

FULL-LENGTH PRACTICE TESTS

PRACTICE TEST 13 – 100 QUESTIONS

1. What tissue produces the annual layers of wood visible as growth rings in a tree cross-section?
 - A. Cork cambium
 - B. Vascular cambium
 - C. Apical meristem
 - D. Pericycle

2. According to ANSI Z133, what is required before any tree work operations begin?
 - A. Equipment maintenance check
 - B. Client payment
 - C. Job hazard assessment
 - D. Permit acquisition

3. Loam soil is considered ideal for tree growth because it has what characteristic?
 - A. Balanced proportions of sand, silt, and clay
 - B. High clay content only
 - C. Pure sand composition
 - D. Maximum water retention

4. The retention of dead leaves on a tree through winter until pushed off by new spring growth is called what?

- A. Abscission
- B. Senescence
- C. Dormancy
- D. Marcescence

5. When using the three-cut method, what is the purpose of the second cut?

- A. To preserve the branch collar
- B. To create the final pruning cut
- C. To remove the bulk of the branch weight
- D. To prevent bark tearing

6. What pruning operation specifically removes lower branches to provide vertical clearance?

- A. Crown raising
- B. Crown thinning
- C. Crown reduction
- D. Crown cleaning

7. What soil property describes the percentage of pore space in a given volume of soil?

- A. Texture
- B. Porosity
- C. Cation exchange capacity
- D. Structure

8. Which CODIT wall is formed by new growth after wounding and is typically the strongest barrier?

- A. Wall 1
- B. Wall 2
- C. Wall 3
- D. Wall 4 (barrier zone)

9. Serpentine larval galleries beneath bark and D-shaped exit holes are characteristic signs of what invasive pest?

- A. Emerald ash borer
- B. Asian longhorned beetle
- C. Gypsy moth
- D. Bronze birch borer

10. What is the minimum diameter required for a climbing tie-in point according to industry standards?

- A. 2 inches of any wood
- B. 6 inches regardless of condition
- C. 4 inches of live, sound wood
- D. 3 inches of dead wood is acceptable

11. The process by which water evaporates from leaf surfaces, creating pull for water movement through xylem, is called what?

- A. Guttation
- B. Transpiration
- C. Root pressure
- D. Osmosis

12. What is the maximum recommended depth for mulch application around trees?

- A. 6-8 inches
- B. 8-12 inches
- C. As deep as available
- D. 2-4 inches

13. A leaf with leaflets arranged along both sides of a central axis (rachis) is classified as what type?

- A. Pinnately compound
- B. Palmately compound
- C. Simple
- D. Bipinnately compound

14. Oak wilt disease is caused by what type of pathogen?

- A. Bacterium
- B. Water mold
- C. Fungus
- D. Virus

15. What should be done if a climbing rope shows evidence of core damage during inspection?

- A. Continue use with extra caution
- B. Immediately retire the rope from climbing service
- C. Downgrade to rigging use only
- D. Mark the damaged section and avoid it

16. A support system using flexible cables installed in the upper crown to limit branch movement is called what?

- A. Bracing
- B. Guying
- C. Propping
- D. Cabling

17. What root tissue layer contains the Casparian strip that regulates entry into the vascular system?

- A. Epidermis
- B. Cortex
- C. Endodermis
- D. Pericycle

18. Which plant hormone is primarily produced in root tips and promotes cell division?

- A. Cytokinin
- B. Auxin
- C. Gibberellin
- D. Ethylene

19. A resistance drill (resistograph) measures what property of wood?

- A. Moisture content
- B. Age of the tree
- C. Species identification
- D. Relative density as the needle penetrates

20. Gall-forming insects cause damage by doing what?

- A. Tunneling through wood
- B. Inducing abnormal tissue growth that shelters the insect
- C. Consuming entire leaves
- D. Sucking phloem sap

21. Trees described as "good compartmentalizers" respond to wounding by doing what?

- A. Forming strong chemical and physical barriers against decay spread
- B. Producing abundant sap
- C. Rapid callus growth only
- D. Shedding affected branches

22. Bacterial leaf scorch is transmitted between trees primarily by what mechanism?

- A. Root grafts
- B. Wind-blown bacteria
- C. Xylem-feeding insects (leafhoppers, spittlebugs)
- D. Contaminated pruning tools

23. In tree risk assessment, what does "likelihood of failure" evaluate?

- A. Target occupancy
- B. Consequences of impact
- C. Cost of mitigation
- D. Probability that the tree or part will fail

24. Lenticels on bark function primarily for what purpose?

- A. Water absorption
- B. Gas exchange
- C. Photosynthesis
- D. Nutrient storage

25. A tree exhibiting sparse crown, small leaves, premature fall color, and progressive dieback over years is most likely experiencing what?

- A. Decline from chronic stress
- B. Acute viral infection
- C. Nutrient toxicity
- D. Normal aging process

26. The palisade mesophyll is the primary site of what process in leaves?

- A. Water storage
- B. Structural support
- C. Photosynthesis
- D. Gas exchange regulation

27. According to standard calculations, the minimum tree protection zone radius equals what?

- A. Half the crown spread
- B. Distance to the dripline
- C. 6 feet for all trees
- D. 1 foot per inch of trunk diameter

28. Interveinal chlorosis on the youngest leaves with veins remaining green indicates deficiency of what nutrient?

- A. Nitrogen
- B. Iron or manganese
- C. Phosphorus
- D. Potassium

29. Willows and poplars are examples of trees with what compartmentalization ability?

- A. Excellent compartmentalizers
- B. Moderate compartmentalizers
- C. Poor compartmentalizers
- D. Non-compartmentalizers

30. The most critical factor for successful tree establishment after transplanting is what?

- A. Adequate moisture for the limited root system
- B. Heavy fertilization
- C. Deep planting for stability
- D. Immediate structural pruning

31. What results when soil pore spaces are collapsed by heavy equipment or foot traffic?

- A. Improved drainage
- B. Enhanced root growth
- C. Increased aeration
- D. Compaction

32. A flush cut is problematic because it does what?

- A. Leaves too much stub
- B. Removes the branch collar and damages trunk tissue
- C. Prevents decay entry
- D. Creates an improper angle

33. Ectomycorrhizal fungi form what type of association with tree roots?

- A. External sheath (mantle) and growth between cells without penetrating cell walls
- B. Penetration into root cells
- C. Parasitic relationship
- D. No physical contact with roots

34. What percentage of live crown removal from a mature tree may cause stress and epicormic sprouting?

- A. Any amount
- B. More than 50%
- C. More than 25%
- D. More than 75% only

35. According to the 10-20-30 rule, no single family should represent more than what percentage of the urban forest?

- A. 10 percent
- B. 20 percent
- C. 25 percent
- D. 30 percent

36. What type of tree inventory estimates population characteristics using statistical sampling methods?

- A. Complete inventory
- B. Sample inventory
- C. Individual tree assessment
- D. Risk-based inventory

37. Mobile nutrients cause deficiency symptoms to appear on what part of the tree first?

- A. Older leaves
- B. Youngest leaves
- C. Bark
- D. Throughout the tree uniformly

