PRACTICE EXAM 6: 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 coastal pump-station replacement will demolish the existing seawall and several nearby survey marks. Which control strategy best protects the project datum during construction?

A. Use only marks attached to the seawall because they are closest to the work
B. Let each trade establish independent temporary coordinates when its work begins
C. Establish redundant control on stable upland monuments outside the demolition and settlement zone
D. Rely exclusively on machine-control positions without maintaining recoverable monuments

2. A redevelopment project receives elevations from a legacy drainage study identified only as 'County Datum' and new GNSS-derived orthometric elevations. What should be resolved before merging the surfaces?

A. Average the two elevation sets so local differences cancel statistically
B. Rename the old elevations to the new datum without changing any values
C. Use the old datum for grading and the GNSS datum for structures without a transformation
D. Determine and document the relationship between the two vertical references using reliable common control

3. Repeated EDM measurements to a calibrated baseline agree within 0.003 ft, yet every observation is about 0.045 ft too long. This result is best described as:

A. High precision with poor accuracy caused by a systematic bias
B. High accuracy with poor precision caused only by random scatter
C. Both high precision and high accuracy because the readings agree
D. Neither precision nor accuracy because a constant bias cannot be diagnosed

4. A forested watershed requires terrain elevations beneath dense tree canopy for a hydraulic model. Which primary collection method should be considered first?

A. Conventional aerial photography alone, assuming the canopy surface equals the ground
B. Airborne lidar capable of obtaining ground returns through vegetation, tied to project control
C. One RTK GNSS observation at each road crossing only
D. A planimeter measurement from an existing small-scale watershed map

5. A control network around an industrial plant must allow a field office to detect a single bad direction or distance. Which design feature contributes most to that goal?

A. Exactly the minimum number of observations required to compute coordinates
B. Rounding field observations before adjustment so small discrepancies disappear
C. Using one unknown point as the only reference for every setup
D. Redundant observations that produce multiple independent geometric checks and closures

6. Before planning a drone topographic survey for a quarry expansion, which scope information is most important to define?

A. The brand of trucks expected to haul material during construction
B. Survey limits, required surface detail and breaklines, target accuracy, datum, and final deliverables
C. The color scheme that will be used on the contractor's progress charts
D. Whether the office staff prefers portrait or landscape page orientation

7. A project handoff must allow another crew to reconstruct an arbitrary site grid several years later. Which information belongs in the control-system documentation?

A. The grid origin, orientation, units, scale basis, monument descriptions, and any ties to external control
B. Only the coordinate assigned to the first occupied setup point
C. A note permitting each future crew to rotate the grid for convenience
D. Only the number of decimal places displayed in the coordinate file

8. Record drawings show an abandoned water line close to a proposed drilled shaft, but the line's horizontal accuracy is unknown. How should the record position be treated during planning?

A. As survey control that overrides direct field evidence because it appears on an approved plan
B. As a legal property line that cannot be questioned during construction
C. As approximate information that should be field-verified when the consequence of conflict is significant
D. As sufficiently accurate if the drawing is enlarged to a larger plotting scale

9. A long underground conveyance tunnel has no usable satellite visibility after the portal. Which control approach is most appropriate for extending horizontal control inside?

A. A redundant terrestrial traverse or comparable line-of-sight network tied to portal control
B. Standalone GNSS positions collected inside the tunnel at longer occupation times
C. A new arbitrary coordinate origin at each setup without common orientation
D. Estimated coordinates based only on construction station labels painted on the wall

10. A design baseline is 2,850.00 ft on the ground. The project combined scale factor for converting ground distance to grid distance is 0.999742. What grid distance should be placed in the coordinate file?

A. 2,850.74 ft
B. 2,849.26 ft
C. 2,849.74 ft
D. 2,848.53 ft

11. A highway interchange survey must support centerline geometry, profiles, drainage crossings, and later construction staking. Which survey classification best describes the overall effort?

A. A hydrographic survey concerned mainly with submerged bottom elevations
B. A deformation survey intended primarily to detect structural movement
C. A route survey supported by horizontal and vertical control
D. A boundary retracement whose principal purpose is ownership determination

12. A settlement-monitoring program must reliably detect vertical movement of about 0.015 ft. Which planning criterion should control equipment and procedure selection?

A. Use any instrument that displays elevations to three decimal places
B. Collect one observation per point because repeated observations cannot improve reliability
C. Choose the instrument with the greatest horizontal range regardless of vertical precision
D. Expected survey uncertainty should be materially smaller than 0.015 ft, with repeatable checks

13. A two-year viaduct project needs permanent project benchmarks. Which location is generally best?

A. A temporary form board that will be stripped after the first concrete placement
B. A stable structure or ground point outside anticipated excavation, fill settlement, and heavy-equipment disturbance
C. The crest of a newly placed embankment that is still consolidating
D. A paint mark on a barrier scheduled to be relocated during traffic staging

14. A drone survey must model a newly paved logistics yard whose surface is nearly featureless and contains long areas of uniform dark pavement. Which planning measure most directly addresses the photogrammetric risk?

A. Increase flight speed so each photograph contains a larger ground footprint
B. Remove checkpoints because a smooth paved surface is assumed to be planar
C. Add well-distributed targets or supplemental observations where image texture is too weak for reliable matching

D. Avoid all GNSS control because aerial images and satellite positioning cannot be combined

15. A rail-extension corridor passes through active traffic, steep cuts, and a short tunnel. Which sequence is most appropriate before final staking begins?

A. Stake final track points first and establish control after the contractor begins grading
B. Compute final quantities before collecting any terrain or profile observations
C. Create unrelated local coordinate systems for each obstacle and reconcile them after construction
D. Reconnaissance, establish control, collect corridor data, finalize design geometry, then perform construction staking

16. A civil engineer prepares construction-control mapping for a floodwall and signs a note stating the positional accuracy of the measured fixed-work data. Under California Business and Professions Code section 6731.1, how is that activity characterized?

A. It is included within civil engineering surveying when it concerns the listed fixed-work engineering-survey activities
B. It becomes a cadastral boundary survey solely because an accuracy statement is signed
C. It is prohibited unless every nearby property corner is first retraced and monumented
D. It guarantees the physical location of every concealed utility shown on the construction drawings

17. A California civil engineering firm needs a land-surveying service that is incidental to a pump-station project, but the civil engineer in responsible charge is not personally authorized to perform that particular surveying service. Which arrangement is permitted by Business and Professions Code section 6731.2?

A. The civil engineer may perform any boundary work personally whenever the prime contract calls it incidental
B. The firm may offer or procure the service when the surveying is performed by or under the direction of a properly authorized survey professional
C. An unlicensed field technician may independently complete the service if the civil engineer later reviews the finished map

D. Responsible direction is unnecessary for incidental surveying performed within a larger civil engineering contract

18. A prefabricated pipe spool must pass through an existing sleeve with only 0.06 ft of positional clearance between the allowable centerline envelope and the installed anchors. What survey-control plan is most appropriate?

A. Use a method whose expected uncertainty can be as large as the entire 0.06-ft clearance
B. Round all measured offsets to the nearest 0.1 ft before deciding whether the spool fits
C. Rely on repeated shots alone because repetition eliminates calibration and control errors
D. Use measurement uncertainty well below 0.06 ft and verify the position with an independent check

19. A new chilled-water line will pass near a high-voltage duct bank whose mapped depth is uncertain. What should the survey plan include before final vertical-clearance decisions?

A. Targeted locating and, when the risk warrants, direct exposure tied to project horizontal and vertical control
B. A larger plotting scale only, because enlargement improves the utility's true depth accuracy
C. Removal of the uncertain duct bank from the base map so the profile is easier to read
D. A requirement to wait until trench excavation reaches the crossing before evaluating the conflict

20. A project uses a combined factor of 0.999615 to convert grid distances to ground distances. What ground distance corresponds to a grid baseline of 4,260.00 ft?

