PRACTICE EXAM 10: 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 solar-farm base map is plotted at 1 inch = 75 ft. A proposed collector road measures 6.48 inches on the plan. What ground length does it represent?

A. 432 ft
B. 511 ft
C. 864 ft
D. 486 ft

2. A bridge replacement project will demolish both abutments and most nearby pavement. Where should the primary horizontal control be established?

A. On paint marks placed on the abutment scheduled for removal
B. On temporary nails driven into the first lift of new asphalt
C. On stable monuments outside demolition and likely construction disturbance
D. On equipment pads that will be relocated as construction progresses

3. A transmission-line control network totals 9,600 ft. The office sets its closure budget from a 1:24,000 minimum precision. How many feet of linear closure can be allowed?

A. 0.40 ft
B. 0.20 ft
C. 0.80 ft

D. 2.50 ft

4. A 3,200-ft control line will be measured with an EDM whose proportional uncertainty is 2 ppm, ignoring the constant term. What uncertainty comes from the ppm component?

A. 0.00064 ft
B. 0.0064 ft
C. 0.064 ft
D. 0.64 ft

5. A levee-improvement design must integrate with an agency vertical control network. What should be confirmed before field observations begin?

A. An arbitrary elevation chosen on the first stable point
B. The benchmark datum, units, and reliable connection from project control to the agency network
C. That GNSS ellipsoid heights may be used directly as project elevations
D. That every crew may establish its own local vertical reference

6. For a campus grading survey, grid lines are laid out every 140 ft across an 840-ft width and every 90 ft across a 540-ft length, with lines on every boundary. How many crossings result?

A. 49 points
B. 36 points
C. 42 points
D. 56 points

7. A rail-yard expansion will require repeated staking while tracks, ballast, and drainage are reconstructed. Which control strategy is best?

A. Place all control between the existing rails so it remains near the alignment
B. Use a single unreferenced control point at the midpoint of the yard

C. Use durable primary control beyond active work and establish replaceable working control from redundant ties
D. Let each construction phase establish unrelated coordinates to simplify setup

8. A 4.2-mile pipeline corridor will have planned cross-section stations every 300 ft, including both project endpoints. Approximately how many stations are required?

A. 74 stations
B. 76 stations
C. 79 stations
D. 75 stations

9. A proposed GNSS control mark lies beside a tall metallic warehouse wall. What is the strongest reason to reconsider the location?

A. Reflected satellite signals can cause multipath and degrade the GNSS solution
B. The wall changes the EDM prism constant for all future observations
C. The wall causes magnetic declination to become zero at the point
D. The wall prevents a level rod from being read at any distance

10. Instrument-centering and target-centering uncertainties are estimated at 0.021 ft and 0.028 ft. If they are independent, what single planimetric uncertainty represents their RSS combination?

A. 0.007 ft
B. 0.049 ft
C. 0.035 ft
D. 0.025 ft

11. A roadway design survey will be used later for profiles, quantities, and construction staking. What stationing practice is most useful?

A. Restart stationing at 0+00 whenever the instrument setup changes
B. Use different station values for topography and construction to avoid overlap
C. Assign station labels only after the final pavement has been built
D. Maintain one documented stationing system tied to the project alignment and any station equations

12. An aerial-topography flight strip must cover a rectangular footprint 3,600 ft long by 420 ft wide. Approximately how many acres are inside the coverage footprint?

A. 17.36 acres
B. 34.71 acres
C. 30.00 acres
D. 39.67 acres

13. For a drainage-design survey at a culvert outlet, which terrain information deserves special collection emphasis?

A. A uniform grid only, even if it misses the channel edges and invert
B. Channel thalweg, banks, headwalls, flow-line elevations, and slope-break features controlling drainage geometry
C. Property corner monuments only, regardless of drainage location
D. Photographs without measured elevations because the channel shape is visible

14. A control sight is 1,800 ft long. To keep the transverse effect of an angular error below about 0.025 ft, what angular error is approximately allowable? Use the small-angle relation and answer in arc-seconds.

A. 1.43 arc-sec
B. 5.73 arc-sec
C. 2.86 arc-sec
D. 8.59 arc-sec

15. A large open stockpile site needs dense surface coverage plus sharp definition of berm toes and crests. Which planned method is most efficient?

A. Use rapid dense point collection for the surface and supplement it with surveyed breaklines at the berm features
B. Collect only a few random elevations because interpolation will create the missing surface
C. Use differential leveling for every individual surface point across the entire site
D. Omit berm breaklines because a dense point cloud always preserves discontinuities automatically

16. A total-station survey will use several prism types during a plant expansion. What should the survey plan require before production work?

A. Assume all prisms have zero constant because modern total stations compensate automatically
B. Change prism constants only if the measured horizontal angle appears unusual
C. Use target height as the prism constant so one field can serve both purposes
D. Verify and document the prism constants and target-height conventions for each target type

17. A project will combine network RTK positions with total-station detail work. What planning feature best supports a common coordinate framework?

A. Allow each instrument type to use an unrelated local rotation
B. Transform the datasets only by visually matching linework in CAD
C. Establish shared control points that can be occupied or checked by both methods
D. Use separate northing origins and reconcile them after construction

18. A preliminary site plan shows a rectangular work area 4.80 inches by 3.60 inches at 1 inch = 90 ft. What ground area does the rectangle represent?

A. 15,552 sq ft
B. 139,968 sq ft
C. 116,640 sq ft
D. 174,960 sq ft

19. Why should a primary control network include redundant observations rather than only the minimum geometry needed to compute coordinates?

A. Redundancy provides independent checks that can reveal blunders, weak geometry, or disturbed control

B. Redundancy guarantees every repeated observation will be numerically identical

C. Redundancy eliminates the need to record raw observations and setup notes

D. Redundancy allows the surveyor to change datums later without any transformation

20. Settlement marks are proposed at chainages 0, 280, 560, and continuing every 280 ft through chainage 2,240. How many marks are in the complete sequence?

A. 8 monuments

B. 10 monuments

C. 7 monuments

D. 9 monuments

21. A remote industrial site will use an assumed horizontal coordinate system. What should the project records preserve?

A. Only the final plotted coordinates because the assumed origin can be reconstructed from them

B. The assumed origin, orientation, units, control descriptions, and any later relationship to external coordinates

C. A statement that the coordinates are state plane even though no transformation was performed

D. Different assumed origins for each crew so coordinates remain numerically convenient

22. A project allows 0.060 ft total horizontal uncertainty. One independent control component contributes 0.036 ft. What root-sum-square uncertainty remains available for all other independent components?

A. 0.024 ft
B. 0.096 ft
C. 0.048 ft
D. 0.036 ft

23. A design survey crosses a steep rock cut with a sharp top and toe. Why should those lines be collected explicitly rather than relying only on scattered spot elevations?

A. They are breaklines that control abrupt changes in surface slope and prevent the model from smoothing across the cut
B. They establish legal property ownership along the rock face
C. They automatically correct all vertical datum errors in the survey
D. They are needed only for drafting symbols and do not affect the terrain model

24. A reconnaissance plan includes 16 candidate control setups at 14 minutes each, plus 52 minutes for recovery checks and documentation. How much field time should be budgeted?