38. For unqualified workers, what is the minimum approach distance from electrical conductors rated at 75 kV?

- A. 10 feet
- B. 10 feet plus 4 inches
- C. 11 feet (10 feet plus 10 inches for 25 kV above 50 kV threshold)
- D. 15 feet

39. What is the most common cause of stem-girdling roots in landscape trees?

- A. Genetic predisposition
- B. Excessive watering
- C. Disease infection
- D. Container production defects or planting too deeply

40. A tree with structural defects poses risk only when what other condition exists?

- A. The tree is mature
- B. A target is present within the potential failure zone
- C. The defect is visible
- D. The tree has been previously pruned

41. Phloem tissue transports what substances through the tree?

- A. Only water
- B. Only minerals
- C. Sugars and organic compounds
- D. Oxygen

42. What is the approximate establishment period for a 4-inch caliper transplanted tree?

- A. Approximately 4 years
- B. 6 months
- C. 2 weeks
- D. 1 year

43. Root damage on the north side of a tree will most likely cause decline symptoms to appear where?

- A. On the south side
- B. At the top of the tree
- C. Uniformly throughout
- D. On the north side of the crown

44. Fire blight disease affects trees in what plant family?

- A. Fagaceae (oak family)
- B. Rosaceae (rose family)
- C. Pinaceae (pine family)
- D. Betulaceae (birch family)

45. In the trunk formula method of tree appraisal, the basic value is determined by what?

- A. Trunk cross-sectional area multiplied by a unit cost
- B. Crown volume
- C. Species rarity
- D. Age of the tree

46. What level of tree risk assessment uses specialized diagnostic equipment?

- A. Limited visual assessment
- B. Windshield survey
- C. Advanced (Level 3) assessment
- D. Basic assessment

47. Before committing full weight to a tie-in point, what test should be performed?

- A. Visual inspection only
- B. Chemical analysis
- C. No testing required
- D. Load testing by gradually applying body weight

48. ANSI Z133 requires job briefings to include information about what?

- A. Equipment costs
- B. Hazards, work procedures, and emergency plans
- C. Marketing strategies
- D. Long-term contracts

49. The woundwood that grows over pruning cuts originates from what tissue?

- A. Heartwood
- B. Pith
- C. Cambium at wound margins
- D. Bark surface

50. What tool uses compressed air to remove soil without damaging tree roots?

- A. Air excavation (air spade)
- B. Mechanical trencher
- C. Hand shovel
- D. Hydraulic excavator

51. Why is species diversity important in urban forest management?

- A. Simplified maintenance
- B. Reduced costs
- C. Uniform appearance
- D. Protection against catastrophic pest and disease losses

52. When should guy wires be removed from a transplanted tree?

- A. Never
- B. After root establishment (typically 1-2 growing seasons)
- C. After 10 years
- D. After 5 years minimum

53. Crown thinning achieves what objective?

- A. Reduced tree height
- B. Increased crown density
- C. Reduced crown density while maintaining natural form
- D. Removal of lower branches

54. When trees close stomata during drought, what physiological consequence occurs?

- A. Reduced photosynthesis and carbohydrate production
- B. Increased water absorption
- C. Enhanced growth
- D. Improved pest resistance

55. Conservation biological control involves what approach?

- A. Importing exotic predators
- B. Applying microbial pesticides
- C. Eliminating all insects
- D. Protecting and enhancing existing natural enemy populations

56. The branch bark ridge is located at what position on a branch union?

- A. Below the branch
- B. At the top where branch and trunk bark meet
- C. At the branch tip
- D. Inside the branch

57. What factor determines whether a worker is "qualified" vs "unqualified" for work near electrical conductors?

- A. Specific training and authorization for line-clearance work
- B. Years of experience only
- C. Certification level only
- D. Personal choice

58. A reduction cut differs from a heading cut because reduction cuts are made to laterals of what minimum size?

- A. Any available size
- B. Equal to the removed branch
- C. At least one-third the diameter of the removed branch
- D. At least one-half the diameter

59. When should foliar (tissue) analysis be used instead of soil testing?

- A. To determine soil pH
- B. For routine annual testing
- C. To measure organic matter
- D. When soil tests show adequate nutrients but trees show deficiency symptoms

60. If climbing equipment becomes entangled, what is the proper response?

- A. Continue climbing
- B. Stop, secure position, and carefully untangle
- C. Cut the rope
- D. Descend immediately

61. Plant health care programs emphasize what primary approach?

- A. Prevention and maintaining overall plant health
- B. Reactive chemical applications
- C. Calendar-based treatments
- D. Removing stressed plants

62. Why are trunk wounds near the ground more structurally significant than wounds higher up?

- A. They are more visible
- B. They affect leaf production
- C. They compromise the structural foundation where loads transfer
- D. They heal slower

63. Earlywood cells produced in spring differ from latewood cells by having what characteristics?

- A. Thicker walls
- B. Smaller diameter
- C. Higher density
- D. Larger diameter with thinner walls

64. What is the best time to begin structural pruning of young trees?

- A. After maturity
- B. Early in development when corrections require small cuts
- C. Only after defects cause problems
- D. During decline

65. Powdery mildew diseases are caused by what type of organism?

- A. Bacteria
- B. Viruses
- C. Fungi
- D. Nematodes

66. What is the primary function of root hairs?

- A. Increase surface area for water and nutrient absorption
- B. Structural support
- C. Carbohydrate storage
- D. Hormone production

67. In risk assessment, what does a school bus stop beneath a tree with hanging dead branches represent?

- A. A minor concern
- B. A structural defect only
- C. An assessment limitation
- D. A high-occupancy target with vulnerable population

68. Excessive mulch depth (greater than 4-6 inches) causes what problems?

- A. Only improved appearance
- B. Bark decay, oxygen deprivation, and girdling root development
- C. Enhanced root growth
- D. Better water retention only

69. Deep planting of trees leads to what long-term problems?

- A. Trunk decay and development of girdling roots
- B. Improved stability
- C. Enhanced vigor
- D. Better drought tolerance

70. Sonic tomography creates images of internal tree condition using what method?

- A. X-ray radiation
- B. Chemical sampling
- C. Sound wave transmission analysis
- D. Visual assessment

71. What is the minimum lateral branch size for a proper reduction cut according to ANSI A300?

- A. One-quarter the removed branch diameter
- B. One-half the removed branch diameter
- C. Any size
- D. One-third the removed branch diameter

72. What pruning malpractice removes interior branches while leaving only foliage at branch ends?

- A. Crown cleaning
- B. Lion-tailing
- C. Crown reduction
- D. Crown raising

73. Why is preserving mature trees during development considered valuable?

- A. Only for simplified permits
- B. Reduced insurance rates
- C. Immediate environmental benefits not replaceable for decades
- D. Lower construction costs

74. What tree condition indicates that climbing should not proceed without further evaluation?

- A. Evidence of severe structural defects or basal decay
- B. Presence of lichen
- C. Previous pruning
- D. Minor deadwood

75. The feed control bar on a wood chipper serves what safety function?

- A. Adjusts chip size
- B. Increases feed speed
- C. Directs chip discharge
- D. Stops or reverses the feed mechanism when activated

