PRACTICE EXAM 9: CALIFORNIA ENGINEERING SURVEYING (100 QUESTIONS)

This practice exam contains 100 multiple-choice questions modeled on the California Civil Engineering Surveying examination content areas. Allow 2.5 hours for a timed simulation. Select the single best answer for each question. Use consistent surveying sign conventions, stationing, and units. An answer key with worked explanations follows the exam.

1. A preliminary route map uses a scale of 1 inch = 60 feet. A proposed access road measures 7.35 inches on the map. What ground distance does that represent?

A. 441 ft
B. 411 ft
C. 451 ft
D. 462 ft

2. During reconnaissance for a control survey through a developed corridor, which site condition most strongly favors adding an intermediate control point?

A. A nearby fire hydrant with a known color
B. A wider shoulder that shortens walking distance
C. A paved surface that is easy to occupy
D. Long stretches where buildings block intervisibility between planned setups

3. A control traverse is expected to have a perimeter of 8,400 ft. If the project requires a minimum relative precision of 1:20,000, what is the largest allowable linear misclosure?

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

D. 2.38 ft

4. A distance of 2,750 ft will be measured with equipment having a stated distance uncertainty of 3 ppm, ignoring any constant term. Approximately what distance uncertainty comes from the ppm component?

A. 0.000825 ft
B. 0.0825 ft
C. 0.00825 ft
D. 0.825 ft

5. A project requires elevations to remain consistent with an established public works vertical control network. What is the best planning action before fieldwork begins?

A. Assume an elevation of 100.00 ft on the first convenient point
B. Identify the project benchmark datum and verify connection to published control
C. Use ellipsoid heights directly as project elevations without conversion
D. Set independent elevations at each work area to simplify computations

6. A rectangular topographic site is 720 ft by 480 ft. If preliminary spot elevations are planned on a 120-ft grid including all boundary grid lines, how many grid intersections are required?

A. 24 points
B. 30 points
C. 35 points
D. 42 points

7. Which control arrangement is generally best for a construction project that will require repeated layout over several months?

A. Temporary nails placed only inside active excavation limits
B. A single unreferenced point near the center of the work

C. Paint marks on equipment expected to remain on the site

D. Stable, well-monumented control outside likely disturbance areas with redundant ties

8. A corridor survey will cover 3.6 miles. Cross-sections are planned every 200 ft, including both endpoints. Approximately how many cross-section stations should be planned?

A. 97 stations

B. 95 stations

C. 96 stations

D. 101 stations

9. A proposed GNSS control point is directly beside a reflective glass building. What planning concern is most important?

A. The prism constant will change with satellite elevation

B. Level rod graduation errors will increase near the building

C. Multipath from reflected satellite signals may degrade the position

D. Magnetic declination will alter the GNSS coordinate system

10. A survey specification combines independent horizontal error components of 0.018 ft and 0.024 ft. Using root-sum-square combination, what is the combined uncertainty?

A. 0.006 ft

B. 0.021 ft

C. 0.042 ft

D. 0.030 ft

11. For a route survey that will later support design profiles and construction staking, what is the most useful planning approach to stationing?

A. Establish one consistent stationing system tied to the project alignment

B. Restart stationing at zero whenever the crew changes instrument setups
C. Use unrelated station values for topography and construction phases
D. Assign station numbers only after construction begins

12. A mapping limit is 300 ft wide along a 2,400-ft corridor. What approximate ground area must be covered, in acres?

A. 1.653 acres
B. 16.53 acres
C. 13.22 acres
D. 18.18 acres

13. When planning a topographic survey for design around an existing drainage structure, which feature should receive particular field emphasis?

A. Only points forming a uniform square grid regardless of terrain
B. Breaklines and elevations that control the drainage geometry
C. Only property corner monuments outside the drainage area
D. Only photographs because elevations can be inferred later

14. A planned control line is 1,350 ft long. To keep a centering-related angular contribution below about 0.03 ft at the far end, what maximum angular error is approximately allowable in arc-seconds? Use small-angle approximation.

A. 2.29 arc-sec
B. 9.17 arc-sec
C. 4.58 arc-sec
D. 22.92 arc-sec

15. A survey crew must collect dense topography across a large, open, unobstructed site. Which planning choice most directly improves efficiency without reducing required detail?

A. Reduce the number of required breaklines because dense points replace all features

B. Use only differential leveling for every surface point across the site

C. Set a new independent datum for each portion of the site

D. Use a collection method capable of rapidly capturing dense surface points, then supplement breaklines

16. Under California engineering surveying practice, which activity is within the civil engineering surveying functions described for a registered civil engineer when performed in connection with civil engineering work?

A. Determining the configuration or contour of the earth surface for engineering purposes

B. Establishing land ownership boundaries as an independent cadastral service

C. Issuing title insurance based on record documents

D. Preparing legal opinions resolving disputed property ownership

17. A project will use both GNSS and conventional total-station observations. What is the best control-planning principle?

A. Keep the GNSS and total-station networks entirely separate until final drafting

B. Apply separate arbitrary rotations to each dataset to improve local fit

C. Create common control points observed by both methods so the datasets can be checked together

D. Use different vertical datums for the two collection methods

18. A rectangular parcel shown for preliminary design is 5.60 inches by 3.25 inches at a scale of 1 inch = 80 ft. What is the corresponding ground area in square feet?

A. 116,480 sq ft

B. 1,456 sq ft

C. 93,200 sq ft

D. 186,368 sq ft

19. Why is redundancy intentionally planned into a control network?

A. It eliminates the need to record raw field observations
B. It provides independent checks that help reveal blunders or unstable control
C. It guarantees every observation will have identical precision
D. It allows any datum to be substituted without coordinate transformation

20. A 1,980-ft baseline will have control points nominally every 330 ft, including both endpoints. How many control points are planned?

A. 6 points
B. 8 points
C. 9 points
D. 7 points

21. Before using an assumed local horizontal datum for an isolated site, what should the surveyor confirm?

A. That magnetic north is identical to grid north at the site
B. That all elevations can therefore be treated as ellipsoid heights
C. That the project does not require direct integration with an external coordinate framework
D. That a local datum automatically satisfies any future GIS requirement

22. A planning tolerance allows a maximum positional error of 0.05 ft. An expected setup component is 0.03 ft. Assuming independent components, what remaining root-sum-square error budget is available for all other sources?

A. 0.040 ft
B. 0.020 ft
C. 0.050 ft
D. 0.080 ft

23. For a design survey in steep terrain, why should breakline collection be planned in addition to spot elevations?

A. Breaklines are needed only to establish property ownership
B. Breaklines eliminate the need for any vertical control
C. Breaklines convert slope distances to horizontal distances automatically
D. Breaklines preserve abrupt changes in surface slope that isolated points may not model correctly

24. A route reconnaissance identifies 14 proposed setup locations. If each setup is budgeted at 18 minutes and an additional 70 minutes is allowed for control checks, what total field time should be planned?

A. 252 min
B. 322 min
C. 288 min
D. 392 min

25. Which planning document most directly helps a field crew understand what must be located for an engineering topographic survey?