A. 224 min
B. 268 min
C. 328 min
D. 276 min

25. Before sending a crew to collect engineering topography for a wastewater upgrade, which planning document is most useful?

A. Only the project charge number and client billing contact
B. A blank feature-code list with no project limits or accuracy requirements
C. A scope defining survey limits, required features, control references, accuracy needs, and deliverable requirements
D. A property-owner mailing list unrelated to the engineering survey limits

26. A level setup uses a benchmark elevation of 742.36 ft and a backsight of 5.18 ft. What is the height of instrument?

A. 747.54 ft
B. 737.18 ft
C. 747.18 ft
D. 752.72 ft

27. From the same setup, HI = 747.54 ft and the foresight to TP-1 is 6.73 ft. What is the elevation of TP-1?

A. 754.27 ft
B. 741.36 ft
C. 752.72 ft
D. 740.81 ft

28. A total station measures a 418.60-ft slope distance at an elevation angle of +6.20 degrees. What horizontal distance corresponds to the observation?

A. 45.24 ft
B. 416.15 ft
C. 418.60 ft
D. 420.99 ft

29. The line of sight from instrument center to prism center is 418.60 ft long and inclined +6.20 degrees. What rise occurs from instrument center to prism center?

A. 416.15 ft
B. 418.60 ft
C. 6.20 ft
D. 45.21 ft

30. When setting a level rod on a turning point, which field condition is most important?

A. The point should be soft enough that the rod tip can sink slightly for stability
B. The point should be firm, well defined, and unlikely to settle between observations
C. The turning point should move with the rod so the crew can maintain balance
D. The point should be chosen only to maximize the foresight length

31. A digital-level crew deliberately chooses setups so backsight and foresight lengths remain similar. Which error-control benefit is the crew seeking?

A. Balanced sights reduce the effect of collimation error and partially offset curvature and refraction effects
B. Balanced sights make the benchmark elevation independent of the rod readings
C. Balanced sights eliminate the need to level the instrument before observing
D. Balanced sights cause every foresight reading to equal the previous backsight

32. Four repeated horizontal angle observations are 61.428°, 61.434°, 61.431°, and 61.429°. What is their arithmetic mean?

A. 61.4280°
B. 61.4310°
C. 61.4305°
D. 61.4340°

33. A total station is oriented on azimuth 214.30°. A setout direction is obtained by rotating 82.65° clockwise from that orientation. What azimuth should the instrument display?

A. 131.65°
B. 296.95°
C. 82.65°
D. 277.05°

34. During a precise angle set, why might a crew observe the target in both telescope faces?

A. Changing face doubles the EDM prism constant and improves distance accuracy
B. Face-right automatically converts grid azimuths to geodetic azimuths
C. Using two faces removes the need to center the instrument over the station
D. Face-left and face-right observations help reveal or cancel certain instrumental and pointing errors

35. Starting reduced level is 318.44 ft. Four successive signed height differences are +2.36, -0.92, +1.48, and -3.11 ft. What reduced level results after applying all four?

A. 317.33 ft
B. 318.63 ft
C. 318.25 ft
D. 319.17 ft

36. A reflectorless shot is taken to a dark, wet, highly oblique concrete surface. What should the crew recognize?

A. Reflectivity and incidence angle can reduce the reliability of the returned EDM distance
B. The horizontal circle becomes unusable whenever reflectorless mode is selected
C. The target surface changes the local vertical datum by an unknown amount
D. The instrument automatically converts the shot into a slope percentage measurement

37. A level loop starts on a benchmark at 625.18 ft. Sum BS = 42.77 ft and sum FS = 39.54 ft. The published closing benchmark elevation is 628.36 ft. What signed vertical misclosure results?

A. -0.05 ft
B. +3.18 ft
C. +0.05 ft
D. +3.23 ft

38. An instrument station elevation is 455.20 ft with HI = 5.35 ft. A prism at HT = 6.00 ft is observed with a vertical center-to-center difference of +9.84 ft. What is the ground elevation at the prism point?

A. 464.39 ft
B. 458.39 ft
C. 470.39 ft
D. 454.69 ft

39. A network RTK rover repeatedly reports a float solution at a critical control point. What is the best field response?

A. Store the float coordinate immediately because repeated display values prove accuracy
B. Improve satellite conditions or observation time, obtain a fixed solution, and verify the point independently
C. Average the float coordinates until the software reports a smaller standard deviation
D. Change the point name and continue because solution status does not affect coordinate quality

40. After orienting a total station to a known backsight, what is the strongest immediate check before collecting many detail points?

A. Trust the setup because the data collector accepted the entered coordinates
B. Change the coordinate system if the first detail shot appears inconsistent
C. Wait until the end of the day to perform all orientation checks at once
D. Observe a third known point or recheck the backsight and compare with its known direction and distance

41. For a southeast-trending rail-control leg, length = 612.40 ft and azimuth = 128.75°. Compute the signed latitude, ΔN, for the leg.

A. +383.32 ft
B. +477.60 ft
C. -383.32 ft

D. -477.60 ft

42. The rail-control leg is 612.40 ft at azimuth 128.75°. What signed departure, ΔE, does that leg contribute to the traverse?

A. +477.60 ft
B. -383.32 ft
C. -477.60 ft
D. +383.32 ft

43. Control point A is N 10,450.00 ft, E 7,820.00 ft. Apply a 612.40-ft leg at azimuth 128.75° to obtain the coordinates of point B.

A. N 10927.60 ft, E 7436.68 ft
B. N 10066.68 ft, E 8297.60 ft
C. N 10833.32 ft, E 7342.40 ft
D. N 10833.32 ft, E 8297.60 ft

44. The coordinate-closure report lists residuals ΔN = -0.16 ft and ΔE = +0.30 ft. What is the magnitude of the resultant closure vector?

A. 0.14 ft
B. 0.46 ft
C. 0.34 ft
D. 0.30 ft

45. A QA summary shows 6,120 ft of traversed distance and a 0.34-ft resultant closure. Which approximate relative-precision ratio describes the traverse?

A. 1:6,120
B. 1:9,000

C. 1:36,000
D. 1:18,000

46. During Bowditch adjustment, total easting residual is -0.27 ft over 4,500 ft of traverse. What proportional easting correction belongs to a 750-ft leg?

A. -0.045 ft
B. +0.045 ft
C. +0.270 ft
D. +0.015 ft

47. What azimuth corresponds to the bearing S 38°20' E?

A. 38°20'
B. 218°20'
C. 321°40'
D. 141°40'

48. What quadrant bearing corresponds to azimuth 312°15'?

A. N 47°45' W
B. N 42°15' W
C. S 47°45' E
D. S 42°15' W

49. Two independent coordinate standard uncertainties are 0.014 ft and 0.019 ft. What is their root-sum-square combined uncertainty?

A. 0.024 ft
B. 0.005 ft
C. 0.033 ft

D. 0.017 ft

50. A CAD export lists four boundary vertices in order: (E,N) = (1000,1000), (1260,1040), (1210,1290), and (940,1240). What plan area does the coordinate-area method return?

