III. Water Distribution, Introductory Answers

Distribution System Components

1. **b.** Metal scrappers
   Reference: *Water System Operations (WSO) Series (AWWA)*
2. **b.** Bacterial contamination
   Reference: *Water System Operations (WSO) Series (AWWA)*
3. **a.** Large plug
   Reference: *Water System Operations (WSO) Series (AWWA)*
4. **b.** air-and-vacuum relief valve
   Reference: *Water System Operations (WSO) Series (AWWA)*
5. **d.** All of the above
   Reference: *Water Distribution Operator Training Handbook (AWWA)*
6. **d.** Double check valve
   Reference: *Water System Operations (WSO) Series (AWWA)*
7. **d.** To control the direction of flow
   Reference: *Water System Operations (WSO) Series (AWWA)*
8. **b.** pressure gauges
   Reference: *Water System Operations (WSO) Series (AWWA)*
9. **c.** Near street intersections
   Reference: *Water System Operations (WSO) Series (AWWA)*
10. **d.** cubic feet or gallons
    Reference: *Water System Operations (WSO) Series (AWWA)*
11. **b.** Electrical pulse generator type
    Reference: *Water System Operations (WSO) Series (AWWA)*
12. **b.** System pressure
    Reference: *Water System Operations (WSO) Series (AWWA)*
13. **a.** water quality and reliability.
    Reference: *Water Distribution Operator Training Handbook (AWWA)*

14. **a.** Inspect the first check valve
Reference: *Water System Operations (WSO) Series (AWWA)*

15. **d.** All of the above
Reference: *Water Distribution Operator Training Handbook (AWWA)*

16. **d.** All of the above
Reference: *Water System Operations (WSO) Series (AWWA)*

17. **b.** 25 min
Reference: *Math for Distribution System Operators (AWWA)*

First, convert the pipe diameter from inches to feet.

Number of feet = (8.0 in.)(1 ft/12 in.) = 0.667 ft

Next, determine the volume in gallons for 145 ft of the 8.0-in. pipeline.

Equation: Volume, gal = (0.785)(Diameter, ft)^2(Length, ft)(7.48 gal/ft^3)

However, three volumes need to be flushed.

Volume, gal = (0.785)(0.667)(0.667)(145 ft)(7.48 gal/ft^3)(3 volumes) = 1,136.35 gal

Then, find the flushing time.

$$\text{Flushing time, min} = \frac{1,136.35 \text{ gal}}{45 \text{ gpm}} = 25.25 \text{ min, round to 25 min}$$

18. **b.** a primacy agency
Reference: *Water System Operations (WSO) Series (AWWA)*

19. **a.** organic compounds, permeation
Reference: *Water System Operations (WSO) Series (AWWA)*

20. **b.** Boilers
Reference: *Water System Operations (WSO) Series (AWWA)*

21. **b.** ensure the drain valve is completely closed
Reference: *Water System Operations (WSO) Series (AWWA)*

22. **a.** packing rings or mechanical seals
Reference: *Water System Operations (WSO) Series (AWWA)*

23. **d.** do not flood, test cocks
Reference: *Water System Operations (WSO) Series (AWWA)*

24. **c.** To prevent an illegal connection
Reference: *Water System Operations (WSO) Series (AWWA)*

25. **d.** All of the above
Reference: *Water System Operations (WSO) Series (AWWA)*

26. **d.** 97.28% meter accuracy
Reference: *Math for Distribution System Operators (AWWA)*

$$\text{Equation : Meter accuracy, \%} = \frac{(\text{Meter reading, gal})(100\%)}{\text{Actual volume, gal}}$$

$$\text{Meter accuracy, \%} = \frac{(3,685 \text{ L})(100\%)}{3,788 \text{ L}} = 97.28\% \text{ meter accuracy}$$

27. **b.** Wear rings

Reference: *Water System Operations (WSO) Series (AWWA)*

28. **b.** year

Reference: *Water System Operations (WSO) Series (AWWA)*

29. **a.** horizontal: capacity; vertical: head, power, and efficiency

Reference: *Water Treatment Operator Training Handbook (AWWA)*

30. **c.** dry-barrel hydrants

Reference: *Water System Operations (WSO) Series (AWWA)*

31. **c.** State and local codes

Reference: *Water System Operations (WSO) Series (AWWA)*

32. **b.** Sewer

Reference: *Water System Operations (WSO) Series (AWWA)*

33. **c.** 440/480 V

Reference: *Water System Operations (WSO) Series (AWWA)*

34. **a.** magnetic

Reference: *Water System Operations (WSO) Series (AWWA)*

35. **a.** 20 psi

Reference: *Water System Operations (WSO) Series (AWWA)*

36. **c.** 12.3 ft^3/s

Reference: *Math for Distribution System Operators (AWWA)*

$$\text{Equation}: ft^3/s = \frac{(mgd)(1,000,000\ gal)(1\ ft^3)(1\ day)(1\ min)}{1\ MG\ (7.48\ gal)(1,440\ min)(60\ s)}$$

$$\text{or } ft^3/s = \frac{(mgd)(1,000,000\ gal)(1\ ft^3)(1\ day)}{1\ MG\ (7.48\ gal)(86,400\ s)}$$

$$ft^3/s = \frac{(7.94\ mgd)(1,000,000\ gal)(1\ ft^3)(1\ day)(1\ min)}{1\ MG\ (7.48\ gal)(1,440\ min)(60\ s)} = 12.3\ ft^3/s$$

37. **d.** ANSI/NSF, 61

Reference: *Water System Operations (WSO) Series (AWWA)*

38. **b.** bare pigs

Reference: *Water System Operations (WSO) Series (AWWA)*

39. **c.** gastrointestinal problems

Reference: *Water System Operations (WSO) Series (AWWA)*

40. **c.** 213,844 gal

Reference: *Math for Distribution System Operators (AWWA)*

Equation: Volume, gal = (Cross-sectional area of the pipe, ft^2)(Length, ft)(7.48 gal/ft^3)

Therefore, we must first convert miles and inches to feet to use the above equation.

First, convert 1.46 miles to feet for the larger pipe. (5,280 ft/mile)(1.46 miles) = 7,708.8 ft

Then, determine the remainder of the feet for the smaller pipe.

1.93 miles – 1.46 miles = 0.47 mile for smaller pipe.

Convert 0.47 mile to feet. (5,280 ft/mile)(0.47 mile) = 2,481.6 ft

Next, convert 18.0 in. to feet. (18.0 in.)(1 ft/12 in.) = 1.50 ft

Then, determine the cross-sectional area of each pipe size.

Equation: Area, ft^2 = (0.785)(Diameter, ft)^2(Length, ft)(7.48 gal/ft^3)

Volume, gal for 2.0-ft-diameter pipe =

(0.785)(2.00 ft)(2.00 ft)(7,708.8 ft)(7.48 gal/ft^3) = 181,058 gal

Volume, gal for 1.5-ft diameter pipe =

(0.785)(1.50 ft)(1.50 ft)(2,481.6 ft)(7.48 gal/ft^3) = 32,786 gal

Last, add the two volumes together for the total volume.

Total volume, gal = 181,058 gal + 32,786 gal = 213,844 gal

41. **a.** glands
Reference: *Water System Operations (WSO) Series (AWWA)*

42. **b.** Slide valve
Reference: *Water System Operations (WSO) Series (AWWA)*

43. **b.** Pitot
Reference: *Water System Operations (WSO) Series (AWWA)*

44. **b.** Operate storage facilities to enhance mixing
Reference: *Water Distribution Operator Training Handbook (AWWA)*

45. **d.** differential-pressure
Reference: *Water System Operations (WSO) Series (AWWA)*

46. **b.** Stuffing box
Reference: *Water System Operations (WSO) Series (AWWA)*

47. **d.** a certain range of flows, low, low maintenance, larger pipelines
Reference: *Water System Operations (WSO) Series (AWWA)*

48. **d.** clogged, over-register, worn, under-register
Reference: *Water System Operations (WSO) Series (AWWA)*

49. **a.** iron
Reference: *Water System Operations (WSO) Series (AWWA)*

50. **b.** 1,360,000 gal
Reference: *Math for Distribution System Operators (AWWA)*

First, find the volume in gallons for each of the distribution pipes.

Equation: Volume, gal = (0.785)(Diameter, ft)^2(Length, ft)(7.48 gal/ft^3)

Volume, pipe "A" gal = (0.785)(2.0 ft)(2.0 ft)(489 ft)(7.48 gal/ft^3) = 11,485 gal

Volume, pipe "B" gal = (0.785)(1.5 ft)(1.5 ft)(2,655 ft)(7.48 gal/ft^3) = 35,077 gal

Next, determine the volume of the storage tank.

Equation: Volume, gal = (0.785)(Diameter, ft)^2(Height, ft)(7.48 gal/ft^3)

Volume, gal = (0.785)(91 ft)(91 ft)(27.02 ft)(7.48 gal/ft^3) = 1,313,831

Last, add the three volumes together for the total volume.

Total vol., gal = 11,485 gal + 35,077 gal + 1,313,831 gal = 1,360,393 gal

51. **a.** proportional to velocity
Reference: *Water Distribution Operator Training Handbook (AWWA)*

52. **a.** To equalize the pressure on the two sides of the gates
Reference: *Water Distribution Operator Training Handbook (AWWA)*

53. **b.** Bituminous
Reference: *Water System Operations (WSO) Series (AWWA)*

54. **b.** the rate of doing work
Reference: *Water System Operations (WSO) Series (AWWA)*

55. **b.** Air-and-vacuum, high, blowoff, low
Reference: *Water System Operations (WSO) Series (AWWA)*

56. **b.** reinforced concrete pressure pipe
Reference: *Water System Operations (WSO) Series (AWWA)*

57. **c.** arterial-loop system
Reference: *Water System Operations (WSO) Series (AWWA)*

58. **b.** 2.46 fps
Reference: *Math for Distribution System Operators (AWWA)*

First, convert the number of gallons per minute to cubic feet per second.

$$\text{Number of ft}^3/\text{s} = \frac{385\ \text{gpm}}{(7.48\ \text{gal/ft}^3)(60\ \text{s/min})} = 0.858\ \text{ft}^3/\text{s}$$

Next, convert the diameter from inches to feet.

Number of ft = (8.00 in.)(1 ft/12 in.) = 0.667 ft

Equation: Flow, ft^3/s = (Area, ft^2)(Velocity, fps), where the Area = (0.785)(Diameter, ft)^2

0.858 ft^3/s = (0.785)(0.667 ft)(0.667 ft)(Flow, fps)

Rearrange and solve for the flow in fps.

$$\text{Flow, fps} = \frac{0.858\ \text{ft}^3/\text{s}}{(0.785)(0.667\ \text{ft})(0.667\ \text{ft})} = 2.4568\ \text{fps, round to } \mathbf{2.46\ fps}$$

59. **a.** surges
Reference: *Water System Operations (WSO) Series (AWWA)*

60. **b.** Frame-mounted
Reference: *Water System Operations (WSO) Series (AWWA)*

61. **a.** proportional
Reference: *Water System Operations (WSO) Series (AWWA)*

62. **d.** Both b and c

Reference: *Water Distribution Operator Training Handbook (AWWA)*

63. **d.** 858,000 lb

First, calculate the tank's area.

Equation : Area, $ft^2 = (0.785)(\text{Diameter, ft})^2$

Area, $ft^2 = (0.785)(49.5\ ft)^2 = (0.785)(49.5\ ft)(49.5\ ft) = 1,923.45\ ft^2$

Next, determine the pressure in pounds per ft^2 on the tank's bottom.

Equation : Pressure, $lb/ft^2 = \left(\text{Water density, } lb/ft^2\right)(\text{Height, ft})$

Pressure, $lb/ft^2 = \left(62.4\ lb/ft^3\right)(7.15\ ft) = 446.16\ lb/ft^2$

Lastly, find the upward force on the bottom of the tank

Equation : Upward force, $lb = \left(\text{Area, } ft^2\right)\left(\text{Pressure, } lb/ft^2\right)$

Upward force, $lb = \left(1,923.45\ ft^2\right)\left(446.16\ lb/ft^2\right) = 858,166\ lb$, round to $858,000\ lb$

64. **a.** Correlative rights

Reference: *Water System Operations (WSO) Series (AWWA)*

65. **d.** All the above

Reference: *Water System Operations (WSO) Series (AWWA)*

66. **c.** long-distance transmission mains

Reference: *Water System Operations (WSO) Series (AWWA)*

67. **a.** Setting renewal priorities

Reference: *Water System Operations (WSO) Series (AWWA)*

68. **a.** fire protection

Reference: *Water System Operations (WSO) Series (AWWA)*

69. **c.** Butterfly valve

Reference: *Water Distribution Operator Training Handbook (AWWA)*

70. **b.** 84 gpm

Reference: *Math for Distribution System Operators (AWWA)*

First, convert the pipe diameter from inches to feet.

Pipe diameter, ft = (10.0 in.)(1 ft/12 in.) = 0.833 ft

Next, determine the volume in gallons for 310 ft of the 10-in. pipeline.

Equation: Volume, gal = $(0.785)(\text{Diameter, ft})^2(\text{Length, ft})(7.48\ gal/ft^3)$

Volume, gal = $(0.785)(0.833\ ft)(0.833\ ft)(310\ ft)(7.48\ gal/ft^3)$

Volume, gal = 1,263 gal

Then, find the amount of gallons that were removed.

Gallons removed $= \dfrac{1,263\ gal}{15\ min} = 84.2\ gpm$

71. **d.** The anodes will disintegrate quickly.

Reference: *Water Distribution Operator Training Handbook (AWWA)*

72. **b.** 0.734

Reference: *Math for Distribution System Operators (AWWA)*

$\frac{73.4\%}{100\%} = 0.734$

73. **b.** 18.3 psi

Reference: *Math for Distribution System Operators (AWWA)*

First, calculate the number of cubic feet of water present.

$\frac{1,375,000 \text{ gal}}{7.48 \text{ gal/ft}^3} = 183,823.53 \text{ ft}^3$

Then, the number of ft^3 = (0.785)(Diameter, ft)^2(Depth, ft)

Solve for depth:

183,823.53 ft^3 = (0.785)(70 ft)(70 ft)(Depth, ft)

$$\text{Depth, ft} = \frac{183,823.53 \text{ ft}^3}{(0.785)(74.5 \text{ ft})(74.5 \text{ ft})}$$

Depth = 42.19 ft

Next, solve for the number of psi at the bottom of the tank.

$$\text{psi} = \frac{\text{Depth, ft}}{2.31 \text{ ft/psi}} = \frac{42.19 \text{ ft}}{2.31 \text{ ft/psi}} = 18.264\text{psi, round to } 18.3\text{psi}$$

74. **a.** a double cover

Reference: *Water System Operations (WSO) Series (AWWA)*

75. **b.** permeable layer, confined by upper and lower layers, impermeable

Reference: *Water Distribution Operator Training Handbook (AWWA)*

76. **b.** 1.99 fps

Reference: *Math for Distribution System Operators (AWWA)*

First, convert the diameter in inches to feet.

Number of feet = (10.0 in.)(1 ft/12 in.) = 0.833

Next, determine the cross-sectional area of the pipe.

Equation: Area, ft^2 = (0.785)(Diameter, ft)^2

Area, ft^2 = (0.785)(0.833 ft)(0.833 ft) = 0.5447 ft

Next, determine the ft^3/s.

Number of ft^3/s = (1,287,000 gal/24 h)(1 ft^3/7.48 gal)(1 h/3,600 s) = 1.0847 ft^3/s

Last, determine the flow in fps.

Equation: Flow, ft^3/s = (Area, ft^2)(Velocity, fps)

Rearrange the formula to solve for velocity.

$$\text{Velocity, fps} = \frac{\text{Flow, ft}^3/\text{s}}{\text{Area, ft}^2}$$

Substitution:

$$\text{Velocity, fps} = \frac{1.0847 \text{ ft}^3/\text{s}}{0.5447 \text{ ft}^2} = 1.9914 \text{ fps, round to } 1.99 \text{ fps}$$

77. **b.** Mortar
Reference: *Water System Operations (WSO) Series (AWWA)*

78. **c.** dead ends
Reference: *Water System Operations (WSO) Series (AWWA)*

79. **b.** Maintaining adequate system pressure
Reference: *Water Distribution Operator Training Handbook (AWWA)*

80. **a.** Storage tank
Reference: *Water System Operations (WSO) Series (AWWA)*

81. **b.** rotational speed of a shaft
Reference: *Water System Operations (WSO) Series (AWWA)*

82. **b.** air gap, reduced-pressure zone backflow preventer
Reference: *Water System Operations (WSO) Series (AWWA)*

83. **b.** Ultrasonic system
Reference: *Water System Operations (WSO) Series (AWWA)*

84. **a.** Polyvinyl chloride
Reference: *Water System Operations (WSO) Series (AWWA)*

85. **a.** be repumped to boost water pressure after treatment.
Reference: *Water System Operations (WSO) Series (AWWA)*

86. **d.** All of the above
Reference: *Water System Operations (WSO) Series (AWWA)*

87. **c.** ¾-in.
Reference: *Water System Operations (WSO) Series (AWWA)*

88. **c.** alternately toward the flow, then away in a diagonal direction across the pipe.
Reference: *Water System Operations (WSO) Series (AWWA)*

89. **c.** PVC, concrete pressure, lined ductile iron
Reference: *Water System Operations (WSO) Series (AWWA)*

90. **a.** elevated storage is not available
Reference: *Water System Operations (WSO) Series (AWWA)*

91. **c.** of laminar flow, either side
Reference: *Water Distribution Operator Training Handbook (AWWA)*

92. **b.** Double check valve
Reference: *Water System Operations (WSO) Series (AWWA)*

93. **a.** Transmission mains
Reference: *Water System Operations (WSO) Series (AWWA)*

94. **c.** absorption pit
Reference: *Water System Operations (WSO) Series (AWWA)*

95. **c.** 12.8 hours
Reference: *Math for Distribution System Operators (AWWA)*
Equation : $\text{Detention time, hours} = \dfrac{(\text{Tank volume})(24\ \text{h/d})}{\text{Flow, gal/d}}$

Substitution:

First, convert MG to gallons: (3.25 MG)(1,000,000/1 M) = 3,250,000 gal

And (6.10 mgd)(1,000,000/1 M) = 6,100,000 gal/d

$$\text{Detention time, hours} = \frac{(3,250,000\ \text{gal})(24\ \text{h/d})}{6,100,000\ \text{gal/d}} = 12.787\ \text{hours, round to } 12.8\ \text{hours}$$

96. **d.** All of the above
Reference: *Water System Operations (WSO) Series (AWWA)*

97. **b.** Needs special protection in high-chloride soils
Reference: *Water System Operations (WSO) Series (AWWA)*

98. **b.** Annually
Reference: *Water Distribution Operator Training Handbook (AWWA)*

99. **d.** Graphite
Reference: *Water System Operations (WSO) Series (AWWA)*

100. **b.** The meter will under register or not register anything at low flows.
Reference: *Water Distribution Operator Training Handbook (AWWA)*

101. **c.** 15-in., repaired or replaced

102. **d.** All of the above
Reference: *Water Distribution Operator Training Handbook (AWWA)*

103. **c.** Steel
Reference: *Water System Operations (WSO) Series (AWWA)*

104. **c.** flanged meter couplings.
Reference: *Water Distribution Operator Training Handbook (AWWA)*

105. **c.** Concrete
Reference: *Water System Operations (WSO) Series (AWWA)*

106. **a.** They may not be accurate.
Reference: *Water Distribution Operator Training Handbook (AWWA)*

107. **b.** flexible, reinforced diaphragm
Reference: *Water Distribution Operator Training Handbook (AWWA)*

108. **a.** plug
Reference: *Water System Operations (WSO) Series (AWWA)*

109. **b.** 152 psi
Reference: *Math for Distribution System Operators (AWWA)*

First, subtract the number of feet above the bottom of the lake from the total depth.