A. A clear scope defining limits, required features, control, and deliverable accuracy
B. Only a blank field-book index page
C. Only the project billing code and charge number
D. A list of nearby property owners without survey limits

26. During an office review of level notes, BM-12 is listed at elevation 512.84 ft with a 5.27-ft backsight from the first setup. What line-of-sight elevation should be entered as HI?

A. 507.57 ft
B. 517.11 ft
C. 518.11 ft
D. 523.38 ft

27. A level-book setup has HI = 518.11 ft. The closing sight from that setup to TP-3 reads 6.43 ft. Which elevation belongs beside TP-3?

A. 511.43 ft
B. 524.54 ft
C. 512.84 ft
D. 511.68 ft

28. A level run begins at elevation 240.00 ft. Successive elevation changes are +3.42 ft, -1.18 ft, +0.76 ft, and -2.25 ft. What is the final elevation?

A. 239.25 ft
B. 240.75 ft
C. 241.93 ft
D. 245.61 ft

29. For coordinate reduction, an EDM observation is 286.40 ft along the line of sight and the telescope is inclined +8.5 degrees from horizontal. Which horizontal component should be used?

A. 42.34 ft
B. 286.40 ft
C. 283.25 ft
D. 289.55 ft

30. For the same 286.40-ft slope distance at +8.5 degrees, what is the vertical difference between the instrument and prism centers?

A. 283.25 ft
B. 286.40 ft
C. 43.12 ft

D. 42.33 ft

31. When differential leveling across uneven terrain, what is the best turning-point characteristic?

A. A loose clod of soil near the midpoint of the sight
B. A firm, well-defined point that will not settle or move between sights
C. A flexible object that is easy to reach with the rod
D. A point chosen only because it gives the longest possible foresight

32. Why are approximately balanced backsight and foresight distances desirable in precise differential leveling?

A. They reduce the effect of certain systematic errors such as collimation and curvature/refraction imbalance
B. They make the benchmark elevation independent of the rod readings
C. They eliminate the need to level the instrument carefully
D. They allow the rod to be read without a defined turning point

33. Four observations of the same horizontal angle are 73.214 degrees, 73.220 degrees, 73.216 degrees, and 73.218 degrees. What is their arithmetic mean?

A. 73.214 degrees
B. 73.217 degrees
C. 73.216 degrees
D. 73.219 degrees

34. A backsight line has azimuth 128.40 degrees. The crew turns a clockwise horizontal angle of 96.75 degrees to the foresight. What is the foresight azimuth?

A. 31.65 degrees
B. 96.75 degrees

C. 225.15 degrees
D. 263.85 degrees

35. A reflectorless total-station shot is taken to a highly oblique shiny metal surface. What field concern is most appropriate?

A. The measurement automatically becomes a vertical angle only
B. The horizontal circle can no longer be read by the instrument
C. The instrument level bubble becomes irrelevant to the observation
D. The returned distance may be less reliable because target reflectivity and geometry can affect the measurement

36. A rod reading on a benchmark is mistakenly recorded 0.12 ft too large as a backsight. If no later error compensates, how will elevations computed from that setup be affected?

A. 0.12 ft too high
B. 0.12 ft too low
C. 0.24 ft too high
D. 0.24 ft too low

37. When observing a precise horizontal angle with a total station, why might the crew measure in both faces?

A. Face-left and face-right observations help cancel or reveal certain instrumental errors
B. The second face doubles the prism constant for the distance measurement
C. Face-right observations automatically convert grid north to true north
D. Changing face eliminates atmospheric effects on EDM distance

38. An office closure check starts from benchmark 684.22 ft. The level-book totals are $\Sigma BS = 32.47$ ft and $\Sigma FS = 25.25$ ft, while the closing benchmark is published as 691.38 ft. What signed closure results?

A. -0.06 ft
B. +7.16 ft
C. +7.22 ft
D. +0.06 ft

39. While locating an existing utility before construction, which field action best addresses the risk of a surface mark being offset from the actual buried line?

A. Assume every paint mark lies exactly over the utility centerline
B. Ignore utility information unless a structure is visible above ground
C. Collect available utility marks and visible features, then note uncertainty and obtain additional verification where critical
D. Shift the mapped utility to the nearest property line for consistency

40. A crew sets a prism pole 6.00 ft high. The instrument axis is 5.20 ft above its station. The measured vertical difference from instrument axis to prism center is +12.46 ft. If the instrument-station elevation is 403.18 ft, what is the ground elevation at the prism point?

A. 408.38 ft
B. 414.84 ft
C. 415.64 ft
D. 426.84 ft

41. Convert the bearing S 38.20 degrees E to azimuth measured clockwise from north.

A. 38.20 degrees
B. 218.20 degrees
C. 321.80 degrees
D. 141.80 degrees

42. A line points into the northwest quadrant and its stored clockwise direction from north is 307.60 degrees. Which bearing label represents the identical line orientation?

A. N 37.60 degrees W
B. S 52.40 degrees E
C. N 52.40 degrees W
D. S 52.40 degrees W

43. Course AB is 425.00 ft at azimuth 34.00 degrees. When reducing the line to rectangular components, what north-south component should be assigned to AB?

A. +352.34 ft
B. +237.66 ft
C. -352.34 ft
D. +425.00 ft

44. Course AB is 425.00 ft at azimuth 34.00 degrees. When the same line is reduced to coordinates, what east-west component should be assigned to AB?

A. +352.22 ft
B. +237.66 ft
C. -237.66 ft
D. +425.00 ft

45. Control point P has N 4,820.50 ft and E 2,145.20 ft. The adjusted increment to Q is ΔN = -176.35 ft and ΔE = +94.80 ft. Which coordinate pair is Q?

A. N 4,996.85 ft, E 2,050.40 ft
B. N 4,644.15 ft, E 2,050.40 ft
C. N 4,996.85 ft, E 2,240.00 ft
D. N 4,644.15 ft, E 2,240.00 ft

46. An inverse check is required between control A (N 1,250.00, E 3,400.00) and control B (N 1,610.00, E 3,880.00). What distance should the office computation return?

A. 480.00 ft
B. 720.00 ft
C. 600.00 ft
D. 840.00 ft

47. From point A to point B, the coordinate differences are +360 ft north and +480 ft east. What is the azimuth from A to B?

A. 36.87 degrees
B. 53.13 degrees
C. 126.87 degrees
D. 233.13 degrees

48. During angular closure review of a five-sided traverse, the measured interior-angle sum is 539°59′20″. Using measured minus theoretical, what signed angular closure should be reported?

A. -40 arc-sec
B. +40 arc-sec
C. -20 arc-sec
D. +80 arc-sec

49. If the -40 arc-second angular misclosure of a five-angle traverse is distributed equally, what correction should be applied to each measured angle?

A. +8 arc-sec
B. -8 arc-sec
C. +5 arc-sec
D. +10 arc-sec

50. The coordinate closure residuals of a traverse are +0.18 ft in latitude and -0.24 ft in departure. What magnitude should be reported for the horizontal closure vector?