A. 60,000 sq ft
B. 67,400 sq ft
C. 72,500 sq ft
D. 81,000 sq ft

51. A measured ground distance is 2,485.60 ft. If the combined scale factor to grid is 0.99991, what grid distance should be used?

A. 2,485.60 ft
B. 2,485.82 ft
C. 2,485.38 ft
D. 2,483.11 ft

52. A 385.00-ft slope distance is measured on a line with a vertical angle of 7°30'. What is the horizontal distance?

A. 50.24 ft
B. 385.00 ft
C. 388.32 ft
D. 381.71 ft

53. Three repeated distance observations are 256.842 ft, 256.836 ft, and 256.847 ft. What is their arithmetic mean?

A. 256.836 ft
B. 256.842 ft

C. 256.847 ft
D. 256.850 ft

54. A curve stakeout sheet gives R = 840 ft and Δ = 42°. What distance from the PI back along either tangent locates the PC or PT?

A. 322.45 ft
B. 615.75 ft
C. 602.06 ft
D. 59.76 ft

55. For the same radius 840 ft and central angle 42°, what is the curve arc length?

A. 322.45 ft
B. 602.06 ft
C. 615.75 ft
D. 59.76 ft

56. For the same 840-ft radius and 42° central angle, what is the long chord length?

A. 322.45 ft
B. 615.75 ft
C. 59.76 ft
D. 602.06 ft

57. Beginning at PC station 18+42.60, the alignment follows 615.75 ft of circular arc before reaching PT. What station label belongs at PT?

A. 23+96.75
B. 24+58.35
C. 18+48.75

D. 30+68.10

58. The PI is at station 32+18.40. Moving backward 356.25 ft along the incoming tangent reaches the PC. What is the PC station?

A. 35+74.65
B. 32+18.40
C. 25+05.90
D. 28+62.15

59. A 600-ft equal-tangent vertical curve has PVI station 44+00 and PVI elevation 742.60 ft. Incoming grade is -1.80%. What is the PVC station?

A. 41+00
B. 38+00
C. 44+00
D. 47+00

60. For the same vertical curve, what is the PVC elevation if PVI elevation is 742.60 ft and incoming grade is -1.80%?

A. 737.20 ft
B. 739.00 ft
C. 748.00 ft
D. 742.60 ft

61. For the same vertical curve, what is the PVT elevation if the outgoing grade is +1.20%?

A. 739.00 ft
B. 746.20 ft
C. 748.00 ft

D. 742.60 ft

62. Using the same 600-ft vertical curve, what is the curve elevation at station 44+00, 300 ft from the PVC?

A. 748.00 ft
B. 742.60 ft
C. 744.85 ft
D. 741.10 ft

63. Between stations 10+50 and 13+00, a tangent profile rises from elevation 812.45 ft to 818.35 ft. Express that rise as percent grade.

A. +2.36%
B. +1.97%
C. +2.50%
D. -2.36%

64. A 2.5% descending grade begins at elevation 930.20 ft. What is the elevation 360 ft ahead?

A. 939.20 ft
B. 927.70 ft
C. 920.70 ft
D. 921.20 ft

65. A rectangular parcel measures 365 ft by 540 ft. What is its area in acres?

A. 4.52 acres
B. 3.89 acres
C. 5.24 acres
D. 197,100 acres

66. A triangular area has base 286 ft and perpendicular height 174 ft. What is its area?

A. 49,764 sq ft
B. 24,882 sq ft
C. 23,010 sq ft
D. 46,020 sq ft

67. An average-end-area earthwork segment is 80 ft long. End areas are 620 sq ft and 860 sq ft. What volume is contained between the sections, in cubic yards?

A. 59,200 cu yd
B. 1,096.30 cu yd
C. 2,192.59 cu yd
D. 2,368.52 cu yd

68. Two points have coordinates P1(E 4,260.00, N 8,910.00) and P2(E 4,590.00, N 9,150.00). What is the horizontal distance between them?

A. 330.00 ft
B. 240.00 ft
C. 570.00 ft
D. 408.04 ft

69. From P1(E 4,260.00, N 8,910.00) to P2(E 4,590.00, N 9,150.00), what is the azimuth from north?

A. 36.027°
B. 126.027°
C. 53.973°
D. 233.973°

70. A contour line at elevation 520 ft and the next contour at 525 ft are 0.86 in apart on a map at 1 in = 40 ft. What average ground slope lies between them?

A. 5.81%
B. 11.63%
C. 17.20%
D. 14.53%

71. On a map with a 2-ft contour interval, a point lies halfway between the 684-ft and 686-ft contours along a straight uniform slope. What elevation is interpolated?

A. 685 ft
B. 684.5 ft
C. 686.5 ft
D. 688 ft

72. A map scale is 1 inch = 50 ft. Two utility structures plot 3.86 inches apart. What ground distance separates them?

A. 96.5 ft
B. 193 ft
C. 243 ft
D. 386 ft

73. Contours form a series of closed loops with elevations increasing toward the center and no depression hachures. What terrain feature is indicated?

A. A hill or local high point
B. A closed depression or sink
C. A uniform flat terrace with no elevation change
D. A stream channel with contours pointing downstream

74. Why should a topographic map preserve breaklines along curb returns, retaining walls, and drainage channels?

A. Breaklines automatically establish property boundaries for every mapped feature
B. Breaklines force the surface model to honor abrupt changes in slope and feature geometry
C. Breaklines remove the need for any spot elevations or vertical control
D. Breaklines exist only for labeling and do not influence the digital terrain surface

75. At a plotted scale of 1 inch = 30 ft, a building footprint measures 2.75 in by 1.90 in. What ground footprint area does the plot represent?

A. 522.5 sq ft
B. 2,850.0 sq ft
C. 4,702.5 sq ft
D. 9,405.0 sq ft

76. A contour map shows V-shaped contours crossing a narrow drainage. In which general direction does the point of each V face?

A. Downstream, in the direction of water flow
B. Always toward true north regardless of terrain
C. Toward the nearest property boundary monument
D. Upstream, toward higher ground

77. On a profile, one horizontal inch represents 100 ft while one vertical inch represents 10 ft. What vertical-exaggeration ratio does that pair of scales create?

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

78. A GIS polygon derived from the survey reports 165,000 square feet. What acreage value should be shown to two decimal places?

A. 1.65 acres
B. 4.35 acres
C. 3.79 acres
D. 7.58 acres

79. A digital terrain model produces triangles crossing directly through a concrete retaining wall. What is the best mapping correction?

A. Increase label text size so the wall is more visible on the sheet
B. Add or correct breaklines along the wall so triangulation respects the discontinuity
C. Delete nearby spot elevations so the surface becomes smoother
D. Change the contour interval without changing the surface model

80. A cross-section drawing uses 1 in = 20 ft horizontally. The left edge of pavement plots 1.35 in from centerline. What offset should be labeled?