Depth at point in question = 367 ft − 15 ft = 352 ft

$$\text{Equation : psi} = \frac{\text{Depth, ft}}{2.31\ \text{ft/psi}}$$

Substitution:

$$\text{psi} = \frac{352\,\text{ft}}{2.31\,\text{ft/psi}} = 152.38\,\text{psi, round to } 152\,\text{psi}$$

110. **b.** 220/240 V

Reference: *Water System Operations (WSO) Series (AWWA)*

111. **b.** Plastic encased pipeline

Reference: *Water System Operations (WSO) Series (AWWA)*

112. **b.** 12,300 ft^2

Reference: *Math for Distribution System Operators (AWWA)*

Equation: Area = $\pi(r)^2$, where π = 3.14.

Area of tank = (3.14)(62.5 ft)(62.5 ft) = 12,266 ft, round to 12,300 ft^2

113. **b.** Pressure-relief valves

Reference: *Water System Operations (WSO) Series (AWWA)*

114. **b.** 3–5 years

Reference: *Water Distribution Operator Training Handbook (AWWA)*

115. **a.** 11,500 gal

Reference: *Water System Operations (WSO) Series (AWWA)*

Give answer to 3 significant figures.

Equation: $\text{Volume, ft}^3 = \frac{(b_1 + b_2)\,(\text{Height, ft})\,(\text{Length, ft})}{2}$

$\text{Volume, ft}^3 = \frac{(4.2\text{ ft} + 7.9\text{ ft})(3.1\text{ ft})(82.1\text{ ft})}{2}$

$\text{Volume, ft}^3 = \frac{(12.1\text{ft})\,(3.1\text{ft})\,(82.1\text{ft})}{2} = \frac{3,079.571}{2} = 1,539.79\text{ ft}^3$

Next, find the number of gallons.

$\text{Number of gal} = \left(1,539.79\text{ ft}^3\right)\left(7.48\text{ gal/ft}^3\right) = 11,517.6\text{ gal, round to } 11,500\text{ gal}$

116. **d.** All of the above

Reference: *Water Distribution Operator Training Handbook (AWWA)*

117. **a.** start and stop flows

Reference: *Water System Operations (WSO) Series (AWWA)*

118. **c.** 0.315 m^3/s

Reference: *Math for Distribution System Operators (AWWA)*

First, convert gallons to liters.

Equation: Number of Liters = (Number of gpm)(1 min/60 s)(3.785 L/gal)

Number of Liters = (4,994 gpm)(1 min/60 s)(3.785 L/gal) = 315.038 L/s

Next convert liters per second (L/s) to cubic meters per second.

$\text{Equation : Number m}^3/\text{s} = \frac{\text{Flow, L/s}}{1,000\text{L/m}^3}$

$\text{Number m}^3/\text{s} = \frac{315.038\text{ L/s}}{1,000\text{ L/m}^3} = 0.315\text{ m}^3/\text{s}$

119. **c.** 31 hours 32 min

Reference: *Math for Distribution System Operators (AWWA)*

First, determine the capacity of the swimming pool in gallons.

Equation: Volume, gal = (Length, ft)(Width, ft)(Depth, ft)(7.48 gal/ft^3)\

Volume, gal = (31 ft)(21 ft)(5.4 ft)(7.48 gal/ft^3) = 26,295 gal

Next, find the time to fill the pool.

$$\text{Equation : Time, min} = \frac{\text{Volume, gal}}{\text{Rate, gpm}}$$

$$\text{Time, min} = \frac{26,295 \text{ gal}}{13.9 \text{ gpm}} = 1,891.73 \text{ min}$$

Convert minutes to hours.

$$\text{Time, hours} = \frac{1,891.73 \text{ min}}{60 \text{ min/h}} = 31.53 \text{ hours}$$

Next, convert 0.53 hours by multiplying by 60 min/h:

Number of minutes = (0.53 hours)(60 min/h) = 31.8 min, round to 32 min

Thus, time to fill the pool is 31 hours and 32 min

120. **a.** 1.83 ft/s in 10.0-in. pipe

Reference: *Water System Operations (WSO) Series (AWWA)*

Flow in 8.0-in. pipe equals the flow in the 10.0-in. pipe as the flow must remain constant:

$Q_1 = Q_2$

Since Q, flow = (Area)(Velocity), it follows that: (Area 1)(Velocity 1) = (Area 2)(Velocity 2)

First, find the diameters in feet for the 8.0-in. and 10-in. pipes:

Diameter for 8.0-in., ft = 8.0-in(1 ft/12-in.) = 0.667 ft

Diameter for 10.0-in., ft = 10.0-in(1 ft/12-in.) = 0.833 ft

Then determine the areas of each size pipe: Area = (0.785)(Diameter, ft)^2

Area 1 (8.0-in.), ft^2 = (0.785)(0.667 ft)(0.667 ft) = 0.349 ft^2

Area 2 (10.0-in.), ft^2 = (0.785)(0.833 ft)(0.833 ft) = 0.545 ft^2

Lastly, substitute areas calculated and known velocity in 8.0-in. pipe.

(0.349 ft^2)(2.85 ft/s) = (0.545 ft^2)(x, ft/s) Solve for x:

$$\text{x, ft/s} = \frac{(0.349 \text{ ft}^2)(2.85 \text{ ft/s})}{(0.545 \text{ ft}^2)} = 1.825 \text{ ft/s, round to 1.83 ft/s in 10.0-in. pipe}$$

121. **c.** 11,531.65 ft^2

Reference: *Math for Distribution System Operators (AWWA)*

First, find the surface area of the tank's wall. Imagine cutting the wall and rolling it out so that it is flat. The length of this now flat wall is simply the circumference of the tank and is defined as (Diameter)(π).

The area of the tank wall then is the length of the wall times the height:

Wall area, ft^2 = (Diameter, ft)(π)(Height, ft)

Substitution:

Wall area, ft^2 = (65.0 ft)(3.14)(24.0 ft) = 4,898.4 ft^2

Next, find the top and bottom surface area.

Top and bottom area, ft^2 = (2, top and bottom)(0.785)(Diameter, ft)^2

Top and bottom area, ft^2 = (2)(0.785)(65.0 ft)(65.0 ft) = 6,633.25 ft^2

Total area of tank, ft^2 = 4,898.4 ft^2 + 6633.25 ft^2 = 11,531.65 ft^2

122. **a.** Reinforced concrete noncylinder pipe

Reference: *Water System Operations (WSO) Series (AWWA)*

123. **a.** The total feet of head against which a pump must work

Reference: *Water System Operations (WSO) Series (AWWA)*

124. **c.** Flexural strength

Reference: *Water System Operations (WSO) Series (AWWA)*

125. **a.** state and local health authorities

Reference: *Water System Operations (WSO) Series (AWWA)*

126. **c.** in direct proportion, rotor

Reference: *Water System Operations (WSO) Series (AWWA)*

127. **c.** 7.3 mgd

Reference: *Math for Distribution System Operators (AWWA)*

$$\text{Equation : Avg. mgd flow} = \frac{\text{Sum of mgd used each day}}{\text{Total time. days}}$$

$$\text{Avg. mgd flow} = \frac{7.9 + 8.0 + 6.5 + 6.8 + 7.0 + 7.3 + 7.8}{7 \text{ days}} = 7.33 \text{ mgd, round to } 7.3 \text{ mgd}$$

128. **c.** the vertical distance from point of pressure measurement to the hydraulic grade line

Reference: *Water System Operations (WSO) Series (AWWA)*

129. **c.** industrial, domestic

Reference: *Water System Operations (WSO) Series (AWWA)*

130. **b.** 103 ft

Reference: *Math for Distribution System Operators (AWWA)*

Equation: Circumference = (π)(Diameter) Rearrange the equation to solve for the diameter.

$$\text{Diameter} = \frac{\text{Circumference}}{(\pi)}$$

$$\text{Diameter} = \frac{323 \text{ ft}}{3.14} = 103 \text{ ft}$$

131. **b.** high-carbon spring-steel blades

Reference: *Water System Operations (WSO) Series (AWWA)*

132. **a.** Concrete

Reference: *Water System Operations (WSO) Series (AWWA)*

133. **a.** 10%

Reference: *Water System Operations (WSO) Series (AWWA)*

134. **b.** 13.7 ft

Reference: *Math for Distribution System Operators (AWWA)*

Write the equation, arranging it to solve for the unknown, drawdown.

$$\text{Equation : Drawdown, ft} = \frac{\text{Well yield, gpm}}{\text{Specific yield, gpm/ft}}$$

$$\text{Drawdown, ft} = \frac{129 \text{ gpm}}{45 \text{ gpm/ft}} = 13.7 \text{ ft}$$

135. **c.** Pump station piping

Reference: *Water System Operations (WSO) Series (AWWA)*

136. **a.** SCADA

Reference: *Water System Operations (WSO) Series (AWWA)*

137. **a.** Thrust anchors

Reference: *Water System Operations (WSO) Series (AWWA)*

138. **b.** 2 ft

Reference: *Water System Operations (WSO) Series (AWWA)*

139. **d.** 1 full turn

Reference: *Water System Operations (WSO) Series (AWWA)*

140. **b.** DIP

Reference: *Water System Operations (WSO) Series (AWWA)*

141. **b.** 63,400 gal pumped

Reference: *Math for Distribution System Operators (AWWA)*

Let x = the number of gallons pumped in 24 hours.

$$\frac{\text{x, gal pumped}}{7 \text{ hours}} = \frac{435,000 \text{ gal}}{48 \text{ hours}}$$

$$\text{x, gal pumped} = \frac{(435,000 \text{ gal})(7 \text{ hours})}{48 \text{ hours}} = 63,437.5 \text{ gal, round to } 63,400 \text{ gal pumped}$$

142. **d.** A check valve then a gate valve

Reference: *Water System Operations (WSO) Series (AWWA)*

143. **b.** 2

Reference: *Water System Operations (WSO) Series (AWWA)*

144. **d.** do not wear or damage shaft sleeves

Reference: *Water System Operations (WSO) Series (AWWA)*

145. **a.** globe valve, spring

Reference: *Water Distribution Operator Training Handbook (AWWA)*

146. **c.** 0.058 psi

Reference: *Water System Operations (WSO) Series (AWWA)*

First, find the head loss in feet.

Equation : $\text{Headloss, ft} = \frac{(\text{velocity})^2}{2(g)}$; where g is the acceleration of gravity

$$\text{Head loss, ft} = \frac{(2.95\ \text{fps})^2}{2\,(32.2\ \text{ft/sec}^2)} = \frac{(2.95\ \text{fps})\,(2.95\ \text{fps})}{64.4\ \text{ft/sec}^2} = 0.135\ \text{ft}$$

Next, convert head loss in feet to head loss in psi.

Head loss, psi = (0.135 ft) (0.433 psi/ft) = 0.058 psi

147. **d.** push-on joint

Reference: *Water System Operations (WSO) Series (AWWA)*

148. **c.** Backsiphonage

Reference: *Water System Operations (WSO) Series (AWWA)*

149. **b.** Rotary pump

Reference: *Water System Operations (WSO) Series (AWWA)*

150. **b.** Three

Reference: *Water System Operations (WSO) Series (AWWA)*

151. **d.** All of the above

Reference: *Water System Operations (WSO) Series (AWWA)*

152. **a.** AWWA, National Science Foundation (NSF)

Reference: *Water System Operations (WSO) Series (AWWA)*

153. **b.** 27.1 hours

Reference: *Math for Distribution System Operators (AWWA)*

First, convert gallons per minute to gallons per hour (gph): (1,750 gpm)(60 min/h) = 105,000 gph

Next, convert MG to gallons.

Number of gal = (2.85 MG)(1,000,000/1 M) = 2,850,000 gal

Equation: Time, hours = Number of gallons/gph

Time, hours = 2,850,000 gal/105,000 gph = 27.143 hours, round to 27.1 hours

154. **a.** low friction loss, rotor

Reference: *Water System Operations (WSO) Series (AWWA)*

155. **d.** Centrifugal pump

Reference: *Water System Operations (WSO) Series (AWWA)*

156. **a.** Submersible pump

Reference: *Water System Operations (WSO) Series (AWWA)*

157. **d.** 510 yd^3

Reference: *Math for Distribution System Operators (AWWA)*

First, determine the number of cubic feet excavated from the trench.

Equation: Volume, ft^3 = (Length, ft)(Width, ft)(Depth, ft)

Volume, ft^3 = (728 ft)(4.2 ft)(4.5 ft) = 13,759.2 ft^3, round to 13,800 ft^3

Next, find the number of cubic yards.

$$\text{Number of } yd^3 = \frac{13,759.2\ ft^3}{27\ ft^3/yd^3} = 509.6\ yd^3, \text{ round to } 510\ yd^3$$

158. **c.** annually

Reference: *Water System Operations (WSO) Series (AWWA)*

159. **d.** 609,000 lb

Reference: *Math for Distribution System Operators (AWWA)*

First, calculate the tank's area.

Equation: Area, ft = (Length, ft)(Width, ft)

Area, ft^2 = (50.0 ft)(24.0 ft) = 1,200 ft^2

Next, determine the pressure in pounds per square feet on the tank's bottom.

Equation: Pressure, lb/ft^2 = (Water Density, lb/ft^3)(Height, ft)

Pressure, lb/ft^2 = (62.4 lb/ft^3)(8.13 ft) = 507.312 lb/ft^2

Last, find the upward force on the bottom of the tank.

Equation: Upward force, lb = (Area, ft^2)(Pressure, lb/ft^2)

Upward force, lb = (1,200 ft^2)(507.312 lb/ft^2) = 608,774.4 lb, round to 609,000 lb

160. **a.** 26.5 hr

Reference: *Math for Distribution System Operators (AWWA)*

First, convert gpm to gallons per hour (gph): (1,100 gpm)(60 min/h) = 66,000 gph

Next, convert 1.75 MG to gallons:

(1.75 MG)(1,000,000 gals/1 M) = 1,750,000 gal

Equation: Time, hours = Number of gallons/gph

Time, hours = 1,750,000 gal/66,000 gph = 26.5 hours

161. **d.** autumn

Reference: *Water System Operations (WSO) Series (AWWA)*

162. **b.** lubrication style, 6 months or at annual intervals

Reference: *Water System Operations (WSO) Series (AWWA)*

163. **a.** 60 cycles or 60 Hz

Reference: *Water System Operations (WSO) Series (AWWA)*

164. **c.** Too high a space requirement
Reference: *Water System Operations (WSO) Series (AWWA)*

165. **d.** All of the above
Reference: *Water Distribution Operator Training Handbook (AWWA)*

166. **a.** other than a service line
Reference: *Water System Operations (WSO) Series (AWWA)*

167. **a.** Four
Reference: *Water System Operations (WSO) Series (AWWA)*

168. **a.** 20 psi
Reference: *Water System Operations (WSO) Series (AWWA)*

169. **b.** 81.4 psi
Reference: *Math for Distribution System Operators (AWWA)*

Equation: Pressure head, ft = (Pressure, psi)(2.31 ft/psi)

Rearrange to solve for pressure in psi:

$$\text{Pressure, psi} = \frac{\text{Pressure head, ft}}{2.31\ \text{ft/psi}}$$

Substitute known values:

$$\text{Pressure, psi} = \frac{188\ \text{ft}}{2.31\ \text{ft/psi}} = 81.4\ \text{psi}$$

170. **d.** 7,790 ft^2
Reference: *Math for Distribution System Operators (AWWA)*

Equation: Area = $(\pi)r^2$

Area = (3.14)(49.8 ft)(49.8 ft) = 7,787 ft^2, round to 7,790 ft^2

171. **d.** All of the above
Reference: *Water System Operations (WSO) Series (AWWA)*

172. **c.** Vertical turbine pump
Reference: *Water System Operations (WSO) Series (AWWA)*

173. **a.** appropriative rights
Reference: *Water System Operations (WSO) Series (AWWA)*

174. **c.** artesian well
Reference: *Water Distribution Operator Training Handbook (AWWA)*

175. **b.** compound meter
Reference: *Water System Operations (WSO) Series (AWWA)*

176. **d.** 132 min
Reference: *Math for Distribution System Operators (AWWA)*

First, convert the pipe diameter from inches to feet.

Number of feet = (10.0 in.)(1 ft/12 in.) = 0.833 ft

Next, determine the volume in gallons for 1,625 ft of the 10-in. pipeline.