A. 0.06 ft
B. 0.30 ft
C. 0.21 ft
D. 0.42 ft

51. A traverse totaling 6,750 ft closes by 0.30 ft linearly. Which 1:N expression represents its closure ratio?

A. 1:11,250
B. 1:20,250
C. 1:22,500
D. 1:45,000

52. Adjustment notes show one traverse leg carries 15% of the total traverse length. The northing closure is +0.24 ft. Under a length-proportional Bowditch adjustment, what correction is assigned to that leg?

A. +0.036 ft
B. -0.024 ft
C. -0.040 ft
D. -0.036 ft

53. The same 900-ft course represents 15% of a 6,000-ft traverse. If total departure closure is -0.30 ft, what Bowditch departure correction belongs to the course?

A. -0.045 ft
B. +0.045 ft
C. +0.030 ft
D. +0.050 ft

54. A point at N 2,000.00 ft, E 1,500.00 ft receives adjusted coordinate increments of +312.45 ft north and -128.30 ft east. What are its new coordinates?

A. N 2,312.45 ft, E 1,371.70 ft
B. N 1,687.55 ft, E 1,628.30 ft
C. N 2,312.45 ft, E 1,628.30 ft
D. N 1,687.55 ft, E 1,371.70 ft

55. What is the area of a triangle with a 180-ft base and a perpendicular height of 126 ft?

A. 22,680 sq ft
B. 9,720 sq ft
C. 11,340 sq ft
D. 15,300 sq ft

56. A rectangular site is 360 ft by 275 ft. A 40-ft by 65-ft rectangular exclusion lies entirely inside it. What net area remains?

A. 99,000 sq ft
B. 101,600 sq ft
C. 93,800 sq ft
D. 96,400 sq ft

57. The design sheet lists a 650-ft simple-curve radius and a 42-degree intersection angle. What PI-to-PC tangent distance should be computed for layout?

A. 249.51 ft
B. 238.24 ft
C. 476.47 ft
D. 526.93 ft

58. For a 650-ft simple circular alignment deflecting 42 degrees, what centerline distance follows the arc from PC to PT?

A. 238.24 ft
B. 476.47 ft
C. 249.38 ft
D. 513.65 ft

59. A curve layout sheet gives PI 58+42.60 and T = 249.38 ft. Which station should be assigned to the point where curvature begins?

A. 58+34.38
B. 60+91.98
C. 55+93.22
D. 53+43.84

60. A curve begins at station 55+93.22 and has 476.47 ft of arc length. Which station label belongs at the point of tangency at the far end?

A. 58+34.38
B. 60+91.98
C. 63+19.07
D. 60+69.69

61. During curve staking, two radial lines differ by 12 degrees on a 650-ft radius. What straight-line chord should separate the two curve points?

A. 68.31 ft
B. 135.89 ft
C. 136.14 ft
D. 272.03 ft

62. A vertical curve is 500 ft long, with entering grade +2.4% and exiting grade -1.6%. What is the algebraic grade difference A = g2 - g1?

A. -4.0%
B. +0.8%
C. +4.0%
D. -0.8%

63. A 500-ft crest vertical curve changes grade from +2.4% to -1.6%. How far from the PVC is the tangent grade horizontal?

A. 200 ft
B. 250 ft
C. 375 ft
D. 300 ft

64. At a point 200 ft into a 500-ft vertical transition, the PVC is elevation 812.50 ft and the grades change from +2.4% to -1.6%. What parabolic-curve elevation should be used there?

A. 816.50 ft
B. 814.90 ft
C. 815.70 ft
D. 817.30 ft

65. Between stations 12+00 and 15+80, a profile climbs from 624.80 ft to 636.20 ft. What constant percent grade would connect those endpoints?

A. +3.00%
B. +2.50%
C. +3.80%
D. -3.00%

66. A design grade is +1.75% beginning at station 20+00 with elevation 455.60 ft. What is the design elevation at station 23+40?

A. 449.65 ft
B. 459.10 ft
C. 463.30 ft
D. 461.55 ft

67. A straight baseline runs from (E 1000, N 1000) to (E 1600, N 1000). A point is at (E 1325, N 1088). What is its perpendicular offset from the baseline?

A. 325 ft along line
B. 88 ft left/north
C. 88 ft right/south
D. 413 ft total

68. A straight profile segment runs from station 40+00/elevation 702.40 ft to station 43+00/elevation 711.40 ft. What elevation should be plotted at station 41+80?

A. 705.40 ft
B. 708.40 ft
C. 707.80 ft
D. 709.60 ft

69. Office coordinates for a closed site boundary, in order, are (0,0), (160,0), (210,90), and (40,140). What area does the coordinate method produce?

A. 18,100 sq ft
B. 22,700 sq ft
C. 20,100 sq ft
D. 40,200 sq ft

70. After a traverse adjustment, what is the best reason to retain both raw and adjusted coordinates in the project record?

A. Only adjusted coordinates are useful because raw data should be discarded
B. Raw coordinates automatically become legal boundary evidence after adjustment
C. Keeping both sets eliminates the need to document the adjustment method
D. The raw observations preserve what was measured, while adjusted coordinates document the accepted closure distribution

71. A field separation is represented by 4.86 inches on a sheet whose graphic scale is 1 inch = 50 ft. What ground distance does that plotted separation imply?

A. 97.2 ft
B. 243 ft
C. 250 ft
D. 486 ft

72. Two contour lines represent elevations 420 ft and 425 ft. A point lies 40% of the horizontal distance from the 420-ft contour toward the 425-ft contour along a uniform slope. What elevation is interpolated?

A. 422.0 ft
B. 421.0 ft
C. 423.0 ft
D. 424.0 ft

73. On a topographic map, contour lines that are very closely spaced generally indicate what terrain condition?

A. A nearly level surface
B. A relatively steep slope
C. A vertical datum change
D. A larger map scale by itself

74. A profile shows elevation 531.20 ft at station 8+00 and 536.60 ft at station 9+20, connected by a straight line. What is the profile elevation at station 8+50?

A. 532.95 ft
B. 534.20 ft
C. 535.70 ft
D. 533.45 ft

75. A 675-ft feature must be drawn on a sheet using 1 inch = 75 ft. What plotted length should the drafter expect?

A. 9.00 in
B. 7.50 in
C. 8.00 in
D. 10.00 in

76. A planimeter gives 12.0 square inches for a closed region on a 1 inch = 40 ft drawing. What ground area corresponds to that measured plan area?

A. 480 sq ft
B. 9,600 sq ft
C. 19,200 sq ft
D. 38,400 sq ft

77. When contour lines cross a narrow stream valley, the contour pattern commonly forms a V that points in which direction?

A. Downstream, toward lower ground
B. Upstream, toward higher ground
C. Perpendicular to the map north arrow regardless of terrain

D. Toward the nearest benchmark regardless of drainage

78. What does a cross-section prepared perpendicular to a roadway centerline primarily show?

A. The entire horizontal alignment from beginning to end
B. Only property ownership along the road corridor
C. Ground or design elevations laterally across the alignment at a selected station
D. The magnetic bearing of the centerline at every station

79. A plotting standard allows 0.02 inch uncertainty on a map at 1 inch = 100 ft. What ground uncertainty does that represent?