76. Deficiency symptoms appearing on the oldest leaves first indicate the nutrient has what characteristic?

- A. Immobility
- B. Mobility (can translocate to new growth)
- C. Toxicity
- D. Abundance

77. What does the condition rating in tree appraisal evaluate?

- A. Tree health and structural integrity
- B. Species characteristics
- C. Location factors
- D. Age only

78. What is the fundamental difference between pollarding and topping?

- A. They are identical
- B. Topping is always appropriate
- C. Pollarding is planned ongoing management; topping is indiscriminate cutting
- D. Pollarding is more harmful

79. What factor most influences the rate at which trees close wounds?

- A. Wound dressing type
- B. Season of injury
- C. Wound shape
- D. Tree vigor and growth rate

80. What distinguishes sapwood from heartwood in terms of function?

- A. Heartwood conducts more water
- B. Sapwood contains living cells and conducts water
- C. They are functionally identical
- D. Sapwood is always darker

81. A basic tree risk assessment should evaluate what components?

- A. Only the trunk
- B. Only visible defects
- C. Crown, trunk, root zone, and target area
- D. Only the crown

82. A horizontal crack through a tree trunk indicates what condition?

- A. A serious structural defect with potential for imminent failure
- B. Normal growth pattern
- C. Minor cosmetic issue
- D. Improved strength

83. Air excavation tools remove soil using what medium?

- A. Water pressure
- B. Mechanical action
- C. Chemical treatment
- D. Compressed air that displaces soil without cutting roots

84. Reaction wood forms in response to what condition?

- A. Disease
- B. Non-vertical orientation or mechanical stress
- C. Drought
- D. Nutrient deficiency

85. When is fertilization most appropriate for established landscape trees?

- A. When testing confirms nutrient deficiency
- B. Every spring
- C. During drought
- D. Immediately after transplanting

86. A mushroom cluster at the base of a tree is classified as what type of diagnostic evidence?

- A. An environmental factor
- B. A symptom
- C. A sign (direct evidence of the pathogen)
- D. Normal occurrence

87. What rigging component controls the descent rate of pieces being lowered?

- A. Sling
- B. Choker
- C. Anchor point
- D. Friction device

88. The proper sequence for integrated pest management is what?

- A. Treat first, identify later
- B. Monitor, identify, threshold determination, tactic selection
- C. Calendar-based applications
- D. Remove all affected plants

89. Oak wilt is transmitted between non-root-grafted trees primarily by what?

- A. Wind
- B. Rain splash
- C. Insect vectors (nitidulid beetles) carrying spores to wounds
- D. Soil contamination

90. What root condition commonly develops in container-grown trees held too long?

- A. Circling and potentially girdling roots
- B. Deep taproot
- C. Improved root architecture
- D. Enhanced fibrous root development

91. Root collar excavation is performed to accomplish what?

- A. Add fertilizer
- B. Improve drainage
- C. Increase mulch depth
- D. Expose and assess the trunk-root transition zone

92. Higher specific gravity in wood indicates what property?

- A. Lower strength
- B. Greater density and strength
- C. Lighter weight
- D. More decay susceptibility

93. What must be done before climbing any tree for work?

- A. Pre-climb safety assessment for hazards
- B. Financial appraisal
- C. Inventory documentation
- D. Marketing evaluation

94. Tree protection fencing should be installed at what point in a construction project?

- A. After grading
- B. When problems appear
- C. Before any construction activity begins
- D. At project completion

95. Action thresholds in IPM define what?

- A. Maximum chemical rates
- B. Cost limits
- C. Calendar dates
- D. Pest levels at which treatment is justified

96. How often should lightning protection systems be inspected?

- A. Every 10 years
- B. Annually and after lightning events
- C. Never after installation
- D. Monthly

97. What is the minimum inspection frequency for cable and brace support systems?

- A. Every 5 years
- B. Monthly
- C. Annually and after major storms
- D. Only when problems are visible

98. Crown raising is performed to accomplish what objective?

- A. Provide vertical clearance beneath the crown
- B. Reduce crown density
- C. Remove dead branches
- D. Reduce tree height

99. Nitrogen-fixing bacteria form associations with trees in what plant family?

- A. Pinaceae
- B. Rosaceae
- C. Fagaceae
- D. Fabaceae (legumes)

100. In tree risk assessment, "likelihood of impact" evaluates what?

- A. Failure probability
- B. Probability that failure will strike the target
- C. Consequence severity
- D. Tree species

PRACTICE TEST 13: ANSWER KEY

WITH EXPLANATIONS

1. **B. Vascular cambium** - The vascular cambium is a thin cylindrical layer of meristematic cells located between the bark and wood. Each growing season, it produces new xylem (wood) cells toward the inside and new phloem cells toward the outside. In temperate climates, the contrast between large spring cells (earlywood) and smaller summer cells (latewood) creates the visible annual growth rings. Counting these rings provides tree age, while ring width indicates growing conditions during each year.
2. **C. Job hazard assessment** - ANSI Z133 requires that before any tree work operations begin, a thorough job hazard assessment must be conducted to identify potential dangers. This assessment includes evaluating tree condition, electrical hazards, traffic, bystanders, terrain, weather conditions, and any site-specific hazards. The assessment informs work planning, equipment selection, personal protective equipment requirements, and emergency procedures. Beginning work without proper hazard assessment violates safety standards and puts workers at unnecessary risk.
3. **A. Balanced proportions of sand, silt, and clay** - Loam soil contains roughly balanced proportions of sand, silt, and clay particles, combining the beneficial properties of each. Sand provides drainage and aeration; silt contributes to water retention and nutrient availability; clay offers nutrient-holding capacity through cation exchange. This balance creates ideal conditions for root growth with adequate drainage, moisture retention, aeration, and nutrient availability that pure sand or clay soils cannot provide.
4. **D. Marcescence** - Marcescence is the retention of dead leaves on the tree through winter, with leaves eventually falling in spring when pushed off by expanding buds. This phenomenon is common in American beech, some oaks (particularly young trees and lower branches), and hornbeam. The evolutionary advantage is debated—theories include protection of buds from browsing animals, snow capture for spring moisture, and delayed nutrient cycling. Marcescence differs from normal deciduous leaf drop (abscission).
5. **C. To remove the bulk of the branch weight** - The second cut in the three-cut method is made from the top, several inches farther from the trunk than the undercut. When this cut reaches the undercut, the branch falls safely, removing most of the branch weight. The undercut prevents bark tearing as the branch falls. With the heavy branch removed, the final (third) cut can be made carefully just outside the branch collar without risk of the branch tearing bark as it falls.