Equation: Volume, gal = (0.785)(Diameter, ft)^2(Length, ft)(7.48 gal/ft^3)

Volume, gal = (0.785)(0.833 ft)(0.833 ft)(1,625 ft)(7.48 gal/ft^3) = 6,620.86 gal

Then, find the flushing time.

$$\text{Flushing time, min} = \frac{6,620.86 \text{ gal}}{50.0 \text{ gpm}} = 132.4 \text{ min, round to } 132 \text{ min}$$

177. **b.** equal to or greater than that
Reference: *Water System Operations (WSO) Series (AWWA)*

178. **a.** Turbine pump
Reference: *Water Distribution Operator Training Handbook (AWWA)*

179. **a.** Cast-iron pipe
Reference: *Water System Operations (WSO) Series (AWWA)*

180. **b.** 2.01 ft/s
Reference: *Math for Distribution System Operators (AWWA)*

First, convert the diameter from inches to feet. Number of feet = (8.0 in.)(1 ft/12 in.) = 0.667 ft

Next, convert the number of gallons per minute to cubic feet per second.

$$\text{Number of ft}^3\text{/s} = \frac{315 \text{ gpm}}{(7.48 \text{ gal/ft}^3)(60 \text{ s/min})} = 0.702 \text{ ft}^3\text{/s}$$

Equation for flow is Flow, ft^3/s = (Area, ft^2)(Velocity, fps);

Where the area = (0.785)(Diameter, ft)^2

0.702 ft^3/s = (0.785)(0.667 ft)(0.667 ft)(Flow, fps)

Rearrange the problem to solve for flow:

$$\text{Flow, ft/s} = \frac{0.702 \text{ ft}^3\text{/s}}{(0.785)(0.667 \text{ ft})(0.667 \text{ ft})} = 2.010 \text{ ft/s}$$

181. **d.** an altitude valve, unrestricted
Reference: *Water System Operations (WSO) Series (AWWA)*

182. **b.** Ductile iron
Reference: *Water System Operations (WSO) Series (AWWA)*

183. **a.** blue baby syndrome (methemoglobinemia)
Reference: *Water System Operations (WSO) Series (AWWA)*

184. **c.** supply, downstream, relief valve's spring tension
Reference: *Water System Operations (WSO) Series (AWWA)*

Equipment Installation, Operation, and Maintenance

1. **a.** corporation stop
Reference: *Water System Operations (WSO) Series (AWWA)*

2. **c.** 6 hr
   Reference: *Water Distribution Operator Training Handbook (AWWA)*
3. **b.** 1–2 ft
   Reference: *Water System Operations (WSO) Series (AWWA)*
4. **b.** The local fire department
   Reference: *Water System Operations (WSO) Series (AWWA)*
5. **c.** 4.76 gpm/ft
   Reference: *Water System Operations (WSO) Series (AWWA)*
   Equation: $\text{Specific yield, gpm/ft} = \frac{\text{Well yield, gpm}}{\text{Drawdown, ft}}$
   $\text{Specific yield, gpm/ft} = \frac{107\ \text{gpm}}{22.5\ \text{ft}} = 4.755\ \text{gpm/ft, round to } 4.76\ \text{gpm/ft}$
6. **d.** Plug and ball
   Reference: *Water System Operations (WSO) Series (AWWA)*
7. **d.** All of the above
   Reference: *Water System Operations (WSO) Series (AWWA)*
8. **a.** Dry-barrel hydrants
   Reference: *Water System Operations (WSO) Series (AWWA)*
9. **a.** tensile and flexural strength
   Reference: *Water System Operations (WSO) Series (AWWA)*
10. **b.** 15%
    Reference: *Water System Operations (WSO) Series (AWWA)*
11. **c.** bronze, machined, hydrant or valve
    Reference: *Water System Operations (WSO) Series (AWWA)*
12. **b.** 5-psi
    Reference: *Water System Operations (WSO) Series (AWWA)*
13. **c.** five
    Reference: *Water System Operations (WSO) Series (AWWA)*
14. **d.** All of the above
    Reference: *Water System Operations (WSO) Series (AWWA)*
15. **b.** static level, drawdown, pump is losing efficiency
    Reference: *Water Distribution Operator Training Handbook (AWWA)*
16. **b.** 2.5-in., 4.5-in., pumper suction hose
    Reference: *Water System Operations (WSO) Series (AWWA)*
17. **b.** crystallizes
    Reference: *Water System Operations (WSO) Series (AWWA)*
18. **c.** solder joints, flare and/or compression joints
    Reference: *Water Distribution Operator Training Handbook (AWWA)*

19. **c.** Flapper valve
Reference: *Water System Operations (WSO) Series (AWWA)*

20. **a.** distribute surface loads
Reference: *Water Distribution Operator Training Handbook (AWWA)*

21. **b.** Warm-climate hydrants
Reference: *Water System Operations (WSO) Series (AWWA)*

22. **a.** ball valves
Reference: *Water Distribution Operator Training Handbook (AWWA)*

23. **b.** Fewer customer complaints
Reference: *Water Distribution Operator Training Handbook (AWWA)*

24. **d.** well-graded, 1-in.
Reference: *Water System Operations (WSO) Series (AWWA)*

25. **c.** copper, steel, asbestos cement, concrete
Reference: *Water System Operations (WSO) Series (AWWA)*

26. **a.** Sandy soils
Reference: *Water System Operations (WSO) Series (AWWA)*

27. **c.** concrete blocks, inside
Reference: *Water Distribution Operator Training Handbook (AWWA)*

28. **c.** shear, tensile, flexural
Reference: *Water System Operations (WSO) Series (AWWA)*

29. **d.** All of the above
Reference: *Water System Operations (WSO) Series (AWWA)*

30. **c.** calcium hypochlorite
Reference: *Water Distribution Operator Training Handbook (AWWA)*

31. **b.** electrical resistivity
Reference: *Water System Operations (WSO) Series (AWWA)*

32. **d.** Bypass valve
Reference: *Water System Operations (WSO) Series (AWWA)*

33. **c.** It eliminates entry into the building.
Reference: *Water System Operations (WSO) Series (AWWA)*

34. **b.** upper, dense
Reference: *Water System Operations (WSO) Series (AWWA)*

35. **c.** Double check valve
Reference: *Water System Operations (WSO) Series (AWWA)*

36. **c.** Flow-through systems
Reference: *Water Distribution Operator Training Handbook (AWWA)*

37. **c.** 300 mg/L, 3 hr
Reference: *Water System Operations (WSO) Series (AWWA)*

38. **c.** Centrifugal-jet pump

Reference: *Water System Operations (WSO) Series (AWWA)*

39. **c.** 76 psi

Reference: *Math for Distribution System Operators (AWWA)*

First, calculate the column of water in feet.

Number of feet = Total depth of well – Depth to water – Number of feet above bottom

Number of ft = 306.1 – 124.7 ft – 5.8 ft = 175.6 ft

Next, find the pressure in psi. This time, use 0.433 psi/ft.

Equation: Pressure, psi = (Number of ft)(0.433 psi/ft)

Pressure, psi = (175.6 ft)(0.433 psi/ft) = 76.03 psi, round to 76 psi

40. **d.** 92.2 ft

Reference: *Math for Distribution System Operators (AWWA)*

Equation: Drawdown, ft = Pumping water level, ft – Static water level, ft

Rearrange the equation to solve for static water level.

Static water level, ft = Pumping water level, ft – Drawdown, ft

Substitute known values:

Static water level, ft = 106.4 ft – 14.2 ft = 92.2 ft

41. **d.** All of the above

Reference: *Water Distribution Operator Training Handbook (AWWA)*

42. **b.** Pumping

Reference: *Water System Operations (WSO) Series (AWWA)*

43. **b.** 110 yd^3

Reference: *Math for Distribution System Operators (AWWA)*

First, find the number of cubic feet. Equation: Volume, ft^3 = (Length, ft)(Width, ft)(Depth, ft)

Volume, ft^3 = (112 ft)(4.5 ft)(5.9 ft) = 2,973.6 ft^3

Next, convert cubic feet to cubic yards. Know 1 yd^3 is 27 ft^3, thus:

$$\frac{2,973.6\ ft^3}{27\ ft^3/yd^3} = 110.13\ yd^3, \text{round to } 110\ yd^3$$

44. **a.** nozzle

Reference: *Water System Operations (WSO) Series (AWWA)*

45. **a.** 2–4 in.

Reference: *Water Distribution Operator Training Handbook (AWWA)*

46. **b.** Fuses or circuit breakers

Reference: *Water System Operations (WSO) Series (AWWA)*

47. **a.** 2-in.

Reference: *Water System Operations (WSO) Series (AWWA)*

48. **a.** pipe friction losses
Reference: *Water System Operations (WSO) Series (AWWA)*

49. **d.** the same material as water main materials
Reference: *Water Distribution Operator Training Handbook (AWWA)*

50. **c.** expansive under the action of freezing but will not fracture
Reference: *Water Distribution Operator Training Handbook (AWWA)*

51. **b.** Clay soils
Reference: *Water System Operations (WSO) Series (AWWA)*

52. **d.** All of the above
Reference: *Water System Operations (WSO) Series (AWWA)*

53. **a.** 1 min, 10-min
Reference: *Water System Operations (WSO) Series (AWWA)*

54. **c.** compacted soil so the barrel of the pipe has continuous firm support
Reference: *Water System Operations (WSO) Series (AWWA)*

55. **d.** 8.77 gpm/ft
Reference: *Math for Distribution System Operators (AWWA)*

$$\text{Equation : Specific yield, gpm/ft} = \frac{\text{Well yield, gpm}}{\text{Drawdown, ft}}$$

$$\text{Specific yield, gpm/ft} = \frac{121\ \text{gpm}}{13.8\ \text{ft}} = 8.768\ \text{gpm/ft, round to } 8.77\ \text{gpm/ft}$$

56. **a.** low-flow, low-pressure
Reference: *Water System Operations (WSO) Series (AWWA)*

57. **c.** 25 mg/L
Reference: *Water System Operations (WSO) Series (AWWA)*

58. **d.** Both b and c
Reference: *Water Distribution Operator Training Handbook (AWWA)*

59. **c.** Gray cast-iron pipe
Reference: *Water System Operations (WSO) Series (AWWA)*

60. **a.** coupon, saved for checking its condition
Reference: *Water System Operations (WSO) Series (AWWA)*

61. **a.** granular material with few fines is being used
Reference: *Water System Operations (WSO) Series (AWWA)*

62. **d.** On the shaft, in or near the bearings
Reference: *Water System Operations (WSO) Series (AWWA)*

63. **c.** Wet-barrel hydrants
Reference: *Water System Operations (WSO) Series (AWWA)*

64. **b.** ductile-iron pipe
Reference: *Water System Operations (WSO) Series (AWWA)*

65. **b.** Chemical metering pump
Reference: *Water Distribution Operator Training Handbook (AWWA)*

66. **a.** a small leak
Reference: *Water System Operations (WSO) Series (AWWA)*

67. **d.** All of the above
Reference: *Water Distribution Operator Training Handbook (AWWA)*

68. **a.** 6%
Reference: *Water System Operations (WSO) Series (AWWA)*

69. **a.** Horizontal gate valve
Reference: *Water System Operations (WSO) Series (AWWA)*

70. **d.** 2.5 ft/s, 3.5 ft/s
Reference: *Water System Operations (WSO) Series (AWWA)*

71. **b.** Tapping valve
Reference: *Water System Operations (WSO) Series (AWWA)*

72. **a.** 150 psi
Reference: *Water System Operations (WSO) Series (AWWA)*

73. **c.** plugged with the standard type of pipe material that is being used
Reference: *Water System Operations (WSO) Series (AWWA)*

74. **d.** Corporation stops
Reference: *Water System Operations (WSO) Series (AWWA)*

75. **d.** Both b and c
Reference: *Water Distribution Operator Training Handbook (AWWA)*

76. **b.** large-diameter mains
Reference: *Water System Operations (WSO) Series (AWWA)*

77. **c.** ANSI/AWWA Standard C652
Reference: *Water Distribution Operator Training Handbook (AWWA)*

78. **b.** thoroughly clean the exterior of the pipe
Reference: *Water Distribution Operator Training Handbook (AWWA)*

79. **b.** Steel pipe, essentially all
Reference: *Water System Operations (WSO) Series (AWWA)*

80. **b.** Thermal-overload relays
Reference: *Water System Operations (WSO) Series (AWWA)*

81. **a.** 2 ft.
Reference: *Water System Operations (WSO) Series (AWWA)*

82. **b.** a flanged connection, advantage, cannot
Reference: *Water System Operations (WSO) Series (AWWA)*

83. **a.** whenever reasonably possible
Reference: *Water System Operations (WSO) Series (AWWA)*

84. **b.** A calibrated makeup reservoir
Reference: *Water System Operations (WSO) Series (AWWA)*

85. **d.** Electrical line
Reference: *Water System Operations (WSO) Series (AWWA)*

86. **c.** clays
Reference: *Water System Operations (WSO) Series (AWWA)*

87. **b.** copper tubing, iron pipe thread, plastic pipe
Reference: *Water System Operations (WSO) Series (AWWA)*

88. **b.** Gate valve
Reference: *Water System Operations (WSO) Series (AWWA)*

89. **b.** 1 month
Reference: *Water System Operations (WSO) Series (AWWA)*

90. **b.** is all the way to the face of the bell, spigot
Reference: *Water Distribution Operator Training Handbook (AWWA)*

91. **a.** no greater residual than the feedwater
Reference: *Water Distribution Operator Training Handbook (AWWA)*

92. **a.** drawdown remains the same but the static level drops
Reference: *Water Distribution Operator Training Handbook (AWWA)*

93. **c.** Mueller, larger, iron-pipe
Reference: *Water System Operations (WSO) Series (AWWA)*

94. **b.** monthly, annually
Reference: *Water System Operations (WSO) Series (AWWA)*

95. **b.** partially or totally shut the line down
Reference: *Water System Operations (WSO) Series (AWWA)*

96. **b.** 6 in., pressure and flow, at the end
Reference: *Water Distribution Operator Training Handbook (AWWA)*

97. **a.** The water should be tested again.
Reference: *Water System Operations (WSO) Series (AWWA)*

98. **d.** hydrometer, antifreeze and/or water, alkaline water
Reference: *Water System Operations (WSO) Series (AWWA)*

99. **d.** Durability
Reference: *Water System Operations (WSO) Series (AWWA)*

100. **a.** partially backfilled
Reference: *Water System Operations (WSO) Series (AWWA)*

101. **a.** diesel, fuel-injection
Reference: *Water System Operations (WSO) Series (AWWA)*

102. **a.** wrinkle bending
Reference: *Water System Operations (WSO) Series (AWWA)*

103. **a.** the regulatory requirements
Reference: *Water Distribution Operator Training Handbook (AWWA)*

104. **d.** All of the above
Reference: *Water Distribution Operator Training Handbook (AWWA)*

105. **a.** 6–12 months, environmental conditions
Reference: *Water System Operations (WSO) Series (AWWA)*

106. **c.** a leveling board
Reference: *Water System Operations (WSO) Series (AWWA)*

107. **b.** diffuser
Reference: *Water System Operations (WSO) Series (AWWA)*

108. **b.** well face or screen, bailer
Reference: *Water System Operations (WSO) Series (AWWA)*

109. **b.** Not clean
Reference: *Water System Operations (WSO) Series (AWWA)*

110. **c.** Restricted flow
Reference: *Water System Operations (WSO) Series (AWWA)*

111. **b.** 5 days
Reference: *Water System Operations (WSO) Series (AWWA)*

112. **c.** ice, flap valves, pressure, and vacuum
Reference: *Water System Operations (WSO) Series (AWWA)*

113. **c.** closed, vertical
Reference: *Water System Operations (WSO) Series (AWWA)*

114. **d.** 1 year
Reference: *Water System Operations (WSO) Series (AWWA)*

115. **c.** amplifiers
Reference: *Water System Operations (WSO) Series (AWWA)*

116. **b.** New, should not, closed
Reference: *Water System Operations (WSO) Series (AWWA)*

Disinfection Monitoring, Evaluation, Adjustment, and Laboratory Analysis/ Interpretation

1. **b.** 35.3 lb of $Ca(OCl)_2$

First, calculate the number of gallons in the pipeline.

Equation: Pipe volume, gal = (0.785)(Diameter, ft)^2(Length, ft)(7.48 gal/ft^3)

Pipe volume, gal = (0.785)(3.00 ft)(3.00 ft)(1,040 ft)(7.48 gal/ft^3) = 54,960 gal

Convert gallons to million gallons.

Pipe volume, MG = (54,960 gal)(1 M/1,000,000) = 0.05496 MG

Next, determine the number of pounds of calcium hypochlorite [$Ca(OCl)_2$] needed using the modified "pounds" formula.

$$Ca(OCl)_2,\ lb = \frac{(MG)(Dosage,\ mg/L)(8.34\ lb/gal)(100\%)}{Available\ chlorine,\ \%}$$

$$Ca(OCl)_2,\ lb = \frac{(0.05496\ MG)(50.0\ mg/L)(8.34\ lb/gal)(100\%)}{65.0\%} = 35.3\ lb\ of\ Ca(OCl)_2$$

2. **d.** Fecal contamination

Reference: *Water System Operations (WSO) Series (AWWA)*

3. **a.** Chloroform

Reference: *Water System Operations (WSO) Series (AWWA)*

4. **c.** 98.39% meter accuracy

Reference: *Math for Distribution System Operators (AWWA)*

First, convert cubic feet to gallons.

Number of gallons = $(118.4\ ft^3)(7.48\ gal/ft^3)$ = 885.632 gal

$$Equation: Meter\ accuracy,\ \% = \frac{(Meter\ reading,\ gal)(100\%)}{Actual\ volume,\ gal}$$

$$Meter\ accuracy,\ \% = \frac{(885.632\ gal)(100\%)}{900.1\ gal} = 98.39\%\ meter\ accuracy$$

5. **d.** Tastes and odors

Reference: *Water System Operations (WSO) Series (AWWA)*

6. **c.** reduction in oxygen

Reference: *Water Distribution Operator Training Handbook (AWWA)*

7. **a.** 2 mg/L

Reference: *Water Distribution Operator Training Handbook (AWWA)*

8. **b.** 4-log, viruses

Reference: *Water Distribution Operator Training Handbook (AWWA)*

9. **d.** 2.52 mg/L

Reference: *Math for Distribution System Operators (AWWA)*

First, convert cubic feet per second to mgd.

$$mgd = \frac{(23.4\ ft^3/s)(7.48\ gal/ft^3)(86,400\ s/d)}{1,000,000/1M} = 15.123\ mgd$$

Equation: lb/d = (mgd)(Dosage, mg/L)(8.34 lb/d)

Rearrange to solve for dosage.

$$Dosage,\ mg/L = \frac{Number\ of\ lb/d\ of\ chlorine}{(mgd)(8.34\ lb/gal)}$$

$$Dosage,\ mg/L = \frac{318\ lb/d}{(15.123\ mgd)(8.34\ lb/gal)} = 2.5213\ mg/L,\ round\ to\ 2.52 mg/L$$

10. **c.** 26 gal of NaOCl

Reference: *Math for Distribution System Operators (AWWA)*

First, calculate the number of gallons in the pipeline.

Equation: Number of gal = (0.785)(Diameter, ft)^2(Length, ft)(7.48 gal/ft^3)

Number of gal = (0.785)(2.5 ft)(2.5 ft)(4,408 ft)(7.48 gal/ft^3) = 161,768 gal

Convert gallons to MG.

Number of MG = (161,768 gal)(1 M/1,000,000) = 0.161768 MG

Next, determine the number of pounds of sodium hypochlorite (NaOCl) needed using the "pounds" formula.