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

80. Which map product is best described as planimetric rather than topographic?

A. A contour map showing ridges, valleys, and spot elevations
B. A profile showing existing and proposed grades along an alignment
C. A cross-section showing ground elevations at offsets from centerline
D. A drawing emphasizing horizontal locations of roads, buildings, and utilities without terrain contours

81. A construction point is 286.75 ft ahead of station 14+65.30 along the alignment. What is its station?

A. 17+22.05
B. 14+38.55
C. 17+52.05
D. 20+52.05

82. At station 30+00 a proposed pipe invert is 298.40 ft. The design line rises 0.60% for the next 350 ft. What invert should be staked at station 33+50?

A. 296.30 ft
B. 299.00 ft
C. 302.10 ft
D. 300.50 ft

83. At a proposed pavement grade point, design elevation is 742.65 ft and existing ground is 744.10 ft. What is the required cut or fill?

A. 1.45 ft cut
B. 1.45 ft fill
C. 0.55 ft cut
D. 2.90 ft cut

84. A fill slope is specified at 2H:1V. The hinge point is 6.0 ft above the catch-point ground elevation. Ignoring irregular ground, what horizontal run is required from hinge to catch?

A. 3.0 ft
B. 12.0 ft
C. 6.0 ft
D. 18.0 ft

85. A roadway crown elevation at centerline is 615.80 ft. The pavement falls at 2.0% cross slope to an edge 18 ft away. What is the design edge elevation?

A. 615.08 ft
B. 616.16 ft
C. 615.44 ft
D. 615.62 ft

86. A crew is laying out curb, trench, and footing work in areas that will soon be excavated. What is the principal reason to establish offset stakes?

A. Offsets preserve reference points outside excavation or construction disturbance
B. Offsets change the design coordinate system so calculations are unnecessary
C. Offsets guarantee that earthwork quantities will balance
D. Offsets remove the need to identify station and grade on the stake

87. A baseline runs east from point (E 5000.00, N 8000.00). A construction point is 125.00 ft ahead and 36.00 ft left of the baseline origin. What are the point coordinates?

A. E 5,125.00 ft, N 7,964.00 ft
B. E 5,125.00 ft, N 8,036.00 ft
C. E 5,036.00 ft, N 8,125.00 ft
D. E 4,875.00 ft, N 8,036.00 ft

88. A vertical curve is 400 ft long with g1 = -1.0% and g2 = +3.0%. What is the grade 150 ft from the PVC?

A. -0.50%
B. +1.00%
C. +2.00%
D. +0.50%

89. A vertical curve begins at elevation 520.00 ft with g1 = -1.0%, g2 = +3.0%, and length 400 ft. What is the curve elevation 150 ft from the PVC?

A. 518.50 ft
B. 519.63 ft
C. 520.75 ft
D. 521.13 ft

90. To verify a rectangular structural grid after layout, the crew needs the theoretical diagonal for a 90-ft by 120-ft rectangle. What should that check distance be?

A. 147.65 ft
B. 180.00 ft
C. 210.00 ft
D. 150.00 ft

91. The storm-drain profile begins with invert 188.25 ft at station 5+00 and continues 325 ft on a 0.80% downgrade. What invert is required at station 8+25?

A. 187.45 ft
B. 190.85 ft
C. 185.65 ft
D. 184.85 ft

92. A proposed sidewalk edge is 10 ft from centerline and 0.18 ft lower than centerline. What cross slope does that represent?

A. 1.80%
B. 0.18%
C. 1.00%
D. 5.56%

93. A construction drawing contains a station equation. What is the most important staking implication?

A. The horizontal alignment physically breaks at the equation
B. All offsets must be measured from a new vertical datum
C. Station values can jump while physical distance along the alignment remains continuous
D. Curve radii automatically change at the station equation

94. On a typical offset grade stake, why should the offset distance be written clearly with the cut or fill information?

A. So crews can transfer grade from the preserved stake to the design point
B. The offset distance is used to change the benchmark elevation
C. Writing the offset makes an independent control check unnecessary
D. The offset identifies the legal property boundary automatically

95. A footing corner design elevation is 356.80 ft. The hub elevation is 359.25 ft. What cut should be marked from the hub to design elevation?

A. 2.45 ft fill
B. 2.45 ft cut
C. 1.55 ft cut
D. 3.05 ft cut

96. A straight curb segment rises from elevation 610.20 ft at station 22+00 to 614.95 ft at station 24+50. What percent grade should intermediate stakes follow?

A. +1.50%
B. +2.10%
C. -1.90%
D. +1.90%

97. A stake is set 25.00 ft right of a northbound baseline at station 10+80. The baseline origin at station 10+00 has coordinates E 4,000.00 ft, N 6,000.00 ft. What are the stake coordinates?

A. E 3,975.00 ft, N 6,080.00 ft
B. E 4,025.00 ft, N 6,080.00 ft
C. E 4,080.00 ft, N 6,025.00 ft
D. E 4,025.00 ft, N 5,920.00 ft

98. Before staking a critical structural layout point from a total-station setup, what check provides the strongest immediate protection against an unnoticed bad setup orientation?

A. Rely only on the instrument display showing that the setup was stored
B. Use a longer prism pole so the point is easier to see
C. Observe an independent known control point and compare the computed check position or direction
D. Change the point description after the stake is set

99. At one earthwork stake, existing ground is 903.92 ft and the proposed surface is 905.35 ft. What grading instruction belongs on the stake?

A. 1.43 ft fill
B. 1.43 ft cut
C. 0.73 ft fill
D. 2.86 ft fill

100. What is the best reason to keep a construction staking field record after stakes are set?

A. It guarantees the contractor will not disturb any stakes
B. It replaces the project plans as the controlling design document
C. It converts temporary construction stakes into permanent survey monuments
D. It documents control, calculations, offsets, elevations, and checks used to reproduce or verify the layout

Practice Exam 9: Answer Key and Explanations

1. A — Multiply the plotted length by the map scale: 7.35 x 60 = 441 feet. Dividing by the scale would reverse the relationship, while the other values reflect common multiplication or transcription errors. The result is a planning-level ground distance used to estimate corridor length before detailed field layout. Units and signs should be checked.

2. D — Control must support reliable sight lines between successive setups. If buildings block intervisibility, an intermediate point can preserve the traverse geometry and reduce awkward short sights or excessive offsets. Surface convenience and nearby features may help operations, but they do not solve the fundamental requirement that the selected control network be observable from the intended stations.

3. B — Relative precision is perimeter divided by linear misclosure, so the allowable misclosure is 8,400/20,000 = 0.42 foot. A smaller misclosure would exceed the minimum requirement, while larger values would not satisfy 1:20,000. This calculation belongs in survey planning because it establishes the acceptance criterion before observations are collected. Units and signs should be checked.

4. C — Three parts per million means three units of error per one million units measured. Multiplying 2,750 feet by 3 x 10^-6 gives 0.00825 foot. The larger distractors shift the decimal incorrectly. This estimate helps determine whether the selected instrument can reasonably support the project accuracy before the crew mobilizes. Units and signs should be checked.