A. 4,258.36 ft
B. 4,260.39 ft
C. 4,261.64 ft
D. 4,262.28 ft

21. A planned control traverse will be 8,400 ft long. If the project requires a minimum relative closure of 1:20,000, what maximum linear misclosure should the planning target allow?

A. 0.42 ft
B. 0.21 ft
C. 0.84 ft
D. 4.20 ft

22. A total station will be used for a precision plant layout where many shots are short and reflector-based. Which calibration item should be specifically confirmed before work begins?

A. The field controller uses the same screen brightness as the office monitor
B. The tripod legs are extended to exactly the same length at every setup
C. The prism constant assigned in the instrument matches the actual reflector system being used
D. The instrument file contains the contractor's preferred layer colors

23. A narrow 12-mile pipeline corridor needs primary horizontal control. Which network geometry is generally preferable to a single unclosed chain of setups?

A. One continuous open traverse with no external ties because it minimizes observations
B. A corridor network with periodic ties, loops, or independent checks that provide meaningful closure
C. Separate assumed bearings for every mile so local errors remain isolated
D. Only temporary side shots from construction stakes with no durable primary monuments

24. A design team needs elevations related to mean-sea-level-based agency data, not merely internally consistent local heights. What vertical-control decision should be made during planning?

A. Assign the first benchmark an elevation of 100.00 ft and label it with the agency datum name
B. Use ellipsoid heights directly as orthometric elevations without a geoid relationship
C. Select the datum after grading so the final surface can be shifted to match quantities
D. Use the specified published vertical datum or establish a documented tie from project benchmarks to it

25. Reconnaissance finds that a proposed GNSS control point is beside a metal-clad warehouse and beneath overhead conductors. What is the best planning response?

A. Keep the point because nearby metal always strengthens satellite geometry
B. Increase antenna height indefinitely so reflections no longer affect observations
C. Accept the location if a coordinate can be displayed, regardless of solution quality indicators
D. Relocate or supplement the point to reduce obstruction and multipath, then verify the chosen control independently

26. A total station measures a slope distance of 612.48 ft at an elevation angle of +8°20'. What horizontal distance is observed, neglecting curvature and refraction?

A. 606.01 ft
B. 618.87 ft
C. 88.96 ft
D. 605.27 ft

27. From station A, elevation 524.36 ft, a total station has HI = 5.42 ft. It sights a prism with target height 5.10 ft at slope distance 438.20 ft and elevation angle +4°15'. What is the prism-point elevation?

A. 556.83 ft
B. 567.34 ft
C. 557.15 ft
D. 514.46 ft

28. In differential leveling, BM 7 has elevation 286.44 ft. A backsight of 6.18 ft is taken on BM 7, followed by a foresight of 4.73 ft to TP 1. What is the elevation of TP 1?

A. 276.53 ft
B. 287.89 ft
C. 285.00 ft
D. 297.35 ft

29. A level test shows an apparent elevation difference error of +0.036 ft when the backsight and foresight lengths differ by 180 ft. Assuming the error is proportional to sight-length imbalance, what error would be expected for a 75-ft imbalance?

A. +0.015 ft
B. +0.006 ft
C. +0.027 ft
D. +0.086 ft

30. A total station occupies N 10,000.00 ft, E 5,000.00 ft. A point to be set has N 10,185.00 ft, E 5,240.00 ft. What horizontal distance from the occupied station is required?

A. 425.00 ft
B. 240.00 ft
C. 185.00 ft
D. 303.03 ft

31. A 100.00-ft steel tape is standardized at 68°F with coefficient of thermal expansion 0.00000645 per °F. It is used at 88°F to measure one full tape length. What temperature correction should be applied?

A. -0.0129 ft
B. +0.0013 ft
C. +0.0129 ft
D. +0.1290 ft

32. A crew observes the same horizontal angle on face left as 72°18'24" and on face right, reduced to the same sense, as 72°18'36". What mean angle should be recorded?

A. 72°18'24"
B. 72°18'30"
C. 72°18'36"
D. 72°19'00"

33. An EDM specification includes a scale term of 3 ppm. Ignoring the constant term, what distance contribution does 3 ppm represent on a 2,400-ft line?

A. 0.0007 ft
B. 0.0720 ft
C. 0.7200 ft
D. 0.0072 ft

34. A prism has an actual constant of -30 mm, but the total station is set to 0 mm. What field effect should the crew expect on reflector distances?

A. Only random angular scatter, with no effect on measured distance
B. A systematic distance bias because the instrument is applying the wrong reflector offset
C. A vertical-datum shift that changes every benchmark elevation equally
D. No effect unless the measured line is longer than one kilometer

35. During RTK GNSS work, a rover changes from a fixed ambiguity solution to a float solution near a row of tall buildings. What is the best field response for a precision point?

A. Average the float coordinate for a few seconds and automatically classify it as fixed
B. Keep the point if the displayed coordinate has enough decimal places
C. Do not accept the point as equivalent to fixed RTK; restore a reliable fixed solution or use another checked method
D. Ignore the solution status because building reflections improve ambiguity resolution

36. After setting up on a known point and orienting to a backsight, a crew begins staking. Which field check is most effective before many points are set?

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

B. Change the project datum to match the first stake that appears reasonable
C. Assume the orientation is correct because the instrument accepted the setup
D. Avoid checking until the end of the day so production is not interrupted

37. A differential-level run begins on elevation 412.755 ft and closes on a benchmark with known elevation 398.420 ft. The sum of backsights is 31.684 ft and the sum of foresights is 46.007 ft. What is the vertical misclosure?

A. -0.012 ft
B. +14.323 ft
C. +0.012 ft
D. -14.335 ft

38. A total station observes a slope distance of 725.30 ft at an elevation angle of -3°40'. What vertical component corresponds to the line of sight?

A. +46.38 ft
B. 723.82 ft
C. -44.12 ft
D. -46.38 ft

39. A level setup has HI = 615.280 ft. A foresight to a proposed grade hub reads 6.435 ft. What elevation is established at the hub?

A. 608.845 ft
B. 621.715 ft
C. 609.155 ft
D. 608.435 ft

40. A crew must observe through strong midday heat shimmer across a paved lot. Which field practice is most appropriate for precise leveling or sighting?

A. Increase every sight to the instrument's maximum range so refraction averages out

B. Shorten and balance sight lengths when possible, and observe under more stable conditions if the specification requires it

C. Take all observations as close to the hot pavement as possible

D. Ignore atmospheric effects because repeated readings automatically remove systematic refraction

41. A control line from Point A to Point B is 412.80 ft long with azimuth 145°40'. What change in northing, ΔN, occurs from A to B?

A. +232.82 ft

B. +340.88 ft

C. -340.88 ft

D. -232.82 ft

42. For the same 412.80-ft control line with azimuth 145°40', what change in easting, ΔE, occurs from A to B?

A. +232.82 ft

B. -340.88 ft

C. -232.82 ft

D. +340.88 ft

43. A traverse begins at N 5,250.00 ft, E 9,800.00 ft. The next course has latitude -142.35 ft and departure +208.60 ft. What are the coordinates of the next point?

A. N 5,392.35 ft, E 9,591.40 ft

B. N 5,107.65 ft, E 10,008.60 ft

C. N 5,107.65 ft, E 9,591.40 ft

D. N 5,392.35 ft, E 10,008.60 ft

44. A project specification requires traverse relative precision of at least 1:25,000. A loop totals 7,800 ft and closes with 0.28 ft of linear misclosure. Which assessment is correct?

