Board Exam Desk

Sanitary Engineering Reviewer

Sanitary Engineering Licensure Examination | PRC | 120 original questions

2026 Edition | Updated November 2026

Original board-style practice questions with an answer key.

Practice questions

Hydraulics and Hydrology

1. Water flows at a mean velocity of 1.2 m/s in a full 300 mm diameter pipe. What is the discharge?

A. 339.3 L/s
B. 21.2 L/s
C. 84.8 L/s
D. 360.0 L/s

2. A 1,500 m long, 250 mm cast-iron main (Hazen-Williams C = 120) carries 50 L/s. Using the SI Hazen-Williams formula, what is the friction head loss?

A. 15.04 m
B. 7.52 m
C. 3.01 m
D. 12.03 m

3. A 200 mm pipe, 800 m long, has a Darcy friction factor of 0.02 and carries water at 1.5 m/s. What is the head loss due to friction?

A. 4.59 m
B. 9.17 m
C. 18.35 m
D. 6.12 m

4. Water with kinematic viscosity 1.0 x 10^-6 m2/s flows at 0.5 m/s in a 100 mm pipe. What is the Reynolds number and flow regime?

A. 5,000; transitional
B. 500; laminar
C. 500,000; laminar
D. 50,000; turbulent

5. In a horizontal pipe, the velocity of water rises from 1 m/s to 3 m/s at a contraction. Neglecting losses, what is the pressure drop between the two sections?

A. 2.0 kPa
B. 8.0 kPa
C. 4.0 kPa
D. 1.0 kPa

6. A pump delivers 60 L/s against a total dynamic head of 40 m with an overall efficiency of 75%. What input power is required?

A. 23.5 kW
B. 31.4 kW
C. 17.7 kW
D. 39.2 kW

7. A concrete-lined rectangular channel 2.0 m wide carries water 0.8 m deep on a slope of 0.001 with Manning n = 0.015. What is the discharge?

A. 2.91 m3/s
B. 1.23 m3/s
C. 0.98 m3/s
D. 1.96 m3/s

8. A 25 ha urban catchment has a runoff coefficient of 0.6. For a design rainfall intensity of 80 mm/h, what is the peak runoff by the rational method?

A. 2.00 m3/s
B. 5.56 m3/s
C. 3.33 m3/s
D. 33.33 m3/s

9. A sharp-edged 50 mm orifice (Cd = 0.62) discharges from a tank under a constant head of 2.0 m. What is the discharge?

A. 12.30 L/s
B. 5.39 L/s
C. 7.63 L/s
D. 30.50 L/s

10. A suppressed rectangular sharp-crested weir 1.5 m long operates under a head of 0.30 m. Using Q = 1.84 L H^1.5 (SI), what is the discharge?

A. 0.828 m3/s
B. 0.136 m3/s
C. 0.327 m3/s
D. 0.454 m3/s

11. Two identical centrifugal pumps that were running singly are now operated in parallel on the same system. What is the main effect?

A. Discharge rises at about the same head
B. Head doubles at the same discharge
C. Discharge and head both halve
D. Efficiency of each pump doubles

12. A valve at the end of a long pipeline closes instantly, stopping water moving at 1.5 m/s. If the pressure wave speed is 1,200 m/s, what is the pressure rise?

A. 1.80 MPa
B. 0.90 MPa
C. 3.60 MPa
D. 0.18 MPa

13. A pump begins to make crackling noise and its impeller shows pitting. Which condition most likely causes this?

A. Discharge valve is fully open
B. Suction lift is less than zero
C. Pump speed is below the rated value
D. NPSH available is below NPSH required

14. In hydrology, what does a 2-hour unit hydrograph represent?

A. Total streamflow during any 2-hour storm
B. Baseflow that remains 2 h after rain ends
C. Direct runoff from one unit of excess rain in 2 h
D. Rainfall intensity averaged over 2 h

15. A culvert is designed for a 50-year flood. What is the probability that this flood is equaled or exceeded at least once in 10 years?

A. 20.0%
B. 81.7%
C. 18.3%
D. 2.0%

16. An aquifer has hydraulic conductivity 30 m/day, porosity 0.30 and a hydraulic gradient of 0.002. What is the average seepage (pore) velocity?

A. 0.06 m/day
B. 0.20 m/day
C. 0.018 m/day
D. 2.00 m/day

17. A well fully penetrates a confined aquifer 20 m thick with K = 40 m/day. Observation wells at 10 m and 100 m show a 1.5 m difference in head at steady state. What is the pumping rate?

A. 3,275 m3/day
B. 1,637 m3/day
C. 7,540 m3/day
D. 521 m3/day

18. Three pipes of different diameters are connected in series between two reservoirs. Which statement is correct?

A. Same head loss in each; flows add up
B. Flow divides in proportion to diameter
C. Same flow in each; head losses add up
D. Total loss equals the largest pipe loss

19. Water flows at 4.0 m/s and 0.5 m depth in a wide rectangular channel. What is the Froude number and flow type?

A. 0.82; subcritical
B. 0.90; subcritical
C. 1.81; supercritical
D. 1.00; critical

20. What is the gauge pressure at the bottom of an open water tank filled to a depth of 6 m?

A. 6.0 kPa
B. 58.9 kPa
C. 160.2 kPa
D. 29.4 kPa

Water Supply and Treatment

21. A town had 40,000 people in 2010 and 48,000 in 2020. Using the geometric (uniform percentage) method, what is the projected 2040 population?