5. B — Vertical work should begin from a clearly identified datum and a verified benchmark connection. Arbitrary elevations can be useful on isolated work only when allowed, while ellipsoid heights are not automatically equivalent to project orthometric elevations. Independent local elevations also destroy consistency. Confirming the datum first prevents systematic elevation offsets throughout design and construction surveying.

6. C — Along the 720-foot side, grid lines occur at 0 through 720 feet, giving seven positions. Along the 480-foot side, there are five positions. The total number of intersections is therefore 7 x 5 = 35. Adding one in each direction is necessary because both boundary grid lines are included in the planned coverage.

7. D — Long-duration construction control should survive grading, excavation, traffic, and repeated occupation. Stable monuments outside disturbance areas, supported by redundant ties, give the crew recoverable geometry and allow independent checks. Points inside excavation or on movable equipment are vulnerable, while a single unreferenced point provides no practical way to detect movement or restore the project control.

8. A — Convert 3.6 miles to 19,008 feet. At 200-foot spacing there are 95 complete intervals, with a remainder, so stations occur at the start, every 200 feet through 19,000 feet, and at the ending project limit. Counting both endpoints gives 97 planned sections. Endpoint treatment matters when estimating field effort and data volume.

9. C — Reflective walls can cause GNSS signals to reach the antenna by both direct and reflected paths, producing multipath error. Prism constants apply to optical EDM measurements, rod graduation concerns leveling, and magnetic declination relates to magnetic directions rather than satellite positioning. Reconnaissance should favor open sky and reduced reflective surfaces when reliable GNSS control is required.

10. D — Independent random error components combine by root-sum-square, not by simple addition. Squaring 0.018 and 0.024, summing, and taking the square root gives 0.030 foot. The 0.042-foot value is the arithmetic sum and is overly conservative for independent components. This planning calculation helps compare expected survey uncertainty with project tolerance. Units and signs should be checked.

11. A — A single stationing system tied to the project alignment allows topography, profiles, design, and later construction stakes to reference the same longitudinal framework. Restarting stationing or using unrelated systems invites interpretation errors. Establishing stationing during planning also makes field notes, plan sheets, offsets, curve data, and construction layout easier to cross-check throughout the project.

12. B — The corridor area is 300 x 2,400 = 720,000 square feet. Dividing by 43,560 square feet per acre gives approximately 16.53 acres. The decimal-shift distractor understates the work substantially. This planning estimate helps gauge field time, data density, and whether supplemental collection methods may be efficient for the required coverage.

13. B — Drainage design depends strongly on grade breaks, channel edges, inverts, tops of banks, and other breaklines that define surface form. A uniform grid alone can miss abrupt changes, and photographs cannot replace measured elevations. Property monuments may be needed for other purposes, but they do not describe the controlling topographic geometry of the drainage feature.

14. C — For a small angular error, lateral displacement is approximately distance times the angle in radians. Rearranging gives angle = 0.03/1,350 radian. Multiplying by 206,265 arc-seconds per radian gives about 4.58 arc-seconds. This planning estimate connects angular performance directly to the positional tolerance expected at the far control point. Units and signs should be checked.

15. D — Large open sites can benefit from rapid dense data collection, but important breaklines still need deliberate definition. Dense points do not automatically capture every edge or drainage feature. Differential leveling can be precise but inefficient for broad topographic coverage, and multiple independent datums create inconsistencies. Method selection should match both required density and terrain characteristics.

16. A — California law describes civil engineering surveying functions that include locating, relocating, establishing, reestablishing, or retracing the alignment or elevation of fixed works and determining earth-surface configuration for civil engineering purposes. Boundary determination is separately regulated land surveying practice. The question therefore focuses on engineering-related topographic work rather than independent cadastral or legal-title services.

17. C — Common points let the surveyor compare GNSS-derived and conventional coordinates within one reference framework. Completely separate networks can conceal datum, scale, or orientation inconsistencies until late in the project. Arbitrary rotations and different vertical datums make integration worse. Shared control provides practical redundancy and a direct check when combining observations from different technologies.

18. A — The ground dimensions are 5.60 x 80 = 448 feet and 3.25 x 80 = 260 feet. Their product is 116,480 square feet. Area scales by the square of the linear scale, so simply multiplying the plotted area by 80 would be incorrect. This conversion helps estimate actual site coverage from a preliminary plan.

19. B — Redundancy means collecting more independent observations than the bare minimum needed to compute positions. Those extra relationships make closures and consistency checks possible, helping reveal blunders or movement. Redundancy does not erase the need for complete notes, does not make all observations equally precise, and does not allow incompatible datums to be exchanged without proper transformation.

20. D — A 1,980-foot line contains six 330-foot intervals. Because a point is required at both ends, the number of points is one more than the number of intervals: 7. Confusing intervals with points gives six. This simple planning count is useful when estimating monument quantities, occupation time, and the number of setup locations required.

21. C — An assumed local datum can be practical when the project is self-contained and no external coordinate integration is required. If design, GIS, agency, or adjoining project data must align with a published framework, an arbitrary system may create avoidable transformation work. Magnetic direction and vertical datum are separate issues, so they do not determine whether a local horizontal datum is.

22. A — With independent error components, the total variance is the sum of component variances. The remaining budget is sqrt(0.05^2 - 0.03^2) = 0.040 foot. Simply subtracting 0.03 from 0.05 gives 0.02 foot and does not follow root-sum-square combination. The result guides selection of other observations and equipment. This planning check keeps the survey method consistent with the required control and deliverable.

23. D — A terrain model must represent ridges, toes, tops of banks, walls, channels, and other locations where slope changes abruptly. Breaklines force the model to honor those features between measured points. Spot elevations alone may interpolate across them incorrectly. Breaklines do not establish ownership, replace vertical control, or perform measurement reductions; they organize surface geometry.

24. B — Fourteen setups at 18 minutes each require 252 minutes. Adding 70 minutes for control checks gives 322 minutes total. The 252-minute choice omits the planned checks, while the other distractors reflect simple budgeting errors. Including verification time in the estimate is important because checking control is part of the field procedure, not optional overhead.

25. A — A useful survey scope tells the crew where to work, which features and elevations are required, what control and datum apply, and what accuracy the final product must support. Administrative information may be useful, but it does not define technical completeness. Clear scope reduces omissions, unnecessary observations, and inconsistent decisions between crews working on the same project.

26. C — Using the height-of-instrument method, add the backsight to the known benchmark elevation: 512.84 + 5.27 = 518.11 feet. Subtracting the backsight would move in the wrong vertical direction. The computed HI becomes the reference for subsequent foresight or intermediate-sight elevations from that setup and should be recorded clearly in the level notes.

27. D — A foresight is subtracted from the height of instrument to obtain the point elevation. Therefore 518.11 - 6.43 = 511.68 feet. Adding the foresight would incorrectly place the turning point above the line of sight. The turning-point elevation should then be used with the next backsight to establish a new height of instrument.

28. B — Apply each rise as a positive elevation change and each fall as a negative change. The net change is +0.75 foot, so the final elevation is 240.75 feet. Treating every reading as positive or reversing one sign produces the distractors. A running arithmetic check is useful for catching sign errors before leaving the site.

