on a line geometrically parallel to the baseline at a constant 12.00-ft perpendicular offset
D. Rotate the offset direction at each setup to avoid obstructions

95. A bridge bearing seat should finish at elevation 946.35 ft, but an as-staked check gives 946.49 ft. State the vertical correction needed to bring the seat to design.

A. Lower the seat 0.14 ft

B. Raise the seat 0.14 ft

C. Lower the seat 1.40 ft

D. No adjustment because the difference is under one foot

96. At a crossing, the underside of an existing slab is elevation 118.70 ft while the proposed pipe crown is elevation 115.55 ft. How much vertical separation remains between those two surfaces?

A. 234.25 ft

B. 3.15 ft

C. 1.58 ft

D. 4.25 ft

97. A contractor is about to grade with machine control using a supplied digital model. Before relying on blade guidance, what independent survey verification has the highest priority?

A. Delete physical control because machine guidance replaces monuments

B. Verify the machine localization or transformation against independent project control and known elevations

C. Assume the model is correct if it loads without a software warning

D. Accept the first displayed blade elevation without checking a known point

98. An as-built survey shows a drain invert 0.22 ft lower than design at one structure. What should the surveyor do first before concluding the installation is wrong?

A. Edit the as-built value to match the design profile

B. Assign fault to the contractor before repeating the observation

C. Average the design and observed elevations and report the midpoint

D. Recheck the observed point, benchmark, instrument setup, datum, and controlling design value with an independent observation

99. At one physical station, the alignment equation changes from 72+40 back to 71+65 ahead. Traveling 425 ft farther using ahead stationing, what label will appear at the new point?

A. 75+90 ahead
B. 76+65 ahead
C. 75+15 ahead
D. 72+90 ahead

100. Project stake conventions define F as fill and FG as finished grade. A stake reads 'F 0.85 to FG.' How should that instruction be interpreted in the field?

A. Excavate 0.85 ft to reach subgrade
B. Shift the stake horizontally 0.85 ft toward centerline
C. Add 0.85 ft vertically to reach finished grade under the project convention
D. Rotate the alignment 0.85 degrees before setting the next point

Practice Exam 7: Answer Key and Explanations

1. D — Primary control should outlive the work it supports. Stable monuments outside excavation and settlement zones are less likely to move or disappear, and redundancy allows another mark to preserve position if one is disturbed. Demolition marks, unrelated trade systems, and machine-only references provide weak continuity and make independent recovery difficult.

2. B — Elevation values are meaningful only within a defined vertical reference. Common benchmarks or another verified tie can establish the offset or transformation between the assumed system and NAVD 88. Averaging incompatible elevations creates a hybrid datum, relabeling does not transform values, and maintaining two uncontrolled systems can create systematic design conflicts.

3. A — Displayed resolution is not the same as measurement uncertainty. To identify movement near 0.010 ft, the combined procedure, control, instrument, and environmental error should be comfortably smaller than the movement being evaluated. Repetition and independent checks help distinguish real displacement from noise, whereas long range or extra displayed digits alone do not establish accuracy.

4. C — Remote sensing can efficiently cover inaccessible terrain, but control and targeted supplemental observations are still needed where vegetation, shadow, occlusion, or sharp grade breaks reduce surface reliability. Sparse road shots cannot define complex slopes, old small-scale mapping may not meet accuracy needs, and deleting breaklines can distort cliffs, channels, and other abrupt terrain changes.

5. D — Reconnaissance identifies the physical constraints that control-method selection must accommodate. Access, line of sight, satellite visibility, safety, and monument survivability determine where GNSS and terrestrial observations are practical and where redundant ties are needed. Drawing colors and page counts are production matters, while minimizing control without regard to geometry can weaken the network.

6. A — The required product determines the acquisition plan. Limits, accuracy, surface detail, breaklines, datum, checkpoints, and deliverables govern flight height, overlap, control, processing, and supplemental field work. Choosing equipment first can lead to a method that cannot meet the objective, while graphic styling does not define measurement performance or establish a recoverable reference system.