NaOCl, lb = (MG)(Dosage, mg/L)(8.34 lb/gal)

NaOCl, lb = (0.161768 MG)(25 mg/L)(8.34 lb/gal) = 33.729 lb

Last, determine the number of gallons needed.

$$\text{NaOCl, gal} = \frac{(\text{Number of lb, NaOCl})(100\%)}{(\text{NaOCl, lb/gal})(6.0\%)}$$

$$\text{NaOCl, gal} = \frac{(33.729\ \text{lb})(100\%)}{(10.34\ \text{lb/gal})(12.5\%)} = 26.096\ \text{gal, round to 26 gal of NaOCl}$$

11. **b.** lower concentrations of THMs, ineffective, inactivating *Giardia*

Reference: *Water System Operations (WSO) Series (AWWA)*

12. **b.** 151 tablets of $Ca(OCl)_2$

Reference: *Math for Distribution System Operators (AWWA)*

First, determine the volume of the pipeline in million gallons.

$$\text{Pipeline, MG} = \frac{(0.785)(\text{Diameter, ft})^2(\text{Length, ft})(7.48\ \text{gal/ft}^3)}{1,000,000/\text{M}}$$

$$\text{Pipeline, MG} = \frac{(0.785)(3.0\ \text{ft})(3.0\ \text{ft})(1,865\ \text{ft})(7.48\ \text{gal/ft}^3)}{1,000,000/\text{M}} = 0.09856\ \text{MG}$$

Next, determine the number of pounds of calcium hypochlorite needed.

$$\text{Ca(OCl)}_2\text{, lb} = \frac{(\text{MG})(\text{Dosage, mg/L})(8.34\ \text{lb/gal})}{\%\ \text{purity}}$$

$$\text{Ca(OCl)}_2\text{, lb} = \frac{(0.09856\ \text{MG})(50.0\ \text{mg/L})(8.34\ \text{lb/gal})}{65.0\%/100\%} = 63.23\ \text{lb}$$

Last, find the number of tablets needed.

$$\text{Tablets, number} = \frac{63.23\ \text{lb}}{0.42\ \text{lb per tablet}} = 150.55\ \text{tablets, round to 151 tablets of Ca(OCl)}_2$$

13. **a.** 2.96 mg/L

Reference: *Water System Operations (WSO) Series (AWWA)*

First, determine the number of pounds of chlorine used.

Equation: $\text{Chlorine, lb} = \frac{(\text{Hypochlorite, gal})\,(\text{Hypochlorite, \%})\,(8.34\ \text{lb/gal})}{100\%}$

$\text{Chlorine, lb} = \frac{(22.6\ \text{gal})\,(9.5\%)\,(8.34\ \text{lb/gal})}{100\%} = 17.906\ \text{lb}$

Next, convert gallons of water to million gallons.

MG = (725,000 gal) (1M/1,000,000) = 0.725 MG

Lastly, determine the actual chlorine dosage.

Equation: $\text{Dosage, mg/L} = \frac{\text{Chlorine, lb}}{(\text{Volume, MG})\,(8.34\ \text{lb/gal})}$

$\text{Dosage, mg/L} = \frac{17.906\ \text{lb}}{(0.725\ \text{MG})\,(8.34\ \text{lb/gal})} = 2.96\ \text{mg/L}$

14. **b.** 0.05–0.2 mg/L

Reference: *Water System Operations (WSO) Series (AWWA)*

15. **a.** 50.1 mg/L of $Ca(OCl)_2$

Reference: *Math for Distribution System Operators (AWWA)*

First, convert the diameter of the pipe from inches to feet.

Number of ft = (24.0 in.)(1 ft/12 in.) = 2.00 ft

Next, determine the number of gallons in the pipeline.

Number of gal = (0.785)(2.0 ft)(2.0 ft)(1,248 ft)(7.48 gal/ft^3) = 29,313 gal

Then convert gallons to million gallons.

Number of MG = (29,313 gal)(1 M/1,000,000) = 0.029313 MG

Last, solve for the dosage of calcium hypochlorite using the "pounds" formula.

$Ca(OCl)_2$, lb = (MG)(Dosage, mg/L)(8.34 lb/gal)

$Ca(OCl)_2\ \text{dosage, mg/L} = \frac{Ca(OCl)_2,\ \text{lb}}{(\text{MG})(8.34\ \text{lb/gal})}$

$Ca(OCl)_2\ \text{dosage, mg/L} = \frac{12.25\ \text{lb, } Ca(OCl)_2}{(0.029313\ \text{MG})(8.34\ \text{lb/gal})}$

$Ca(OCl)_2$ dosage, mg/L = 50.11 mg/L, round to 50.1 mg/L of $Ca(OCl)_2$

16. **d.** 64 tablets

Reference: *Math for Distribution System Operators (AWWA)*

First, determine the volume of the pipelines in million gallons.

$$\text{Pipe, MG} = \frac{(0.785)(\text{Diameter, ft})^2(\text{Length, ft})(7.48\ \text{gal/ft}^3)}{1,000,000/\text{M}}$$

$$\text{Pipe A, MG} = \frac{(0.785)(2.00\ \text{ft})(2.00\ \text{ft})(1,015\ \text{ft})(7.48\ \text{gal/ft}^3)}{1,000,000/\text{M}} = 0.02384\ \text{MG}$$

$$\text{Pipe B, MG} = \frac{(0.785)(1.50\ \text{ft})(1.50\ \text{ft})(1,347\ \text{ft})(7.48\ \text{gal/ft}^3)}{1,000,000/\text{M}} = 0.01780\ \text{MG}$$

Next, add the number of MG in the two pipes.

Total MG in both pipes = 0.02384 MG + 0.01780 MG = 0.04164 MG

Next, determine the number of pounds of calcium hypochlorite needed.

$$\text{Ca(OCl)}_2\text{, lb} = \frac{(\text{MG})(\text{Dosage, mg/L})(8.34\ \text{lb/gal})}{\text{Percentage available chlorine}}$$

$$\text{Ca(OCl)}_2\text{, lb} = \frac{(0.04164\ \text{MG})(50.0\ \text{mg/L})(8.34\ \text{lb/gal})}{65.0\%/100\%\ \text{available chlorine}} = 26.71\ \text{lb}$$

Last, find the number of tablets needed.

$$\text{Number of tablets} = \frac{26.71\ \text{lb}}{0.42\ \text{lb per tablet}} = 63.6, \text{round to 64 tablets}$$

17. **c.** Heterotrophic plate counts

Reference: *Water Distribution Operator Training Handbook (AWWA)*

18. **b.** control corrosiveness of the finished water

Reference: *Water Distribution Operator Training Handbook (AWWA)*

19. **d.** 84 gal of NaOCl

Reference: *Math for Distribution System Operators (AWWA)*

First, determine the capacity in gallons of the storage tank.

Equation: Volume, gal = (0.785)(Diameter, ft)^2(Height, ft)(7.48 gal/ft^3)(10% full/100%)

Volume, gal = (0.785)(105 ft)(105 ft)(32.5 ft)(7.48 gal/ft^3)(10% full/100%) = 210,394 gal

Next, convert gallons to million gallons.

Number of MG = (210,394 gal)(1 M/1,000,000) = 0.210394 MG

Next, find the number of pounds of sodium hypochlorite needed using the "pounds" equation. Note: Drop the day on both sides of the equation as it is not needed in this case.

Equation: Chlorine, lb = (MG)(Dosage, mg/L)(8.34 lb/gal)

Chlorine, lb = (0.210394 MG)(50 mg/L)(8.34 lb/gal) = 87.734 lb

$$\text{NaOCl gal} = \frac{(\text{Chlorine, lb})(100\%)}{(8.34\ \text{lb/gal})(\text{Hypochlorite, \%})}$$

$$\text{NaOCl gal} = \frac{(87.734\ \text{lb})(100\%)}{(8.34\ \text{lb/gal})(12.5\%)} = 84.16\ \text{gal, round to 84 gal of NaOCl}$$

20. **b.** Sediment deposition

Reference: *Water System Operations (WSO) Series (AWWA)*

21. **a.** Size of the water system

Reference: *Water System Operations (WSO) Series (AWWA)*

22. **c.** 0.64 mg/L, 0.48 mg/L, *Giardia lamblia*

Reference: *Water Distribution Operator Training Handbook (AWWA)*

23. **d.** All of the above

Reference: *Water System Operations (WSO) Series (AWWA)*

24. **b.** high amounts, children

Reference: *Water Distribution Operator Training Handbook (AWWA)*

25. **a.** 66 mL/min

Reference: *Math for Distribution System Operators (AWWA)*

First, determine the number of gallons that was pumped.

Equation: Tank volume, gal = (0.785)(Diameter, ft)^2(Level Drop, ft)(7.48 gal/ft^3)

Tank volume, gal = (0.785)(3.5 ft)(3.5 ft)(0.35 ft)(7.48 gal/ft^3) = 25.175 gal

Next, find the number of minutes in 24 hours.

Number of min = (24.0 hours)(60 min/h) = 1,440 min

Last, determine the number of milliliters per minute.

$$\text{Number of gpm} = \frac{(25.175\ \text{gal})(3785\ \text{mL/gal})}{1,440\ \text{min}} = 66.17\ \text{mL/min, round to 66 mL/min}$$

26. **d.** 28.7 lb/day of chlorine

Reference: *Math for Distribution System Operators (AWWA)*

First, convert the pumping rate to mgd.

$$\text{Equation : mgd} = \frac{(\text{pumping rate, gpm})(1,440\ \text{min/d})}{1,000,000/\text{M}}$$

Substitute and solve:

$$\text{Equation : mgd} = \frac{(735\ \text{gpm})(1,440\ \text{min/d})}{1,000,000/\text{M}} = 1.0584\ \text{mgd}$$

Next, use the "pounds" equation to solve the problem.

Equation: Chlorine, lb/d = (mgd)(Dosage, mg/L)(8.34 lb/gal)

Chlorine, lb/d = (1.0584 mgd)(3.25 mg/L)(8.34 lb/gal) = 28.7 lb/d of chlorine

27. **a.** 30 min

Reference: *Water Distribution Operator Training Handbook (AWWA)*

28. **c.** auto decomposition, ammonia

Reference: *Water Distribution Operator Training Handbook (AWWA)*

29. **d.** Water temperature approaching ambient temperature

Reference: *Water System Operations (WSO) Series (AWWA)*

30. **c.** cross-connection

Reference: *Water System Operations (WSO) Series (AWWA)*

31. **a.** coliform, total coliform

Reference: *Water Distribution Operator Training Handbook (AWWA)*

32. **d.** Both b and c

Reference: *Water Distribution Operator Training Handbook (AWWA)*

33. **d.** 417 lb of HTH

Reference: *Math for Distribution System Operators (AWWA)*

$$\text{Equation : HTH, percent solution} = \frac{(\text{lb HTH})(100\%)}{(\text{Number of gal})(8.34\ \text{lb/gal})}$$

Rearrange the equation to solve for pounds of HTH:

HTH, lb = (% solution)(Number of gal)(8.34 lb/gal)/100%

HTH, lb = (10.0% solution)(500 gal)(8.34 lb/gal)/100% =

HTH, lb = 417 lb of HTH

34. **b.** monthly

Reference: *Water Distribution Operator Training Handbook (AWWA)*

35. **b.** not understanding requirements.

Reference: *Water Distribution Operator Training Handbook (AWWA)*

36. **c.** 28 lb of sodium hypochlorite

Reference: *Math for Distribution System Operators (AWWA)*

First, convert gallons to million gallons.

Number of MG = (8,500 gal)(1 M/1,000,000) = 0.0085 MG

Then, determine the pounds of calcium hypochlorite needed.

$$\text{Equation : NaOCl, lb} = \frac{(\text{MG})(\text{Dosage, mg/L})(8.34\ \text{lb/gal})}{\%\ \text{Available chlorine}}$$

$$\text{NaOCl, lb} = \frac{(0.0085\ \text{MG})(50\ \text{mg/L})(8.34\ \text{lb/gal})}{12.5\%/100\%}$$

NaOCl, lb = 28.356 lb

37. **a.** chloramination, HAA5

Reference: *Water Distribution Operator Training Handbook (AWWA)*

38. **a.** 1–3 ft

Reference: *Water Distribution Operator Training Handbook (AWWA)*

39. **a.** 2.8% soda ash slurry

Reference: *Math for Distribution System Operators (AWWA)*

$$\text{Percentage of soda ash slurry} = \frac{(\text{Soda ash, lb})(100\%)}{\text{Soda ash, lb} + (8.34\ \text{lb/gal})(\text{Number gallons of water})}$$

Substitution:

$$\text{Percentage of soda ash slurry} = \frac{(18\ \text{lb})(100\%)}{18\ \text{lb} + (8.34\ \text{lb/gal})(75\ \text{gal})}$$

$$\frac{(18\text{ lb})(100\%)}{18\text{ lb} + 625.5\text{ lb}} = \frac{(18\text{ lb})(100\%)}{643.5\text{ lb}} = 2.8\%\text{ soda ash slurry}$$

40. **d.** Chlorine residual

Reference: *Water System Operations (WSO) Series (AWWA)*

41. **c.** Atom

42. **a.** 29.0 lb of soda ash

Reference: *Math for Distribution System Operators (AWWA)*

This type of problem in which there is one unknown can be set up as a ratio.

Let x = unknown (pounds of soda ash). The equation is:

$$\frac{\text{x lb, Soda ash}}{\text{Number of gal}_2} = \frac{\text{Number of lb, Soda ash}}{\text{Number of gal}_1}$$

$$\frac{\text{x lb, Soda ash}}{100\text{ gal}} = \frac{45\text{ lb, soda ash}}{155\text{ gal}}$$

$$\text{x lb, soda ash} = \frac{(45\text{ lb, soda ash})(100\text{ gal})}{155\text{ gal}} = 29.03\text{ lb, round to 29.0 lb of soda ash}$$

43. **d.** 1, more than 5%

Reference: *Water System Operations (WSO) Series (AWWA)*

Security, Safety, Administrative Procedures, and Public Interactions

1. **c.** nonalloyed carbon steel

Reference: *Water System Operations (WSO) Series (AWWA)*

2. **d.** The employer

Reference: *Water System Operations (WSO) Series (AWWA)*

3. **a.** soil has been disturbed such that a concrete block will not work

Reference: *Water System Operations (WSO) Series (AWWA)*

4. **b.** Severe diarrhea

Reference: *Water System Operations (WSO) Series (AWWA)*

5. **d.** Both a and b

6. **c.** refer to local utility policy

Reference: *Water Distribution Operator Training Handbook (AWWA)*

7. **b.** encouraged, have never been

Reference: *Water System Operations (WSO) Series (AWWA)*

8. **a.** taste, color, and odor

Reference: *Water Distribution Operator Training Handbook (AWWA)*

9. **a.** Physical threat

Reference: *Water System Operations (WSO) Series (AWWA)*

10. **b.** vehicles

Reference: *Water System Operations (WSO) Series (AWWA)*

11. **a.** side effects that endanger public health.
Reference: *Water System Operations (WSO) Series (AWWA)*

12. **c.** SDWA, 1996 Amendment
Reference: *Water System Operations (WSO) Series (AWWA)*

13. **b.** USEPA
Reference: *Water System Operations (WSO) Series (AWWA)*

14. **a.** Terrorism
Reference: *Water Distribution Operator Training Handbook (AWWA)*

15. **c.** PVC or polyethylene
Reference: *Water Distribution Operator Training Handbook (AWWA)*

16. **a.** lane width
Reference: *Water System Operations (WSO) Series (AWWA)*

17. **a.** carbon dioxide or dry powder, water or soda-acid
Reference: *Water System Operations (WSO) Series (AWWA)*

18. **a.** drag shield
Reference: *Water System Operations (WSO) Series (AWWA)*

19. **a.** Bioterrorism, 3,300
Reference: *Water System Operations (WSO) Series (AWWA)*

20. **a.** governor; the particular state's EPA
Reference: *Water Distribution Operator Training Handbook (AWWA)*

21. **a.** hard clay
Reference: *Water System Operations (WSO) Series (AWWA)*

22. **b.** IESWTR
Reference: *Water Distribution Operator Training Handbook (AWWA)*

23. **b.** Firm clays and tills with low moisture content
Reference: *Water System Operations (WSO) Series (AWWA)*

24. **a.** steep
Reference: *Water System Operations (WSO) Series (AWWA)*

25. **d.** Both b and c
Reference: *Water Distribution Operator Training Handbook (AWWA)*

26. **c.** utilities
Reference: *Water System Operations (WSO) Series (AWWA)*

27. **b.** develop standards
Reference: *Water System Operations (WSO) Series (AWWA)*

28. **d.** All of the above
Reference: *Water Distribution Operator Training Handbook (AWWA)*

29. **a.** access control

Reference: *Water Distribution Operator Training Handbook (AWWA)*

30. **b.** Card-reader systems

Reference: *Water System Operations (WSO) Series (AWWA)*

31. **a.** 12 months

Reference: *Water Distribution Operator Training Handbook (AWWA)*

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III. Water Distribution, Introductory Questions

Distribution System Components

1. What type of mechanical pipe cleaning unit has high-carbon spring-steel blades?

   a. Scraping pigs
   b. Metal scrappers
   c. Spiral pigs
   d. Bladed pigs

2. What will the loss of pressure in a water system possibly cause besides compromising firefighting capabilities?

   a. Pipe collapses
   b. Bacterial contamination
   c. Corrosion
   d. Collapsing pipes

3. _____ valves are most often used where pressure is relatively high and positive shutoff is required, such as the discharge of a high-lift pump.

   a. Large plug
   b. Gate
   c. Large globe
   d. Altitude

4. It is best to have an _____ to prevent the collapse of a pipe when it is being emptied.

   a. air-purging valve
   b. air-and-vacuum relief valve
   c. actuator
   d. atmospheric vacuum breaker

5. _____ have a major impact on the reliability of the distribution system to deliver an uninterrupted supply.

   a. Main break frequencies
   b. Breakdown of distribution pumps
   c. Power outages
   d. All of the above

6. What backflow prevention device is, at a minimum, required at the potable meter for domestic water booster pumps?

   a. Reduced-pressure zone backflow preventer
   b. Atmospheric pressure breaker
   c. Pressure vacuum breaker
   d. Double check valve

7. What is the purpose of a check valve?

   a. To control the rate of flow
   b. To control the velocity of flow
   c. To control the pressure
   d. To control the direction of flow

8. It is best to use _____ to determine the hydraulic grade line.

   a. piezometer readings
   b. pressure gauges
   c. elevations
   d. flow rate and elevations

9. Where would be the best place for hydrants to be located?

   a. Close to buildings
   b. Near the street
   c. Near street intersections
   d. Behind protective barriers

10. The most common meter register records the flow in _____.

    a. imperial gallons
    b. cubic meters and gallons
    c. cubic meters
    d. cubic feet or gallons

11. This type of meter sends an electrical signal to a remote register mounted outside the building after a particular amount of water is used.

    a. Automatic meter reader
    b. Electrical pulse generator type
    c. Radio or satellite
    d. Scanning unit

12. How are distribution pump operations controlled?

    a. Water flow
    b. System pressure
    c. Control switches
    d. Altitude valves

13. The main distribution system performance categories that are included in the distribution system operator objective are _____.

    a. water quality and reliability
    b. water quality and power availability
    c. operating costs and emergency procedures
    d. operating costs and distribution capacity

14. What should an operator inspect first if a reduced pressure zone backflow preventer leaks at the vent?

    a. Inspect the first check valve
    b. Inspect the second check valve
    c. Check the regulator
    d. Check the test cocks

15. Which of the following factors are key for system design and important to consider when expanding distribution systems?

    a. Pressure
    b. Flow
    c. Water quality
    d. All of the above

16. Why should gaskets for piping not to be stored next to electrical motors?

    a. Excessive heat can ruin them.
    b. Oil from motor can damage them.
    c. Grease from motor can damage them.
    d. All of the above.