29. C — When the vertical angle is referenced from horizontal, the horizontal component is slope distance times cosine of the vertical angle. Thus 286.40 cos 8.5 degrees = 283.25 feet. Using sine gives the vertical component, while leaving the slope distance unreduced is incorrect. The reduced distance is the appropriate horizontal value for coordinate work.

30. D — The vertical component of a slope distance is S sin v when the vertical angle v is measured from horizontal. Here 286.40 sin 8.5 degrees = 42.33 feet. The cosine result is the horizontal component. The sign is positive because the sight is upward, but instrument and prism heights still must be handled when computing ground elevations.

31. B — A turning point transfers elevation between instrument setups, so it must remain stable while both the foresight and next backsight are observed. Loose soil or flexible objects can move and corrupt the elevation transfer. Sight length matters, but stability is more important than maximizing distance. A firm, well-defined point also supports reliable rod placement.

32. A — Equalizing backsight and foresight lengths causes several distance-dependent effects to cancel or nearly cancel within each setup, including line-of-sight collimation error and much of the curvature/refraction imbalance. It does not remove the need for a leveled instrument, stable turning points, or correct rod readings. Balanced sights are therefore a practical field-control technique.

33. B — The arithmetic mean is the sum of the four observations divided by four. Their total is 292.868 degrees, giving 73.217 degrees. Selecting one observation instead of averaging ignores the redundancy gained from repeated measurements. Averaging repeated observations can reduce random scatter, provided the measurements are made under comparable conditions and no blunder is present.

34. C — For a clockwise angle measured from the backsight direction, add the turned angle to the backsight azimuth. Thus 128.40 + 96.75 = 225.15 degrees. No 360-degree wrap is needed in this case. The other values result from subtraction or unrelated combinations. Recording the reference direction and rotation sense prevents quadrant mistakes.

35. D — Reflectorless EDM performance depends on the surface that returns the signal. Very oblique, reflective, dark, or irregular targets can weaken or bias the returned measurement, depending on instrument and conditions. The angle system and instrument leveling still function normally. A questionable reflectorless shot should be checked from another geometry or with a suitable prism when accuracy matters.

36. A — A backsight is added to the known elevation to form the height of instrument. If the backsight is recorded 0.12 foot too large, the computed HI is 0.12 foot too high, and elevations derived from that HI are likewise 0.12 foot too high. The error propagates until a correct independent elevation check exposes it.

37. A — Observing an angle in both instrument faces reverses parts of the instrument geometry, allowing some systematic angular errors to cancel in the mean and helping reveal setup or pointing problems. It does not change the prism constant, perform a north-reference conversion, or eliminate atmospheric EDM effects. Repeated face observations therefore provide useful angular redundancy and quality control.

38. D — The observed closing elevation is 684.22 + 32.47 - 25.25 = 691.44 feet. Compared with the known 691.38-foot benchmark, the run closes 0.06 foot high, so the misclosure is +0.06 foot. The 7.22-foot value is the total rise from the raw sums, not the closure error against known control. Units and signs should be checked.

39. C — Surface utility markings can carry positional uncertainty and may represent interpreted underground information rather than a directly surveyed pipe or cable. The survey should document what was observed, preserve the source and uncertainty, and seek potholing, records, or other verification where conflicts are critical. Treating paint as exact geometry can create serious design and construction risk.

40. B — Start at the instrument-station ground elevation, add instrument height, add the measured upward vertical difference to the prism center, then subtract prism height to reach the target ground point. The calculation is 403.18 + 5.20 + 12.46 - 6.00 = 414.84 feet. Instrument and prism heights must not be omitted from trigonometric leveling.

41. D — A southeast bearing is measured eastward from south. Azimuths are measured clockwise from north, so S 38.20 E converts to 180 - 38.20 = 141.80 degrees. The 38.20-degree choice treats the bearing angle as an azimuth, while 218.20 degrees would correspond to a southwest direction. Quadrant identification controls the conversion.

42. C — An azimuth between 270 and 360 degrees lies in the northwest quadrant. The acute bearing angle is 360 - 307.60 = 52.40 degrees, giving N 52.40 W. Using the same acute angle with a southeast or southwest label describes different directions. The quadrant letters therefore matter just as much as the numeric bearing angle. Check units and signs carefully.

43. A — Latitude is the north-south component of a course and equals distance times cosine of azimuth when azimuth is measured from north. Thus 425 cos 34 degrees = +352.34 feet. The sine gives departure, and the sign is positive because the course lies in the northeast quadrant. Correct component signs are essential in traverse closure.

44. B — Departure is the east-west component and equals distance times sine of azimuth. For 425 feet at 34 degrees, 425 sin 34 degrees = +237.66 feet. The sign is positive because the line runs east of north.

Confusing sine and cosine swaps departure and latitude, a common source of coordinate errors in traverse calculations.

45. D — Apply latitude directly to northing and departure directly to easting. The endpoint is N = 4,820.50 - 176.35 = 4,644.15 feet and E = 2,145.20 + 94.80 = 2,240.00 feet. The signs come from the stated components, so changing both or applying a component to the wrong coordinate produces the distractors.

46. C — The coordinate differences are 360 feet north and 480 feet east. The horizontal distance is sqrt(360^2 + 480^2) = 600.00 feet, a 3-4-5 triangle scaled by 120. Adding the coordinate differences directly is incorrect. The inverse distance is determined from the orthogonal northing and easting differences between the two points.

47. B — Both coordinate differences are positive, so the line lies in the northeast quadrant. Azimuth from north is atan(departure/latitude) = atan(480/360) = 53.13 degrees. The complementary 36.87-degree angle is measured from east instead. The southwest value reverses direction. Using atan2 with departure and latitude helps preserve the correct quadrant. Units and signs should be checked.

48. A — For a five-sided polygon, the theoretical interior-angle sum is (5 - 2) x 180 = 540 degrees. The measured total is 40 arc-seconds short of 540 degrees, so measured minus theoretical equals -40 arc-seconds. The sign identifies the direction of closure and should remain consistent when corrections are later distributed.

49. A — The measured angles are collectively 40 arc-seconds too small, so the total correction must be +40 arc-seconds. Dividing equally among five angles gives +8 arc-seconds per angle. Applying -8 arc-seconds would increase the misclosure instead of removing it. Equal distribution is appropriate here because the problem specifically directs an equal angular adjustment.

50. B — Linear misclosure is the resultant of the north-south and east-west closure components. Compute sqrt(0.18^2 + 0.24^2) = 0.30 foot. Algebraically adding the signed components would give -0.06 foot and does not represent the closure vector magnitude. This resultant is the value used when evaluating traverse relative precision. Units and signs should be checked.

51. C — Relative precision is the traverse perimeter divided by linear misclosure. Here 6,750/0.30 = 22,500, so the closure is 1:22,500. A larger denominator indicates better relative closure. The calculation does not by itself prove the survey meets every project requirement, but it provides a standard way to compare the observed closure with a specified criterion.

52. D — The Bowditch latitude correction equals the negative total latitude misclosure multiplied by the course-length fraction. Thus -0.24 x 900/6,000 = -0.036 foot. The correction has the opposite sign of the misclosure so the adjusted latitude sums close. The rule distributes coordinate corrections in proportion to course lengths throughout the traverse.