A. No; the achieved precision is about 1:2,800
B. No; the achieved precision is about 1:7,800
C. No; the achieved precision is about 1:22,000
D. Yes; the achieved precision is about 1:27,900

45. A 2,400-ft traverse has an easting misclosure of -0.36 ft. Under the Bowditch rule, what easting correction should be assigned to a 600-ft course?

A. -0.09 ft
B. +0.36 ft
C. +0.09 ft
D. -0.36 ft

46. A CAD file stores the direction from control point P to Q as azimuth 236°15'. Field stake notes require a quadrant bearing. How should P-to-Q be written?

A. N 56°15' E
B. S 33°45' W
C. N 33°45' W
D. S 56°15' W

47. Field notes describe a control line as N 27°40' W, but the data collector requires a clockwise azimuth from north. Which azimuth should be entered?

A. 27°40'
B. 332°20'
C. 152°20'
D. 207°40'

48. A six-sided closed traverse has measured interior angles totaling 720°00'48". If the angular misclosure is distributed equally among the six angles, what correction should be applied to each measured angle?

A. -8"
B. +8"
C. -48"
D. +48"

49. A four-corner site has coordinates (0,0), (160,0), (190,90), and (40,130), in feet. Approximately how many acres does the coordinate polygon contain?

A. 0.389 acre
B. 0.407 acre
C. 0.443 acre
D. 0.204 acre

50. At the PI of a simple circular roadway curve, the deflection angle is 42° and the design radius is 850 ft. How far back along the incoming tangent is the PC from the PI?

A. 326.28 ft
B. 311.54 ft
C. 623.08 ft
D. 652.56 ft

51. For the same simple curve, $R = 850$ ft and $\Delta = 42°$. What is the arc length?

A. 326.69 ft
B. 612.32 ft
C. 623.08 ft
D. 653.39 ft

52. For a simple curve with R = 850 ft and Δ = 42°, what is the long chord?

A. 623.08 ft
B. 326.69 ft
C. 642.05 ft
D. 609.23 ft

53. An alignment designer gives PI station 48+75.00 for the curve and the computed PI-to-PC tangent distance is 326.28 ft. At what station does the curve begin?

A. 52+01.28
B. 45+59.72
C. 45+48.72
D. 48+48.72

54. The curve begins at station 45+48.72 and has an arc length of 623.08 ft. What station should be assigned to the end of the curve?

A. 52+01.28
B. 51+71.80
C. 51+61.80
D. 48+75.00

55. A 600-ft symmetrical parabolic vertical curve connects g1 = +2.0% and g2 = -1.0%. The PVC elevation is 742.00 ft. What is the curve elevation 300 ft from the PVC?

A. 745.75 ft
B. 748.00 ft
C. 744.25 ft
D. 750.50 ft

56. For the same 600-ft vertical curve from +2.0% to -1.0%, where is the high point measured from the PVC?

A. 200 ft
B. 300 ft
C. 600 ft
D. 400 ft

57. Existing ground is elevation 318.40 ft at station 12+00. Proposed grade there is 316.95 ft. Using the convention cut = existing minus proposed, what cut is required?

A. 1.45 ft cut
B. 1.45 ft fill
C. 635.35 ft cut
D. 0.69 ft cut

58. A design note specifies a uniform rise of 1 ft for every 50 ft of horizontal run. What percent grade does that ratio represent?

A. +0.50%
B. +4.25%
C. +8.50%
D. +2.00%

59. Control points A and B have coordinates A(N 1,250.00, E 3,600.00) and B(N 1,520.00, E 3,240.00), in feet. What are the coordinates of the midpoint of AB?

A. N 1,520.00 ft, E 3,420.00 ft
B. N 1,385.00 ft, E 3,420.00 ft
C. N 1,385.00 ft, E 3,600.00 ft
D. N 1,270.00 ft, E 3,360.00 ft

60. For the same line from A to B with $\Delta N = +270$ ft and $\Delta E = -360$ ft, what is the quadrant bearing?

A. N 36°52' E approximately
B. S 53°08' E approximately
C. N 53°08' W approximately
D. S 36°52' W approximately

61. A right-triangular staging area has a 360-ft base and a perpendicular height of 240 ft. Approximately how many acres does it contain?

A. 0.992 acre
B. 0.496 acre
C. 1.984 acres
D. 43,200 acres

62. Two end cross-sections have cut areas of 124 sq ft and 176 sq ft and are 50 ft apart. Using the average-end-area method, what volume lies between them?

A. 150.00 cu yd
B. 555.56 cu yd
C. 277.78 cu yd
D. 300.00 cu yd

63. A trench is 4.5 ft wide, 6.0 ft deep, and 320 ft long. Ignoring side slopes and overbreak, what excavation volume is required?

A. 864.00 cu yd
B. 160.00 cu yd
C. 8,640.00 cu yd
D. 320.00 cu yd

64. A horizontal distance measured on the ground is 3,780.00 ft. If the ground-to-grid factor is 0.999820, what grid distance corresponds to the line?

A. 3,780.68 ft
B. 3,779.32 ft
C. 3,779.82 ft
D. 3,778.20 ft

65. A level loop of 2.4 miles has a closing error of -0.018 ft. If the correction is distributed uniformly by distance, what correction should be applied at a point 1.0 mile from the starting benchmark?

A. -0.0075 ft
B. +0.0180 ft
C. -0.0105 ft
D. +0.0075 ft

66. Contour lines on a map become very closely spaced as they cross a hillside. What does that generally indicate about the ground surface?

A. The ground is relatively steep in the direction of maximum slope
B. The ground is nearly level because many contours occupy a short distance
C. The contour interval must have changed at that location
D. The area is necessarily a depression regardless of contour labels

67. A point has perpendicular offsets of 38 ft east and 52 ft north from the origin of a local rectangular system. What is its radial distance from the origin?

A. 90.00 ft
B. 14.00 ft
C. 64.40 ft
D. 46.69 ft

68. A straight alignment from P1(N 0, E 0) to P2(N 400, E 300) is used as a baseline. What is the perpendicular distance from point Q(N 160, E 370) to the infinite baseline?

A. 170.00 ft
B. 200.00 ft
C. 250.00 ft
D. 530.00 ft

69. A design tangent is elevation 128.20 ft at station 10+00 and rises at 1.50%. At what station will the tangent reach elevation 132.70 ft?

A. 12+00
B. 13+60
C. 14+50
D. 13+00

70. A total station occupies point B and must backsight point A. The previously established direction from A to B is azimuth 128°30'. Which azimuth represents the required B-to-A sight?

A. 51°30'
B. 308°30'
C. 231°30'
D. 128°30'

71. A utility easement measures 3.68 inches long on a plotted sheet whose stated scale is 1 inch = 50 ft. What length should be reported on the ground?

A. 73.6 ft
B. 250 ft
C. 184 ft
D. 368 ft

72. Contours 412 ft and 414 ft cross a straight line 36 ft apart. Assuming uniform slope, where along the line from the 412-ft contour is elevation 413.5 ft?

A. 27 ft
B. 9 ft
C. 18 ft
D. 30 ft

73. Two adjacent index contours on a topographic sheet are labeled 225 ft and 230 ft. If every fifth contour is an index contour, what is the basic contour interval?

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

74. On a profile, existing ground crosses the proposed grade line from above to below as station increases. What grading condition changes at the crossing?

A. The alignment changes from tangent to circular curve automatically
B. The map scale changes because the two lines intersect
C. The work changes from cut to fill, assuming cut means existing ground above proposed grade
D. The vertical datum changes from local to published at the crossing

75. A plan is plotted at 1 inch = 40 ft. A utility is 96 ft from the centerline. How far from the centerline should it plot on the paper?

A. 2.40 in
B. 0.42 in
C. 3.84 in
D. 40.00 in

76. Why should a sharp ditch bottom collected during a topographic survey be represented as a breakline in a terrain model?