A. 20.0 ft
B. 13.5 ft
C. 37.0 ft
D. 27.0 ft

81. A finish-grade stake is set where design elevation is 624.80 ft and existing ground is 622.95 ft. What should the stake indicate?

A. 1.85 ft cut
B. 0.95 ft fill
C. 3.70 ft fill
D. 1.85 ft fill

82. A hub elevation is 411.62 ft and the design subgrade elevation is 408.37 ft. What cut should be marked from the hub?

A. 3.25 ft cut
B. 3.25 ft fill
C. 2.25 ft cut
D. 4.25 ft cut

83. From station 12+00 to 16+50, a storm-drain invert is designed to fall 0.0065 ft per horizontal foot. Starting from elevation 276.40 ft, what downstream invert is required?

A. 279.33 ft
B. 273.48 ft
C. 275.75 ft
D. 272.83 ft

84. A curb line rises from elevation 505.10 ft at station 7+50 to 509.30 ft at station 10+30. What constant grade connects the points?

A. +1.25%
B. +1.75%
C. +1.50%
D. -1.50%

85. A sidewalk detail calls for 0.24 ft of fall across a 12-ft horizontal offset from centerline. What percent crossfall does that represent?

A. 0.24%
B. 1.20%
C. 2.00%
D. 5.00%

86. To verify a 72-ft by 96-ft equipment-pad layout, the crew will check the corner-to-corner diagonal. What design diagonal should the tape or EDM show?

A. 116.62 ft
B. 120.00 ft
C. 168.00 ft
D. 96.00 ft

87. A northbound baseline has origin station 20+00 at E 5,600.00 ft, N 3,200.00 ft. What are the coordinates of a stake at station 21+35, 18 ft left?

A. E 5,618.00 ft, N 3,335.00 ft
B. E 5,735.00 ft, N 3,182.00 ft
C. E 5,582.00 ft, N 3,065.00 ft
D. E 5,582.00 ft, N 3,335.00 ft

88. A station equation occurs along a highway alignment. What is the key staking implication?

A. The station labels change at the equation even though the physical alignment remains continuous
B. The horizontal alignment must contain a physical gap at every station equation
C. All vertical elevations reset to zero at the equation location
D. Curve radii automatically change when station values jump

89. Excavation will destroy any marker placed directly on the design line. Why does the crew instead set a lath at a documented offset from that line?

A. The offset changes the legal project boundary to match the excavation
B. The offset eliminates the need to record the design elevation or cut/fill
C. The offset preserves the reference point away from work while allowing the design line or grade to be transferred back
D. The offset guarantees the stake cannot be disturbed by equipment

90. A proposed footing elevation is 732.15 ft. A nearby grade hub is elevation 734.88 ft. What cut from the hub reaches footing elevation?

A. 2.73 ft fill
B. 2.73 ft cut
C. 1.73 ft cut
D. 3.73 ft cut

91. A pipe invert is elevation 145.60 ft at station 3+20 and rises at 0.40% to station 6+70. What is the design invert at 6+70?

A. 144.20 ft
B. 146.00 ft
C. 147.40 ft
D. 147.00 ft

92. A slope stake must locate a 2H:1V fill slope from a hinge point 6.5 ft above existing ground. Ignoring rounding and irregular ground, what horizontal run is required to reach existing ground?

A. 3.25 ft
B. 6.5 ft
C. 19.5 ft
D. 13.0 ft

93. A 3H:1V cut slope must descend 8.0 ft vertically from the catch point to the design hinge. What horizontal offset corresponds to that slope?

A. 24.0 ft
B. 2.67 ft
C. 8.0 ft
D. 32.0 ft

94. A simple construction curve has radius 650 ft and central angle 36°. What tangent length should be used to locate the PC from the PI?

A. 408.41 ft
B. 401.72 ft
C. 211.20 ft
D. 33.45 ft

95. The same 650-ft radius curve begins at PC station 52+40.00 and has central angle 36°. What is the PT station?

A. 54+51.20
B. 56+48.41
C. 56+62.40
D. 58+90.00

96. A 500-ft equal-tangent vertical curve has PVI station 78+00. What are the PVC and PVT stations?

A. PVC 75+50, PVT 80+50
B. PVC 75+00, PVT 81+00
C. PVC 75+50, PVT 80+00
D. PVC 78+00, PVT 83+00

97. For that vertical curve, PVI elevation is 865.40 ft and incoming grade is +1.40%. What is the PVC elevation?

A. 861.90 ft
B. 868.90 ft
C. 867.90 ft
D. 865.40 ft

98. A building column grid line is at E 10,200.00 ft. A column center is specified 14.75 ft west of that line. What easting should be staked?

A. E 10,214.75 ft
B. E 10,195.25 ft
C. E 10,185.25 ft
D. E 10,014.75 ft

99. Two anchor-bolt centerlines are designed 18.00 ft apart. Field measurements from a common control line give offsets 7.42 ft and 25.39 ft. What spacing was actually set?

A. 18.00 ft
B. 17.97 ft
C. 32.81 ft
D. 17.42 ft

100. A pavement design elevation at a check point is 398.62 ft. The as-built elevation is 398.69 ft. What signed as-built deviation, observed minus design, should be reported?

A. -0.07 ft
B. +0.31 ft
C. 0.00 ft
D. +0.07 ft

Practice Exam 10: Answer Key and Explanations

1. D — Map scale converts plotted length to ground length by multiplication. Here, 6.48 inches times 75 feet per inch equals 486 feet. The distractors represent using the wrong scale or reversing digits. This planning conversion helps estimate corridor length and field effort before detailed staking or topographic collection begins. This provides an additional independent check.

2. C — Primary control should survive the project activities it supports. Stable monuments outside demolition, excavation, vibration, and traffic disturbance provide recoverable references for repeated layout and checks. Marks on structures or temporary surfaces scheduled for removal may disappear precisely when needed most. Durable control can support secondary working points closer to the work while preserving overall project continuity.

3. A — Relative precision equals traverse length divided by linear misclosure. Rearranging gives allowable misclosure = 9,600/24,000 = 0.40 foot. A smaller value would exceed the minimum requirement, while larger values would fail it. Establishing this acceptance criterion in advance helps the crew choose suitable instruments, procedures, redundancy, and checking before observations begin.

4. B — Two parts per million means two units of uncertainty for each million units measured. Multiplying 3,200 feet by 2 x 10^-6 gives 0.0064 foot. Moving the decimal one or two places produces the distractors. This estimate helps determine whether the planned instrument specification is compatible with the project accuracy objective.

5. B — A design survey tied to an agency network needs a known vertical reference before data collection. Confirming datum, units, benchmark identity, and the transfer path prevents a systematic elevation shift throughout design and construction. Arbitrary elevations or direct substitution of ellipsoid heights can be appropriate only when specifically defined, not when compatibility with an established network is required.

6. A — The 840-foot dimension contains six 140-foot intervals, which requires seven grid lines including both boundaries. The 540-foot dimension contains six 90-foot intervals, also requiring seven lines. Therefore, 7 x 7 = 49 intersections. Counting intervals instead of grid lines is a common planning error when estimating field point quantities. This provides an additional independent check.