7. B — A local grid is reproducible only when its geometry and physical realization are documented. The origin, rotation, units, scale basis, monument descriptions, and external ties explain how site coordinates relate to the ground. One point cannot define orientation or scale, and allowing arbitrary rotations destroys continuity between design, construction, and later as-built surveys.

8. C — Record plans are useful evidence but may not represent survey-grade positions. Where a footing conflict could have serious consequences, the utility should be located by appropriate field methods and tied to project control. Approval status or graphical enlargement does not improve the source accuracy, and utility linework does not become a legal boundary merely by appearing on a plan.

9. A — GNSS cannot operate normally without satellite signals, so longer occupations do not solve complete blockage. A terrestrial traverse transfers position and orientation through successive setups and can include redundant angles, distances, and closures. Independent coordinate systems or painted station labels lack the common geometric framework needed for reliable alignment, breakthrough, and construction staking.

10. C — Because the stated factor converts ground distance to grid distance, multiply: 3,275.00 x 0.999684 = 3,273.97 ft after rounding. Dividing would perform the reverse conversion. The difference is small on one line but becomes systematic across a project, so the factor definition and distance basis must be documented consistently. This preserves a defensible survey reference.

11. B — Route surveying supports linear engineering facilities by developing alignment, profile, cross-section, topographic, and control information. Those products then support design and construction staking. Hydrographic surveys concentrate on water-related surfaces, deformation surveys monitor movement, and cadastral retracement addresses property boundaries rather than the full engineering geometry of a freeway corridor. This preserves a defensible survey reference.

12. D — A relative closure of 1:30,000 permits one unit of linear misclosure per 30,000 units traversed. Dividing 9,600 ft by 30,000 gives 0.32 ft. A project may choose a tighter operational target, but 0.32 ft is the direct numerical limit represented by the stated ratio for the planned loop. This preserves a defensible survey reference.

13. B — Benchmarks should remain stable, accessible, and recoverable for the duration of the work. A monument outside excavation, settlement, and traffic disturbance is more likely to preserve the vertical reference. New embankment, temporary formwork, and movable barriers can shift or disappear, causing later grade staking to inherit an unstable or unrecoverable elevation basis.

14. D — Image matching depends on recognizable texture appearing in overlapping photographs. Uniform pavement can provide too few stable features for robust reconstruction. Well-distributed targets, checkpoints, or supplemental observations strengthen geometry and verification. Flying faster does not create texture, a planar assumption does not prove accuracy, and removing control weakens the connection between imagery and project coordinates.

15. A — Survey tasks depend on one another. Reconnaissance identifies constraints, control establishes a common reference, field data supports design, and only finalized geometry should be transferred to construction. Staking before control or design reverses that dependency, while computing quantities without terrain data and fragmenting the coordinate system creates avoidable inconsistency and rework.

16. C — Section 6731.1 includes locating alignments or elevations for fixed works, determining surface configuration or fixed-object positions using surveying principles, creating related electronic data, and rendering statements regarding accuracy. Those activities fall within civil engineering surveying as described by the statute. They do not create unrestricted boundary authority or guarantee underground utility locations.

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

18. A — When available tolerance is small, survey uncertainty must be materially smaller so measurement noise does not determine acceptance. Independent checks help expose setup, control, or blunder errors. Rounding to tenths destroys necessary resolution, and repeated observations primarily address random scatter; they do not automatically eliminate systematic errors such as calibration or reference mistakes.

19. D — Where vertical clearance matters, uncertain record depth should not be treated as exact. Appropriate locating methods and selective exposure can establish the actual utility position, then survey ties place that information in the project reference system. Enlarging a drawing does not improve source accuracy, deleting uncertainty hides risk, and waiting until excavation can create costly conflict.

20. B — With factor defined as grid divided by ground, ground distance equals grid distance divided by the factor. Thus 5,120.00 / 0.999735 = 5,121.36 ft. Multiplying would perform the opposite conversion. The project should state this convention clearly because reversing it creates a systematic layout discrepancy over long distances. This preserves a defensible survey reference.