A. It forces every contour to become an index contour at the ditch
B. It changes the horizontal datum to match the ditch alignment
C. It eliminates the need to collect elevations along either side of the ditch
D. It preserves the abrupt change in surface slope so triangulation does not smooth across the feature incorrectly

77. A spot elevation of 258.6 ft lies inside a closed 260-ft contour with no depression hachures. Which interpretation should be questioned first?

A. The spot elevation proves every surrounding contour should be deleted
B. The contour must represent a vertical wall regardless of nearby data
C. The mapping is internally inconsistent because the interior of an ordinary closed 260-ft contour should generally be higher, not lower
D. The spot elevation automatically changes the contour interval for the whole map

78. A plotting standard requires features to be placed within 0.02 inch at map scale. At 1 inch = 100 ft, what ground distance does 0.02 inch represent?

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

79. A map shows grid north and true north separated by a convergence angle. Why should that distinction matter when bearings are transferred between the map and field observations?

A. Directions referenced to different north bases can differ by the convergence angle and must be converted consistently
B. Grid convergence changes every measured distance by the same number of feet

C. True north is only a plotting convention and never affects direction

D. The distinction matters only for vertical elevations, not horizontal angles

80. A roadway cross-section is to be plotted from field offsets and elevations. Which plotting convention most directly preserves the section geometry?

A. Plot station values as vertical coordinates and ignore the measured offsets

B. Use only plan-view northings and eastings without converting them to section offsets

C. Place all points at equal horizontal spacing so the profile is easier to read

D. Plot horizontal offsets from the centerline and vertical elevations at the stated horizontal and vertical scales

81. A curb return point is located at station 22+40 and 18 ft right of centerline. In construction-staking notation, what does the 18-ft value represent?

A. An elevation difference measured from the project benchmark

B. A horizontal offset perpendicular or otherwise defined from the reference alignment to the point

C. A stationing correction added to 22+40

D. A vertical curve length measured along the profile

82. At a subgrade stake, existing ground is 465.82 ft and design subgrade is 463.27 ft. Using cut as positive removal, what should the stake indicate?

A. 2.55 ft fill

B. 929.09 ft cut

C. 1.28 ft cut

D. 2.55 ft cut

83. A roadway hinge point is 12 ft horizontally from centerline. From the hinge, the design side slope is 2H:1V downward. Existing ground is 6 ft below the hinge elevation. Assuming level existing ground across the side-slope run, what centerline offset is the catch point?

A. 18 ft
B. 12 ft
C. 24 ft
D. 36 ft

84. During roadway staking, finished grade is 612.50 ft at station 40+00 and the tangent rises at 0.80%. What elevation should be marked for finished grade at station 43+25?

A. 615.10 ft
B. 609.90 ft
C. 613.30 ft
D. 615.75 ft

85. A sewer profile shows invert elevation 287.60 ft at station 10+00 and 283.83 ft at station 15+80. What is the approximate pipe grade, expressed as a percent fall in the direction of increasing station?

A. 3.77%
B. 0.38%
C. 1.54%
D. 0.65%

86. A building control line must remain available while foundations are excavated. Where should offset stakes or batter-board references be placed?

A. Far enough outside excavation and equipment limits to remain stable, while preserving a measurable tie to the design line
B. Directly on the footing centerline inside the planned excavation
C. On loose spoil piles because they are easy to reach
D. At unrelated convenient locations without recording distances back to the control line

87. A sidewalk cross section starts at elevation 154.25 ft at the back of walk and falls 1.50% across an 8.0-ft width toward the curb. What elevation should be staked at the curb edge?

A. 154.37 ft
B. 154.13 ft
C. 153.05 ft
D. 154.24 ft

88. A rectangular column grid has line A at E = 1,000.00 ft and line 1 at N = 2,000.00 ft. Column C4 is 60 ft east of line A and 90 ft north of line 1. What are its coordinates?

A. N 2,060.00 ft, E 1,090.00 ft
B. N 1,910.00 ft, E 940.00 ft
C. N 2,090.00 ft, E 1,060.00 ft
D. N 2,090.00 ft, E 940.00 ft

89. Pile centers are arranged on a 6 by 8 rectangular grid at 12-ft spacing in both directions. What are the overall dimensions between the outside pile-center rows?

A. 72 ft by 96 ft
B. 60 ft by 84 ft
C. 60 ft by 96 ft
D. 72 ft by 84 ft

90. For a 3H:1V fill slope, the hinge elevation is 420.00 ft and level existing ground is elevation 411.00 ft. The hinge is 20 ft from centerline. What catch-point offset is expected?

A. 47 ft
B. 23 ft
C. 27 ft
D. 60 ft

91. A simple curve has radius 600 ft. For a 50-ft arc interval, what is the central angle subtended by that arc?

A. 2°23'14" approximately
B. 5°00'00" exactly
C. 9°32'58" approximately
D. 4°46'29" approximately

92. For a 600-ft radius curve, what chord length corresponds to a 5° central angle?

A. 26.18 ft
B. 52.36 ft
C. 52.34 ft
D. 104.67 ft

93. A 400-ft symmetrical sag vertical curve begins at PVC station 70+00 with entering grade -1.5% and exiting grade +2.5%. At what station does the low point occur?

A. 70+60
B. 72+00
C. 71+50
D. 73+00

94. A wall face is to be built on a line 8.00 ft east of an established baseline. Which layout method best preserves a consistent offset?

A. Set or compute points on a line geometrically parallel to the baseline at the specified 8.00-ft perpendicular offset
B. Measure 8.00 ft from any convenient point without maintaining perpendicular geometry
C. Rotate the offset direction at each station so stakes avoid obstacles
D. Add 8.00 ft to both northing and easting coordinates regardless of baseline orientation

95. A bridge deck screed rail is designed at elevation 732.80 ft. The survey point on the rail reads 732.68 ft. What adjustment is required to reach design elevation?

A. Lower the rail 0.12 ft
B. Raise the rail 1.20 ft
C. No adjustment because the difference is less than one foot
D. Raise the rail 0.12 ft

96. At a proposed utility crossing, the bottom of an existing duct bank is elevation 104.60 ft and the top of the proposed pipe would be elevation 101.85 ft. What vertical clearance is available?

A. 206.45 ft
B. 2.75 ft
C. 1.75 ft
D. 3.65 ft

97. Before a grader begins machine-control work from a digital terrain model, what survey check is most important?

A. Assume the model is correct if it opens without software warnings
B. Delete physical control because machine guidance makes monuments unnecessary
C. Accept the first blade elevation displayed without comparing it to a known point
D. Verify the machine-control localization or transformation against independent project control and known elevations

98. An as-built survey shows a pipe invert 0.18 ft higher than plan at one structure. What is the best immediate survey response before concluding the pipe was installed incorrectly?

A. Verify the observed point, benchmark, instrument setup, and plan datum or design value with an independent check
B. Change the as-built elevation to match plan because design values always control observed data
C. Assume the contractor is at fault without repeating or checking the observation
D. Average the as-built and design elevations and report the midpoint as the final invert

99. A station equation reads 50+00 back = 49+25 ahead. A point is 300 ft beyond the equation on the ahead stationing. What is its station?

A. 53+00 ahead
B. 52+25 ahead
C. 46+25 ahead
D. 52+00 ahead

100. A grade stake is marked 'C 1.35 to SG' where the project's convention defines C as cut and SG as subgrade. What does the mark direct the contractor to do?