7. C — Long-duration construction benefits from a hierarchy of control. Durable primary control outside disturbance preserves the project reference, while working control can be replaced as phases advance. Control between tracks or a single unreferenced point may be lost or disturbed, and unrelated coordinate systems create avoidable inconsistencies between phases, trades, and as-built surveys.

8. D — Convert 4.2 miles to 22,176 feet. Dividing by 300 gives 73.92 intervals, so 74 intervals are needed to reach or pass the far endpoint. Including both endpoints requires 75 stations. Using only the quotient can undercount because the final partial interval still requires a terminal cross-section station. This provides an additional independent check.

9. A — Large reflective surfaces can produce GNSS multipath, where delayed reflected signals reach the antenna along with direct signals. That can bias positions and make repeated solutions appear unstable. The wall does not determine prism constants or magnetic declination, and it does not inherently prevent leveling. A better control site improves satellite visibility and reduces reflective interference.

10. C — Independent random uncertainty components combine by root-sum-square rather than direct addition. Squaring 0.021 and 0.028 feet, adding, and taking the square root gives 0.035 foot. Direct addition gives 0.049 foot and overstates independent random combination. This planning calculation helps allocate accuracy among equipment, centering, control, and observation procedures. This provides an additional independent check.

11. D — A consistent stationing system allows topography, profiles, design features, earthwork, and construction layout to reference the same physical locations. Setup changes should not alter stationing. If station equations occur, they should be documented explicitly. Delaying station assignment or using unrelated systems increases the chance that design and field crews will reference different points along the alignment.

12. B — The corridor area is 420 x 3,600 = 1,512,000 square feet. Dividing by 43,560 square feet per acre gives approximately 34.71 acres. The result is useful for estimating field effort, data volume, and remote-sensing coverage. Using only one dimension or an incorrect acre conversion produces the alternative values. This provides an additional independent check.

13. B — Hydraulic and grading design depends strongly on the geometry that controls flow. Thalweg, banks, headwalls, inverts, and abrupt slope changes should therefore be located explicitly as breaklines or critical shots. A uniform grid may miss narrow features, while property monuments or photographs alone do not define the vertical geometry needed for design and surface modeling.

14. C — For a small angle, transverse displacement is approximately distance times angle in radians. The allowable angle is 0.025/1,800 radians. Multiplying by 206,265 arc-seconds per radian gives about 2.86 arc-seconds. This planning estimate links angular observation quality to positional tolerance and helps determine whether the proposed sight length and instrument are suitable.

15. A — Dense collection methods can efficiently represent broad surfaces, but critical discontinuities still need explicit definition. Surveying toes, crests, and abrupt edges as breaklines helps the terrain model honor the true geometry. Sparse random points risk smoothing important features, while leveling every point is unnecessarily slow. Planning should combine efficient coverage with targeted feature definition.

16. D — Prism constants affect measured distance, while target heights affect elevation reduction. Different target types may use different constants and reference points, so the crew should verify both before production observations begin. Treating every prism as zero or confusing prism constant with target height creates systematic errors that can propagate through control, topography, and construction layout.

17. C — Common control observed by both systems provides a direct geometric link and an independent way to detect orientation, scale, or coordinate mistakes. Unrelated rotations and origins create avoidable transformation problems, while visual CAD alignment can conceal systematic errors. Planning shared control from the beginning makes integration of GNSS and terrestrial measurements more reliable and traceable.

18. B — The plotted dimensions represent 432 feet and 324 feet on the ground. Their product is 139,968 square feet. Multiplying the map dimensions directly without applying scale underestimates the area, while using an incorrect scale creates the other choices. Planning-area estimates are useful for field staffing, aerial coverage, grid spacing, and expected data volume.

19. A — A minimally determined network can produce coordinates even when an observation contains an unnoticed blunder. Redundant measurements create internal checks, allow residual analysis, and improve the ability to identify weak geometry or disturbed points. They do not make observations identical or eliminate documentation. Datum changes still require a defined transformation or common control relationship.

20. D — The line contains eight equal 280-foot intervals because 2,240/280 = 8. A sequence of eight intervals requires nine monuments when both endpoints are included. Confusing intervals with points produces eight. Counting endpoints correctly is important when estimating monument quantities, observation time, materials, and expected station naming for a monitoring program.

21. B — An assumed coordinate system is usable when its definition is explicit and reproducible. Records should preserve origin, orientation, units, monumentation, and any later tie to an external system. Simply labeling assumed coordinates as state plane is misleading, and changing origins between crews destroys continuity. Good documentation allows future surveys to reproduce or transform the work correctly.

22. C — For independent components, the squared total equals the sum of squared components. The remaining allowance is $\text{sqrt}(0.060^2 - 0.036^2) = 0.048$ foot. Direct subtraction gives 0.024 foot and is not the root-sum-square relationship. This planning calculation helps allocate error among control, centering, instrument, target, and observation sources. This provides an additional independent check.

23. A — A terrain model interpolates between measured points, so abrupt slope changes can be smoothed incorrectly unless controlling edges are represented as breaklines. The top and toe of a rock cut define distinct changes in surface direction. Breaklines affect surface geometry directly; they do not establish ownership or correct datum errors, and they are more than drafting annotations.

24. D — Sixteen setups at 14 minutes each require 224 minutes. Adding 52 minutes for recovery checks and documentation gives 276 minutes total. Ignoring the support work underestimates field time, while adding it twice overstates the budget. Reconnaissance schedules should include both direct observations and the control checks, notes, and recovery work needed for defensible results.

25. C — A field crew needs a clear statement of what area to cover, which features and elevations matter, what control to use, and what accuracy and deliverables are expected. Administrative information alone does not define the survey. A complete scope reduces omissions, inconsistent coding, unnecessary observations, and later remobilization when designers discover missing critical information.

26. A — Height of instrument equals the known point elevation plus the backsight reading. Therefore, 742.36 + 5.18 = 747.54 feet. Subtracting the backsight reverses the leveling relationship. Once HI is established, foresights are subtracted from it to determine new point elevations. Recording the setup clearly allows the level run to be checked independently.

27. D — A foresight is subtracted from the height of instrument to obtain the target-point elevation. Thus 747.54 - 6.73 = 740.81 feet. Adding the foresight would place the point above the line of sight instead of below it. The result should be entered in the level notes before the turning point is used for the next setup.

28. B — Horizontal distance is the slope distance multiplied by the cosine of the elevation angle. Using 418.60 cos(6.20 degrees) gives 416.15 feet. The sine component would be the vertical difference between instrument and target centers. Using the full slope distance as horizontal distance introduces a systematic error that grows as the sight becomes steeper.

29. D — The vertical component of a slope distance is distance times sine of the elevation angle. Therefore, 418.60 sin(6.20 degrees) is approximately 45.21 feet upward. The cosine term is the horizontal component. Treating the angle itself as feet has no dimensional meaning. Instrument and target heights must still be applied to convert center-to-center difference into ground elevation difference.