A. 69,120
B. 64,000
C. 57,600
D. 82,944

22. A community of 25,000 people uses an average of 150 L per capita per day. With a maximum-day factor of 1.5, what is the maximum-day demand?

A. 3,750 m3/day
B. 5,625 m3/day
C. 2,500 m3/day
D. 7,500 m3/day

23. Raw water with very low natural alkalinity is to be coagulated with alum. Why is lime or soda ash often added?

A. Lime acts as the primary coagulant instead
B. Soda ash removes the colour directly
C. Lime prevents filter media from clogging
D. Alum consumes alkalinity and needs a buffer

24. A 10 m3 rapid-mix tank receives 1.5 kW of useful mixing power. With water viscosity 0.001 Pa-s, what is the velocity gradient G?

A. 150 per s
B. 12.2 per s
C. 1225 per s
D. 387 per s

25. A rectangular settling basin 20 m long and 8 m wide treats 6,000 m3/day. What is the surface overflow rate?

A. 300 m3/m2-day
B. 37.5 m3/m2-day
C. 75.0 m3/m2-day
D. 21.4 m3/m2-day

26. A sedimentation tank measures 25 m x 10 m x 3 m deep and receives 4,800 m3/day. What is its theoretical detention time?

A. 3.75 h
B. 2.50 h
C. 6.40 h
D. 1.25 h

27. Estimate the Stokes settling velocity of a 0.05 mm sand particle (specific gravity 2.65) in water at 20 degrees C (viscosity 1.002 x 10^-3 Pa-s).

A. 4.49 mm/s
B. 3.60 mm/s
C. 2.24 mm/s
D. 0.56 mm/s

28. An ideal settling basin has an overflow rate of 1.6 m/h. What fraction of discrete particles with a settling velocity of 0.8 m/h will be removed?

A. 100%
B. 25%
C. 80%
D. 50%

29. A plant must filter 12,000 m3/day through rapid sand filters at a design rate of 120 m3/m2-day. What total filter area is needed?

A. 1,440 m2
B. 10 m2
C. 200 m2
D. 100 m2

30. Water with a chlorine demand of 1.8 mg/L must leave the plant with 0.5 mg/L residual. How much chlorine is used per day for 10,000 m3/day?

A. 18 kg/day
B. 13 kg/day
C. 230 kg/day
D. 23 kg/day

31. During breakpoint chlorination of water containing ammonia, what happens just beyond the breakpoint?

A. Combined chloramines reach their peak level
B. Total residual falls to its lowest value
C. Ammonia concentration starts to increase
D. Free chlorine residual begins to build up

32. At which pH does chlorinated water contain the largest fraction of hypochlorous acid, the stronger disinfectant form?

A. pH 7.5
B. pH 8.5
C. pH 6.0
D. pH 9.5

33. A clearwell provides an effective contact time of 45 minutes with a free chlorine residual of 0.8 mg/L. What CT value is achieved?

A. 56 mg-min/L
B. 45 mg-min/L
C. 3.6 mg-min/L
D. 36 mg-min/L

34. A groundwater contains 60 mg/L calcium and 18 mg/L magnesium. What is its total hardness expressed as CaCO3?

A. 78 mg/L
B. 150 mg/L
C. 224 mg/L
D. 313 mg/L

35. In lime-soda softening, why is soda ash needed in addition to lime?

A. To remove carbonate hardness
B. To raise dissolved oxygen
C. To remove noncarbonate hardness
D. To coagulate the turbidity

36. A well water smells of rotten eggs and leaves brown stains on fixtures. Which first treatment step best addresses both problems?

A. Fluoridation before storage
B. Lime-soda softening alone
C. Aeration followed by filtration
D. Ultraviolet disinfection only

37. What is the main purpose of an elevated storage tank in a water distribution system?

A. Provide primary coagulation of water
B. Equalize demand and keep system pressure
C. Remove sediment from incoming water
D. Replace the need for disinfection

38. Which method analyzes looped water distribution networks by repeatedly correcting assumed pipe flows until head losses balance around each loop?

A. Hardy Cross method
B. Rational method
C. Thiessen polygon method
D. Muskingum method

39. A water treatment operator sets up beakers with varying coagulant doses, mixes, settles, and compares turbidity. What is this test for?

A. Finding the optimum coagulant dose
B. Measuring chlorine demand directly
C. Counting coliform bacteria present
D. Determining filter backwash rate

40. Which treatment process can remove most dissolved salts from brackish water by applying pressure greater than the osmotic pressure?

A. Reverse osmosis
B. Slow sand filtration
C. Plain sedimentation
D. Microscreening

Wastewater Engineering

41. In a BOD test, 6 mL of wastewater is diluted to 300 mL. Initial DO is 8.6 mg/L and DO after 5 days is 4.2 mg/L. What is the BOD5?