A. Place 1.35 ft of fill to reach finished grade regardless of the project convention
B. Shift the stake horizontally 1.35 ft toward centerline
C. Excavate 1.35 ft from the referenced stake elevation or grade reference to reach subgrade, according to the project's stake convention
D. Rotate the alignment 1.35 degrees before setting the next stake

Practice Exam 6: Answer Key and Explanations

1. C — Control must survive the construction activity it supports. Stable, redundant upland monuments provide recoverable references if one point is disturbed and reduce the chance that settlement near the seawall contaminates the network. Marks on demolition features are temporary, separate contractor systems invite inconsistencies, and machine control still requires dependable project control for checks.

2. D — Elevation numbers are comparable only when their vertical references are compatible or a documented transformation relates them. Reliable common benchmarks or other control can establish the offset and reveal inconsistencies. Averaging incompatible datums creates a meaningless hybrid, relabeling changes no elevations, and using two uncoordinated systems can introduce systematic design and staking errors.

3. A — The observations cluster tightly, so the measurement process is precise. Their common displacement from the calibrated baseline shows poor accuracy and suggests a systematic error such as an incorrect prism constant, scale correction, or calibration issue. Random error would mainly increase scatter. Agreement among repeated readings alone does not demonstrate that the observations are accurate.

4. B — Dense vegetation can prevent conventional imagery from seeing the actual ground surface. Airborne lidar can produce multiple returns, including some ground returns through canopy gaps, and those data can be classified and tied to control. Photography alone often models vegetation tops, sparse road observations cannot define terrain continuously, and a planimeter does not collect new elevations.

5. D — Redundancy creates more observations than the minimum needed to solve the network. Those extra measurements form closures and consistency checks that can expose blunders or weak observations during adjustment. A minimally determined network has little internal checking, premature rounding hides information, and referencing everything to one uncertain point can transmit rather than reveal an error.

6. B — Method selection depends on what must be mapped and how accurately. Limits, breaklines, datum, accuracy, and deliverables determine flight coverage, ground control, checkpoints, processing, and supplemental field work. Haul-truck brands and office formatting preferences do not establish measurement requirements. Defining the technical scope first prevents collecting attractive imagery that fails the design purpose.

7. A — An arbitrary grid can be reproduced only if its geometric definition and physical realization are documented. The origin, orientation, units, scale basis, monument descriptions, and external ties show how coordinates relate to the site. One coordinate cannot define orientation or scale, and allowing later crews to rotate the grid would destroy continuity between project surveys.

8. C — Record drawings can be valuable planning evidence without having survey-grade positional accuracy. When a proposed shaft could damage a utility, the uncertainty and consequence justify targeted locating or exposure tied to project control. Enlarging graphics does not improve source accuracy, and record linework does not become controlling survey evidence merely because it appears on an approved drawing.

9. A — GNSS requires satellite signals, so increasing occupation time does not solve complete blockage in a tunnel. A terrestrial traverse can transfer position and orientation through successive setups and can be designed with redundant observations and closure checks. Independent arbitrary systems and painted station labels lack the common geometric control needed for reliable alignment and breakthrough work.

10. B — For a stated ground-to-grid combined factor, multiply the ground distance by the factor: 2,850.00 x 0.999742 = 2,849.2647 ft, which rounds to 2,849.26 ft. Dividing would move in the opposite direction. Small scale-factor differences can accumulate over long baselines, so the project must clearly state which distance basis is being used.

11. C — Route surveying develops the horizontal and vertical information needed for linear facilities such as highways, railways, and pipelines. It commonly includes alignment, profiles, cross-sections, topography, and control that later supports staking. Hydrographic work focuses on water features, deformation surveys monitor movement, and boundary retracement addresses property rights rather than roadway design geometry.

12. D — Displayed digits are not the same as measurement accuracy. To distinguish real movement of about 0.015 ft from observation noise, the monitoring method needs uncertainty comfortably below that magnitude plus repeatable checks for stability and blunders. One-shot observations weaken reliability, and long horizontal range is irrelevant if the required vertical precision cannot be achieved.

13. B — A benchmark should preserve the vertical reference throughout the period it is needed. Stable material outside excavation, settlement, and traffic disturbance is more likely to remain fixed and recoverable. Temporary forms, new fills, and movable barriers can shift or disappear. Good benchmark planning also considers safe access, clear description, and independent ties to other control.

14. C — Photogrammetric reconstruction needs recognizable features that can be matched across overlapping images. A newly paved, visually uniform surface may provide too few reliable tie points. Adding targets, checkpoints, or supplemental ground observations strengthens geometry and independent verification. Flying faster does not create texture, and a planar surface does not remove the need to test mapping accuracy.

15. D — Reconnaissance identifies access, visibility, safety, and control constraints before field work is committed. Control then provides the common reference for corridor mapping and design. Final construction points should be staked only after design geometry is established. Staking first, calculating without terrain data, or fragmenting the coordinate system reverses that dependency and increases rework risk.

16. A — Section 6731.1 includes engineering-survey activities such as locating alignments or elevations for fixed works, determining surface configuration or fixed-object positions, creating related electronic data, and rendering statements about the accuracy of that mapping or measured data. It does not transform fixed-work control into unrestricted cadastral boundary practice or create a guarantee concerning concealed utilities.

17. B — Section 6731.2 permits a registered civil engineer to offer, procure, or offer to procure land-surveying work incidental to civil engineering even when that engineer is not personally authorized for the surveying. The 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. D — A tight clearance requires survey uncertainty to be materially smaller than the available tolerance; otherwise measurement noise can determine whether the installation appears acceptable. An independent check also helps expose setup, control, or blunder errors. Rounding to tenths destroys needed resolution, and repeated observations do not automatically remove systematic errors caused by calibration or faulty control.

19. A — A mapped utility with uncertain depth should not be treated as exact where vertical clearance matters. Locating methods and selective exposure can establish the actual position, then survey ties place that information in the project datum. Enlarging a drawing does not improve source accuracy, deleting uncertain data hides risk, and waiting for excavation can turn uncertainty into a costly conflict.

20. C — If the combined factor is defined as grid divided by ground, ground distance equals grid distance divided by the factor. Thus 4,260.00 / 0.999615 = 4,261.6407 ft, or 4,261.64 ft. Multiplication would shorten the distance instead. The conversion convention must be documented because reversing the factor produces a systematic stakeout discrepancy.

21. A — A relative closure of 1:20,000 means one unit of allowable misclosure for each 20,000 units traversed. For 8,400 ft, the corresponding linear misclosure is 8,400 / 20,000 = 0.42 ft. A stricter project target may be selected, but 0.42 ft is the numerical limit represented by the stated ratio. That planning discipline keeps later fieldwork tied to a defensible reference.

22. C — A wrong prism constant introduces a systematic distance offset into every affected reflector measurement, which is especially important in precision layout. Confirming the instrument setting against the actual prism system prevents that bias. Tripod leg equality is unnecessary, display brightness does not affect measured distance, and drawing-layer colors have no influence on instrument geometry.

23. B — Long narrow corridors can accumulate orientation and distance error. Periodic ties, loops, or independent check observations provide opportunities to detect and control that growth. A completely open chain offers little internal evidence of error, arbitrary bearings prevent consistent coordinates, and temporary side shots do not replace a durable control framework that can survive multiple project phases.

24. D — The project vertical reference should be established before design and staking. Published datum benchmarks or a documented relationship to them allow elevations to be compared with agency information. Simply renaming an assumed elevation does not create a datum tie, ellipsoid heights are not automatically orthometric heights, and changing the reference after grading risks inconsistent plans and quantities.

25. D — Metal surfaces can reflect satellite signals and overhead features can obstruct portions of the sky, degrading GNSS observations through multipath and poor geometry. Moving the point to a clearer location or supplementing it with other control reduces that risk. A displayed coordinate alone is not proof of quality, and antenna height cannot reliably eliminate reflected signals.