21. C — Buildings and vegetation can obstruct satellites and create reflected signals, degrading GNSS geometry and introducing multipath. Moving the point to a cleaner site or supplementing it with terrestrial control reduces those effects. A fixed status is useful but not infallible, and increasing antenna height cannot guarantee elimination of reflected or blocked signal paths.

22. B — The prism constant accounts for the reflector's effective optical offset. If the total station setting does not match the actual prism, measured distances contain a systematic bias that can be significant on precision layout. Tripod leg equality and screen brightness do not determine distance, while CAD layer colors are unrelated to instrument measurement geometry.

23. D — Long corridors can accumulate orientation and distance error. Periodic ties, loops, or independent observations create closure evidence that can reveal and control that growth. Separate bearings destroy coordinate continuity, temporary side shots are not durable primary control, and a completely open chain offers little internal information about whether accumulated error remains acceptable.

24. A — The vertical reference should be defined before collection so every elevation supports the intended design and external coordination. Published benchmarks or a documented transformation can establish that relationship. Simply renaming an assumed elevation does not create a datum tie, and ellipsoid heights require an appropriate relationship before they can represent orthometric elevations.

25. D — Control should represent a stable physical reference, not simply a precise coordinate value. Consolidating backfill may settle and move the monument even if observations are repeatable. Relocating to stable material or providing redundant checks reduces the risk. Assigning an exact number cannot prevent physical movement, and relying on one unstable point removes the ability to detect it.

26. C — Horizontal distance is the slope distance multiplied by the cosine of the elevation angle. Converting 7°35' to decimal degrees and evaluating 684.35 cos(7°35') gives 678.36 ft. The sine gives the vertical component, while dividing by cosine would lengthen rather than reduce the measured slope line. Independent checks strengthen field reliability.

27. A — The line-of-sight vertical component is 512.60 sin(3°50') = 34.27 ft. Add station elevation and instrument height, then subtract target height: 438.22 + 5.31 + 34.27 - 4.85 = 472.95 ft. Using cosine would substitute horizontal distance for vertical rise. Independent checks strengthen field reliability. Independent checks strengthen field reliability. Independent checks strengthen field reliability.

28. B — Using the height-of-instrument relationship, HI = 642.18 + 5.44 = 647.62 ft. The turning-point elevation is HI minus the foresight: 647.62 - 7.12 = 640.50 ft. Equivalently, elevation change is backsight minus foresight, so the point is lower by 1.68 ft. Independent checks strengthen field reliability. Independent checks strengthen field reliability.

29. D — If the collimation-related effect is proportional to the difference in sight lengths, scale 0.028 ft by 60/140. The result is 0.012 ft. This illustrates why balanced backsights and foresights reduce systematic leveling effects. Keeping the same sign is appropriate because the assumed imbalance direction and instrument condition remain unchanged in the comparison.

30. A — The coordinate differences are $\Delta N = +224$ ft and $\Delta E = -252$ ft. The straight horizontal distance is $\sqrt{224^2 + 252^2} = 337.16$ ft. Adding component magnitudes gives a rectangular path, while either individual difference represents only one axis. The signs locate the quadrant but do not change the distance magnitude.

31. C — Temperature correction is $\alpha(T - T0)L$. Here, $0.00000645(40 - 68)(100.00) = -0.0181$ ft. The tape is colder and therefore shorter than at standard temperature, so a nominal 100-ft reading represents slightly less true distance and receives a negative correction. The correction is small but systematic for repeated tape lengths. Independent checks strengthen field reliability.

32. B — When both face observations are expressed in the same angular sense, average them. The degrees and minutes are identical, while the seconds average to $(18 + 30)/2 = 24$ seconds. Direct and reverse observations help reduce certain instrumental effects and provide an immediate field consistency check before the angle is accepted or used in traverse computations.

33. C — A parts-per-million term scales with measured distance. Compute $3{,}150 \times 2.5 / 1{,}000{,}000 = 0.0079$ ft. The result remains in feet because ppm is dimensionless. The constant portion of an EDM accuracy specification, centering error, and atmospheric corrections would be evaluated separately if they were included in the problem. Independent checks strengthen field reliability.