6. **A. Crown raising** - Crown raising (also called crown lifting or raising) is the selective removal of lower branches to increase vertical clearance beneath the tree canopy. This is commonly performed for pedestrian passage, vehicle clearance, sight lines, mowing access, or building clearance. Crown raising should be accomplished gradually on young trees through training rather than removing large lower limbs from mature trees, which creates significant wounds and removes substantial photosynthetic capacity.
7. **B. Porosity** - Soil porosity is the percentage of total soil volume occupied by pore spaces (voids between solid particles). These pores contain the air and water essential for root function. Ideal soil has approximately 50% solid particles and 50% pore space. Compaction reduces porosity by collapsing pore spaces, directly limiting air and water availability for roots. Different pore sizes serve different functions—large pores drain freely (providing aeration), while small pores retain water.
8. **D. Wall 4 (barrier zone)** - In the CODIT (Compartmentalization of Decay in Trees) model, Wall 4 is the barrier zone formed by new wood produced by the cambium after wounding occurs. This wall is typically the strongest because it is composed entirely of new tissue with specialized chemical and physical properties specifically designed to resist decay spread. Its strength depends heavily on tree vigor at the time of wounding—vigorous trees produce stronger Wall 4 barriers than stressed trees.
9. **A. Emerald ash borer** - The emerald ash borer (*Agilus planipennis*) creates distinctive serpentine (S-shaped) larval galleries as larvae feed on phloem and outer sapwood beneath ash bark. Adult beetles create D-shaped exit holes approximately 1/8 inch (3-4 mm) wide when emerging. These diagnostic signs distinguish EAB from other borers. Since its discovery in Michigan in 2002, EAB has killed hundreds of millions of ash trees and continues spreading, fundamentally changing North American forests and urban landscapes.
10. **C. 4 inches of live, sound wood** - Safe climbing tie-in points require live, healthy branches at least 4 inches in diameter at the attachment point with sound connection to the parent stem. The branch must be free of decay, cracks, included bark, and other structural defects. Dead branches should never serve as primary tie-in points regardless of diameter because they may fail without warning. Load testing by pulling firmly before committing full weight helps verify anchor integrity.
11. **B. Transpiration** - Transpiration is the evaporation of water from leaf surfaces, primarily through stomata. This water loss creates negative pressure (tension) in leaf cells that pulls water upward through continuous columns in xylem vessels—the cohesion-tension mechanism. Transpiration is the primary driving force for water movement from roots to leaves, capable of lifting water over 300 feet in tall trees. It also cools leaves and drives nutrient transport from soil.
12. **D. 2-4 inches** - Proper mulch depth is 2-4 inches for optimal benefits without negative effects. This depth effectively conserves soil moisture, moderates temperature extremes, suppresses weeds, and improves soil as it decomposes. Shallower applications provide inadequate benefits;

deeper mulch (greater than 4-6 inches) can cause oxygen deprivation at root surfaces, excessive moisture against bark, rodent habitat, and stem-girdling root development. Proper depth is critical.

13. **A. Pinnately compound** - Pinnately compound leaves have multiple leaflets arranged along both sides of a central axis called the rachis, resembling a feather pattern. Common examples include ash, walnut, hickory, black locust, and sumac. This differs from palmately compound leaves where leaflets radiate from a single point (like buckeye) and from bipinnately compound leaves where the primary divisions are themselves divided (like honeylocust).
14. **C. Fungus** - Oak wilt is caused by the fungus *Bretziella fagacearum* (formerly *Ceratocystis fagacearum*). This vascular pathogen colonizes xylem vessels, blocking water transport and producing toxins. The disease spreads locally through root grafts between adjacent oaks and over longer distances via nitidulid beetles carrying spores from fungal mats on infected trees to fresh wounds on healthy trees. Red oak group species are highly susceptible and often die within weeks; white oaks are more resistant.
15. **B. Immediately retire the rope from climbing service** - Any climbing rope showing evidence of core damage (felt as soft spots, lumps, or inconsistent stiffness), significant sheath wear exposing the core, chemical contamination, heat damage, or shock loading must be immediately retired from life-safety use. Rope failure during climbing can be catastrophic. There is no safe way to continue using a damaged rope—it cannot be repaired, downgraded, or used with caution. When in doubt, retire the rope.
16. **D. Cabling** - Cabling involves installing flexible steel cables in the upper crown to limit the movement of branches or codominant stems relative to each other. Cables reduce the likelihood of failure during wind or ice loading by limiting excessive movement. Standard cables use fixed end connections; dynamic (shock-absorbing) systems allow some movement before engaging. Cabling is often combined with bracing (rigid rods at the attachment point) for comprehensive support of weak unions.
17. **C. Endodermis** - The endodermis is a single layer of cells surrounding the vascular tissue in roots. The Casparian strip—a band of waxy suberin in endodermal cell walls—forces water and dissolved minerals to pass through endodermal cell membranes rather than flowing passively between cells. This checkpoint allows the plant to selectively regulate what enters the vascular system, potentially excluding harmful substances while admitting beneficial nutrients.
18. **A. Cytokinin** - Cytokinins are plant hormones produced primarily in root tips that promote cell division (cytokinesis), delay leaf senescence, and stimulate lateral bud growth. They are transported upward through the xylem to the crown. Cytokinins work antagonistically with auxins in many developmental processes. When root damage reduces cytokinin production, crown health often declines, demonstrating the importance of root-shoot hormone signaling.
19. **D. Relative density as the needle penetrates** - A resistograph (resistance drill) measures the force required to advance a thin needle through wood, recording a profile of relative wood density along

the drilling path. Sound wood offers consistent high resistance; decayed or deteriorated wood shows reduced resistance appearing as valleys on the profile. This tool provides quantitative data about decay location, extent, and residual wall thickness to inform management decisions about trees with suspected internal defects.

20. **B. Inducing abnormal tissue growth that shelters the insect** - Gall-forming insects (certain wasps, midges, aphids, and others) inject chemicals that cause the plant to produce abnormal tissue growths (galls) that shelter and nourish the developing insect. Galls vary widely in appearance depending on the insect species and host plant. While often conspicuous and concerning to tree owners, most galls cause minimal harm to overall tree health. Each gall-forming species typically attacks specific host plants.
21. **A. Forming strong chemical and physical barriers against decay spread** - Good compartmentalizers effectively wall off wounded and decaying tissue through strong chemical barriers (phenolics, tannins, other antimicrobial compounds) and physical barriers (modified cell walls, tyloses). Species like oaks, beeches, and hickories typically compartmentalize well, limiting decay spread from wounds. This genetic capability is enhanced by tree vigor—healthy trees of good-compartmentalizing species respond most effectively.
22. **C. Xylem-feeding insects (leafhoppers, spittlebugs)** - Bacterial leaf scorch, caused by *Xylella fastidiosa*, is transmitted by xylem-feeding insects including leafhoppers, spittlebugs, and sharpshooters. These insects acquire the bacteria while feeding on infected plants and transmit it to healthy plants during subsequent feeding. The bacteria colonize and block xylem vessels, causing the characteristic marginal leaf scorch symptoms. There is no cure; management focuses on stress reduction and vector control.
23. **D. Probability that the tree or part will fail** - Likelihood of failure in tree risk assessment evaluates the probability that a tree or tree part will fail based on the presence and severity of structural defects, the tree's exposure to loading forces (wind, ice, saturated soil), species-specific failure characteristics, and tree size. This assessment considers visible defects, their progression, and environmental factors that could trigger failure. It is one of three components of overall risk rating.
24. **B. Gas exchange** - Lenticels are specialized porous areas in bark that allow gas exchange between living cells inside the tree and the external atmosphere. They appear as raised dots, lines, or corky patches on bark surfaces. As bark develops and replaces the epidermis, lenticels provide the pathway for oxygen to reach living cells and for carbon dioxide to escape. Some species (cherries, birches) have very prominent lenticels useful for identification.
25. **A. Decline from chronic stress** - Progressive symptoms developing over multiple years—sparse crown, small leaves, premature fall color, reduced growth, twig dieback—characterize tree decline from chronic stress. Decline typically results from accumulated stresses: soil compaction, restricted rooting space, grade changes, repeated drought, root damage, pollution, or multiple

interacting factors. Unlike acute problems with rapid onset, decline develops gradually and is often irreversible once advanced.