26. A — Horizontal distance is the slope distance multiplied by the cosine of the elevation angle. Using 8°20' = 8.3333°, 612.48 cos(8.3333°) = 606.01 ft after rounding. Multiplying by sine gives the vertical component instead. Because the angle is modest, the horizontal distance is only slightly shorter than the measured slope distance.

27. C — The vertical component is 438.20 sin(4°15') = 32.47 ft. Add that to station elevation plus instrument height, then subtract target height: 524.36 + 5.42 + 32.47 - 5.10 = 557.15 ft. Instrument and target heights matter because the measured line of sight connects the instrument axis to the prism center.

28. B — Using the height-of-instrument method, HI = 286.44 + 6.18 = 292.62 ft. The turning-point elevation is HI minus the foresight: 292.62 - 4.73 = 287.89 ft. Equivalently, the elevation change is backsight minus foresight, or +1.45 ft. Reversing the signs would incorrectly make the turning point lower. The check helps prevent a field setup error from propagating unnoticed.

29. A — If the collimation-related effect is proportional to the difference in sight lengths, scale the observed error by 75/180. The expected error is 0.036 x 75/180 = 0.015 ft. This illustrates why balancing backsight and foresight distances reduces systematic leveling effects even when the instrument is not perfectly adjusted. The check helps prevent a field setup error from propagating unnoticed.

30. D — The coordinate differences are ΔN = 185 ft and ΔE = 240 ft. The horizontal distance is the hypotenuse: sqrt($185^2 + 240^2$) = 303.03 ft. Simply adding the coordinate differences gives a taxicab distance rather than the straight survey line, while either individual difference represents only one rectangular component. This is the required polar distance.

31. C — Temperature correction for a tape standardized at a reference temperature is $\alpha(T - T0)L$. Here, 0.00000645 x (88 - 68) x 100.00 = +0.0129 ft. The warmer tape is longer than its nominal length, so a full nominal tape reading represents slightly more true distance and receives a positive correction.

32. B — Once both face observations are reduced to the same angular sense, their mean is the average of the two readings. The seconds are (24 + 36)/2 = 30, while degrees and minutes remain unchanged. Averaging direct and reverse observations helps reduce certain instrumental effects and provides an immediate consistency check on the angle measurement.

33. D — Three parts per million means 3 units of possible distance effect per 1,000,000 units measured. On 2,400 ft, the scale contribution is 2,400 x 3/1,000,000 = 0.0072 ft. The units remain feet because ppm is dimensionless. Constant instrument specifications, centering, and atmospheric effects would be considered separately if included. The check helps prevent a field setup error from propagating unnoticed.

34. B — The prism constant accounts for the reflector's effective optical center relative to its physical reference. If the instrument setting does not match the prism, every affected distance contains a systematic offset. The error is not random angular scatter, is unrelated to the vertical datum, and can matter on short precision lines as well as long observations.

35. C — A fixed RTK solution indicates integer ambiguities have been resolved, while a float solution generally has greater and less predictable uncertainty. For a precision point, the crew should improve satellite conditions, reinitialize, occupy longer where appropriate, or use another controlled method. Decimal display precision does not substitute for solution quality, and urban multipath can worsen reliability.

36. A — An immediate observation to known control tests the setup before errors are propagated through many stakes. It can reveal wrong point numbers, incorrect coordinates, prism settings, centering, or orientation mistakes. Instrument acceptance only confirms entered logic, not field truth. Delaying the check increases rework, while changing the datum to fit a stake masks the underlying problem.

37. C — The observed closing elevation is 412.755 + 31.684 - 46.007 = 398.432 ft. Comparing with the known closing elevation, 398.432 - 398.420 = +0.012 ft. The large net change is expected because the line descends; misclosure is only the difference between observed and known closure, not the total elevation change.

38. D — The vertical component of a slope distance is S sin(v). With v = -3°40' = -3.6667°, 725.30 sin(-3.6667°) = -46.38 ft. The negative sign indicates the target line of sight is below the instrument axis. The cosine would produce the horizontal component, which remains close to the full slope distance.

39. A — A foresight is subtracted from the height of instrument to obtain the elevation of the observed point. Therefore, 615.280 - 6.435 = 608.845 ft. Adding the foresight would put the hub above the line of sight, which contradicts the rod reading convention. The calculation assumes the HI has already been established from a valid backsight.

40. B — Strong thermal gradients near heated surfaces can bend lines of sight and make images unstable. Shorter, balanced sights reduce differential effects, and scheduling critical observations during more stable conditions can improve results. Maximum-range sights and near-pavement observations increase exposure to refraction. Repetition helps assess scatter but does not automatically remove a persistent atmospheric bias.

41. C — For an azimuth measured clockwise from north, the northing component is ΔN = D cos(azimuth). Substituting 412.80 ft and 145°40′ gives about -340.88 ft. The negative sign is expected because the line points into the southeast quadrant. The sine term gives the easting component, not the northing change requested here.

42. A — For azimuths measured clockwise from north, the easting component is ΔE = D sin(azimuth). With D = 412.80 ft and azimuth 145°40′, the result is +232.82 ft. The positive sign agrees with the southeast direction, which moves east. The cosine component controls northing and is negative for this particular line.

43. B — Apply the signed rectangular components to the starting coordinates. The negative latitude moves south: 5,250.00 - 142.35 = 5,107.65 ft. The positive departure moves east: 9,800.00 + 208.60 = 10,008.60 ft. Each alternative reverses at least one sign, which would place the new point in the wrong quadrant. Keeping signs, units, and geometry explicit is essential for a defensible result.

44. D — Relative precision is the total traverse length divided by the linear misclosure. Here, 7,800 / 0.28 is approximately 27,857, customarily reported about 1:27,900. Because 27,900 is better than the required denominator of 25,000, the loop meets the stated criterion. The comparison should use the achieved ratio, not the traverse length by itself.

45. C — The Bowditch rule distributes coordinate correction in proportion to course length. The 600-ft course is 600/2,400 = 0.25 of the traverse, so its share of the 0.36-ft easting misclosure is 0.09 ft. Because the observed misclosure is negative, the applied correction must be positive, giving +0.09 ft for that course.

46. D — Azimuth 236°15′ lies between 180° and 270°, so the line is in the southwest quadrant. A southwest quadrant bearing is measured from south toward west. Subtract 180° from the azimuth:

$236°15′ - 180° = 56°15′$. Therefore the field-note bearing is S 56°15′ W, preserving the same physical direction. The alternate angles result from using the wrong quadrant reference.

47. B — A northwest bearing starts at north and turns west. Clockwise azimuths instead increase eastward from north, so a northwest bearing converts by subtracting the bearing angle from 360°. Thus $360°00′ - 27°40′ = 332°20′$. The other choices fall in the wrong quadrant or preserve the bearing angle without converting its directional reference.

48. A — A six-sided polygon has a theoretical interior-angle sum of $(6 - 2)180° = 720°$. The observed total is 48 seconds too large, so the traverse has a +48-second misclosure. Equal adjustment requires applying the opposite sign across six angles: $-48'' / 6 = -8''$ per angle. The corrections must sum to -48 seconds.

49. B — The shoelace coordinate formula gives a site area of 17,750 square feet. Converting square feet to acres requires division by 43,560, yielding about 0.407 acre. The 0.204-acre choice effectively halves the area again, while the other values arise from incorrect coordinate products or conversion. Keep the planar area calculation separate from the unit conversion.

50. A — The distance from PI to PC along the tangent is the simple-curve tangent length, $T = R \tan(\Delta/2)$. With $R = 850$ ft and $\Delta = 42°$, $T = 850 \tan(21°) = 326.28$ ft. Arc length and long chord use different formulas, so values based on those elements do not locate the PC from the PI.