30. B — A turning point transfers elevation from one level setup to the next, so movement between the foresight and subsequent backsight creates a direct vertical error. A firm, clearly defined point provides repeatable rod seating. Soft ground, movable objects, or choosing solely for long sight length can compromise the transfer even when the rod reading itself appears precise.

31. A — Certain systematic effects depend on sight length. Keeping backsight and foresight distances similar causes much of their influence to cancel when elevation differences are computed. This does not remove the need to level the instrument or read the rod carefully. Balanced geometry is a field-control technique that improves leveling reliability without changing the benchmark elevation itself.

32. C — Add the four observations and divide by four: the arithmetic mean is 61.4305 degrees. Selecting one middle observation is not equivalent to averaging all measurements. Repetition helps reduce random pointing and reading effects and provides a check on consistency. A large spread among repeated angles would warrant investigating setup stability, centering, target definition, or observation procedure.

33. B — When the clockwise angle is referenced from the known backsight direction as stated, add it to the backsight azimuth. Thus 214.30 + 82.65 = 296.95 degrees. If the result exceeded 360 degrees, it would be reduced by 360. Direction calculations should always be checked against the observed turning sense and approximate field quadrant.

34. D — Observing both telescope faces reverses the instrument geometry and helps cancel or expose certain collimation, index, and pointing effects when results are combined. It does not alter prism constants or coordinate-system orientation, and it does not excuse poor centering. Repetition in both faces is especially useful when angular precision matters for control or critical layout.

35. C — Apply the signed elevation changes sequentially to the starting elevation. The net change is 2.36 - 0.92 + 1.48 - 3.11 = -0.19 foot. Therefore, the ending elevation is 318.44 - 0.19 = 318.25 feet. Keeping signs explicit in the field or reduction notes reduces the chance of reversing a rise or fall.

36. A — Reflectorless EDM performance depends on the target surface, distance, angle of incidence, and atmospheric conditions. A dark, wet, or highly oblique surface can weaken or distort the returned signal. The instrument may still display a distance, but the crew should evaluate whether the result is reliable enough for the task and obtain an independent check when critical.

37. C — The observed closing elevation is 625.18 + 42.77 - 39.54 = 628.41 feet. Misclosure is observed minus known, so 628.41 - 628.36 = +0.05 foot. The 3.23-foot value is the net observed elevation change, not the closure error. The sign shows that the observed closure finished slightly high. This provides an additional independent check.

38. A — Start with the instrument-station ground elevation and add HI to obtain the instrument-axis elevation. Add the measured +9.84-foot vertical difference to reach the prism center, then subtract the 6.00-foot target height to reach the ground point. The result is 464.39 feet. Omitting either HI or target height shifts the final elevation systematically.

39. B — A float solution means the carrier-phase ambiguities have not been resolved to integers and generally carries greater, less predictable uncertainty than a fixed solution. Critical control should not be accepted merely because coordinates appear stable. Improve conditions, reinitialize, extend observation if appropriate, or use a checked terrestrial method, then verify the resulting point independently.

40. D — An immediate observation to known control tests the occupied point, backsight identification, orientation, centering, and relevant target settings before any error propagates into a large data set. Software acceptance confirms only that values were entered, not that the field setup is correct. Early checks reduce the amount of rework if a setup problem exists.

41. C — Change in northing equals distance times cosine of azimuth. For 128.75 degrees, the line lies in the southeast quadrant, so the northing component must be negative. Evaluating 612.40 cos(128.75 degrees) gives the keyed value. The sine term is the easting component. Quadrant logic is a useful independent check on the computed sign.

42. A — Change in easting equals distance times sine of azimuth. At 128.75 degrees, the course lies east of south, so the easting component is positive. Evaluating 612.40 sin(128.75 degrees) gives the keyed value. The cosine term supplies northing. Checking the expected quadrant before accepting coordinates helps detect swapped functions or reversed signs.

43. B — Apply the signed coordinate components to the starting point. The northing change is negative and the easting change positive for this southeast course, so the endpoint is found by adding those signed values to the starting coordinates. Swapping components or ignoring their signs moves the endpoint into a different location even if the component magnitudes are correct.

44. C — Linear error of closure is the magnitude of the residual coordinate vector. Calculate sqrt((-0.16)^2 + 0.30^2) = 0.34 foot. Adding signed components gives 0.14 foot and adding absolute components gives 0.46 foot, neither of which represents vector magnitude. Closure direction can be analyzed separately after the magnitude is established. This provides an additional independent check.

45. D — Relative precision is the total traverse length divided by the linear closure error. Here, 6,120/0.34 is exactly 18,000, so the traverse closes at approximately 1:18,000. The ratio provides a convenient normalized description of closure quality. It should be compared with the project requirement before an adjustment is accepted for downstream coordinate work.

46. B — Bowditch corrections are proportional to course length and opposite in sign to the total misclosure. The course receives -(-0.27)(750/4,500) = +0.045 foot in easting. Applying a negative correction would worsen the closure, while assigning the full residual to one line would not follow the proportional Bowditch distribution rule. This provides an additional independent check.

47. D — A southeast bearing is measured eastward from south, so its azimuth is 180 degrees minus the bearing angle. Therefore, 180°00' - 38°20' = 141°40'. The other options correspond to different quadrants or to treating the bearing directly as an azimuth. A quadrant sketch is a useful check before converting directions.

48. A — An azimuth between 270 and 360 degrees lies in the northwest quadrant. The acute bearing angle is 360°00' - 312°15' = 47°45'. Therefore the bearing is N 47°45' W. Using the azimuth directly as a bearing or assigning southeast or southwest quadrant letters would contradict the line direction. This provides an additional independent check.

49. A — Independent standard uncertainties combine by taking the square root of the sum of their squares. $\mathrm{sqrt}(0.014^2 + 0.019^2)$ is about 0.024 foot. Direct addition gives 0.033 foot, while simple subtraction gives 0.005 foot. Root-sum-square combination is appropriate only when the components are reasonably independent and expressed on compatible uncertainty bases.

50. B — Using the coordinate-area, or shoelace, formula on the four vertices gives the enclosed plan area. Summing each easting times the next northing, subtracting each next easting times the current northing, and dividing the absolute difference by two produces the keyed square-foot value. Vertex order must follow the polygon boundary without crossing itself.

51. C — Grid distance equals ground distance multiplied by the combined factor when the factor is defined as grid over ground. Multiplying 2,485.60 feet by 0.99991 gives 2,485.38 feet. Using the unscaled ground value ignores the coordinate-system reduction, while dividing by the factor would move in the opposite direction. Confirm the project factor definition before applying it.

52. D — Horizontal distance is slope distance times cosine of the elevation angle. For 385.00 feet at 7°30', the result is approximately 381.71 feet. The sine component is vertical difference, and the full slope distance exceeds the horizontal projection. This reduction is necessary before using an inclined measurement in plan coordinates, stationing, or horizontal geometry calculations.

53. B — The arithmetic mean is the sum of the three observations divided by three. Their total is 770.525 feet, producing 256.8417 feet, which rounds to 256.842 feet. Choosing one observed value without averaging ignores the purpose of repetition. The spread should also be reviewed to determine whether any observation appears inconsistent or deserves further investigation.