26. **C. Photosynthesis** - The palisade mesophyll consists of columnar cells tightly packed beneath the upper epidermis, oriented to maximize light capture. These cells contain abundant chloroplasts and are the primary site of photosynthesis in most leaves. Their elongated shape and perpendicular orientation to the leaf surface optimize exposure of chlorophyll to incoming light, while their position near the upper surface captures maximum light intensity.
27. **D. 1 foot per inch of trunk diameter** - The standard critical root zone (CRZ) or tree protection zone (TPZ) calculation is 1 foot radius per inch of trunk diameter (DBH). This encompasses most roots critical for tree survival. However, this is a minimum—larger zones may be appropriate based on species sensitivity, root distribution patterns, tree value, or site conditions. Protection zones should be physically fenced before construction begins.
28. **B. Iron or manganese** - Interveinal chlorosis (yellowing between veins while veins remain green) on the youngest leaves is the classic symptom of iron or manganese deficiency. These nutrients are immobile in plants—they cannot be translocated from older leaves to support new growth. When deficient, developing leaves show symptoms first. Deficiency often results from high soil pH making these nutrients chemically unavailable rather than their actual absence from soil.
29. **C. Poor compartmentalizers** - Willows and poplars are examples of poor compartmentalizers—species that form weak chemical and physical barriers after wounding, allowing decay to spread extensively. This genetic characteristic means wounds on these species often result in significant internal decay. Understanding compartmentalization ability helps predict wound response and guides management decisions—smaller cuts and careful wound placement are especially important on poor compartmentalizers.
30. **A. Adequate moisture for the limited root system** - Transplanting removes 90-95% of a tree's root system while the crown remains largely intact, creating severe imbalance between water demand and supply. The most critical factor for successful establishment is maintaining adequate moisture in the root ball until new roots grow into surrounding soil (typically 1-3 years depending on size). Without consistent moisture, the limited root system cannot meet the crown's transpiration demands.
31. **D. Compaction** - Soil compaction occurs when heavy equipment, repeated foot traffic, or other forces collapse pore spaces between soil particles. This dramatically reduces porosity, limiting air and water infiltration and physically impeding root penetration. Compaction is one of the most common and serious causes of tree stress in urban environments and construction sites. Prevention through effective protection is far easier than remediation after compaction occurs.
32. **B. Removes the branch collar and damages trunk tissue** - Flush cuts remove the branch collar—the swollen area at the branch base containing specialized tissue for compartmentalization and wound closure. Without the collar, the trunk tissue is directly wounded, compartmentalization is

compromised, and the wound cannot close properly. Flush cuts were once standard practice but research has conclusively shown they cause more harm than cuts that preserve the collar.

33. **A. External sheath (mantle) and growth between cells without penetrating cell walls** - Ectomycorrhizal fungi form a visible sheath (mantle) around root tips and grow between root cortex cells forming the Hartig net, but they do not penetrate root cell walls. This association is common in temperate forest trees including oaks, pines, birches, and beeches. The fungal network dramatically extends absorptive capacity for water and nutrients, especially phosphorus, while the tree provides carbohydrates to the fungus.
34. **C. More than 25%** - Removing more than 25% of live crown from a mature tree may cause significant stress, including depleted energy reserves, reduced photosynthetic capacity, and stimulation of epicormic sprouting (water sprouts with weak attachments). Young, vigorously growing trees may tolerate somewhat more removal, but mature trees have less capacity to recover. Over-pruning is a common cause of tree decline and increased hazard from weakly attached regrowth.
35. **D. 30 percent** - The 10-20-30 diversity guideline recommends that no single family comprise more than 30% of the urban forest. Combined with species limits (10%) and genus limits (20%), this multi-level approach provides comprehensive protection against threats at various taxonomic levels. Family-level limits protect against potential threats that might affect multiple genera within a family, though such broad threats are less common than species or genus-specific problems.
36. **B. Sample inventory** - Sample inventories collect data from statistically selected plots or transects and use statistical methods to estimate population characteristics (species composition, size distribution, condition) without documenting every individual tree. This approach is cost-effective for large areas where complete inventories would be prohibitively expensive. Sample inventories provide data for population-level planning but cannot generate specific work orders for individual trees.
37. **A. Older leaves** - Mobile nutrients (nitrogen, phosphorus, potassium, magnesium) can be translocated from older tissue to support new growth. When these nutrients are deficient, the plant moves existing supplies from older leaves to developing leaves, causing deficiency symptoms to appear on older leaves first. Understanding nutrient mobility helps diagnose specific deficiencies based on symptom distribution within the crown.
38. **C. 11 feet (10 feet plus 10 inches for 25 kV above 50 kV threshold)** - For voltages above 50 kV, the minimum approach distance increases by 4 inches for each additional 10 kV. At 75 kV (25 kV above the 50 kV threshold), the increase is 10 inches (4 inches \times 2.5, rounded). The total minimum distance is 10 feet plus 10 inches, which equals 10 feet 10 inches, rounded to 11 feet for practical application. Precise calculations ensure adequate safety margins.
39. **D. Container production defects or planting too deeply** - Stem-girdling roots most commonly develop from circling roots in containers that continue their circular growth pattern after planting,

or from trees planted too deeply which encourages adventitious roots that may grow tangentially around the trunk. These roots gradually enlarge and compress the trunk, restricting vascular flow. Prevention through proper nursery practices and correct planting depth is far easier than treatment.