34. B — The prism constant models the offset between the reflector's physical reference and effective optical center. If the instrument setting does not match the prism, affected distances inherit a systematic offset. The error is not random angular scatter, does not redefine the vertical datum, and can matter on short precision layout lines as well as longer observations.

35. A — A fixed RTK solution indicates resolved integer ambiguities, while a float solution generally has larger and less predictable uncertainty. A precision control point should not be accepted merely because coordinates are displayed. Improve satellite conditions, reinitialize, extend observations where appropriate, or use a checked terrestrial method, then confirm the point independently before relying on it.

36. D — An early observation to known control tests occupation, orientation, coordinates, centering, prism settings, and point identification before errors are propagated. Software acceptance only confirms the entered setup logic, not field truth. Delaying the check increases rework, while changing the datum to make one stake fit conceals rather than diagnoses the underlying problem.

37. B — The observed closing elevation is $510.455 + 28.644 - 41.327 = 497.772$ ft. Misclosure is observed minus known closure, so $497.772 - 497.780 = -0.008$ ft. The net elevation change is much larger and should not be confused with misclosure, which measures only the residual disagreement at closure. Independent checks strengthen field reliability.

38. D — Vertical component is $S \sin(v)$. With $v = -5°10'$, $588.40 \sin(-5°10') = -52.99$ ft. The negative sign shows the target is below the instrument axis. The cosine produces horizontal distance, while simply treating the angular value as a linear drop has no geometric basis for the measured sight line. Independent checks strengthen field reliability.

39. C — A foresight rod reading is subtracted from height of instrument. Therefore 704.665 - 5.825 = 698.840 ft. Adding the foresight would place the point above the line of sight, opposite the leveling convention. The calculation assumes the HI was established from a valid backsight and that the rod reading was taken on the intended point.

40. A — Strong thermal gradients can bend the line of sight and make images unstable. Shorter, balanced sights reduce differential refraction effects, while cooler or more stable conditions may improve precision. Long near-surface sights increase exposure to heated air. Repetition can reveal scatter but does not guarantee removal of a systematic atmospheric bias that persists during every observation.

41. D — For an azimuth measured clockwise from north, $\Delta N = D \cos(\text{azimuth})$. Substituting 472.60 ft and 128°25' gives -293.66 ft. The negative sign is expected because the line points into the southeast quadrant. The sine term produces the easting component, which is positive for this course. Units and signs should agree.

42. C — For clockwise azimuths from north, $\Delta E = D \sin(\text{azimuth})$. With 472.60 ft at 128°25', the result is +370.29 ft. Easting is positive because the line lies in the southeast quadrant. The cosine term gives the negative northing component, while changing the sign would move the course west instead of east.

43. A — Apply signed components directly. Positive latitude moves north, so N = 9,440.00 + 186.75 = 9,626.75 ft. Negative departure moves west, so E = 2,175.00 - 243.20 = 1,931.80 ft. Each distractor reverses one or both directions. Maintaining signs through the coordinate calculation avoids quadrant mistakes. Units and signs should agree.

44. B — Relative precision is traverse length divided by linear misclosure: 8,950 / 0.24 = about 37,292, reported approximately as 1:37,300. A larger denominator represents better relative closure. The traverse length itself is not the ratio, and multiplying by the misclosure or shifting the decimal gives unrelated values rather than closure quality.

45. B — Bowditch corrections are proportional to course length. The 800-ft course is 800/3,200 = 0.25 of the traverse, so its share of the 0.48-ft easting misclosure is 0.12 ft. Because the observed misclosure is positive, the correction must be negative so the distributed corrections cancel the closure residual rather than reinforce it.

46. A — Azimuth 301°40' lies between 270° and 360°, so the line is in the northwest quadrant. A northwest bearing is measured from north toward west. Subtract the azimuth from 360°: 360°00' - 301°40' = 58°20'. Therefore the equivalent bearing is N 58°20' W. Units and signs should agree. Units and signs should agree.

47. C — A southeast bearing is measured from south toward east. Clockwise azimuth from north is therefore 180° minus the bearing angle: 180°00' - 41°15' = 138°45'. The other values fall in the northeast, southwest, or northwest quadrants and would not describe the same physical line. Units and signs should agree. Units and signs should agree.