17. An 8.0-in.-diameter pipeline needs to be flushed. If the desired length of pipeline to be flushed is 145 ft, how many minutes will it take to flush the line three times at 45 gpm?

    a. 8.4 min
    b. 25 min
    c. 37.8 min
    d. 38 min

18. Auxiliary water sources regarding cross-connections can fall under the supervision of _____.

    a. OSHA
    b. a primacy agency
    c. the utility
    d. the local health department

19. It has been documented that _____ can pass through the walls of plastic pipe even though the pipe is carrying water under pressure. This process by which molecules pass through the plastic pipe is called _____.

    a. organic compounds, permeation
    b. organic compounds, infiltration
    c. acid compounds, permeation
    d. acid compounds, infiltration

20. The potential hazard for this cross-connection system is high.

    a. Swimming pools
    b. Boilers
    c. Commercial food processors
    d. Dishwashers

21. The dry-barrel hydrant should be completely opened when in use to _____.

    a. prevent the hydrant from vibrating and damaging internal components

b. ensure the drain valve is completely closed
c. prevent damage to the main valve due to throttling
d. ensure the operating screw does not get jammed

22. To prevent leakage at the point where the shaft protrudes through the case, either _____ are used to seal the space between these two.

a. packing rings or mechanical seals
b. lantern rings or mechanical seals
c. shaft sleeves or lantern rings
d. lantern rings or packing rings

23. Double check valves should be installed in areas that _____ as the _____ can form a cross-connection if submerged.

a. have a low risk for a biological hazard, relief port
b. have been approved by the primacy agency, relief port
c. have a low risk for biological hazard, test cocks
d. do not flood, test cocks

24. Why should a meter be placed as close to the property line as possible?

a. To prevent injury
b. To prevent it from being blocked
c. To prevent an illegal connection
d. All of the above

25. What will high water pressure cause?

a. More main and service leaks
b. More hot water tank failures
c. More appliance failures
d. All of the above

26. A meter being tested reads 3,685 L. A volumetric tank shows the actual value is 3,788 L. What is the percentage accuracy of the meter?

a. 102.8% meter accuracy
b. 51.4% meter accuracy
c. 95% meter accuracy
d. 97.28% meter accuracy

27. What restricts the flow between the impeller discharge and suction areas in a centrifugal pump to prevent excessive water circulation between the two?

a. Packing rings
b. Wear rings
c. Pump sleeves
d. Lantern rings

28. All hydrants should be inspected at least every _____.

a. 6 months
b. year
c. 2 years
d. 3 years

29. On a pump curve, what is plotted on the horizontal line and the vertical line?

    a. horizontal: capacity; vertical: head, power, and efficiency
    b. horizontal: capacity and power; vertical: head and efficiency
    c. horizontal: head; vertical: capacity, power, and efficiency
    d. horizontal: head and capacity; vertical: power and efficiency

30. An advantage of _____ is that there is no flow of water from a broken hydrant.

    a. warm-climate hydrants
    b. flush hydrants
    c. dry-barrel hydrants
    d. wet-barrel hydrants

31. What agency or regulation determines the frequency of testing and maintenance for a double check valve assembly?

    a. USEPA
    b. SDWA
    c. State and local codes
    d. ANSI/NSF Standard 63

32. What utility line will most likely not be moved for a water utility installing a new water main?

    a. Gas
    b. Sewer
    c. Electrical
    d. Telephone

33. Large motors are usually operated at _____.

    a. 400/420 V
    b. 410/430 V
    c. 440/480 V
    d. 470/490 V

34. A velocity-type flowmeter would be _____.

    a. magnetic
    b. Venturi
    c. flow tube
    d. orifice plate

35. The lowest minimum pressure in distribution systems of _____ is a standard in many states and water system guidelines.

    a. 20 psi
    b. 25 psi
    c. 35 psi
    d. 40 psi

36. Convert 7.94 mgd to cubic feet per second.

    a. 1.2 ft^3/s
    b. 5.1 ft^3/s
    c. 12.3 ft^3/s
    d. 13.7 ft^3/s

37. The _____ Standard _____ covers materials that come in contact with potable water and other issues.

    a. AWWA, 60
    b. ANSI, 61
    c. NSF, 60
    d. ANSI/NSF, 61

38. The first type of cleaning pig to be sent through a main is called _____.

    a. cleaning pigs
    b. bare pigs
    c. scraping pigs
    d. soft pigs

39. Most backflow incidents that cause health problems involve _____.

    a. kidney problems
    b. liver problems
    c. gastrointestinal problems
    d. nerve tissue damage

40. A distribution pipe is 1.93 mi long. What is the volume of water in gallons if the pipe is 2.00 ft in diameter for a length of 1.46 mi and 18.0 in. for the remainder?

    a. 148,272 gal
    b. 312,201 gal
    c. 213,840 gal
    d. 202,915 gal

41. In all motors fitted with ball bearings, roller bearings, or both, the bearing housings are fitted with _____ to keep the grease in and the dirt out.

    a. glands
    b. seals
    c. sleeves
    d. packing

42. What type of valve should be used when the pressure to be regulated is relatively low and tight shutoff is not important?

    a. Plug valve
    b. Slide valve
    c. Butterfly valve
    d. Pinch valve

43. This type of flowmeter measures the velocity based on the difference between the flow's dynamic pressure and the static pressure.

    a. Proportional meter
    b. Pitot
    c. Orifice plate
    d. Turbine meter

44. How can water operators control water age in the distribution system?

    a. Monitor chlorine residual, pH, and temperature
    b. Operate storage facilities to enhance mixing
    c. Test for disinfection by products and HPCs
    d. Lower tank levels by treating less water

45. The measurement devices most commonly used for measuring large quantities of water are _____ flowmeters.

    a. magnetic
    b. positive-displacement
    c. compound
    d. differential-pressure

46. What is the location of a lantern ring on a pump?

    a. Pump shaft
    b. Stuffing box
    c. Impeller shaft
    d. Motor shaft

47. Venturi meters are accurate for _____, have _____ friction loss, require _____, and have long been used for measuring flows in _____.

    a. low to high flows, low, low maintenance, medium and large pipelines
    b. low to high flows, high, high maintenance, medium and large pipelines
    c. a certain range of flows, high, low maintenance, larger pipelines
    d. a certain range of flows, low, low maintenance, larger pipelines

48. If the jets in a multi jet meter become _____, the meter will _____. If the jet orifice becomes _____, the meter will _____.

    a. worn, over-register, clogged, under-register
    b. worn, under-register, clogged, over-register
    c. clogged, under-register, worn, over-register
    d. clogged, over-register, worn, under-register

49. Internal pipeline corrosion control is usually implemented to reduce lead, copper, and _____.

    a. iron
    b. cadmium
    c. zinc
    d. manganese

50. Determine the volume of water in gallons for the following distribution system:

    Distribution pipe "A": 489 ft in length and 2.0 ft in diameter

    Distribution pipe "B": 2,655 ft in length and 1.5 ft in diameter

    Storage tank: 91 ft in diameter and a water height of 27.02 ft

    a. 1,160,000 gal
    b. 1,360,000 gal
    c. 1,314,000 gal
    d. 47,000 gal

51. In a magnetic flowmeter, water passing through the magnetic field induces a small flow of electrified current that is _____, which is converted to flow rate.

    a. proportional to velocity
    b. proportional to velocity squared
    c. indirectly proportional to velocity
    d. indirectly proportional to velocity squared

52. Why are bypass valves often included within large gate valves?

    a. To equalize the pressure on the two sides of the gates
    b. For temporary flow when repaired or replacing the gate valve
    c. To clean the seat before closing the main valve
    d. To open when only small quantities of water are needed

53. What external coating is usually used to protect ductile-iron pipe?

    a. Epoxy
    b. Bituminous
    c. Polyvinyl fluoride
    d. Polybutylene

54. Power is defined as _____.

    a. the amount of energy put into a system
    b. the rate of doing work
    c. the amount of force per unit of time
    d. force multiplied by work

55. _____ relief valves should be at _____ points and _____ valves should be at _____ points in the distribution system.

    a. Air, high, blowoff, dead end
    b. Air-and-vacuum, high, blowoff, low
    c. Air, regular interval, blowoff, dead end
    d. Air-and-vacuum, regular interval, backflow, low

56. Prestressed, steel cylinder piping is a type of _____.

    a. steel cylinder pipe
    b. reinforced concrete pressure pipe
    c. steel pipe
    d. noncylinder steel pipe

57. Large water mains that surround and contribute water supply within the grid from several different directions would be a(n) _____.

    a. grid system.
    b. grid and tree system.
    c. arterial-loop system.
    d. arterial-loop and grid.

58. What is the velocity of flow in feet per second for an 8.00-in.-diameter pipe if it delivers 385 gpm?

    a. 1.51 fps
    b. 2.46 fps
    c. 0.407 fps
    d. 0.66 fps

59. Over time, _____ can cause damage to the pipeline and equipment because it (they) occur(s) so frequently.

    a. surges
    b. pump startup
    c. flow demand changes
    d. controlled pump shutdowns

60. What is a pump design called if it has the impeller mounted on a separate shaft, which is connected to the motor with a coupling?

    a. Close-coupled
    b. Frame-mounted
    c. Horizontal-case
    d. Vertical-case

61. The amount of metal removed from a pipe wall is _____ to the magnitude of the current flowing in the corrosion cell.

    a. proportional
    b. inversely proportional
    c. indirectly proportional
    d. equal

62. Throttling a pump against a gate valve should be avoided because it will _____.

    a. eventually damage the pump
    b. damage the gate valve
    c. reduce efficiency of the pump and thus increase costs
    d. Both b and c

63. A water storage tank is partially underground. The tank is 49.5 ft in diameter and 18.0 ft high. What is the upward force of water pressure in pounds lifting up the tank if the groundwater is 7.15 ft above the base of the tank?

    a. 4.30 lb
    b. 446 lb
    c. 1,920 lb
    d. 858,000 lb

64. Under this allocation of groundwater, this rule requires sharing.

    a. Correlative rights
    b. Reasonable use
    c. Riparian rights
    d. Prior appropriation doctrine

65. Metals that get into the distribution system due to a cross-connection will cause

    a. nervous system damage.
    b. nervous system and liver damage.
    c. vomiting and liver damage.
    d. All the above.

66. Usually steel pipe is used for _____.

    a. plant piping
    b. the suction side of pumps
    c. long-distance transmission mains
    d. initial feed lines to tanks and pump stations

67. What important role do system operators play in a water utility's management pipeline rehabilitation and replacement program?

    a. Setting renewal priorities
    b. Decisions on implementing the plan
    c. Cost decisions
    d. Impact of the program

68. The determining factor in sizing mains, storage facilities, and pumping facilities for communities with a population of less than 50,000 is usually the need for _____.

    a. fire protection
    b. domestic and irrigation use
    c. commercial use
    d. industrial use

69. What valve, if closed too fast, would cause serious water hammer compared to the others listed?

    a. Plug valve
    b. Globe valve
    c. Butterfly valve
    d. Altitude valve

70. A 10.0-in. main line needs to be flushed. If one volume of a 310-ft section of the pipeline was flushed through a fire hydrant for 15 min, what was the flushing rate in gallons per minute?

    a. 1,213.5 gpm
    b. 607.2 gpm
    c. 84.2 gpm
    d. 42.1 gpm

71. A water storage tank with no interior coating has a cathodic protected system installed. What will happen to the anodes?

    a. The anodes will disintegrate the same as if there was an interior coating.
    b. The anodes will not disintegrate and will not protect the tank.
    c. The anodes will disintegrate slightly faster.
    d. The anodes will disintegrate quickly.

72. Convert 73.4% to decimal form.

    a. 0.73
    b. 0.734
    c. 7.34
    d. 73.4

73. A tank is 74.5 ft in diameter and is 42.5 ft to the overflow. If there are 1,375,000 gal of water in the tank, what is the psi at the bottom of the tank?

a. 17.4 psi
b. 18.3 psi
c. 97.5 psi
d. 316.6 psi

74. In extremely cold conditions, meter pits are sometimes constructed with _____ to provide added insulation.

a. a double cover
b. straw packed in the pit above the meter
c. straw and gravel to just above the meter
d. fiberglass insulation

75. A confined aquifer is a(n) _____ of rock that is _____ that is (are) relatively _____.

a. permeable layer, confined by an upper layer, semipermeable
b. permeable layer, confined by upper and lower layers, impermeable
c. impermeable layer, confined by an upper and lower layer, semipermeable
d. impermeable layer, confined by an upper layer, permeable

76. A 10.0-in.-diameter distribution pipe delivers 1,287,000 gal in exactly 24 hours. What is the average flow during the 24 hours in feet per second?

a. 0.59 fps
b. 1.99 fps
c. 0.46 fps
d. 0.502 fps

77. How are the metal parts on concrete pipe protected from corrosion?

a. Resin
b. Mortar
c. Bituminous
d. Creosote

78. The pipeline network design should strive to eliminate or at least reduce the number of _____.

a. pump stations
b. pressure relief stations
c. dead ends
d. storage tanks

79. What is an operator's primary defense against backflow from cross-connections?

a. Performing testing and maintenance of backflow-prevention devices
b. Maintaining adequate system pressure
c. Funding and a clearly and concisely defined service policy
d. Public knowledge and support for the problems associated with cross-connections

80. Sampling for this particular site could be continuous, daily or on a weekly basis.

a. Storage tank
b. Dead-end area
c. Pressure relief station
d. Pump station

81. A tachometer generator is a sensor for measuring the _____.

    a. rotational speed of a motor's rotor
    b. rotational speed of a shaft
    c. the power output in watts or kilowatts.
    d. the voltage, usually of three-phase motors

82. In a sewage treatment plant a(n) _____ is required to isolate an area inside the plant and a _____ at the potable meter.

    a. vacuum pressure breaker, double check valve
    b. air gap, reduced-pressure zone backflow preventer
    c. vacuum breaker, reduced-pressure zone backflow preventer
    d. air gap, double check valve

83. What type of measuring level system has to compensate for the air temperature because the speed of sound in air varies with temperature?

    a. Diaphragm elements
    b. Ultrasonic system
    c. Bellows
    d. Bourdon tube

84. What pipe material, when new, has a C value of 150?

    a. Polyvinyl chloride
    b. Mild steel
    c. Ductile-iron pipe
    d. Cast iron pipe

85. Surface water will most probably _____.

    a. be repumped to boost water pressure after treatment
    b. be of high turbidity when entering the distribution system
    c. need greater-than-average storage capacity
    d. require softening due to excessive hardness

86. What facilities require the highest level of cross-connection and backflow protection?

    a. Sewage plant and agricultural pesticide mixing tanks
    b. Hospitals and funeral homes
    c. Agricultural pesticide mixing tanks and hospitals
    d. All the above

87. Single-family residences are most commonly served with a _____ service line.

    a. $\frac{1}{2}$-in.
    b. $\frac{5}{8}$-in.
    c. $\frac{3}{4}$-in.
    d. 1-in.

88. A sonic meter that measures water velocity works by sending out sound pulses _____.

    a. toward the flow of the liquid, straight down the pipe
    b. alternately toward the flow, then away from the flow straight down the pipe
    c. alternately toward the flow, then away in a diagonal direction across the pipe
    d. simultaneously in both directions, straight down the pipe

89. Generally, _____, _____, and _____ pipes are ranked by utilities as the most favorable materials for maintaining water quality.

a. PTFE, PVC, concrete pressure
b. prestressed steel cylinder, ductile iron, cement-mortar-lined steel
c. PVC, concrete pressure, lined ductile iron
d. PTFE, ductile iron, cement-mortar-lined steel

90. Throttling the discharge valve to approximate system flow should be done when _____.

a. elevated storage is not available
b. it is an off-peak period
c. water usage is minimal
d. there is no check valve between the pump and discharge valve

91. All meters that operate on the principle of determining flow velocity are designed with the assumption _____ through the meter, and every manufacturer has a recommendation for the minimum straight-pipe distance that should be on _____ of a meter.

a. of laminar flow, the upstream side
b. that friction loss is minimized, either side
c. of laminar flow, either side
d. that friction loss is minimized, the upstream side

92. What type of backflow prevention device is not recommended as protection in situations in which a health hazard may result from failure?

a. Reduced-pressure zone backflow preventer
b. Double check valve
c. Air gap
d. None of the above

93. What type of distribution system piping generally runs in straight lines and has few side connections?

a. Transmission mains
b. Auxiliary lines
c. Treatment plant piping
d. Distribution mains

94. Valve vault drains should be connected to a(n) _____.

a. sanitary sewer
b. storm drain
c. absorption pit
d. nearby ditch or gutter

95. If a water tank has a volume of 3.25 MG and the flow from the tank is 6.10 mgd, what is the detention time in hours?

a. 0.787 hours
b. 0.02 hours
c. 12.8 hours
d. 1.28 hours

96. Pesticides that get into the distribution system due to a cross-connection will cause _____.

    a. nervous system damage
    b. flu-like symptoms
    c. vomiting and nausea
    d. All of the above

97. What is a disadvantage to using reinforced concrete pipe?

    a. Poor flow characteristics
    b. Needs special protection in high-chloride soils
    c. O-ring joints are difficult to install
    d. Requires extensive bedding and backfill preparation

98. How often should the anodes be inspected in a cathodic protected water storage tank?

    a. Every 6 months
    b. Annually
    c. 2–3 years
    d. 3–5 years

99. What can reduce the friction between the packing rings and the pump shaft?

    a. Polyethylene
    b. NSF-approved grease
    c. The water being pumped
    d. Graphite

100. If a meter is oversized, what could occur?

    a. The meter will over-register at high flows.
    b. The meter will under-register or not register anything at low flows.
    c. Nothing except cost the utility more for a meter that is too big.
    d. It will under-register at low flows and over-register at high flows.

101. One person should be able be to operate a hydrant using a _____ hydrant wrench, and if a longer one is needed, the hydrant should be _____.

    a. 12-in., repaired or replaced
    b. 14-in., dismantled to remove and replace the operating net and main stem
    c. 15-in., repaired or replaced
    d. 16-in., dismantled to remove and replace the operating net and main stem

102. The major disadvantage(s) of pits for water meters in cold climates is that _____.

    a. they often freeze
    b. snow can cover them, making them hard to find
    c. they can flood and thus need to be pumped out
    d. All of the above

103. What type of pipe, if dewatered rapidly, has the potential to collapse?

    a. CIP
    b. DIP
    c. Steel
    d. Unreinforced concrete

104. Meters that are 1½ and 2 in. most commonly use _____.

a. tapered meter couplings
b. regular pipe couplings
c. flanged meter couplings
d. a special meter coupling designed to provide a seat against a gasket

105. What type of pipe will use elastomeric gaskets?

a. Steel
b. Ductile iron
c. Concrete
d. High-density polyethylene

106. What is the problem with using ordinary comprehensive maps as basic layouts for a water utility?

a. They may not be accurate.
b. There is too much clutter that is not needed, making the utility updated map difficult to read.
c. The map symbols are all different and thus would need to be changed.
d. The cost savings is insignificant, thus it is best for the utility to make its own.