40. **B. A target is present within the potential failure zone** - Tree risk requires both a potential for failure (structural defects) AND a target that could be harmed within the zone where failure could occur. Without a target, there is no risk regardless of defect severity. A severely defective tree in a remote location with no people, property, or activities has no risk rating. Risk assessment resources should focus on situations where failure would actually cause harm.
41. **C. Sugars and organic compounds** - Phloem tissue transports sugars (primarily sucrose) produced during photosynthesis, along with amino acids, hormones, and other organic compounds. Transport occurs through sieve tube elements via the pressure flow mechanism—sugars loaded at sources (mature leaves) create osmotic pressure that pushes the solution toward sinks (roots, fruits, growing points). Phloem is located just inside the bark, making it vulnerable to girdling injury.
42. **A. Approximately 4 years** - A general guideline for establishment is approximately one year per inch of trunk caliper. A 4-inch caliper tree would require approximately 4 years for roots to grow sufficiently into surrounding soil to meet the crown's water demands without supplemental irrigation. During this period, regular watering focused on the root ball is essential. Larger trees require proportionally longer establishment periods.
43. **D. On the north side of the crown** - Root damage affects the crown portion supplied by those specific roots due to vascular connections between root sectors and crown sections. Roots on the north side supply crown portions on the north side; when these roots are damaged, the corresponding crown section shows decline symptoms (wilting, scorch, reduced growth, dieback) while other portions may remain healthier. This diagnostic pattern helps identify root damage locations.
44. **B. Rosaceae (rose family)** - Fire blight, caused by the bacterium *Erwinia amylovora*, affects trees and shrubs in the rose family (Rosaceae) including apple, pear, crabapple, hawthorn, mountain ash, serviceberry, and ornamental *Prunus* species. The disease causes rapid wilting and blackening of shoots that appear scorched, often with characteristic shepherd's crook bending. Fire blight spreads rapidly during warm, wet weather, especially during bloom.
45. **A. Trunk cross-sectional area multiplied by a unit cost** - In the trunk formula method, basic value is calculated by determining trunk cross-sectional area (derived from DBH measurement) and multiplying by a per-square-inch unit cost determined from regional nursery stock prices. This basic value represents the theoretical cost to replace the trunk at nursery prices and is then adjusted by species rating, condition rating, and location rating to determine final appraised value.
46. **C. Advanced (Level 3) assessment** - Advanced assessment (Level 3 in the ANSI A300 framework) uses specialized diagnostic equipment such as resistance drills, sonic tomographs, aerial inspection, or root crown excavation to evaluate conditions that cannot be determined

through visual examination alone. This level is appropriate when internal decay is suspected but extent is unknown, or when detailed quantitative data is needed for high-value trees or critical management decisions.

47. **D. Load testing by gradually applying body weight** - Before trusting a tie-in point with full weight and dynamic climbing loads, load testing helps verify its integrity. Apply body weight gradually while observing and listening for any movement, cracking sounds, or visual changes indicating weakness. If any concern arises during testing, immediately select a different anchor point. Visual inspection alone may miss internal defects that loading can reveal.
48. **B. Hazards, work procedures, and emergency plans** - ANSI Z133 requires job briefings before tree work to communicate specific hazards identified at the site, work procedures and sequence, individual responsibilities, communication protocols, and emergency procedures including rescue plans. Briefings should be repeated when conditions change significantly. Effective communication before and during work prevents incidents resulting from misunderstanding or incomplete information.
49. **C. Cambium at wound margins** - Woundwood (callus) is produced by the vascular cambium at wound margins. Cambial cells around wound edges divide and produce new tissue that gradually rolls over the wound surface from edges toward the center. Trees do not regenerate lost tissue or truly heal—they compartmentalize damage and grow over it. Callus production rate depends on tree vigor; vigorous trees close wounds faster.
50. **A. Air excavation (air spade)** - Air excavation tools use high-pressure compressed air to displace soil particles without cutting roots. This technology enables root examination, root collar investigation, careful work in root zones, and girdling root treatment while minimizing the root damage that would occur with mechanical excavation. The ability to expose roots without severing them has expanded options for tree preservation and diagnostic capabilities.
51. **D. Protection against catastrophic pest and disease losses** - Species diversity protects urban forests from devastating losses when species-specific threats arrive. The loss of American chestnut, American elm, and ash to pests and diseases demonstrates how low-diversity forests are vulnerable. Diversity ensures no single pest or disease can eliminate more than a limited portion of the urban forest, maintaining overall canopy cover and ecosystem services.
52. **B. After root establishment (typically 1-2 growing seasons)** - Guy wires and stakes should remain only until roots establish sufficiently to anchor the tree independently—typically 1-2 growing seasons for most transplants. Leaving support longer prevents proper trunk development (trunk strengthening requires wind movement), creates potential for girdling as the tree grows against support materials, and may allow hardware to become embedded in expanding bark.
53. **C. Reduced crown density while maintaining natural form** - Crown thinning selectively removes branches throughout the crown to reduce density (number of branches and foliage) while maintaining the tree's natural shape and size. Benefits include improved light penetration, reduced

wind resistance, and decreased weight on branch unions. Thinning should be distributed throughout the crown rather than concentrated in any area, and should use thinning cuts (removal at point of origin).

54. **A. Reduced photosynthesis and carbohydrate production** - When stomata close during drought to conserve water, carbon dioxide cannot enter leaves for photosynthesis. With photosynthesis reduced or stopped, the tree cannot produce carbohydrates to maintain functions and must draw on stored reserves. Prolonged stomatal closure depletes reserves, reducing growth, weakening defenses, and potentially causing decline that persists even after drought ends.
55. **D. Protecting and enhancing existing natural enemy populations** - Conservation biological control involves protecting, enhancing, and maintaining populations of natural enemies already present in the environment. Techniques include providing habitat (flowering plants for adult parasitoids), avoiding broad-spectrum pesticides that kill beneficial insects, and maintaining diverse plantings. This sustainable approach forms the foundation of ecologically sound pest management programs.
56. **B. At the top where branch and trunk bark meet** - The branch bark ridge is a raised line of bark at the top of a branch attachment where branch and trunk bark meet and turn inward. It indicates where the pruning cut should begin—starting just above the ridge and angling down and away from the trunk. The ridge helps identify proper cut placement; cutting through it damages trunk tissue while cutting too far away leaves a stub.
57. **A. Specific training and authorization for line-clearance work** - "Qualified" workers for electrical hazard purposes have received specific training in working near energized conductors and are authorized by their employer for such work. This training covers hazard recognition, safe approach distances, emergency procedures, and specialized techniques. Unqualified workers (those without this specific training) must maintain greater distances from conductors regardless of their general experience or certifications.
58. **C. At least one-third the diameter of the removed branch** - ANSI A300 specifies that reduction cuts must be made to lateral branches at least one-third the diameter of the branch being removed. Laterals of this size can assume the terminal role and continue growth without excessive sprouting. Heading cuts (to smaller laterals or random points) stimulate multiple weakly attached sprouts, creating structural problems and ongoing maintenance needs.
59. **D. When soil tests show adequate nutrients but trees show deficiency symptoms** - Foliar (tissue) analysis is particularly valuable when soil tests indicate adequate nutrients but trees display deficiency symptoms. This situation suggests nutrients are present in soil but unavailable (often due to pH) or that root dysfunction prevents uptake. Tissue analysis reveals what the tree has actually absorbed, identifying whether the problem is soil chemistry, root health, or other factors.
60. **B. Stop, secure position, and carefully untangle** - If climbing equipment becomes entangled, stop immediately and secure your position before attempting to resolve the problem. Continuing

to climb with entangled equipment creates unpredictable tensions and movement restrictions. Take time to carefully identify the source of entanglement and resolve it systematically before proceeding. Rushing increases risk of making the situation worse.