48. D — A seven-sided polygon has theoretical interior-angle sum (7 - 2)180° = 900°. The observed sum is 63 seconds too large, so the total correction must be -63 seconds. Dividing equally among seven angles gives -9 seconds per angle. The sign must oppose the measured excess so adjusted angles sum to the theoretical value.

49. A — The coordinate shoelace formula gives an area of 32,038 square feet. Dividing by 43,560 square feet per acre gives 0.735 acre. Halving again, using a non-acre conversion factor, or misordering the coordinate products produces the distractor values. The polygon should be traversed consistently around its perimeter before applying the formula.

50. C — The simple-curve tangent length is $T = R \tan(\Delta/2)$. With R = 760 ft and $\Delta/2 = 18°$, T = 246.94 ft. Arc length and long chord use different formulas, so their values should not be substituted for the PI-to-PC tangent distance. A geometry check confirms the tangent is shorter than the arc.

51. B — Arc length is $L = \pi R\Delta/180$ when the central angle is in degrees. Substituting R = 760 ft and Δ = 36° gives 477.52 ft. The tangent and chord are straight-line curve elements and use trigonometric formulas instead. The arc should be slightly longer than the long chord spanning the same endpoints.

52. D — The long chord is $LC = 2R \sin(\Delta/2)$. With R = 760 ft and half-angle 18°, LC = 469.71 ft. The long chord is a straight connection from PC to PT, so it is slightly shorter than the arc length. Using tangent or tangent-based expressions computes different geometric elements of the curve.

53. D — The PC lies one tangent length before the PI along increasing stationing. Convert 63+25.00 to 6,325.00 ft and subtract 246.94 ft, giving 6078.06 ft, or station 60+78.06. Adding the tangent would locate a point ahead of the PI, while subtracting arc length uses the wrong curve element. Units and signs should agree.

54. C — Stationing progresses along the curve arc, so PT station equals PC station plus arc length. Adding 477.52 ft to 6078.06 ft gives 6555.58 ft, or station 65+55.58. The chord, tangent, and PI station are different geometric quantities and cannot replace the arc distance for curve stationing. Units and signs should agree.

55. B — Use the parabolic vertical-curve equation $y = ElevPVC + g1\,x + A\,x^2/(2L)$, with A = 0.018 - (-0.012) = 0.030. Substituting x = 200 ft gives 815.20 ft. The entering tangent alone omits curve offset, while using the exiting grade from the PVC does not represent the designed parabola.

56. A — Curve grade varies linearly as $g(x) = g1 + (A/L)x$. At the low point, grade equals zero. Solving $0 = -0.012 + (0.030/500)x$ gives x = 200 ft from the PVC. The midpoint is only the low point when the entering and exiting grades are equal in magnitude and opposite in sign.

57. D — Proposed subgrade is higher than existing ground, so material must be added. The required fill is 246.05 - 244.72 = 1.33 ft. Calling it cut reverses the physical condition, while adding the elevations has no grading meaning. A clearly stated sign convention prevents correct arithmetic from being mislabeled on construction notes.

58. A — Percent grade equals vertical change divided by horizontal run times 100. A fall of 2.4 ft over 160 ft is -2.4/160 x 100 = -1.50%. The negative sign follows the stated increasing-station direction.

Reversing the sign describes the opposite direction, while using the inverse ratio produces a much larger incorrect magnitude.

59. B — Midpoint coordinates are the averages of the endpoint coordinates. Northing is (2,840 + 3,260)/2 = 3,050 ft, and easting is (7,120 + 6,760)/2 = 6,940 ft. Averaging must be performed on each coordinate separately; coordinate differences describe the vector between points rather than the midpoint location. Units and signs should agree.

60. C — Positive northing and negative easting place the line in the northwest quadrant. The bearing angle is measured from north: $\arctan(|\Delta E|/|\Delta N|) = \arctan(360/420) \approx 40°36'$. Therefore the bearing is N 40°36' W. Using the complementary angle or changing quadrant letters would point the course in a different direction. Units and signs should agree.