107. A pressure-reducing valve has two upper operating chambers sealed from each other by a _____.

a. float-operated needle valve
b. flexible, reinforced diaphragm
c. spring-loaded seat
d. throttling diaphragm

108. A cone valve has a movable internal part that is cone-shaped and is opened when the rotating _____ is turned through an angle of 90° so fluid can pass through a machined port.

a. plug
b. ball
c. cone
d. disk

109. What is the psi 15 ft above the bottom of a lake that is 367 ft deep?

a. 145 psi
b. 152 psi
c. 165 psi
d. 170 psi

110. Small motors are usually operated at _____.

a. 200/210 V
b. 220/240 V
c. 240/260 V
d. 190/200 V

111. What pipe is especially prone to sliding out of a push-on joint?

a. Ductile-iron pipe
b. Plastic encased pipeline
c. Asbestos-cement pipe
d. Unlined steel pipe

112. How much surface area is contained by a tank that has a radius (r) of 62.5 ft?

a. 196.25 ft^2
b. 12,300 ft^2
c. 24,500 ft^2
d. 24,532 ft^2

113. What can be used for relieving and preventing surges?

a. Check valves
b. Pressure-relief valves
c. Altitude valves
d. Air relief valves

114. Water storage tanks should be cleaned and inspected at least every

a. 1–2 years
b. 3–5 years
c. 6–8 years
d. 7–9 years

115. Find the volume in gallons of a trapezoidal trough that has the following dimensions:

Length = 82.1 ft

Height = 3.1 ft

Bottom width = 4.2 ft (b_1)

Top width = 7.9 ft (b_2)

a. 11,500 gal
b. 206 gal
c. 1,540 gal
d. 3,080 gal

116. Apparent water losses are caused by _____.

a. unknown leaks.
b. inaccurate meters.
c. unauthorized consumption.
d. All of the above.

117. Most control valves in the water system are intended to _____.

a. start and stop flows
b. regulate pressure and throttle flow
c. isolate piping
d. relieve pressure

118. Convert 4,994 gpm to cubic meters per second.

a. 3.15 m^3/s
b. 0.63 m^3/s
c. 0.315 m^3/s
d. 6.3 m^3/s

119. Water is flowing through a faucet at 13.9 gpm. How long will it take to fill a swimming pool in hours and minutes if the pool is 31 ft by 21 ft and averages 5.4 ft in depth?

a. 4 hours 14 min
b. 5 hours 50 min
c. 31 hours 32 min
d. 113,502 hours

120. Water is flowing at a velocity of 2.85 ft/s in an 8.0-in.-diameter pipe. If the pipe changes from the 8.0-in. to a 10.0-in. pipe, what will the velocity be in the 10.0-in. pipe?

a. 1.83 ft/s in 10.0-in. pipe
b. 14.98 ft/s in 10.0-in. pipe
c. 0.22 ft/s in 10.0-in. pipe
d. 4.45 ft/s in 10.0-in. pipe

121. What is the internal surface area of a cylindrical tank (bottom, top, and the cylinder wall), if it is 65.0 ft in diameter and 24.0 ft high? Assume the top is flat.

a. 4,898.40 ft^2
b. 6,633.25 ft^2
c. 11,531.65 ft^2
d. 23,062 ft^2

122. What type of pipe consists of one or more steel cages of welded wire fabric or helically wrapped rods welded to longitudinal rods?

a. Reinforced concrete noncylinder pipe
b. Reinforced concrete cylinder pipe
c. Bar-wrapped concrete cylinder pipe
d. Prestressed concrete cylinder pipe

123. What is effective height?

a. The total feet of head against which a pump must work
b. The distance between the centerline of a pump and the level it is pumping to, including friction and minor losses
c. The dynamic discharge head minus friction and minor losses
d. The static friction head

124. _____ is a measure of the ability of the material to bend without breaking.

a. Shear strength
b. Strain load
c. Flexural strength
d. Tensile strength

125. The plumbing within the customer's premises regarding cross-connections usually falls under the supervision of _____.

a. state and local health authorities
b. the utility
c. the USEPA
d. OSHA

126. The volume of water recorded on a turbine meter's register is _____ to the number of revolutions by the _____.

a. directly proportional, impeller
b. directly proportional, propeller
c. directly proportional, rotor
d. directly proportional, turbine

127. What is the average MG flow from a storage tank given the following data?

Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.
7.9	8.0	6.5	6.8	7.0	7.3	7.8

a. 6.3 mgd
b. 25.7 mgd
c. 7.3 mgd
d. 51.3 mgd

128. Pressure head can be described as _____.

a. the amount of energy that water possesses because of its elevation
b. the amount of energy due to velocity of flow
c. the vertical distance from point of pressure measurement to the hydraulic grade line
d. the gauge pressure due to elevation or velocity

129. Both _____ and _____ customers dislike day-to-day changes in hardness, tastes, temperature, or chemical composition.

a. commercial, industrial
b. commercial, domestic
c. industrial, domestic
d. chemical, industrial

130. If a tank has a circumference of 323 ft, what is the diameter?

a. 100 ft
b. 103 ft
c. 1010 ft
d. 1014 ft

131. Metal scrappers have on their body sections _____.

a. silicon carbide wire
b. high-carbon spring-steel blades
c. flame-hardened steel-wire blades
d. wire brushes imbedded into hardened polyurethanes

132. What type of pipe is the most difficult to tap and repair?

a. Concrete
b. Fiberglass
c. High-density polyethylene
d. Cross-linked polyethylene

133. According to best practices, what percentage of new meters should a water utility test?

a. 10%
b. 20%
c. 25%
d. 50%

134. What is the drawdown of a well if the well yields 129 gpm and the specific yield is 45 gpm/ft?

a. 0.35 ft
b. 13.7 ft
c. 287 ft
d. 5,805 ft

135. What type of distribution system piping in general has exposed piping?

a. Transmission mains
b. Storage tank facilities
c. Pump station piping
d. Distribution auxiliary piping

136. What is the heart of the information system for water utilities?

a. SCADA
b. PLCs
c. RTUs
d. Both b and c

137. What type of thrust control would be best on vertical bends?

a. Thrust anchors
b. Thrust blocks
c. Tie rods
d. Restraining fittings

138. The overflow pipe from an elevated tank should be brought down from the maximum tank level to a point about _____ off the ground surface.

a. 6 in.
b. 2 ft
c. 2.5 ft
d. 3 ft

139. After all packing rings are installed firmly, back off on the gland nuts about _____ before the pump is started.

a. 4 turns
b. 3 turns
c. 2 turns
d. 1 full turn

140. Because of the limited choice of fittings, a combination of special fittings must now be made for _____.

a. CIP
b. DIP
c. Asbestos-cement
d. Steel pipe

141. If a pump moves 435,000 gal in exactly 48 hours, how much will it move in seven hours if all other conditions remain the same?

a. 9,060 gal pumped
b. 63,400 gal pumped
c. 31,700 gal pumped
d. 18,500 gal pumped

142. What is used on the discharge side of a pump, starting next to the pump and going out?

a. A globe valve, then a check valve
b. A gate valve, then a relief valve
c. A gate valve, then a check valve
d. A check valve, then a gate valve

143. During an extremely severe winter, frost may penetrate _____ times deeper than the average winter frost depth.

a. 1.5
b. 2
c. 2.5
d. 3

144. One advantage of using mechanical seals, if operating properly, is they _____.

a. are easy to replace
b. do not have to remove the shaft and impeller from the case
c. fail very slowly, so they can be changed before complete failure
d. do not wear or damage shaft sleeves

145. A pressure relief valve is essentially just a _____ with an adjustable _____ to maintain pressure on the valve seat to keep the valve closed under normal pressure conditions.

a. globe valve, spring
b. globe valve, piston
c. altitude valve, spring
d. altitude valve, piston

146. Determine the head loss in psi for a pipe that has a water velocity of 2.95 fps.

a. 0.312 psi
b. 3.14 psi
c. 0.058 psi
d. 0.060 psi

147. The most popular pipe joint is the _____.

a. ball-and-socket joint
b. mechanical joint
c. flanged joint
d. push-on joint

148. A garden hose connected to a chemical dispenser would produce what type of potential cross-connection hazard?

a. No effect
b. Backpressure
c. Backsiphonage
d. Backpressure or backsiphonage

149. This type of pump uses closely meshed gears, vanes, or lobes.

a. Reciprocating pump
b. Rotary pump
c. Positive-displacement pump
d. Peristaltic pump

150. When testing positive-displacement meters for accuracy, how many different flows are usually used?

a. Two
b. Three
c. Four
d. Five

151. The relief valve on the discharge side of a pump is for _____.

a. protecting the pump from excessive surge pressures
b. flow control
c. pressure regulation
d. All of the above

152. Water quality design considerations for storage facilities must conform to the latest _____ and _____ standards.

a. AWWA, National Science Foundation (NSF)
b. AWWA, ANSI
c. USEPA, ANSI
d. USEPA, NSF

153. A water tank with a capacity of 2.85 MG is being filled at a rate of 1,750 gpm. How many hours will it take to fill the tank?

a. 299 hours
b. 27.1 hours
c. 0.04 hours
d. 29.9 hours

154. Turbine meters have _____, but water must be moving at sufficient speed before the _____ will start to rotate.

a. low friction loss, rotor
b. low friction loss, propeller
c. high friction loss, rotor
d. high friction loss, propeller

155. What type of pump has a relatively low initial cost but needs periodic checks to monitor impeller, packing, or mechanical seal condition?

a. Radial-flow pump
b. Mixed-flow pump
c. Axial-flow pump
d. Centrifugal pump

156. What type of pump is a multistage, mixed-flow, centrifugal pump or turbine pump with an integral or close-connected motor?

a. Submersible pump
b. Deep-well pump
c. Booster pump
d. Axial-flow pump

157. A trench that is 4.2 ft wide, 728 ft long, and 4.5 ft deep is excavated for the purpose of installing a water main. Determine the number of cubic feet and cubic yards that need to be excavated for this water main.

a. 18.9 yd^3
b. 510.3 yd^3
c. 211 yd^3
d. 510 yd^3

158. Each backflow prevention device should be tested for correct operation _____ by an individual specifically qualified for such testing and repair.

a. quarterly
b. semiannually
c. annually
d. every 2 years

159. A rectangular water storage tank is partially underground. The tank is 50.0 ft long, 24.0 ft wide, and 18.5 ft high. What is the upward force of water pressure in pounds lifting up the tank if the groundwater is 8.13 ft above the base of the tank?

a. 2.4 lb
b. 9,210 lb
c. 1,057 lb
d. 609,000 lb

160. A water tank with a capacity of 1.75 MG is being filled at a rate of 1,100 gpm. How many hours will it take to fill the tank?

a. 26.5 hr
b. 159 hr
c. 10.5 hr
d. 1,591 hr

161. In freezing climates, all hydrants should be inspected in the _____.

a. winter
b. early spring
c. late summer
d. autumn

162. Most couplings are of the _____ and require periodic maintenance, usually every _____.

a. lubrication style, 2–3 years
b. lubrication style, 6 months or at annual intervals
c. dry style, 6 months or at annual intervals
d. dry style, 2–3 years

163. Power systems in the United States operate at _____.

a. 60 cycles or 60 Hz
b. 60 cycles or 120 Hz
c. 30 cycles or 60 Hz
d. 60 cycles or 120 Hz

164. What is a serious disadvantage of using barometric loops?

a. They need high surveillance to make sure they are working properly.
b. Initial high cost
c. Too high a space requirement
d. Prevents only backpressure

165. A reduced-pressure zone backflow preventer must be included in locations where the relief port cannot _____.

a. be submerged
b. be vandalized
c. freeze
d. All of the above

166. A distribution main is defined as any pipe in the distribution system _____.

a. other than a service line
b. that is larger than 6 in
c. that is larger than 8 in
d. that is a branch for laterals that carry service lines

167. When testing current or compound meters for accuracy, how many flow rates are typically used?

a. 4
b. 6
c. 8
d. 10

168. In general, fire flow, when delivered to a fire department pumper, has a specified residual pressure of _____.

a. 20 psi
b. 25 psi
c. 35 psi
d. 40 psi

169. If the pressure head on a fire hydrant is 188 ft, what is the pressure in psi?

a. 434.3 psi
b. 81.4 psi
c. 418.0 psi
d. 88.3 psi

170. If a tank's radius is 49.8 ft, what is the area of the tank's bottom?

a. 31,150 ft^2
b. 313 ft^2
c. 1,947 ft^2
d. 7,790 ft^2

171. Fire protection for a community is based on the size of the _____.

a. mains
b. storage facilities
c. pumping facilities
d. All of the above

172. What type of booster pump is generally used in water distribution pumping?

a. Reciprocating pump
b. Positive displacement pump
c. Vertical turbine pump
d. Rotary pump

173. Water rights acquired by means of diverting and putting the water to beneficial use following procedures established by state statutes or courts would be _____.

a. appropriative rights
b. appropriation-permit system
c. correlative rights
d. riparian doctrine

174. If water flows out of a new well that taps an aquifer without the help of the pump, it is called a _____.

a. spring
b. artesian aquifer
c. artesian well
d. piezometric well

175. Customers that have a wide variation in water use should be supplied with a _____.

a. detector-check meter
b. compound meter
c. magnetic meter
d. Venturi meter

176. A 10.0-in. main line needs to be flushed. If the desired length of pipeline to be flushed is 1,625 ft, how many minutes will it take to flush the line at 50.0 gpm?

a. 10,083 min
b. 331,000 min
c. 66 min
d. 132 min

177. When a section of pipe is replaced, the new piece must have a pressure rating _____ of the piece being replaced.

a. equal to that
b. equal to or greater than that
c. greater than that
d. greater than 10%

178. What type of pump is commonly called a can pump?

a. Turbine pump
b. Jet pump
c. Mixed-flow pump
d. Double-suction pump

179. Ductile-iron pipe resembles what other type of pipe?

a. Cast-iron pipe
b. Noncylinder pipe
c. Steel pipe
d. Steel cylinder pipe

180. Determine the flow in fps if a water flow of 315 gpm is going through an 8.0-in. pipe.

a. 1.00 ft/s
b. 2.01 ft/s
c. 2.10 ft/s
d. 3.04 ft/s

181. If a tank is not tall enough to accept full system pressure without overflowing, _____ is installed. Also, flow out of this type of tank is usually _____.

a. a pressure-relief valve, restricted
b. an altitude valve, restricted
c. a pressure-relief valve, unrestricted
d. an altitude valve, unrestricted

182. Of the following, what type of pipe is still manufactured and used in the United States?

a. Cast iron
b. Ductile iron
c. Asbestos-cement
d. High-density polypropylene

183. Nitrates and nitrites that get into the distribution system due to a cross-connection will cause _____.

a. blue baby syndrome (methemoglobinemia)
b. kidney toxicity
c. liver damage
d. nervous system damage

184. When the reduced pressure zone backflow preventer is operating correctly and the _____ pressure exceeds the _____ pressure, the supply pressure opposes the _____ and keeps the valve closed.

a. supply, downstream, first check valve
b. downstream, supply, second check valve
c. supply, downstream, relief valve's spring tension
d. downstream, supply, relief valve's spring tension

Equipment Installation, Operation, and Maintenance

1. When disinfecting a pipe, the chlorine solution is usually injected through a _____ at the point where the new main connects to the existing system.

   a. corporation stop
   b. hydrant
   c. blowoff
   d. air relief valve

2. When disinfecting storage facilities using the chlorinate-and-fill method, how long should the chlorinated water stay in contact with the storage facility before filling it all the way?

   a. 2 hr
   b. 4 hr
   c. 6 hr
   d. 8 hr

3. When using a trench box, trench width should be _____ greater than the outside diameter of the pipe.

   a. 0.5–1 ft
   b. 1–2 ft
   c. 2–3 ft
   d. 3–4 ft

4. If a hydrant is taken out of service for repairs, who must be notified?

   a. The residents or businesses served by this particular hydrant
   b. The local fire department
   c. The police department
   d. The county health department

5. If a well produces 107 gpm with a drawdown of 22.5 ft, what is the specific yield in gpm/ft?

   a. 4.76 gpm/ft
   b. 2.1 gpm/ft
   c. 4.86 gpm/ft
   d. 2.38 gpm/ft

6. What are the two principal types of rotary valves?

   a. Butterfly and gate
   b. Bypass and butterfly
   c. Bypass and gate
   d. Plug and ball

7. Gaskets can be ruined by _____.

   a. dirt, oil, and excessive heat
   b. excessive exposure to sunlight
   c. ozone
   d. All of the above

8. What type of hydrant has the barrel filled with water only when the main valve is open?

   a. Dry-barrel hydrants
   b. Wet-barrel hydrants
   c. Warm-climate hydrants
   d. Flush hydrants

9. A pipe resting on a rock may break if it is weak in _____.

   a. tensile and flexural strength
   b. shear and flexural strength
   c. tensile strength
   d. shear strength and strain load

10. If a water system's unaccounted-for water loss exceeds _____, a system-wide leak survey should be conducted.

    a. 10%
    b. 15%
    c. 20%
    d. 25%

11. A _____ seat ring is a _____ ring mounted in the body of a _____, against which the moving disc of the valve closes.

    a. bronze, polished, pump
    b. stainless steel, polished, pump
    c. bronze, machined, hydrant or valve
    d. stainless steel, machined, hydrant or valve

12. In a new pipe installation, leakage is defined as the volume of water that must be added to the "full" pipeline to maintain a specific test pressure within a _____ range.

    a. 2.5-psi
    b. 5-psi
    c. 7.5-psi
    d. 10-psi

13. The operating nut on the top of a hydrant is _____-sided.

    a. three
    b. four
    c. five
    d. six

14. Flushing a newly installed pipe is done to _____.

    a. remove the high concentration of chlorine used for disinfection
    b. remove mud or soil and other debris
    c. remove entrained air
    d. All of the above

15. If the _____ is unchanged but the _____ is decreasing, it usually indicates that the _____.

    a. drawdown, static level, pump is losing efficiency
    b. static level, drawdown, pump is losing efficiency
    c. well yield, pumping water level, pump is running at too high an amperage
    d. drawdown, static level, pump is running at too high an amperage

16. Most water systems use fire hydrants that have two _____ nozzles and one _____ nozzle in which the larger nozzle is used to connect the _____.

    a. 2.5-in., 4-in., fire hose
    b. 2.5-in., 4.5-in., pumper suction hose
    c. 3-in., 4-in., fire hose
    d. 3-in., 4.5-in., pumper suction hose

17. Some lead pipe, as it gets old, will crack if flexed because it _____.

    a. polymerizes
    b. crystallizes
    c. undergoes chemical reduction
    d. undergoes chemical oxidation

18. Copper tubing used in interior plumbing is usually joined with _____, and copper that is buried is usually joined with _____.

    a. compression joints, solder joints
    b. flare joints, solder joints
    c. solder joints, flare and/or compression joints
    d. flare and/or solder joints, compression joints

19. How do operators contain the pressurized water in a wet tap?

    a. Needle valve
    b. Plug valve
    c. Flapper valve
    d. Gate valve

20. The most important purpose that backfill serves is to _____.

    a. distribute surface loads
    b. protect pipe from corrosion and other damage
    c. to keep the pipe in place
    d. to prevent the pipe from pulling apart or from thrust

21. What type of hydrants have the main valve controlling flow to all the outlet nozzles, and there is no drain mechanism?

    a. Flush hydrants
    b. Warm-climate hydrants
    c. Wet-barrel hydrants
    d. Corey hydrants

22. The valves on newer style curb stops are _____.

    a. ball valves
    b. gate valves
    c. plug valves
    d. poppet valves

23. Why is it best to perform a hydrant-flushing program at night besides causing less traffic disruption?

    a. Flushing at night will take less time
    b. Fewer customer complaints
    c. Because Storage levels will not drop anywhere like during the day
    d. Water demand is much less at night

24. If special trench bedding material is required for a pipe installation, it should be clean, _____, granular material up to _____ in size.

    a. uniformly graded, ½ in.
    b. well-graded, ½ in.
    c. uniformly graded, 1 in.
    d. well-graded, 1 in.