51. C — Arc length is $L = \pi R\Delta/180$ when Δ is in degrees. Substituting 850 ft and 42° gives $\pi \times 850 \times 42/180 = 623.08$ ft. The tangent length and long chord use different trigonometric relationships. Keeping the curve elements distinct is essential when calculating stationing, stake intervals, and design geometry.

52. D — The long chord connects PC directly to PT and equals $2R \sin(\Delta/2)$. For $R = 850$ ft and $\Delta/2 = 21°$, $LC = 2 \times 850 \times \sin(21°) = 609.23$ ft. It is slightly shorter than the 623.08-ft arc length, as expected because a straight chord is shorter than the corresponding circular arc.

53. C — The beginning of curve is the PC, located one tangent length before the PI along increasing stationing. Convert PI station 48+75.00 to 4,875.00 ft, then subtract 326.28 ft to obtain 4,548.72 ft, or station 45+48.72. Doing station arithmetic in feet first avoids separator errors. Adding the tangent would place the station ahead of the PI.

54. B — The end of a simple curve is the PT, and its station equals PC station plus the curve arc length. In feet, 4,548.72 + 623.08 = 5,171.80 ft, which is station 51+71.80. The PI station is a tangent-intersection location and should not replace the arc-based station progression from PC to PT.

55. A — For a parabolic vertical curve, $y = ElevPVC + g1\, x + (A\, x^2)/(2L)$, with grades in decimal form and $A = g2 - g1 = -0.03$. At $x = 300$ ft: $742 + 0.02(300) - 0.03(300^2)/(1{,}200) = 745.75$ ft. The incoming tangent alone would give 748.00 ft, missing curve offset.

56. D — The curve grade varies linearly: $g(x) = g1 + (A/L)x$. A high point occurs where grade equals zero. With $g1 = +0.02$, $A = -0.03$, and $L = 600$ ft, $x = -g1\, L/A = 400$ ft. The midpoint is not necessarily the high point unless the entering and exiting grades are equal and opposite.

57. A — Cut equals existing ground minus proposed grade when existing ground is higher. Here, 318.40 - 316.95 = 1.45 ft, so material must be removed. Calling it fill reverses the physical condition, while adding elevations has no grading meaning. Stating the sign convention explicitly prevents common cut-and-fill labeling mistakes in stake notes and quantity checks.

58. D — Percent grade equals vertical change divided by horizontal run times 100. A rise of 1 ft in 50 ft gives $1/50 \times 100 = +2.00\%$. The positive sign reflects a rise in the stated direction. Confusing the ratio denominator with a percentage or using the inverse ratio would produce much larger, incorrect values.

59. B — The midpoint coordinates are the averages of the endpoint coordinates. Northing is (1,250.00 + 1,520.00)/2 = 1,385.00 ft, and easting is (3,600.00 + 3,240.00)/2 = 3,420.00 ft. Midpoint calculation treats each coordinate independently; using a full endpoint coordinate or averaging coordinate differences instead would place the point incorrectly. in plan.

60. C — Positive northing and negative easting place the line in the northwest quadrant. The bearing angle from north is $\arctan(|\Delta E|/|\Delta N|) = \arctan(360/270)$ = about 53°08'. Therefore the bearing is N 53°08' W. Using the complementary angle or changing quadrant letters would point the course in a different direction. Keeping signs, units, and geometry explicit is essential for a defensible result.

61. A — The area of a right triangle is one-half base times height. Thus $0.5 \times 360 \times 240 = 43{,}200$ square feet. Dividing by 43,560 square feet per acre gives 0.9917 acre, or about 0.992 acre. The 0.496-acre value halves the triangle again, while 43,200 is a square-foot quantity, not acres.

62. C — Average-end-area volume is the average of the two areas times their spacing. The average area is (124 + 176)/2 = 150 sq ft. Multiplying by 50 ft gives 7,500 cubic feet. Dividing by 27 converts to 277.78 cubic yards. Omitting the average or the cubic-foot-to-yard conversion produces the distractor values.

63. D — The rectangular trench volume is width x depth x length = 4.5 x 6.0 x 320 = 8,640 cubic feet. Divide by 27 cubic feet per cubic yard to obtain 320 cubic yards. The 8,640 value is still in cubic feet, while the other choices result from incorrect conversion or omitted dimensions.

64. B — With a stated ground-to-grid factor, multiply the ground distance by the factor: 3,780.00 x 0.999820 = 3,779.3196 ft, which rounds to 3,779.32 ft. Dividing would produce the reverse conversion. Because grid-ground differences accumulate with distance, keeping the factor definition and distance basis clear is essential for coordinate stakeout. Keeping signs, units, and geometry explicit is essential for a defensible result.

65. D — The closing error is -0.018 ft, so the total correction at the end must be +0.018 ft. Assuming error accumulates uniformly with distance, a point 1.0 mile into a 2.4-mile loop receives 1.0/2.4 of that correction: +0.0075 ft. The sign must oppose the observed closing error rather than reinforce it.

66. A — For a fixed contour interval, close contour spacing means the same elevation change occurs over a shorter horizontal distance, which indicates a steeper slope. Widely spaced contours indicate gentler terrain. Close spacing alone does not prove the contour interval changed, and a depression requires additional evidence such as closed contours with appropriate elevation progression or hachures.

67. C — The radial distance is the hypotenuse of the perpendicular coordinate components: sqrt($38^2 + 52^2$) = 64.40 ft. Adding the components gives 90 ft but does not represent straight-line distance. Subtracting gives 14 ft. Rectangular coordinates must be combined with the Pythagorean relationship when converting to a polar distance. Keeping signs, units, and geometry explicit is essential for a defensible result.

68. B — The distance from a point to a line can be found with the two-dimensional cross-product magnitude divided by the baseline length. For vector P1P2 = (400,300) and P1Q = (160,370), |400(370) - 300(160)| / 500 = 200 ft. The calculation uses the infinite baseline, not distance to an endpoint. Keeping signs, units, and geometry explicit is essential for a defensible

69. D — The required elevation increase is 132.70 - 128.20 = 4.50 ft. At a +1.50% grade, horizontal run equals rise divided by grade: 4.50 / 0.015 = 300 ft. Adding 300 ft to station 10+00 gives station 13+00. This reverses the usual grade-elevation calculation by solving for distance first. Using the full station value as the run would be incorrect.

70. B — The direction from B back to A is the reverse of the established A-to-B line, so its azimuth differs by 180°. Because 128°30′ is less than 180°, add 180° to obtain 308°30′. Subtracting the value from 180° or 360° gives a different direction rather than the exact reverse line required for the backsight.

71. C — The scale states that every plotted inch represents 50 feet on the ground. Multiplying 3.68 inches by 50 ft/in gives 184 ft. Dividing by 50 would convert a ground length back to paper distance. The calculation assumes the sheet has not been enlarged or reduced; a graphical scale is safer when reproduction size is uncertain.

72. A — Elevation 413.5 ft is 1.5 ft above 412 ft within a total 2-ft contour rise. The fractional position is 1.5/2 = 0.75 of the 36-ft spacing. Therefore the point lies 27 ft from the 412-ft contour toward the 414-ft contour. Linear interpolation assumes the slope between those contours is uniform.

73. B — Adjacent index contours differ by 230 - 225 = 5 ft. Because every fifth contour is indexed, that 5-ft elevation change spans five ordinary contour intervals. Dividing 5 ft by 5 gives a 1-ft contour interval. Indexing changes line emphasis and labeling frequency, not the elevation increment represented by each consecutive contour line.

74. C — When existing ground is above proposed grade, material must be removed, which is cut. After the existing ground drops below the proposed grade, material must be added, which is fill. Their intersection is therefore a zero cut/fill point. It does not by itself indicate a horizontal curve, scale change, or vertical-datum transition.