61. **A. Prevention and maintaining overall plant health** - Plant health care programs emphasize proactive health maintenance over reactive pest treatment. Healthy, vigorous plants naturally resist and tolerate pest pressure better than stressed plants. PHC integrates proper cultural practices (appropriate watering, mulching, soil management), regular monitoring, accurate diagnosis, and intervention only when thresholds are exceeded, typically reducing pesticide use while improving outcomes.
62. **C. They compromise the structural foundation where loads transfer** - The trunk base is where all above-ground weight and wind loads transfer to the root system. Decay or damage at this location compromises the structural foundation and can lead to complete tree failure. A wound of given size at the base affects a greater percentage of the tree's load-bearing capacity than the same wound higher where the trunk may be larger and loads are distributed differently.
63. **D. Larger diameter with thinner walls** - Earlywood (springwood) is produced early in the growing season when conditions favor rapid growth. These cells are larger in diameter with thinner walls, optimizing water transport capacity when demand is high. Latewood (summerwood) produced later has smaller cells with thicker walls, providing more structural strength. This alternation creates visible annual rings used for age determination.
64. **B. Early in development when corrections require small cuts** - Structural pruning is most effective when started early because corrections require only small cuts that close quickly with minimal stress. Removing a 1-inch competing leader causes far less harm than removing a 6-inch codominant stem later. Early intervention shapes growth before defects become serious structural problems. Regular evaluation and training during the first 10-15 years establishes lifelong structure.
65. **C. Fungi** - Powdery mildew diseases are caused by various fungal species that produce characteristic white, powdery growth on leaf surfaces consisting of mycelium and spores. Unlike most fungi, powdery mildews thrive in dry conditions with high humidity (but not leaf wetness). While unsightly and sometimes causing leaf distortion, powdery mildew rarely causes serious harm to established trees.
66. **A. Increase surface area for water and nutrient absorption** - Root hairs are tubular extensions of epidermal cells on young roots that dramatically increase surface area for absorption—5-20 times compared to roots without hairs. A single root system may have billions of root hairs. They are extremely fragile, short-lived (days to weeks), and continuously replaced as roots grow. Their loss during transplanting explains the need for careful post-transplant water management.
67. **D. A high-occupancy target with vulnerable population** - A school bus stop represents a high-occupancy target where particularly vulnerable people (children) regularly gather. Target

assessment considers type (people vs. property), occupancy rate (frequency and duration of use), and vulnerability (children are more vulnerable than adults). High-occupancy targets with vulnerable occupants require especially careful risk management and may justify more aggressive mitigation measures.

68. **B. Bark decay, oxygen deprivation, and girdling root development** - Excessive mulch depth creates multiple serious problems: reduced oxygen at root surfaces impairs root function; constant moisture against bark promotes decay; warm moist conditions attract bark-gnawing rodents; and roots growing into the mulch layer may develop as girdling roots. Proper mulch depth (2-4 inches) provides benefits without these harmful effects.
69. **A. Trunk decay and development of girdling roots** - Trees planted too deeply have trunk bark in prolonged contact with moist soil, promoting bark decay that can progress into wood. Additionally, buried trunks often produce adventitious roots that grow tangentially, eventually girdling the trunk or major roots. These problems develop gradually over years or decades, making deep planting a hidden cause of later decline.
70. **C. Sound wave transmission analysis** - Sonic tomography uses the transmission of sound waves between multiple sensors placed around the trunk to create cross-sectional images of internal wood condition. Sound travels faster through solid wood and slower through decayed or hollow areas. By analyzing transmission times between sensor pairs, software generates images showing decay location and extent. This non-destructive technique complements other assessment methods.
71. **D. One-third the removed branch diameter** - ANSI A300 specifies that reduction cuts should be made to lateral branches at least one-third the diameter of the branch being removed. Laterals of this minimum size can assume the terminal role and continue growth in the same general direction without stimulating excessive sprouting. Cuts to smaller laterals function more like heading cuts, producing multiple weakly attached sprouts.
72. **B. Lion-tailing** - Lion-tailing is the improper removal of interior branches while leaving foliage only at branch ends, creating a "lion's tail" appearance. This concentrates weight at tips, creating lever-arm forces that stress branch unions. It removes damping foliage that normally slows branch movement in wind and exposes previously shaded bark to sunscald. Lion-tailing increases failure risk and is considered a pruning malpractice.
73. **C. Immediate environmental benefits not replaceable for decades** - Mature trees provide substantial immediate benefits—shade, energy savings, stormwater management, air quality improvement, wildlife habitat, aesthetic value—that newly planted trees cannot match for 20-50+ years. A single mature tree may provide hundreds of dollars in annual environmental benefits. These values cannot be replaced on any practical timeline, making preservation planning essential during development.
74. **A. Evidence of severe structural defects or basal decay** - Trees showing evidence of severe structural problems (extensive basal decay, horizontal cracks, recent lean with root plate

movement, active structural failure) should not be climbed until alternative assessment determines whether they can safely support climbing loads. The dynamic forces of climbing could trigger failure in compromised trees. Alternative access or ground-based assessment may be necessary.

75. **D. Stops or reverses the feed mechanism when activated** - The feed control bar is a critical safety device positioned across the chipper feed opening that stops or reverses the feed mechanism when pushed. If entanglement begins, pushing this bar may halt feed before the operator is pulled further into the machine. This device must be tested before each use and never disabled. Despite this safety feature, proper operating procedures remain essential.
76. **B. Mobility (can translocate to new growth)** - Mobile nutrients (nitrogen, phosphorus, potassium, magnesium) can be moved from older tissue to support new growth. When deficient, the plant translocates existing supplies from older leaves to developing leaves, causing symptoms to appear on older leaves first. This symptom pattern helps diagnose specific deficiencies and distinguishes mobile from immobile nutrient deficiencies.
77. **A. Tree health and structural integrity** - The condition rating in tree appraisal evaluates overall health (crown density, leaf size and color, growth rate, decline symptoms) and structural integrity (absence of decay, cracks, weak attachments, codominant stems). Trees in excellent condition receive 100%; significant problems reduce the rating proportionally. This factor substantially impacts final appraised value—a tree with 50% condition rating is worth only half what an identical healthy tree would be worth.
78. **C. Pollarding is planned ongoing management; topping is indiscriminate cutting** - Pollarding is a traditional practice of repeatedly removing all new growth back to permanent scaffold branches on a regular cycle, initiated on young trees and maintained consistently. It's a planned management system creating distinctive forms. Topping is typically indiscriminate cutting of mature trees without plans for ongoing management, creating serious structural problems, decay, and weakly attached regrowth.
79. **D. Tree vigor and growth rate** - Wound closure rate correlates directly with annual radial growth rate because callus is produced by cambial activity at wound margins. A vigorous tree producing substantial annual growth closes wounds faster than a stressed or slow-growing tree. This relationship explains why maintaining tree health is critical when wounding is unavoidable and why wounds on declining trees may remain permanently open.
80. **B. Sapwood contains living cells and conducts water** - Sapwood is the outer portion of wood containing living parenchyma cells and functional xylem vessels that actively conduct water. As trees grow, older sapwood gradually converts to heartwood through cell death and extractive accumulation. Heartwood no longer conducts water or contains living cells but provides structural support and often resists decay better than sapwood due to accumulated extractives.
81. **C. Crown, trunk, root zone, and target area** - A thorough basic risk assessment systematically evaluates all tree parts that could fail (crown for dead branches and weak attachments, trunk for

cracks and decay, root zone for stability indicators and defects) plus the area around the tree to identify targets and assess consequences. Limiting assessment to any single zone potentially misses critical information needed for accurate risk rating.