25. The transmission of sounds is best in _____ and _____, whereas they are the worst in _____ and _____.

    a. copper, asbestos, plastic, concrete
    b. cast iron, ductile iron, plastic, asbestos cement
    c. copper, steel, asbestos cement, concrete
    d. steel, ductile iron, plastic, concrete

26. What type of soil transmits the best noise?

    a. Sandy soils
    b. Loamy soils
    c. Clay soils
    d. Organic silty soils

27. On a 90° or 45° pipe bend, if shackle rods are used, they should be placed in _____ and be on the _____ of the bend.

    a. undisturbed soil, inside
    b. undisturbed soil, outside
    c. concrete blocks, inside
    d. concrete blocks, outside

28. Pipe _____ breakage may occur when a force exerted on a pipe exceeds the material's _____ or _____ strength.

    a. fatigue, strain, shear
    b. ductile, strain, tensile
    c. shear, tensile, flexural
    d. stress, shear, flexural

29. What kinds of methods are used to place grout in the annular space between the well face and the casing?

    a. Tremie pour and pumping
    b. Tremie pour and dump bailer
    c. Dump bailer, pumping, and water-pressure driving
    d. All of the above

30. The most common means of disinfecting water mains is the use of _____.

    a. liquid chlorine
    b. gas chlorine
    c. calcium hypochlorite
    d. sodium hypochlorite

31. Most corrosive characteristics and conditions affect the _____ of a soil.

    a. neutrality
    b. electrical resistivity
    c. alkalinity
    d. acidity

32. This type of valve reduces the differential pressure across the closed disk and makes the main valve easier to open and close.

    a. Inserting valve
    b. Pressure-reducing valve
    c. Relief valve
    d. Bypass valve

33. What is an advantage for installing a meter pit in areas with deep frost?

    a. The concrete box rarely floods.
    b. Heavy lid construction prevents vehicle damage.
    c. It eliminates entry into the building.
    d. It is easy to locate in the snow due to the metal lid.

34. The compaction of soil in a trench should be done on the _____ backfill if native soil is used and it is relatively _____.

    a. upper, coarse
    b. upper, dense
    c. lower, coarse
    d. lower, dense

35. If a fire hydrant is used to test a new pipeline installation for leakage and pressure, what extra piece of equipment is needed?

    a. Positive-displacement pump
    b. Accurate water meter
    c. Double check valve
    d. A second pressure gauge on hydrant

36. What method of dechlorination has the disadvantages of possibly overdosing, under dosing, and being hard to tell when the chemical has been depleted?

    a. Venturi injection system
    b. Spray feed systems
    c. Flow-through systems
    d. Gravity feed

37. In the slug method for disinfecting a pipe, the chlorine concentration of at least _____ should be used, and the flow rate should be such that the slug remains in contact with each point on the pipe for at least _____ as it passes through the main.

    a. 200 mg/L, 3 hr
    b. 200 mg/L, 4 hr
    c. 300 mg/L, 3 hr
    d. 300 mg/L, 4 hr

38. This type of pump generates high-velocity water and has relatively low cost and maintenance.

    a. Reciprocating pump
    b. Submersible pump
    c. Centrifugal-jet pump
    d. Deep-well pump

39. A well has a depth of 306.1 ft. If the depth to water is 124.7 ft, what is the pressure in psi at 5.8 ft above the bottom? Disregard the additional atmospheric pressure in the well.

    a. 79 psi
    b. 13 psi
    c. 76 psi
    d. 175 psi

40. The pumping water level in a well is 106.4 ft. If the drawdown was 14.2 ft, what must have been the static water level in the well?

    a. 120.6 ft
    b. 113.5 ft
    c. 106.4 ft
    d. 92.2 ft

41. Old pipes should be cleaned if they show signs of _____.

    a. bacterial slime growth
    b. deposits of iron bacteria
    c. tuberculation
    d. All of the above

42. What usually accounts for most of the energy used in water supply when gravity cannot be used?

    a. Valving
    b. Pumping
    c. Lighting
    d. Fuel for vehicles

43. If a trench is 112 ft long, 4.5 ft wide, and 5.9 ft deep, how many cubic yards of soil were excavated?

    a. 84 yd^3
    b. 110 yd^3
    c. 2,974 yd^3
    d. 109,164 yd^3

44. The upper barrel section of a hydrant is often called the _____ section or head.

    a. nozzle
    b. barrel
    c. main valve
    d. operating

45. If there are small rocks in the soil or the soil is unstable, it is often specified before laying down new pipe that special granular bedding material be laid down first. How thick should this granular material be?

    a. 2–4 in.
    b. 4–6 in.
    c. 8–10 in.
    d. 10–12 in.

46. These are normally located in the safety switch just ahead of the starter.

    a. Frequency relays
    b. Fuses or circuit breakers
    c. Reverse-current relays
    d. Phase reversal relays

47. Small drilling machines are used to connect service lines _____ or smaller.

    a. 2 in.
    b. 2.5 in.
    c. 4 in.
    d. 6 in.

48. The primary factor affecting power requirements for pumps is _____.

    a. pipe friction losses
    b. head
    c. amperage rating
    d. flow

49. Service lines that are more than 2 in. in diameter are usually made of _____.

    a. PVC
    b. galvanized iron
    c. high-density polyethylene
    d. the same material as water main materials

50. Compared to PVC, polyethylene pipe is _____.

    a. stronger
    b. susceptible to UV radiation like PVC
    c. expansive under the action of freezing but will not fracture
    d. not very ductile and flexible

51. What type of soil is the worst for transmitting noise?

    a. Loamy soil
    b. Clay soils
    c. Silty soils
    d. Sandy soils

52. What determines the size of a service pipe?

    a. The quantity of water required
    b. The residual pressure required by the customer
    c. The pressure in the main
    d. All of the above

53. When confirming that a well will produce at its design capacity, drawdown measurements are initially measured and recorded every _____ during the first hour, then at gradually longer intervals, typically at _____ intervals as the test progresses.

a. 1 min, 10-min
b. 1 min, 15-min
c. 5 min, 15-min
d. 5 min, 30-min

54. The bottom of a trench for drinking water installation should have _____.

a. blocks for the pipe bells with compacted topsoil material underneath
b. earth pads for the pipe to rest on
c. compacted soil so the barrel of the pipe has continuous firm support
d. clay installed under the pipe bells

55. A well produces 121 gpm. If the drawdown for the well is 13.8 ft, what is the specific yield in gpm/ft?

a. 1,670 gpm/ft
b. 107 gpm/ft
c. 1.17 gpm/ft
d. 8.77 gpm/ft

56. Butterfly valves can be used for throttling under _____ and _____ conditions.

a. low-flow, low-pressure
b. low-flow, high-pressure
c. high-flow, low-pressure
d. high-flow, high-pressure

57. In general, the rate of chlorine application for disinfecting a newly installed pipe should result in a uniform free chlorine concentration of _____ at the end of the section being treated.

a. 2 mg/L
b. 10 mg/L
c. 25 mg/L
d. 50 mg/L

58. Mechanical joints _____.

a. do not allow very much deflection
b. are more expensive than push-on joints
c. take longer to assemble than push-on joints
d. Both b and c

59. This type of pipe is no longer installed in the United States.

a. Ductile-iron pipe
b. Noncylinder reinforced concrete pressure pipe
c. Gray cast-iron pipe
d. High-density polyethylene pipe

60. In a pressure tap for a main, the cut is referred to as a _____, and it should be _____.

    a. coupon, saved for checking its condition
    b. plug, saved for checking its condition
    c. slug, discarded to an appropriate landfill
    d. slug, analyzed for chemical contamination

61. Simply flooding the backfilled or partially backfilled trench will result in good compaction only when _____.

    a. granular material with few fines is being used
    b. the native soil is being used, except if it is mostly clay
    c. a mixture of clay and silt is being used
    d. a mixture of clay and sand is being used

62. Where should vibration readings be taken?

    a. As low on the pump shaft as possible
    b. Top or bottom of pump's casing
    c. As high on the pump shaft as possible
    d. On the shaft, in or near the bearings

63. What type of hydrants have no main valve?

    a. Dry-barrel hydrants
    b. Slide-gate hydrants
    c. Wet-barrel hydrants
    d. Warm-climate hydrants

64. PVC can use bends, tees, and other fittings for _____ because they have the same outside diameter.

    a. cast-iron pipe
    b. ductile-iron pipe
    c. prestressed steel cylinder
    d. reinforced concrete pressure pipe

65. This chemical feed method of dechlorination has the best reproducible results.

    a. Gravity feed
    b. Chemical metering pump
    c. Venturi injector system
    d. Spray feed systems

66. The easiest leak to detect with an electronic amplifier is _____.

    a. a small leak
    b. a moderate leak
    c. a large leak
    d. leaks of any size using this device

67. Ground-probing radar has a disadvantage of _____.

    a. working only under certain soil conditions
    b. requiring special expertise to interpret the results
    c. being very expensive
    d. All of the above

68. At what percentage slope inclination do contractors find it easier to lay the pipe during an installation with the bells facing uphill?

a. 6%
b. 10%
c. 12%
d. 15%

69. It may take 30 min or more to fully open or close this type of large valve.

a. Horizontal gate valve
b. Rising stem gate valve
c. Nonrising-stem gate valve
d. Slide gate valve

70. Flushing a pipe after installation requires a flow velocity of at least _____ and preferably _____.

a. 1.5 ft/s, 2.0 ft/s
b. 2.0 ft/s, 2.5 ft/s
c. 2.0 ft/s, 3.0 ft/s
d. 2.5 ft/s, 3.5 ft/s

71. What type of valve is a specially designed gate valve used to connect a new water main to an existing main under pressure?

a. Cutting-in valve
b. Tapping valve
c. Inserting valve
d. Slide-in valve

72. What pressure is recommended for testing a hydrant?

a. 150 psi
b. 200 psi
c. 250 psi
d. 300 psi

73. In a pipe installation that is not yet complete, the open end should be _____.

a. wrapped in paper to keep out dirt, groundwater, if any, and animals
b. wrapped in plastic with plywood over the end for added strength
c. plugged with the standard type of pipe material that is being used
d. Screened off using a $\frac{1}{4}$-in. screen

74. What type of valve is used only when service is being initiated or discontinued?

a. Auxiliary valves
b. Gate valves
c. Curb stops
d. Corporation stops

75. Currently, what type(s) of plastic is (are) generally used for water services?

a. Polybutylene
b. Polyvinyl chloride
c. Polyethylene
d. Both b and c

76. The slug method is usually used for _____.

    a. small-diameter mains
    b. large-diameter mains
    c. PVC pipe
    d. cement or ductile-iron pipe

77. Underwater inspection of storage facilities by divers or submersible equipment should follow _____.

    a. ANSI/NSF Standard C652
    b. ANSI/NSF Standard C653
    c. ANSI/AWWA Standard C652
    d. ANSI/AWWA Standard C653

78. Before installing the sleeve around the break of a main pipe, _____.

    a. take a picture of the leak
    b. thoroughly clean the exterior of the pipe
    c. disinfect the sleeve
    d. loosen the bolts on the sleeve

79. _____ should be coated and provided with cathodic protection under _____ soil conditions.

    a. Cast iron, essentially all
    b. Steel pipe, essentially all
    c. Cast iron, most
    d. Steel pipe, most

80. _____ are provided on starters to prevent the pump motor from burning out if abnormal operating conditions increase the load beyond the pump's design.

    a. Overcurrent relays
    b. Thermal-overload relays
    c. Circuit breakers
    d. Fuses

81. According to best practices, hydrants should be set back from the curb at least _____.

    a. 2 ft
    b. 2.5 ft
    c. 3 ft
    d. 4 ft

82. The type of auxiliary valve most often used is directly connected to the hydrant by _____; one _____ of this arrangement is that the valve _____ separate from the hydrant.

    a. a flanged connection, disadvantage, can
    b. a flanged connection, advantage, cannot
    c. shackle rods, disadvantage, can
    d. shackle rods, advantage, cannot

83. Lead (Pb) service lines are now being eliminated _____.

a. whenever reasonably possible
b. after they start leaking
c. by USEPA mandate, Title 22, Section 41
d. by the USEPA Lead and Copper Rule

84. On a new pipe installation leak test, what is the preferred method for measuring makeup water volume?

a. A centrifugal pump
b. A calibrated makeup reservoir
c. A water meter
d. A pitot tube

85. During an excavation to install a water line, what do operators need to be very careful of because it often looks like a tree root?

a. Gas line
b. Galvanized pipe
c. Fiber optics
d. Electrical line

86. In regards to trench excavations, tills with low moisture content would be most similar to _____.

a. gravel
b. silts
c. clays
d. sands

87. Flare fittings are available for connecting lengths of _____ and adapting to _____. The same fittings can also be used for _____ of the same dimensions.

a. plastic pipe, iron pipe thread, ductile-iron threads
b. copper tubing, iron pipe thread, plastic pipe
c. copper tubing, ductile iron, stainless steel
d. plastic pipe, stainless steel, iron pipe

88. This type of valve is not designed to regulate or throttle water flow.

a. Globe valve
b. Gate valve
c. Plug valve
d. Needle valve

89. After about _____ of initial full-service operation on a new pump, or as directed by the manufacturer, all bearings should be regreased.

a. 2 weeks
b. 1 month
c. 2 months
d. 3 months

90. The line on the spigot end of push-on joints needs to be pushed "home" such that the line _____, when the joint is set completely, and the _____ end of the push-on joint is the end that is beveled.

    a. just disappears into the bell, spigot
    b. is all the way to the face of the bell, spigot
    c. just disappears into the bell, inside the bell
    d. is all the way to the face of the bell, inside the bell

91. After a new pipeline has passed the bacteriological tests, the highly chlorinated water should be flushed until the water exiting the pipe has a chlorine residual of _____.

    a. no greater residual than the feedwater
    b. less than 2.5 mg/L
    c. less than 4.0 mg/L
    d. less than 5.0 mg/L

92. An operator knows the water table is falling if the _____.

    a. drawdown remains the same but the static level drops
    b. drawdown is decreasing but the recovery time is increasing
    c. drawdown is increasing but the specific capacity is decreasing
    d. well yield is increasing and the recovery time is decreasing

93. The _____ thread has a _____ diameter and a steeper taper, which gives it greater strength than the _____ thread.

    a. iron-pipe, smaller, Mueller
    b. Mueller, smaller, iron-pipe
    c. Mueller, larger, iron-pipe
    d. iron-pipe, larger, Mueller

94. Critical pump equipment that is operated continuously may require _____ inspections; less critical pump equipment may be inspected _____.

    a. weekly, quarterly
    b. monthly, annually
    c. annually, biannually
    d. quarterly, annually

95. In a major leak, the first consideration is to _____.

    a. shut the line down
    b. partially or totally shut the line down
    c. try to first repair the leak with the pipe under pressure to prevent any backflow into the system
    d. inform the fire department and police

96. If a dead-end main is at least _____ in diameter and has sufficient _____, a fire hydrant should be installed _____ of the pipe.

    a. 4 in., pressure, at the end
    b. 6 in., pressure and flow, at the end
    c. 4 in., pressure and flow, near or at the end
    d. 6 in., pressure, near or at the end

97. If a pipe disinfection test fails to meet minimum standards during the first test, what should be done?

a. The water should be tested again.
b. Disinfect the pipe again.
c. Add more disinfectant and test again.
d. Repeat the entire disinfection procedure.