61. B — Triangle area is one-half base times perpendicular height: 0.5 x 410 x 275 = 56,375 square feet. Dividing by 43,560 square feet per acre gives about 1.294 acres. The square-foot value is not already acres, and halving the area twice or using 10,000 as an acre conversion produces incorrect results.

62. C — Average end area is (138 + 204)/2 = 171 sq ft. Multiplying by 60 ft gives 10,260 cubic feet. Dividing by 27 converts to 380.00 cubic yards. The distractors omit the spacing, omit the averaging factor, or leave the result in cubic feet rather than converting to cubic yards. Units and signs should agree.

63. D — Rectangular trench volume is width x depth x length: 5.5 x 4.0 x 450 = 9,900 cubic feet. Dividing by 27 gives 366.67 cubic yards. Leaving the answer in cubic feet or dropping a factor changes the units or geometry. The calculation assumes constant width and depth with no overbreak or side slopes.

64. A — The stated ground-to-grid factor is multiplied by the ground distance: 4,460.00 x 0.999910 = 4,459.60 ft. Dividing performs the reverse conversion. Although the difference is only a few tenths of a foot, applying the wrong direction systematically shifts coordinate-based stakeout over long baselines. Units and signs should agree. Units and signs should agree.

65. B — The loop closes +0.027 ft high, so the total adjustment at the end must be -0.027 ft. At 1.2 miles in a 3.6-mile loop, apply one-third of the total: -0.027 x 1.2/3.6 = -0.009 ft. The sign must oppose the observed error, not reinforce it. Units and signs should agree.

66. A — For a fixed contour interval, wider spacing means a given elevation change occurs over more horizontal distance, so the terrain is gentler. Closely spaced contours indicate steeper slopes. Spacing by itself does not show a datum change, and a depression requires evidence such as closed contours with decreasing inward elevations or appropriate depression symbols.

67. C — The east and north offsets are perpendicular components, so radial distance is the hypotenuse: $\text{sqrt}(47^2 + 63^2)$ = 78.60 ft. Adding gives a rectangular path rather than straight-line distance, and subtracting gives only the component difference. A coordinate-to-polar conversion should preserve the right-triangle geometry of the axes. Units and signs should agree.

68. D — Point-to-line distance can be found from the two-dimensional cross-product magnitude divided by baseline length. Using vector P1P2 = (500,200) and P1Q = (170,310), the distance is $|500(310) - 200(170)| / \sqrt{500^2 + 200^2} = 224.69$ ft. Endpoint distance is a different quantity. Units and signs should agree. Units and signs should agree.

69. B — The required rise is 357.10 - 352.60 = 4.50 ft. At a +1.25% grade, horizontal run is 4.50 / 0.0125 = 360 ft. Adding 360 ft to station 20+00 gives station 23+60. Solving for distance first avoids treating the station label itself as a horizontal run. Units and signs should agree.

70. A — A reverse direction differs by 180°. Because the A-to-B azimuth is 214°20', subtract 180° to obtain the B-to-A azimuth of 34°20'. Using 360° minus the original azimuth gives 145°40', which is not the back azimuth. The same physical line must reverse exactly while retaining its straight orientation. Units and signs should agree.

71. C — At 1 inch = 60 ft, multiply paper distance by 60 ft per inch. Thus 4.25 x 60 = 255 ft. Dividing would convert ground length back to paper distance. The calculation assumes the sheet has not been resized; if reproduction scale is uncertain, a graphical scale should be checked before measuring from the print.

72. B — Elevation 528 ft is 3 ft above 525 within a total 4-ft rise. The fractional position is 3/4 of the 80-ft spacing, so distance is 60 ft from the 525-ft contour toward 529 ft. Linear interpolation assumes the slope between the two contour crossings is uniform along the selected line.

73. D — The two index contours differ by 10 ft. If every fifth contour is an index contour, that elevation difference spans five ordinary contour intervals. Dividing 10 ft by 5 gives a 2-ft contour interval. Index lines are emphasized for readability; the indexing frequency does not change the underlying elevation increment between consecutive contours.