54. A — For a simple circular curve, tangent length is R tan(Delta/2). With R = 840 feet and Delta = 42 degrees, T = 840 tan(21 degrees), giving the keyed value. Arc length, long chord, and external distance use different formulas, so substituting one of them changes both magnitude and geometric meaning.

55. C — Arc length equals radius multiplied by the central angle in radians. Converting 42 degrees to radians and multiplying by 840 feet gives the keyed arc length. Tangent, long chord, and external distance describe different parts of the curve. Keeping degrees and radians straight is essential when applying the arc-length formula in coordinate or station computations.

56. D — The long chord spans directly from PC to PT and equals 2R sin(Delta/2). Substituting R = 840 feet and Delta = 42 degrees gives the keyed distance. Arc length follows the curved path and is longer, while tangent and external distance refer to other curve elements. A sketch helps prevent choosing the wrong formula.

57. B — Stationing along a simple circular curve increases by arc length, not by tangent length or chord length. Adding 615.75 feet to PC station 18+42.60 gives station 24+58.35. Converting station notation to ordinary feet before adding reduces clerical errors. The result should be checked against the overall alignment stationing and any station equations.

58. D — The PC lies one tangent length back from the PI along the incoming tangent. Convert station 32+18.40 to 3,218.40 feet and subtract 356.25 feet to obtain 2,862.15 feet, or station 28+62.15. Adding the tangent would locate the forward tangent point rather than the PC. Station arithmetic should be done in feet first.

59. A — An equal-tangent vertical curve extends half its total length on each side of the PVI. Half of 600 feet is 300 feet, so the PVC station is 44+00 minus 300 feet = 41+00. The grade values affect elevations and curve shape but not the station offset from the PVI for an equal-tangent curve.

60. C — Moving from the PVC forward 300 feet along the incoming tangent at -1.80% reaches the PVI. Therefore, PVI elevation = PVC elevation + g1(300), so PVC elevation = 742.60 - (-0.018)(300) = the keyed value. Because the incoming grade falls toward the PVI, the PVC must be higher than the PVI.

61. B — The PVT lies 300 feet beyond the PVI along the outgoing +1.20% tangent. The elevation rises by 0.012 x 300 = 3.60 feet, so add that amount to the PVI elevation. The PVC calculation uses the incoming grade and the opposite station direction. Keeping the tangent side and grade sign clear avoids vertical-curve endpoint errors.

62. C — Vertical-curve elevation is PVC elevation + g1x + A $x^2/(2L)$, where A = g2 - g1. At x = 300 feet, the tangent term and parabolic correction combine to produce the keyed elevation. The PVI elevation lies on the tangent intersection, not necessarily on the curve. Substituting tangent elevation alone omits curvature.

63. A — The elevation rise is 5.90 feet over 250 feet of horizontal station distance. Grade = 5.90/250 x 100 = +2.36%. The positive sign follows increasing elevation with increasing station. Dividing by an incorrect distance or reversing the direction produces the distractors. Check whether a vertical curve interrupts the interval before applying a constant grade.

64. D — A 2.5% descending grade drops 0.025 foot per horizontal foot. Over 360 feet, the drop is 9.00 feet. Subtracting from 930.20 gives 921.20 feet. Adding the change would reverse the grade direction, while using 2.5 feet instead of 2.5 percent misinterprets the slope. Station distance is treated as horizontal distance here.

65. A — The rectangular area is 365 x 540 = 197,100 square feet. Dividing by 43,560 square feet per acre gives approximately 4.52 acres. Leaving the area in square feet while labeling it acres is a unit error. Acre conversion is common in planning, quantity estimates, right-of-way work, and mapping summaries, so units should be carried explicitly.

66. B — Triangle area equals one-half base times perpendicular height. Substituting 286 feet and 174 feet gives 24,882 square feet. Multiplying base and height without the one-half factor doubles the area. The height must be perpendicular to the selected base; using an oblique side length in place of perpendicular height would not produce the correct plan area.

67. C — Average-end-area volume equals the average of the two cross-sectional areas times the spacing. The average area is 740 square feet, giving 59,200 cubic feet over 80 feet. Dividing by 27 converts to approximately 2,192.59 cubic yards. Omitting the average or the cubic-foot conversion creates the incorrect alternatives. This provides an additional independent check.

68. D — The coordinate differences are 330 feet in easting and 240 feet in northing. Straight-line distance is $\mathrm{sqrt}(330^2 + 240^2) = 408.04$ feet. The component differences are not the total line length, and their arithmetic sum gives only a rectilinear path. Coordinate differences should be signed for direction, although distance uses their squared magnitudes.

69. C — Azimuth from north is obtained from atan2(delta E, delta N). Both coordinate differences are positive, so the line lies in the northeast quadrant. Using 330 feet east and 240 feet north gives about 53.973 degrees. Reversing the ratio produces the complementary angle, while adding 180 degrees would describe the reverse direction from P2 back to P1.

70. D — The contour interval is 5 feet. The map spacing of 0.86 inch represents 34.4 feet horizontally at 40 feet per inch. Percent slope is 5/34.4 x 100 = 14.53%. Using map inches directly instead of converting to ground distance creates a unit error. Closely spaced contours represent steeper ground than widely spaced contours.

71. A — Under a straight uniform-slope assumption, halfway between consecutive 684-foot and 686-foot contours corresponds to halfway in elevation, or 685 feet. Interpolation is proportional to the distance between contours. This is only an estimate of the modeled surface; abrupt terrain breaks, walls, channels, or nonuniform slopes require surveyed breaklines or additional spot elevations rather than simple interpolation.

72. B — Multiply the plotted separation by the stated scale: 3.86 x 50 = 193 feet. Dividing by the scale or treating inches as tens of feet produces the other values. Scale-based measurements should be treated with precision appropriate to the source drawing, because graphical line width and plotting resolution may limit how accurately the distance can be read.

73. A — Closed contours that rise in elevation toward the center depict a hill or local high. A depression normally uses hachures or other notation and has elevations that decrease inward. Stream contours typically form V-shaped patterns related to drainage. Reading contour values together with their shape is essential; line shape alone can be ambiguous without the elevation labels.

74. B — Breaklines connect surveyed points along significant terrain discontinuities and instruct the surface model not to interpolate freely across them. Curbs, walls, channel edges, and similar features can be smoothed incorrectly without this structure. Breaklines complement, rather than replace, spot elevations and vertical control. They describe terrain geometry, not legal ownership or merely drafting appearance.

75. C — Convert both plotted dimensions to ground dimensions before computing area. The sides are 82.5 feet and 57.0 feet, so the footprint area is 4,702.5 square feet. Scaling only one dimension underestimates area because area scales in two directions. Graphical measurements should also be reported with realistic precision for the map scale and linework quality.

76. D — Where contours cross a drainage, the V generally points upstream because each contour bends toward higher elevation as it enters the channel. Water flows in the opposite direction, downhill through the open side of the V. This rule is a useful terrain-reading check, but actual contour labels and surrounding elevations should still be examined before interpreting drainage direction.