75. A — Paper distance equals ground distance divided by the scale denominator expressed in feet per inch. Here, 96 ft / 40 ft per inch = 2.40 inches. Multiplication would move in the opposite conversion direction. The calculation assumes the printed plan is at its stated scale; digital zooming does not change the underlying drawing coordinates.

76. D — A breakline tells the terrain model that connected points define a significant linear change in slope, such as a ditch bottom, ridge, or curb. Without it, triangulation may connect points across the feature and create an unrealistic surface. Breaklines do not change the datum, alter contour indexing, or remove the need for adequate supporting elevations.

77. C — An ordinary closed contour without depression markings typically encloses higher ground as elevations increase inward. A spot elevation of 258.6 ft inside a 260-ft closed contour conflicts with that expectation unless other geometry explains it. The inconsistency should be checked against field data and surface modeling rather than automatically deleting all contours or changing the contour interval.

78. B — At 1 inch = 100 ft, a plotting tolerance of 0.02 inch corresponds to 0.02 x 100 = 2.0 ft on the ground. This converts a paper-space tolerance into ground units. It does not mean the underlying survey must always have exactly 2-ft accuracy; project specifications may require much tighter positional accuracy than plotting alone.

79. A — Grid north follows the mapping projection, while true north follows the local meridian. Their angular difference can be significant enough to affect orientation when directions move between coordinate and geodetic references. The effect is angular, not a constant distance correction, and it applies to horizontal direction work rather than vertical elevation. The reference basis should be stated explicitly.

80. D — A cross-section represents terrain perpendicular or otherwise referenced to an alignment. Its horizontal axis is offset, and its vertical axis is elevation, each at the declared scale. Using station as the vertical coordinate, raw plan coordinates without section transformation, or equal spacing would distort the actual shape and could misrepresent slopes, ditches, shoulders, and catch points.

81. B — Construction station-offset notation separates position along an alignment from lateral position away from it. Station 22+40 identifies the longitudinal location, while 18 ft right identifies the horizontal offset on the specified side. It is not an elevation, a station equation, or a vertical-curve length. Plans should define the exact offset convention where geometry is complex.

82. D — Existing ground is higher than the design subgrade, so material must be removed. The required cut is 465.82 - 463.27 = 2.55 ft. A fill label would reverse the physical condition, while adding elevations is meaningless for grading. Clear stake conventions should distinguish whether the mark references finished grade, subgrade, or another construction surface.

83. C — A 2H:1V side slope requires 2 ft of horizontal run for each 1 ft of vertical drop. A 6-ft drop therefore needs 12 ft horizontally beyond the hinge. Adding the 12-ft hinge offset gives a catch-point offset of 24 ft from centerline. The calculation assumes existing ground remains level over that outward distance.

84. A — Station 43+25 is 325 ft ahead of 40+00. A +0.80% tangent rises 0.008 × 325 = 2.60 ft across that run. Adding the rise to 612.50 ft gives 615.10 ft. The stake value should also be independently checked against design control so a sign or stationing error is not carried into construction.

85. D — The sewer drops 287.60 - 283.83 = 3.77 ft over a station difference of 580 ft. Grade magnitude is drop divided by run times 100: 3.77 / 580 × 100 ≈ 0.65%. Because the question asks for percent fall in the direction of increasing station, report the positive fall magnitude rather than a signed algebraic slope.

86. A — Offsets protect design control when the actual line or point will be destroyed by excavation. They should be stable, accessible, outside disturbance, and tied by a clearly recorded distance or geometry to the intended feature. Stakes inside excavation or on spoil piles are likely to move, while undocumented convenient marks cannot reliably reconstruct the design line after disturbance.

87. B — A 1.50% fall across 8.0 ft produces a vertical drop of $0.015 \times 8.0 = 0.12$ ft. Subtracting that drop from 154.25 ft gives a curb-edge elevation of 154.13 ft. Adding the change would reverse the stated cross-slope direction, while treating 1.50% as 1.50 ft would greatly exaggerate the drop.

88. C — North and east offsets add to the corresponding grid-line coordinates. The column northing is 2,000 + 90 = 2,090 ft, and the easting is 1,000 + 60 = 1,060 ft. Swapping the offsets or reversing an offset sign places the column on a different grid intersection. Construction layout should confirm the project's axis convention before staking.

89. B — Spacing occurs between adjacent pile-center rows, so six rows create five 12-ft spaces and eight rows create seven 12-ft spaces. The dimensions are therefore 5 x 12 = 60 ft and 7 x 12 = 84 ft. Multiplying the number of rows by spacing incorrectly adds one extra interval in each direction.

90. A — The vertical difference is 420 - 411 = 9 ft. A 3H:1V fill slope requires 3 x 9 = 27 ft of horizontal run from the hinge to existing ground. Adding the 20-ft hinge offset gives a catch point 47 ft from centerline. This assumes level ground beyond the hinge and no intermediate grade breaks.

91. D — For an arc length s, the central angle in radians is s/R. Here, 50/600 = 0.083333 radian. Converting to degrees gives 4.77465°, or 4°46'29". This is the angular increment for a 50-ft arc on a 600-ft radius, not a 50-ft chord, which would produce a slightly different angle. Independent checks help prevent small layout errors from becoming costly construction rework.

92. C — Chord length is $C = 2R \sin(\Delta/2)$. With R = 600 ft and Δ = 5°, C = 1,200 sin(2.5°) = 52.34 ft. The arc length for 5° is slightly larger, about 52.36 ft, which explains one distractor. Doubling or halving the chord formula produces the other incorrect choices. Independent checks help prevent small layout errors from becoming costly construction

93. C — On a parabolic vertical curve, grade at distance x from PVC is $g(x) = g1 + (A/L)x$. The low point occurs where grade equals zero. With g1 = -0.015, A = 0.040, and L = 400 ft, x = 150 ft. Adding 150 ft to PVC station 70+00 gives station 71+50.

94. A — A constant wall offset is a parallel-line problem. The offset must be applied perpendicular to the baseline or computed from its unit normal so the separation remains 8.00 ft everywhere. Adding 8 ft to both coordinates shifts diagonally, arbitrary measurements lose geometric consistency, and rotating the offset direction changes the designed line rather than preserving it.

95. D — The observed rail elevation is 0.12 ft below the design elevation: 732.80 - 732.68 = +0.12 ft. Therefore the rail must be raised by 0.12 ft. Lowering would increase the discrepancy. Construction tolerances may be much smaller than a foot, so the fact that the difference is under one foot does not make it acceptable.

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, 104.60 - 101.85 = 2.75 ft. Adding elevations has no physical meaning, and the other choices reflect arithmetic errors. Required clearance should then be compared with the applicable design criterion.

97. D — Machine control is only as reliable as the coordinate transformation, calibration, model, and control used to initialize it. Checking against independent known points can reveal localization shifts, unit errors, datum mistakes, or vertical offsets before grading progresses. A file that opens successfully is not a survey check, and physical control remains valuable for independent verification and recovery.

98. A — An apparent construction discrepancy should first be separated from survey or reference error. Rechecking the point, benchmark, setup, datum, and design value can confirm whether the 0.18-ft difference is real. Editing observations to fit the plan destroys evidence, assigning fault before verification is premature, and averaging design with as-built data creates a value that represents neither condition.

99. B — The equation establishes that the physical location labeled 50+00 on back stationing is labeled 49+25 on ahead stationing. Moving 300 ft forward using ahead stationing gives 49+25 + 300 = 52+25 ahead. Using 50+00 as the starting label after the equation would produce 53+00 and ignore the stated station equation.

100. C — The notation communicates a vertical cut amount to the subgrade surface, but its exact reference must follow the project's established stake-marking convention. It does not describe a horizontal offset or angle. Treating cut as fill would reverse the intended grading action. Crews should confirm abbreviations and reference surfaces before relying on stake information.