74. C — Where existing ground is below proposed grade, material must be added, so the condition is fill. After existing ground rises above proposed grade, material must be removed, so the condition becomes cut. Their intersection is a zero cut-fill point. It does not by itself indicate a horizontal curve, map-scale change, or datum transition.

75. D — Paper distance equals ground distance divided by the scale in feet per inch. Thus 72 ft / 30 ft per inch = 2.40 inches. Multiplying would convert in the wrong direction. The calculation assumes the plotted sheet remains at its stated size; digital zoom or photocopy scaling can make ruler measurements misleading.

76. A — Breaklines tell the surface model that connected points represent a significant linear change in slope. Without them, triangulation can connect points across the top or toe and create an unrealistic surface. Breaklines do not alter the datum or contour interval, and they complement rather than replace sufficient elevation observations along the feature.

77. A — An ordinary closed contour without depression markings generally encloses higher terrain as elevations rise inward. A 742.3-ft spot inside a 744-ft closed contour conflicts with that expectation unless additional geometry explains it. The appropriate response is to check field data and surface modeling rather than assume a wall, change the contour interval, or delete surrounding contours automatically.

78. D — Convert paper tolerance to ground units using the stated scale: 0.015 inch x 200 ft per inch = 3.0 ft. This is a graphical tolerance conversion, not necessarily the required accuracy of the underlying survey. Project specifications can demand substantially tighter field accuracy than the amount implied by plotting resolution alone.

79. C — Grid north follows the mapping projection, while true north follows the local meridian. Their angular separation, grid convergence, can affect bearings or azimuths transferred between coordinate and geodetic references. The effect is angular rather than a constant distance correction and is relevant to engineering alignment work whenever directions come from different reference bases.

80. B — A cross-section represents terrain or design geometry relative to an alignment, so its horizontal dimension is offset and its vertical dimension is elevation. Using the declared scales preserves slopes and grade breaks. Station belongs to the longitudinal alignment, raw plan coordinates require transformation, and equal spacing would distort the measured transverse geometry.

81. A — Station-offset notation separates longitudinal and lateral position. Station 18+75 identifies where the point lies along the alignment, while 22 ft left identifies its horizontal offset on the specified side. The value is not an elevation, station equation, or vertical-curve length. Plans should define how offsets are measured when alignment geometry is complex.

82. B — Existing ground is higher than the design footing bottom, so material must be removed. The cut is 528.14 - 524.86 = 3.28 ft. Calling it fill reverses the physical condition, halving the difference has no basis, and adding elevations is meaningless. Stake notes should clearly identify the reference surface as bottom of footing.

83. C — A 1.5H:1V cut slope requires 1.5 ft of horizontal run for each foot of vertical rise. An 8-ft rise therefore needs 12 ft horizontally beyond the hinge. Adding the 16-ft hinge offset gives 28 ft from centerline. The calculation assumes level existing ground and no intermediate grade breaks. Independent checks reduce construction rework.

84. D — Station 36+50 is 450 ft ahead of 32+00. A -0.65% grade changes elevation by -0.0065 x 450 = -2.925 ft. Adding that change to 684.20 ft gives 681.275 ft, which rounds to 681.28 ft. The sign follows the stated fall in the direction of increasing station. Independent checks reduce construction rework.

85. C — The pipe drops 412.90 - 408.15 = 4.75 ft over 625 ft of station distance. Percent fall is 4.75/625 x 100 = 0.76%. The question asks for fall magnitude, so report a positive percentage. Using the elevation drop itself or dividing in the wrong direction produces the larger distractor values.

86. D — Offset references preserve design geometry after the original line or point is disturbed. They should be stable, accessible, outside excavation and traffic, and connected to the design line by documented distances or coordinates. Marks inside the excavation or on spoil can move, while undocumented convenient points cannot reliably reconstruct the intended alignment.

87. B — A 2.0% fall across 6.5 ft produces a vertical drop of 0.020 x 6.5 = 0.13 ft. Subtracting from 226.40 ft gives 226.27 ft. Adding would reverse the stated cross-slope direction, while treating 2.0% as 2.0 ft would greatly exaggerate the elevation change. Independent checks reduce construction rework. Independent checks reduce construction rework.