53. B — Bowditch departure correction is the negative departure misclosure times the course-length fraction. With a -0.30-foot misclosure, the correction is positive: +0.30 x 900/6,000 = +0.045 foot. The positive correction offsets the westward closure error. Latitude and departure corrections are computed independently even though they use the same proportional length factor.

54. A — Apply the adjusted latitude to northing and the adjusted departure to easting. Northing becomes 2,000.00 + 312.45 = 2,312.45 feet. Easting becomes 1,500.00 - 128.30 = 1,371.70 feet. The negative east-west increment moves west. Maintaining sign conventions prevents a correctly computed component from being applied in the wrong coordinate direction.

55. C — Triangle area equals one-half the base times the perpendicular height. One-half x 180 x 126 = 11,340 square feet. Using the full rectangle product doubles the area, while the other values result from incorrect dimensions. The height must be perpendicular to the base; a sloping side cannot simply be substituted without resolving the geometry.

56. D — The gross rectangle contains 360 x 275 = 99,000 square feet. The excluded area is 40 x 65 = 2,600 square feet. Subtracting gives 96,400 square feet net. Adding the exclusion or failing to remove it produces incorrect results. Composite areas should be broken into simple shapes with signs handled consistently.

57. A — For a simple circular curve, tangent length T = R tan(Delta/2). Substituting R = 650 feet and Delta = 42 degrees gives 650 tan 21 degrees = 249.51 feet. Using the full central angle in the tangent formula would be incorrect. The tangent is measured from PI to either PC or PT.

58. B — Arc length is radius multiplied by the central angle in radians. Forty-two degrees equals 42 pi/180 radians, so L = 650 x 42 pi/180 = 476.47 feet. The tangent length is a different curve element. Keeping radians and degrees straight is essential when applying the compact arc-length formula. Units and signs should be checked.

59. C — The PC lies one tangent length before the PI along stationing. Convert station 58+42.60 to 5,842.60 feet, subtract 249.38 feet, and obtain 5,593.22 feet, or station 55+93.22. Adding the tangent would locate a point beyond the PI. Station arithmetic is easiest when first converted to total feet. Units and signs should be checked.

60. D — The PT station equals the PC station plus the arc length. Using total feet, 5,593.22 + 476.47 = 6,069.69 feet, which is station 60+69.69. Adding tangent length instead of curve length would produce the wrong station because stationing follows the centerline alignment, including the curve arc between PC and PT.

61. B — A chord subtending central angle theta has length C = 2R sin(theta/2). For R = 650 feet and theta = 12 degrees, C = 1,300 sin 6 degrees = 135.89 feet. Using the arc-length expression gives a slightly different value, while omitting the factor of two gives roughly half the correct chord.

62. A — The algebraic grade difference is g2 - g1, not the absolute difference unless the problem specifically asks for magnitude. Here -1.6% - (+2.4%) = -4.0%. The negative sign indicates a crest-type change from positive to negative grade. Keeping grade signs is essential for vertical-curve equations and locating high or low points.

63. D — Grade changes linearly along a parabolic vertical curve. The rate is (g2 - g1)/L = -0.04/500 per foot. Setting g(x) = 0.024 + rx equal to zero gives x = 300 feet from the PVC. Because the grade changes from positive to negative, this zero-grade location is the curve high point.

64. C — For a parabolic vertical curve, elevation at distance x is E_PVC + g1 x + (A x^2)/(2L), with grades in decimal form. Substituting x = 200 feet gives 812.50 + 4.80 - 1.60 = 815.70 feet. Using only the entering tangent would ignore the parabolic correction caused by changing grade.

65. A — The elevation change is 11.40 feet over a horizontal station difference of 380 feet. Grade = 11.40/380 x 100 = +3.00%. The sign is positive because elevation increases with station. Mixing station notation with feet or using the final station number itself as distance would produce an incorrect grade. Units and signs should be checked.

66. D — The station difference is 340 feet. A +1.75% grade rises 0.0175 foot per horizontal foot, so the elevation change is 5.95 feet. Adding to 455.60 gives 461.55 feet. Subtracting would reverse the grade direction. Converting station notation to actual distance before applying the grade avoids a common setup error. Units and signs should be checked.

67. B — The baseline is horizontal in coordinate space because both endpoints have northing 1000. The point northing is 1088, so its perpendicular distance from the line is 88 feet to the north, which is left when traveling east along the baseline. The 325-foot value is the along-line station component, not the perpendicular offset.

68. C — The station 41+80 is 180 feet into a 300-foot interval, or 60% of the way from the first elevation to the second. The total rise is 9.00 feet, so 60% is 5.40 feet. Adding to 702.40 yields 707.80 feet. Straight-grade interpolation is linear between the two known profile points. Units and signs should be checked.

69. C — Using the coordinate area, or shoelace, formula on the vertices in order gives one-half the absolute difference of the cross-product sums. The forward sum is 43,800 and the reverse sum is 3,600, giving (43,800 - 3,600)/2 = 20,100 square feet. Vertex order must follow the polygon boundary without crossing. Units and signs should be checked.

70. D — Raw observations and unadjusted computations preserve the measurement record, while adjusted coordinates show the results after a stated closure method is applied. Keeping both provides traceability and makes later review possible. Discarding raw data removes evidence needed to diagnose problems. Retention does not transform engineering control into boundary evidence or replace adjustment documentation.

71. B — Ground distance equals plotted inches multiplied by feet per inch. Therefore 4.86 x 50 = 243 feet. Dividing by 50 reverses the scale relationship, and 486 feet effectively doubles the correct scale. Scale conversions should be performed before using plotted measurements for design checks or approximate field quantities. Units and signs should be checked.

72. A — The contour elevation difference is 5 feet. At 40% of the distance from the lower contour toward the higher contour, the interpolated rise is 0.40 x 5 = 2 feet. Adding to 420 gives 422 feet. This interpolation assumes the slope between contours is approximately uniform along the line used for the estimate.

73. B — Contour spacing reflects the horizontal distance required for the terrain to change by one contour interval. When contours crowd together, the same vertical change occurs over a short horizontal distance, indicating a steep slope. Widely spaced contours usually indicate gentler terrain. Contour spacing does not by itself signal a datum change or determine the map scale.

74. D — Station 8+50 is 50 feet into the 120-foot interval from 8+00 to 9+20. The total rise is 5.40 feet, so the proportional rise is 5.40 x 50/120 = 2.25 feet. Adding to 531.20 gives 533.45 feet. Because the profile segment is straight, linear interpolation is appropriate. Units and signs should be checked.

75. A — To convert a ground distance to plotted inches, divide by the scale denominator expressed as feet per inch. Thus 675/75 = 9.00 inches. Multiplying would produce an impossible drawing length. This relationship is the inverse of converting plan inches to ground feet, so identifying which direction the scale conversion runs is essential.

76. C — Area scales with the square of the linear scale. Each square inch represents 40 x 40 = 1,600 square feet, so 12.0 square inches represents 19,200 square feet. Multiplying area by only 40 ignores the squared relationship. This is why plan-area conversions differ fundamentally from simple line-length scale conversions. Units and signs should be checked.