77. A — Vertical exaggeration is the horizontal ground distance represented by one plotted inch divided by the vertical ground distance represented by one plotted inch. Here, 100/10 = 10, so the profile is exaggerated 10:1 vertically. This makes small grade changes easier to see, but it also makes slopes appear much steeper than they would at equal scales.

78. C — Divide the mapped square-foot area by 43,560 square feet per acre. The result is approximately 3.79 acres. Multiplying instead of dividing or using an unrelated conversion produces the distractors. Area labels should reflect the quality of the source survey and should not imply greater precision than the measured boundary or mapping data support.

79. B — A triangulated surface can connect points across a discontinuity unless breaklines constrain the triangulation. Adding the wall as a properly coded breakline makes the surface honor the abrupt elevation change. Label size and contour interval affect presentation but not the underlying geometry, while deleting valid nearby points may make the model less accurate rather than fixing the structural problem.

80. D — The plotted offset is converted using the horizontal drawing scale: 1.35 inches times 20 feet per inch equals 27.0 feet. The vertical scale, if different, would not apply to this horizontal measurement. Mapping and profile sheets often use different horizontal and vertical scales, so the direction and scale associated with each measured dimension must be identified correctly.

81. D — Design grade is 1.85 feet above existing ground, so material must be added and the stake should indicate fill. Reversing the subtraction would produce a cut label and direct construction the wrong way. Field records should define the sign and reference convention consistently, particularly when hubs, laths, or offset stakes are used instead of the design point itself.

82. A — The hub is above the design subgrade, so construction must cut downward. The vertical difference is 411.62 - 408.37 = 3.25 feet. A fill label would reverse the required action. Stake notes should identify whether the cut is measured from the hub top, tack, or another reference and should include enough information for independent checking.

83. B — The station difference is 450 feet. A 0.65% falling grade drops 0.0065 x 450 = 2.925 feet. Subtracting from 276.40 gives 273.475 feet, which rounds to 273.48 feet. The direction of grade matters; adding the drop would reverse the design. Confirm whether station distance is horizontal and whether any grade breaks intervene.

84. C — The rise is 4.20 feet over 280 feet of station distance. Dividing 4.20 by 280 and multiplying by 100 gives +1.50%. The sign is positive because elevation increases with station. This constant-grade calculation is valid only when no vertical curve or grade break lies between the stated endpoints. Construction notes should identify the controlling line clearly.

85. C — Cross slope magnitude equals vertical difference divided by horizontal offset. Thus 0.24/12 x 100 = 2.00%. The 0.24-foot drop is not itself a percentage. If a sign convention is used, the slope may be reported negative when falling away from centerline, but the question asks only for magnitude. Verify the design reference line before staking.

86. B — For a rectangle, the diagonal follows the Pythagorean theorem. $\text{sqrt}(72^2 + 96^2) = 120$ feet. Measuring both diagonals and comparing them with this design value helps verify that the pad corners are square. Correct side lengths alone do not prove the included angles are 90 degrees, so diagonal checks provide an important independent geometric test.

87. D — From station 20+00 to 21+35, move 135 feet north along the baseline. Facing north, left is west, so subtract the 18-foot offset from easting. The resulting stake coordinates are E 5,582.00 and N 3,335.00 feet. Relating left and right to the direction of increasing station is essential when converting offsets into coordinate changes.

88. A — A station equation changes the numerical station assigned to a physical point but does not create a gap in the alignment. Crews must determine whether a requested station lies before or after the equation so they stake the correct physical location. Station equations do not automatically alter elevations, curve radii, or the underlying coordinate geometry of the project alignment.

89. C — An offset stake places the physical marker away from excavation, paving, or other activity likely to destroy the design point. Its recorded offset and direction allow line and grade to be transferred back to the intended location. The method does not change legal boundaries or eliminate documentation, and no stake location can guarantee protection from construction disturbance.

90. B — The hub is 2.73 feet above the proposed footing elevation, so the required construction action is a 2.73-foot cut from the hub reference. Calling it fill reverses the direction. The stake should clearly identify the reference point and feature because a cut value is meaningful only when the contractor knows exactly what surface or elevation it controls.

91. D — The station difference is 350 feet. At +0.40%, the invert rises 0.004 x 350 = 1.40 feet. Adding that to 145.60 gives 147.00 feet. Reversing the sign would incorrectly make the pipe fall. Utility staking should also confirm whether the plan elevations refer to invert, centerline, top of pipe, or another construction surface.

92. D — A 2H:1V slope requires 2 feet of horizontal run for every 1 foot of vertical change. For a 6.5-foot fill height, the horizontal run is 13.0 feet. Using 6.5 feet treats the slope as 1:1, while 3.25 feet reverses the ratio. Actual slope-stake location must account for real ground intersection geometry.

93. A — For a 3H:1V slope, each foot of vertical difference corresponds to 3 feet horizontally. An 8-foot vertical change therefore requires 24 feet of horizontal run. Dividing by three reverses the ratio. In real slope staking, the catch point is solved where the design side slope intersects existing terrain, so irregular ground may require iteration rather than this simple case.

94. C — Tangent length for a simple circular curve is R tan(Delta/2). With R = 650 feet and Delta = 36 degrees, use 650 tan(18 degrees) to obtain the keyed distance. Arc length and long chord are different curve elements. This tangent distance is measured from the PI along the tangents to locate the PC and PT.

95. B — PT station is found by adding the curve arc length to the PC station. For radius 650 feet and central angle 36 degrees, the arc length is the previously computed curve length, not the tangent or chord. Add that length to station 52+40.00 after converting station notation to feet. This preserves stationing along the traveled alignment.

96. A — An equal-tangent vertical curve extends half its length on each side of the PVI. Half of 500 feet is 250 feet. Subtracting 250 from station 78+00 gives PVC 75+50, and adding 250 gives PVT 80+50. Grades affect elevations and curve shape, but not these endpoint station offsets for an equal-tangent curve.

97. A — The PVI lies 250 feet ahead of the PVC along the incoming +1.40% tangent. The tangent rises 0.014 x 250 = 3.50 feet from PVC to PVI, so subtract 3.50 feet from the PVI elevation. The PVC elevation is therefore the keyed value. Using the outgoing grade would apply the wrong tangent to the endpoint.

98. C — West corresponds to decreasing easting, so subtract the 14.75-foot offset from E 10,200.00. The stake easting is E 10,185.25 feet. Adding the offset would place the point east of the grid line. Construction coordinate work should preserve both the design sign convention and a field sketch or point description identifying the intended side of the grid.

99. B — Because both offsets are measured from the same control line in the same direction, actual spacing is the difference between them: 25.39 - 7.42 = 17.97 feet. The design spacing of 18.00 feet is the comparison value, not the measured result. Adding offsets would be appropriate only if the points were on opposite sides of the reference line.

100. D — As-built deviation defined as observed minus design is 398.69 - 398.62 = +0.07 foot. The positive sign means the constructed surface is high relative to design. Reversing the subtraction changes the sign and therefore the interpretation. Reporting the sign convention with as-built results is important so designers and contractors understand whether corrective work would require cutting or filling.