98. Internal combustion coolant should be checked with a _____, and if the coolant is low, _____ should be added, but never add _____.

a. reflectometer, antifreeze, acidic water
b. hydrometer, antifreeze and/or water, acidic water
c. refractometer, water, acidic water
d. hydrometer, antifreeze and/or water, alkaline water

99. What pipe quality provides for long life, toughness, and the ability to maintain tight joints with little or no maintenance?

a. Corrosion resistance
b. Strength
c. Pressure rating
d. Durability

100. After a new pipe has been laid in a trench, it should first be _____.

a. partially backfilled
b. completely backfilled
c. tested to see if there are any leaks
d. tested to see if it holds the pressure and if there are any leaks

101. The fuel level in emergency generators needs to be monitored very frequently, especially for _____ because running out of fuel can cause major damage to the _____ systems.

a. diesel, fuel-injection
b. gasoline, fuel pump and electrical
c. diesel, fuel pump and electrical
d. gasoline, fuel injection

102. Long-radius bends for steel pipe can also be made in smaller-sized pipe by the use of _____.

a. wrinkle bending
b. a hydraulic bender
c. prefabricated bends by the manufacturer
d. a hickey bender

103. Backfill for a newly installed pipe above the springline varies depending on _____.

a. the regulatory requirements
b. type of valves used
c. type of connections used
d. the utility's SOPs

104. In a trenchless main replacement, what type of installation system is used?

    a. Static bursting
    b. Pneumatic
    c. Hydraulic
    d. All of the above

105. After the first oil change for a pump motor, future oil changes should be performed every _____ depending on manufacturer recommendations, operating frequency, and _____.

    a. 6–12 months, environmental conditions
    b. 6–12 months, pump type
    c. 1–2 years, environmental conditions
    d. 1–2 years, pump type

106. To make sure there are no voids or high spots in the bedding of a trench, the operator should use _____.

    a. laying blocks
    b. a grading level
    c. a leveling board
    d. a story pole

107. When testing a hydrant at full flow, it is best to use a _____.

    a. hose that is laid down in the gutter or a ditch
    b. diffuser
    c. rigid pipe angled down
    d. gate valve

108. Well surging will dislodge fine material from the _____, and a _____ will remove the fines.

    a. well face, tremie
    b. well face or screen, bailer
    c. screen, tremie
    d. gravel pack and screen, pump

109. What is the most common cause of pipe joint failure?

    a. Misalignment
    b. Not clean
    c. Gasket missing
    d. Not fully driven "home"

110. What can an air pocket in a water main cause?

    a. Cavitation
    b. Water hammer
    c. Restricted flow
    d. Eventual corrosion in that area

111. Before pressure and leakage tests are done for a new pipe installation, allow at least _____ for the concrete used for thrust blocks to cure.

a. 2 days
b. 5 days
c. 7 days
d. 10 days

112. Storage tank screens can become clogged, usually with_____, so tanks should also have _____ to relieve excess _____ if the screens become blocked.

a. ice, flap valves, corrosion-causing chlorine moisture and pressure
b. plant debris, air-and-vacuum valves, corrosion-causing chlorine moisture and pressure
c. ice, flap valves, pressure and vacuum
d. plant debris, air-and-vacuum valves, pressure and vacuum

113. Valves stored outside in freezing climates should be _____ and have their disks in a _____ position.

a. closed, horizontal
b. open, vertical
c. closed, vertical
d. open, horizontal

114. A water audit is usually done by most utilities over a period of _____.

a. 1 week
b. 1 month
c. 1 quarter
d. 1 year

115. Electronic listening devices for finding leaks use _____.

a. geophones
b. aquaphones
c. amplifiers
d. an acoustic analyzer

116. _____ hydrants installed at the same time as a new main _____ be pressure-tested along with the main, and the hydrant's auxiliary valves should be _____ during the main pressure test.

a. Only wet-barrel, should not, closed
b. New, should not, closed
c. New, should, open
d. All, should, open

Disinfection Monitoring, Evaluation, Adjustment, and Laboratory Analysis/ Interpretation

1. A pipe that is 3.00 ft in diameter and 1,040 ft long is to be disinfected with 65.0% calcium hypochlorite [$Ca(OCl)_2$] tablets that are glued with an NSF-approved glue to the top of the pipe as it is emplaced in the trench. If the desired dose is 50.0 mg/L, how many pounds of calcium hypochlorite are required?

   a. 32.7 lb of $Ca(OCl)_2$
   b. 35.3 lb of $Ca(OCl)_2$
   c. 37.1 lb of $Ca(OCl)_2$
   d. 38.8 lb of $Ca(OCl)_2$

2. What was the primary reason that the USEPA promulgated the final Ground Water Rule in October 2006?

   a. Arsenic contamination
   b. Radon contamination
   c. Nitrites contamination
   d. Fecal contamination

3. What is the principal trihalomethane?

   a. Chloroform
   b. Bromodichloromethane
   c. Dibromochloromethane
   d. Bromoform

4. A meter being tested by a laboratory shows a reading of 118.4 ft^3. A volumetric tank used to measure the water that flowed through the meter indicates the actual volume as 900.1 gal. What is the percentage accuracy of the meter?

   a. 7.6% meter accuracy
   b. 13.2% meter accuracy
   c. 98.39% meter accuracy
   d. 86.8% meter accuracy

5. What water quality problem can be considered both a chemical and biological issue?

   a. Nitrification
   b. Color
   c. *E. coli*
   d. Tastes and odors

6. Nitrification can lead to disinfectant residual decay and result in growth of bacteria and a(n) _____.

   a. increase in pH
   b. increase in alkalinity
   c. reduction in oxygen
   d. reduction in nitrogen

7. Controlling lead leaching in the pH range of 6–9 pH units generally requires the dissolved inorganic carbon to be greater than _____.

   a. 2 mg/L
   b. 2.5 mg/L
   c. 3.5 mg/L
   d. 5 mg/L

8. In the Ground Water Rule, systems found to be at high risk for fecal contamination are required to provide _____ inactivation of _____.

   a. 2-log, *Cryptosporidium*
   b. 4-log, viruses
   c. 4-log, *Cryptosporidium*
   d. 2-log, viruses

9. What is the dosage in mg/L for a treatment plant that uses 318 lb/d of chlorine and treats 23.4 ft^3/s?

   a. 2,542.0 mg/L
   b. 0.40 mg/L
   c. 175.4 mg/L
   d. 2.52 mg/L

10. A pipe that is 2.5 ft in diameter and 4,408 ft long is to be disinfected with 12.5% sodium hypochlorite solution. If the desired dose is 25.0 mg/L, how many gallons of sodium hypochlorite are needed? Assume the hypochlorite solution weighs 10.34 lb/gal.

    a. 18.8 gal of NaOCl
    b. 23 gal of NaOCl
    c. 26 gal of NaOCl
    d. 29.6 gal of NaOCl

11. Chloramine produces a _____, and it is also, compared to chlorine, relatively _____ for _____.

    a. short-lasting residual, ineffective, inactivating most cyst-forming bacteria
    b. lower concentrations of THMs, ineffective, inactivating *Giardia*
    c. higher concentration of DBPs, ineffective, inactivating most cyst-forming bacteria
    d. long-lasting residual, effective, *Giardia*

12. How many calcium hypochlorite tablets, each weighing 0.42 lb, are needed to disinfect a water main given the following information:

Length of pipe = 1,865 ft	Pipe diameter = 3.0 ft
Calcium hypochlorite = 65.0% available chlorine	Dosage required = 50.0 mg/L

    a. 148 tablets of $Ca(OCl)_2$
    b. 151 tablets of $Ca(OCl)_2$
    c. 156 tablets of $Ca(OCl)_2$
    d. 163 tablets of $Ca(OCl)_2$

13. What must have been the chlorine dose if 22.6 gal of a 9.5% sodium hypochlorite solution was used to treat 725,000 gal of water?

    a. 2.96 mg/L
    b. 3.12 mg/L
    c. 3.3 mg/L
    d. 3.50 mg/L

14. What is the National Secondary Drinking Water Regulation for aluminum?

    a. 0.01–0.05 mg/L
    b. 0.05–0.2 mg/L
    c. 0.1–0.3 mg/L
    d. 0.1–0.5 mg/L

15. As a new 24.0-in.-diameter pipe that is 1,248 ft long was installed, 64.5% calcium hypochlorite [$Ca(OCl)_2$] tablets were taped to the top of the pipe. If a total of 12.25 lb were used, what must have been the dosage as calcium hypochlorite purity?

    a. 50.1 mg/L of $Ca(OCl)_2$
    b. 50.8 mg/L of $Ca(OCl)_2$
    c. 51.7 mg/L of $Ca(OCl)_2$
    d. 54.9 mg/L of $Ca(OCl)_2$

16. How many calcium hypochlorite tablets are needed to disinfect a water main given the following information:

    Length of pipe A = 1,015 ft
    Pipe A diameter = 2.00 ft
    Length of pipe B = 1,347 ft
    Pipe B diameter = 1.50 ft
    Calcium hypochlorite = 65.0% available chlorine
    Dosage required = 50.0 mg/L
    Each tablet is 0.42 lb

    a. 58 tablets
    b. 60 tablets
    c. 62 tablets
    d. 64 tablets

17. What is (are) the nitrification indicator parameter(s) that should be monitored for utilities that use chloramine?

    a. Nitrate
    b. Gram-positive coliforms
    c. Heterotrophic plate counts
    d. Ammonia-to-TOC ratio

18. The main objective of the Lead and Copper Rule is to _____.

    a. apply enhanced coagulation if out of compliance
    b. control corrosiveness of the finished water
    c. make facilities increase source water treatment for preventative measures
    d. apply cathodic protection throughout the distribution system

19. A storage tank that is going to be put back in service requires disinfection at a dosage of 50 mg/L. If the tank has a diameter of 105 ft and is 32.5 ft in height at the overflow, how many gallons of a 12.5% sodium hypochlorite (NaOCl) solution are needed if the tank will only be filled to 10%? Give answer to the nearest gallon.

    a. 80 gal of NaOCl
    b. 81 gal of NaOCl
    c. 83 gal of NaOCl
    d. 84 gal of NaOCl

20. What parameter would not indicate a water quality problem with direct potential to impact public health?

    a. Disinfectant decay
    b. Sediment deposition
    c. Nitrification
    d. Tastes and odors

21. The frequency of sampling for contaminants, including microbiological contaminants, depends on several factors. What is one of these factors?

    a. Size of the water system
    b. Type of treatment chemicals used
    c. Treatment process
    d. Service connections

22. A disinfection profile must be prepared by water systems with TTHM or HAA5 that have annual distribution levels of _____ or _____, respectively, or higher, and they will also consist of daily _____ log inactivation.

    a. 0.60 mg/L, 0.40 mg/L, *Giardia lamblia*
    b. 0.60 mg/L, 0.40 mg/L, *Cryptosporidium*
    c. 0.64 mg/L, 0.48 mg/L, *Giardia lamblia*
    d. 0.64 mg/L, 0.48 mg/L, *Cryptosporidium*

23. This measurement (These measurements) can provide a sensitive measure of water quality in the distribution system.

    a. Chlorine residual
    b. pH
    c. Turbidity
    d. All of the above

24. Lead is hazardous if consumed in _____, particularly for _____.

    a. even very low amounts, children
    b. high amounts, children
    c. even very low amounts, adults
    d. high amounts, adults

25. A sodium hypochlorite solution is being pumped from a small day tank that is 3.5 ft in diameter. If the level in the tank drops 0.35 ft in 24.0 HR, how many milliliters per minute of hypochlorite solution was used? Make sure to use the appropriate number of significant figures in your answer.

    a. 66 mL/min
    b. 66.17 mL/min
    c. 66.2 mL/min
    d. 70 mL/min

26. What should the setting be on a chlorinator in pounds per day if the dosage desired is 3.25 mg/L and the pumping rate from the well is 735 gpm?

    a. 20.1 lb/d of chlorine
    b. 8.83 lb/d of chlorine
    c. 239.4 lb/d of chlorine
    d. 28.7 lb/d of chlorine

27. When disinfecting storage facilities using the surface application method, how long should the applied disinfection be in contact with all surfaces before potable water is introduced into the tank?

    a. 30 min
    b. 1 hr
    c. 2 hr
    d. 8 hr

28. Chloramine residuals can undergo _____ over time, releasing _____, which can promote nitrification.

    a. auto decomposition, nitric oxide
    b. biological decomposition, nitrogen
    c. auto decomposition, ammonia
    d. biological decomposition, nitrate

29. What would not require sample collection and analysis in the distribution system?

    a. Taste and odor
    b. Disinfectant residual
    c. Discoloration
    d. Water temperature approaching ambient temperature

30. The most serious example of water changing in the distribution system from the water that entered the system at the water plant is _____.

    a. bacterial growth
    b. algae growth
    c. cross-connection
    d. corrosion by products

31. With regard to the Revised Total Coliform Rule under the treatment technique for _____, _____ serves as an indicator of the potential pathway of contamination into the distribution system.

    a. coliform, total coliform
    b. fecal coliform, coliform
    c. fecal coliform, total coliform
    d. *E. coli*, coliform

32. When disinfecting a new pipeline using the chlorine tablet or granule methods, it cannot be used on _____ pipe.

a. CIP
b. screwed-joint steel
c. solvent-welded plastic
d. Both b and c

33. How many pounds of high test hypochlorite (HTH) are needed to make exactly 500 gal of a 10.0% HTH solution?

a. 388 lb of HTH
b. 395 lb of HTH
c. 406 lb of HTH
d. 417 lb of HTH

34. The Total Coliform Rule requires _____ sampling at each distribution sampling point.

a. weekly
b. monthly
c. quarterly
d. routinely, as per public health department,

35. Most violations of water regulations are caused by _____.

a. hiding results or falsification of records
b. not understanding requirements
c. turning off the flow to the combined filter turbidity meter
d. bumping the filters

36. A small tank containing 8,500 gal of water needs to be disinfected to be put back in service. If the dosage needed is 50 mg/L, how many pounds of sodium hypochlorite (NaOCl) that has 12.5% available chlorine are required?

a. 12 lb of sodium hypochlorite
b. 24 lb of sodium hypochlorite
c. 28 lb of sodium hypochlorite
d. 2,800 lb of sodium hypochlorite

37. In _____ systems, _____ formation is limited.

a. chloramination, HAA5
b. chloramination, TTHM
c. chlorine dioxide, HAA5
d. chlorine dioxide, TTHM

38. In the full storage facility chlorination method using sodium hypochlorite, the hypochlorite should be poured into the tank when the water reaches a level of _____ deep, if possible.

a. 1–3 ft
b. 4–5 ft
c. 5–6 ft
d. about 10 ft

39. If 18 lb of soda ash are mixed with 75 gal of water, what will be the percentage of soda ash in the resulting slurry?

    a. 2.8% soda ash slurry
    b. 23.35% soda ash slurry
    c. 2.9% soda ash slurry
    d. 0.28% soda ash slurry

40. What is the most important measurement of water quality in the distribution system?

    a. Turbidity
    b. Temperature
    c. pH
    d. Chlorine residual

41. What is the smallest particle that still retains the characteristics of an element?

    a. Proton
    b. Molecule
    c. Atom
    d. Nucleus

42. Forty-five pounds of soda ash is dissolved in 155 gal of water to produce a desired concentration. How many pounds of soda ash are needed to make the same desired concentration if exactly 100 gal of water is used?

    a. 29.0 lb of soda ash
    b. 69.75 lb of soda ash
    c. 14.5 lb of soda ash
    d. 3.4 lb of soda ash

43. A level _____ sanitary assessment is triggered if a public water source has _____ of the routine and repeat monthly samples as total coliform positive.

    a. 1, 5% or more
    b. 2, 5% or more
    c. 2, more than 5%
    d. 1, more than 5%

Security, Safety, Administrative Procedures, and Public Interactions

1. If _____ tie-rods are used for restraining pipe, they should be coated or covered for protection against corrosion.

    a. stainless steel
    b. brass
    c. nonalloyed carbon steel
    d. aluminum

2. Who is required to correct workplace hazards?

    a. OSHA
    b. The employee
    c. The supervisor
    d. The employer

3. Thrust anchors are usually used when _____.

   a. soil has been disturbed such that a concrete block will not work
   b. time and cost need to be reduced
   c. there is a horizontal bend in the pipe
   d. there is a vertical bend in the pipe

4. What is the primary symptom(s) of salmonellosis?

   a. Vomiting
   b. Severe diarrhea
   c. Severe intestinal cramps
   d. High fever and diarrhea causing dehydration

5. The main reason to test hydrants and record all information is to _____.

   a. protect the public
   b. maintain the hydrants in good working order
   c. protect the operator's job
   d. Both a and b

6. When a distribution operator is confronted with the media due to a problem, it is best to _____.

   a. offer as much information as possible
   b. be detailed
   c. refer to local utility policy
   d. All of the above

7. Compliance with AWWA Standards is _____, and products _____ AWWA approved.

   a. mandatory, have never been
   b. encouraged, have never been
   c. encouraged, are always tested first to be
   d. mandatory, are always tested first to be

8. The aesthetic qualities of water include _____.

   a. taste, color, and odor
   b. DPBs and iron
   c. turbidity and pathogenic organisms
   d. pathogenic organisms, taste, and odor

9. What is the most likely threat to a drinking water system?

   a. Physical threat
   b. Biological threat
   c. Chemical threat
   d. Natural threat

10. Records indicate that the greatest number of accidents in the water industry involve _____.

    a. the weather
    b. vehicles
    c. chlorine gas
    d. confined space

11. It is of greatest importance that chemicals used to treat water do not cause _____.

    a. side effects that endanger public health
    b. tastes and odors
    c. color
    d. corrosion

12. What USEPA regulation requires consumer confidence reports to be provided to its customers?

    a. Public Notification Rule
    b. Contaminant Monitoring Rule
    c. SDWA, 1996 Amendment
    d. Surface water Treatment Rule, 1975

13. A list of vulnerabilities was determined by a _____-mandated assessment of SCADA systems for a number of large utilities in the United States.

    a. Homeland Security
    b. USEPA
    c. NSA
    d. CIA/FBI

14. Threats to a water distribution system have varying probabilities of occurring. What threat would *least* likely occur from the following?

    a. Terrorism
    b. Vandalism
    c. System aging
    d. Natural disasters

15. During an extended water outage, a temporary waterline may be used. What pipeline materials are approved?

    a. Fire hoses or rubber hoses
    b. Steel or fire hose
    c. PVC or polyethylene
    d. Polyethylene or rubber hoses

16. When traffic control is required for a pipe repair or installation, the cone taper length depends on _____.

    a. lane width
    b. traffic volume
    c. weather conditions
    d. length of time of lane closure

17. For electrical fires, use _____, but never use _____.

    a. carbon dioxide or dry powder, water or soda-acid
    b. dry powder or soda-acid, water or carbon dioxide
    c. dry powder, carbon dioxide, or soda-acid; water
    d. carbon dioxide, water or dry powder

18. Another name for shielding is _____.

    a. drag shield
    b. drag box
    c. sand shield
    d. All of the above

19. As required under the _____ Act, a drinking water utility serving more than _____ persons must do a vulnerability assessment update or complete an emergency response plan and certify these to the USEPA.

    a. Bioterrorism, 3,300
    b. Cyber Terrorism, 3,300
    c. Physical Terrorism, 10,000
    d. Chemical Terrorism, 10,000

20. The primacy agency in each state is designated by the _____, and the primacy agency can be _____.

    a. governor; the particular state's EPA
    b. USEPA; Department of Natural Resources
    c. state health department; Department of Natural Resources
    d. USEPA; the particular state's public health department

21. Wide trenches should be avoided for small-diameter pipe if at all possible, particularly in _____ soils.

    a. hard clay
    b. silty
    c. sandy
    d. hard pan

22. What regulation requires sanitary surveys?

    a. SWTR
    b. IESWTR
    c. Public Notification Rule
    d. Lead and Copper Rule

23. What soils can be easily and safely excavated?

    a. Calcareous sand
    b. Firm clays and tills with low moisture content
    c. Wet silts
    d. Sand with high moisture content

24. When digging in firm soil, there is a tendency to make the trench too _____.

    a. steep
    b. wide
    c. deep
    d. long

25. Before a confined space is entered, an employer is required to have _____.

    a. a first aid kit, defibrillator, water, and food
    b. testing, monitoring, and ventilation equipment
    c. lighting, barriers, ladders, and personal protective equipment as needed for the particular confined space
    d. Both b and c

26. Natural disasters, such as earthquakes and floods, need contingency plans that are developed by the _____.

    a. USEPA
    b. state governments
    c. utilities
    d. FEMA

27. The American Water Works Association will _____.

    a. test products
    b. develop standards
    c. approve products
    d. approve regulations

28. The major performance categories for drinking water distribution system operations are _____.

    a. to meet firefighting requirements, satisfy customer demands, and maintain water quality
    b. to efficiently perform system operations
    c. to deliver sufficient water
    d. All of the above

29. Each major item in a vulnerability assessment has critical security-related physical components. These include _____.

    a. access control
    b. power
    c. police
    d. firefighting

30. What provides the most reliable, flexible method of controlling access to a facility?

    a. 24/7 manned, closed-circuit TV
    b. Card-reader systems
    c. Key-lock systems
    d. Electrified locking systems

31. For a water utility to improve its energy use, it should have at least _____ of energy and cost data to establish a baseline.

    a. 12 months
    b. 2 years
    c. 3 years
    d. 5 years