82. **A. A serious structural defect with potential for imminent failure** - Horizontal cracks through the trunk indicate the trunk is actively separating—structural failure in progress. Unlike vertical cracks that may be relatively stable, horizontal cracks indicate shear failure. Movement visible when the tree sways confirms severity. Such trees typically require immediate mitigation. This is among the most serious defects encountered in tree risk assessment.
83. **D. Compressed air that displaces soil without cutting roots** - Air excavation tools use high-pressure compressed air to blow soil particles apart and away from roots without cutting them. This allows root examination, root collar investigation, trenching in root zones, and girdling root treatment while minimizing the damage that mechanical excavation would cause. This technology has expanded options for tree preservation and improved diagnostic capabilities.
84. **B. Non-vertical orientation or mechanical stress** - Reaction wood is specialized wood formed in response to non-vertical orientation (lean) or mechanical stress, helping trees maintain or regain upright position. In hardwoods, tension wood forms on the upper side of leaning stems, pulling upward. In conifers, compression wood forms on the lower side, pushing upward. Reaction wood has different properties than normal wood.
85. **A. When testing confirms nutrient deficiency** - Fertilization is most beneficial when actual nutrient deficiencies limit health or growth. Soil or tissue testing identifies whether deficiencies exist and which nutrients are needed. Fertilizing without confirmed need wastes resources, may harm trees (excess nitrogen promotes succulent growth susceptible to pests), and can pollute water. Most established trees in reasonably healthy landscapes do not require regular fertilization.
86. **C. A sign (direct evidence of the pathogen)** - Fungal fruiting bodies (mushrooms, conks, brackets) are reproductive structures of fungi—direct evidence of the organism itself, making them "signs" of disease rather than "symptoms" (which are plant responses). Mushroom clusters at tree bases often indicate root rot fungi like *Armillaria*. Finding a conk indicates established decay; determining significance requires assessing extent and structural implications.
87. **D. Friction device** - Friction devices (Port-a-wrap, rigging wrench, rope wrapped around posts or bollards) allow ground personnel to control descent rate by applying friction to the lowering line. Proper friction management enables smooth, controlled lowering; insufficient friction allows dangerous uncontrolled descent with shock loading potential. The person controlling the friction device has critical responsibility for safe rigging operations.
88. **B. Monitor, identify, threshold determination, tactic selection** - Integrated pest management follows a systematic decision process: (1) regular monitoring detects pest presence, (2) accurate identification ensures appropriate response, (3) action thresholds determine whether intervention

is justified, and (4) appropriate tactics are selected based on effectiveness, cost, and environmental impact. This prevents unnecessary treatment while ensuring effective response when warranted.

89. **C. Insect vectors (nitidulid beetles) carrying spores to wounds** - Oak wilt spreads between trees not connected by root grafts primarily via nitidulid (sap-feeding) beetles that carry fungal spores from mats on infected trees to fresh wounds on healthy trees. These beetles are most active in spring and early summer, which is why oak pruning is discouraged April-July in oak wilt areas. Root grafts spread disease between adjacent connected oaks.
90. **A. Circling and potentially girdling roots** - Trees grown too long in containers develop circling roots that conform to container walls. This root-bound condition often persists after planting—roots may continue circling rather than growing outward. Without correction at planting (cutting, spreading, or removing circling roots), they may eventually girdle the trunk, causing decline or death years or decades later.
91. **D. Expose and assess the trunk-root transition zone** - Root collar excavation removes soil, mulch, or debris burying the trunk base, allowing visual assessment of the root-trunk transition (root flare) and identification of problems like girdling roots, trunk decay, or improper planting depth. Many tree problems trace to buried root flares. Excavation is both diagnostic (identifying problems) and often therapeutic (allowing treatment of girdling roots, drying of bark).
92. **B. Greater density and strength** - Specific gravity (ratio of wood density to water density) correlates directly with wood strength. Higher specific gravity indicates denser wood with more cell wall material per unit volume, resulting in greater mechanical strength and stiffness. Species with high specific gravity (oak, hickory, locust) produce stronger wood than those with low specific gravity (cottonwood, willow, basswood).
93. **A. Pre-climb safety assessment for hazards** - Before climbing any tree, a thorough safety assessment must identify potential hazards: structural defects (cracks, decay, weak attachments), dead branches in the climbing path, electrical conductors, wildlife (especially stinging insects), and overall tree condition. This inspection determines whether climbing is safe and identifies conditions requiring precautions or alternative access. Pre-climb assessment is mandatory under ANSI Z133.
94. **C. Before any construction activity begins** - Effective tree protection requires physical barriers installed before any construction activity—before equipment arrives on site. The fence must be at the protection zone boundary, remain throughout construction, and be clearly marked. Protection implemented after construction begins cannot prevent damage already done; prevention is the only effective strategy for tree preservation during development.
95. **D. Pest levels at which treatment is justified** - Action thresholds define pest populations or damage levels at which treatment becomes justified because potential harm exceeds treatment costs and risks. Below threshold, pest presence is tolerated because damage is minor or natural

enemies may provide control. Above threshold, intervention is warranted. Thresholds vary with plant value, pest species, time of year, and management objectives.

96. **B. Annually and after lightning events** - Lightning protection systems require annual inspection to verify component condition (corrosion, damage, loose connections) and proper function. Additional inspection after lightning strikes detects damage not immediately visible. Tree growth may require conductor repositioning or extension over time. Proper maintenance ensures the system provides intended protection throughout its service life.
97. **C. Annually and after major storms** - Cable and brace support systems require regular inspection to ensure continued function. Annual inspection at minimum, plus inspection after significant storms (wind, ice, heavy snow), verifies hardware condition, cable tension (for standard cables), tree growth around components, and whether the system remains appropriate for current tree conditions. Neglected systems may fail to provide support or may damage trees.
98. **A. Provide vertical clearance beneath the crown** - Crown raising removes lower branches to increase vertical clearance beneath the tree canopy for pedestrians, vehicles, sight lines, buildings, or other uses. It should be accomplished gradually through training young trees rather than removing large lower limbs from mature trees, which creates significant wounds and removes substantial photosynthetic capacity.
99. **D. Fabaceae (legumes)** - Nitrogen-fixing bacteria (*Rhizobium* and related species) form symbiotic relationships with trees in the legume family (Fabaceae), including black locust, honeylocust, Kentucky coffeetree, redbud, and mimosa. Bacteria in root nodules convert atmospheric nitrogen (N_2) to ammonia, which plants can use. This symbiosis allows legumes to thrive in nitrogen-poor soils and enriches soil for subsequent plants.
100. **B. Probability that failure will strike the target** - Likelihood of impact evaluates the probability that if the tree or part fails, it will actually strike the identified target. Factors include target location relative to potential failure direction, target occupancy rate (how often the target is present), and target mobility (whether it can move away from danger). Even a tree certain to fail may have low impact likelihood if the target is rarely present or positioned away from likely failure direction.