88. A — Apply the grid offsets to the corresponding coordinate axes. Northing is 7,000 + 120 = 7,120 ft, and easting is 2,500 + 90 = 2,590 ft. Swapping offsets or reversing their signs moves the column to a different grid location. The project drawing should confirm the positive axis directions before staking.

89. A — Spacing occurs between adjacent rows, so seven rows contain six 10-ft intervals and nine rows contain eight 10-ft intervals. The outside center-to-center dimensions are therefore 60 ft by 80 ft. Multiplying the number of rows directly by spacing adds one extra interval in each direction and overstates the grid dimensions.

90. D — The vertical drop is 508 - 500 = 8 ft. A 2.5H:1V fill slope needs 2.5 x 8 = 20 ft of horizontal run from the hinge to existing ground. Adding the 24-ft hinge offset gives a catch point 44 ft from centerline, assuming level existing ground beyond the hinge.

91. C — For an arc length s, central angle in radians is $s/R = 60/700$. Converting to degrees gives about 4.91107°, which is approximately 4°54'40" approximately. This angle applies to a 60-ft arc, not a 60-ft chord. Chord-based staking would use a slightly different inverse-trigonometric relationship. Independent checks reduce construction rework. Independent checks reduce construction rework.

92. B — Chord length is $C = 2R \sin(\Delta/2)$. With R = 700 ft and $\Delta = 4°$, $C = 1{,}400 \sin(2°) = 48.86$ ft. The corresponding arc is slightly longer, which explains the nearby distractor. Halving or doubling the chord formula produces the other incorrect lengths. Independent checks reduce construction rework.

93. D — On a parabolic vertical curve, grade is $g(x) = g_1 + (A/L)x$. Setting grade to zero with $g_1 = +0.022$, $A = -0.035$, and $L = 450$ ft gives $x = 282.86$ ft from the PVC. Adding that distance to station 88+00 places the high point at 90+82.86. Independent checks reduce construction rework.

94. C — A constant offset line must remain parallel to the reference baseline, with separation measured perpendicular to that baseline or derived from its unit normal. Changing both coordinates by a fixed amount creates a diagonal shift unless axes happen to align favorably. Arbitrary or rotating offsets change the intended wall geometry rather than preserve it.

95. A — The observed seat is 946.49 - 946.35 = 0.14 ft above design, so it must be lowered by 0.14 ft. Raising would increase the discrepancy, and a one-foot threshold is unrelated to the project tolerance. The adjustment should be communicated with a clear reference to the bearing-seat design elevation. Independent checks reduce construction rework.

96. B — Vertical clearance is the elevation of the lower surface of the upper facility minus the elevation of the upper surface of the lower facility. Here, 118.70 - 115.55 = 3.15 ft. Adding elevations has no physical meaning, and the other options reflect arithmetic errors rather than the actual separation. Independent checks reduce construction rework.

97. B — Machine control depends on the project model, localization, coordinate transformation, antenna or sensor calibration, and control used to initialize the system. Independent checks on known points can reveal datum shifts, unit errors, or vertical offsets before grading progresses. A file opening successfully is not a survey verification, and recoverable physical control remains valuable.

98. D — A discrepancy should first be separated from survey or reference error. Reobserving the point and verifying control, benchmark, setup, datum, and design value can confirm whether the 0.22-ft difference is real. Editing observations destroys evidence, assigning fault before verification is premature, and averaging design with as-built data represents neither condition.

99. A — At the physical equation point, ahead stationing is 71+65. Moving 425 ft forward gives 71+65 + 4+25 = 75+90 ahead. Starting from the back label would ignore the station equation and produce 76+65. Station equations change labels at a location; they do not change the physical distance traveled beyond it.

100. C — The notation communicates a vertical fill amount to the finished-grade surface under the project's stated stake convention. It does not describe a horizontal offset, angle, or subgrade cut. Because staking abbreviations vary among agencies and contractors, the field crew should confirm the reference surface and sign convention before acting on any cut-or-fill mark.