77. B — Where contours cross a stream valley, they bend upstream because the contour must rise on each side of the channel before crossing the valley at the corresponding elevation. The V therefore points toward higher ground. The water itself flows generally opposite the point of the V, toward lower elevations. This pattern helps interpret drainage from contours alone.

78. C — A roadway cross-section is a transverse slice through the corridor at a particular station. It shows elevations and offsets across the alignment, allowing the designer or constructor to see lanes, shoulders, ditches, side slopes, and existing ground relationships. A profile instead shows longitudinal elevation along the alignment, while ownership and magnetic bearings are separate information.

79. A — Map uncertainty converts to ground uncertainty using the same linear scale. At 100 feet per inch, 0.02 inch corresponds to 2.0 feet on the ground. This does not mean the original survey observations are necessarily uncertain by two feet; it describes the ground significance of the stated plotting tolerance at that map scale.

80. D — Planimetric mapping emphasizes horizontal positions and shapes of visible or mapped features, such as pavement edges, structures, utility features, and similar objects, without necessarily representing terrain relief. Topographic mapping adds elevation information such as contours and spot elevations. Profiles and cross-sections are elevation views rather than purely planimetric representations of horizontal feature locations.

81. C — Convert station 14+65.30 to 1,465.30 feet and add the 286.75-foot forward distance. The result is 1,752.05 feet, or station 17+52.05. Stationing is simply cumulative distance along the alignment unless a station equation is specified. Performing arithmetic in total feet first reduces errors when carrying the result back into station notation.

82. D — The station difference is 350 feet. At +0.60%, the pipe rises 0.006 x 350 = 2.10 feet. Adding that to 298.40 gives elevation 300.50 feet. A positive grade increases elevation with increasing station. The stake or cut sheet should clearly identify whether the value is invert, centerline, or another design reference.

83. A — Existing ground is 744.10 feet and proposed grade is lower at 742.65 feet. Material must therefore be removed by 744.10 - 742.65 = 1.45 feet, which is cut. If proposed grade were higher, the result would be fill. Construction stakes must communicate both magnitude and whether the contractor should cut or add material.

84. B — A 2H:1V slope requires two feet of horizontal run for each foot of vertical change. With 6.0 feet of vertical difference, the horizontal run is 2 x 6.0 = 12.0 feet. Reversing the ratio gives 3.0 feet. This simplified calculation assumes the ground at the catch point behaves as stated.

85. C — A 2.0% cross slope drops 0.02 foot per horizontal foot. Over 18 feet, the drop is 0.36 foot. Subtracting from the centerline elevation gives 615.44 feet at the edge. The sign is determined by the stated fall away from crown. Offsets and cross-slope direction should be marked clearly on construction stakes.

86. A — A stake placed directly on an excavation line, curb, footing, or other work may be destroyed before it can be used. An offset stake preserves the same design reference at a known lateral distance outside disturbance. It does not replace coordinate calculations, earthwork balancing, or clear labeling. The offset itself must be documented so crews can reconstruct the intended point.

87. B — Traveling east, the along-line direction increases easting. Left of an eastbound line is north, so the 36-foot offset increases northing. The coordinates are therefore E 5,125.00 and N 8,036.00 feet. Reversing left and right changes the northing sign, while swapping the along-line and offset components applies the geometry to the wrong axes.

88. D — Grade changes linearly from -1.0% to +3.0% over 400 feet. The grade-change rate is 4.0%/400, and after 150 feet the grade has increased by 1.5 percentage points. Adding that to -1.0% gives +0.50%. This intermediate grade is tangent to the parabolic vertical curve at that station. Units and signs should be checked.

89. B — Use the parabolic vertical-curve equation E = E_PVC + g1 x + A x^2/(2L). Here the tangent term is -1.50 feet and the parabolic term is +1.125 feet, giving 520.00 - 1.50 + 1.125 = 519.625 feet, rounded to 519.63. Using only tangent grade would miss the curve correction. Units and signs should be checked.

90. D — For a true rectangle, the diagonal follows the Pythagorean theorem. sqrt(90^2 + 120^2) = 150 feet. Checking both diagonals against this value is a practical way to verify squareness after the grid corners are laid out. Matching side lengths alone does not guarantee the included angles are exactly 90 degrees.

91. C — The station difference is 325 feet. A 0.80% falling grade drops 0.008 x 325 = 2.60 feet. Subtracting from 188.25 gives 185.65 feet. The calculation uses horizontal station distance and decimal grade. For construction, the crew should verify that the plan grade direction and invert reference match the stake information.

92. A — Cross slope magnitude is the elevation difference divided by horizontal offset. Thus 0.18/10 x 100 = 1.80%. Reporting 0.18% confuses feet of drop with percent. The direction would be negative if defined as falling away from centerline, but the question asks for magnitude. This calculation is common when checking constructed pavement or sidewalk grades.

93. C — A station equation changes the station label assigned to a location without creating a physical gap in the alignment. The crew must know whether a listed station lies before or after the equation so the correct physical point is staked. It does not alter the horizontal geometry, vertical datum, offsets, or curve radii unless separate design changes are specified.

94. A — An offset stake intentionally sits away from the feature, so the contractor needs the offset distance and direction to transfer the grade or line back to the design location. A cut or fill value without its offset context can be misapplied. The marking does not change benchmark elevation, replace independent checks, or establish a property boundary.

95. B — The hub is above the required footing elevation, so the contractor must cut downward from the hub reference. The difference is 359.25 - 356.80 = 2.45 feet. Calling it fill would reverse the construction action. Stake notes should also make clear whether the cut is referenced to the hub top, tack, or another marked point.

96. D — The elevation rise is 4.75 feet over 250 feet of station distance. Grade = 4.75/250 x 100 = +1.90%. The positive sign follows increasing elevation with increasing station. This grade can be used to compute intermediate curb elevations, but the crew should confirm no vertical curve or grade break occurs between the endpoints.

97. B — From station 10+00 to 10+80, move 80 feet north along the baseline. Facing north, right is east, so the 25-foot offset increases easting. The resulting coordinates are E 4,025.00 and N 6,080.00 feet. Correctly relating left/right to the alignment direction is essential when converting construction offsets into coordinate increments. Units and signs should be checked.

98. C — An independent observation to known control tests the actual setup orientation and coordinate relationship rather than merely trusting stored setup values. A wrong backsight point, coordinate entry, or orientation can otherwise propagate to every stake. Prism height and descriptions matter operationally but do not independently verify the setup geometry. Critical layout should be checked before construction proceeds.

99. A — Proposed grade is higher than existing ground, so material must be added. The required fill is 905.35 - 903.92 = 1.43 feet. A cut label would direct the opposite action. Field staking conventions vary, so the numerical value, sign convention, design feature, and reference point should all be marked consistently on the stake and notes.

100. D — Construction stakes can be disturbed, questioned, or replaced, so a complete field record is essential for reproducing how each point was established. The record should identify control, observations, computed positions, offsets, elevations, and checks. It cannot prevent disturbance, supersede the design plans, or give temporary stakes the status of permanent survey monuments.