A. 4.4 mg/L
B. 88 mg/L
C. 220 mg/L
D. 430 mg/L

42. A wastewater has a BOD5 of 180 mg/L and a first-order rate constant of 0.23 per day (base e). What is its ultimate BOD?

A. 123 mg/L
B. 263 mg/L
C. 194 mg/L
D. 207 mg/L

43. A food plant discharges 500 m3/day of wastewater with a BOD of 900 mg/L. Taking 0.06 kg BOD per person per day, what is its population equivalent?

A. 750 persons
B. 7,500 persons
C. 4,500 persons
D. 75,000 persons

44. An aeration tank of 2,500 m3 holds MLVSS of 2,500 mg/L and receives 8,000 m3/day with a BOD of 200 mg/L. What is the F/M ratio?

A. 0.64 per day
B. 0.08 per day
C. 0.26 per day
D. 1.28 per day

45. Mixed liquor with MLSS of 2,500 mg/L settles to 300 mL in a 1 L cylinder after 30 minutes. What is the sludge volume index?

A. 83 mL/g
B. 750 mL/g
C. 120 mL/g
D. 12 mL/g

46. An aeration basin of 3,000 m3 holds 3,000 mg/L MLSS. Sludge is wasted at 60 m3/day from the return line at 10,000 mg/L; effluent solids are negligible. What is the SRT?

A. 5 days
B. 50 days
C. 1.5 days
D. 15 days

47. An activated sludge tank of 3,000 m3 treats 12,000 m3/day. What is the hydraulic retention time?

A. 4 h
B. 6 h
C. 0.25 h
D. 12 h

48. What is the main purpose of a grit chamber placed ahead of primary clarifiers?

A. Remove dissolved organics by oxidation
B. Thicken waste activated sludge
C. Disinfect the incoming raw sewage
D. Remove sand and gravel to protect equipment

49. Which removal range is typical of a well-operated primary clarifier treating municipal wastewater?

A. TSS 90-95% and BOD 85-90%
B. TSS 10-20% and BOD 5-10%
C. TSS 25-40% and BOD 50-70%
D. TSS 50-70% and BOD 25-40%

50. In biological nitrification, which group of bacteria oxidizes ammonia to nitrite?

A. Nitrobacter
B. Pseudomonas
C. Methanosarcina
D. Nitrosomonas

51. Which set of conditions is needed for biological denitrification?

A. Fully aerobic zone with high DO
B. Anaerobic zone free of any nitrate
C. Anoxic zone with nitrate and a carbon source
D. High chlorine residual and low pH

52. Enhanced biological phosphorus removal relies on which zone arrangement?

A. Aerobic zone followed by anaerobic zone
B. Two aerobic zones in series only
C. Anoxic zone with chemical dosing only
D. Anaerobic zone followed by aerobic zone

53. An anaerobic digester shows falling gas production, rising volatile acids, and dropping pH. Which microbial group is most likely inhibited?

A. Methane-forming archaea
B. Acid-forming bacteria
C. Nitrifying bacteria
D. Aerobic heterotrophs

54. Sludge at 2% solids is thickened to 6% solids with no loss of dry solids. If 100 m3 is thickened, what is the new volume?

A. 33.3 m3
B. 66.7 m3
C. 300 m3
D. 50.0 m3

55. In a facultative stabilization pond, what supplies most of the oxygen used by aerobic bacteria in the upper layer?

A. Mechanical surface aerators
B. Methane oxidation at the bottom
C. Algal photosynthesis
D. Nitrate reduction in sludge

56. A river flowing at 2.0 m3/s with BOD 2 mg/L receives 0.5 m3/s of effluent with BOD 40 mg/L. What is the BOD just below the outfall after complete mixing?

A. 21.0 mg/L
B. 12.0 mg/L
C. 8.0 mg/L
D. 9.6 mg/L

57. On a dissolved-oxygen sag curve below a waste outfall, what condition holds at the critical point?

A. Deoxygenation rate equals reaeration rate
B. DO equals the saturation concentration
C. BOD has been completely exerted
D. Reaeration rate is exactly zero

58. A trickling filter 20 m in diameter receives 2,000 m3/day of settled sewage with a recirculation ratio of 1.0. What is the hydraulic loading?

A. 6.4 m3/m2-day
B. 12.7 m3/m2-day
C. 3.18 m3/m2-day
D. 25.5 m3/m2-day

59. Why is the COD of a domestic wastewater normally higher than its BOD5?

A. Strong oxidant also attacks resistant organics
B. COD test runs longer than five days
C. BOD test adds extra carbon substrate
D. COD measures only the inorganic matter

60. Which Philippine law, enacted in 2004, provides the framework for water quality management, including wastewater discharge permits?

A. RA 8749, Philippine Clean Air Act
B. RA 9275, Philippine Clean Water Act
C. RA 9003, Ecological Solid Waste Act
D. RA 6969, Toxic Substances Act

Solid and Hazardous Waste Management

61. A city of 120,000 people generates municipal solid waste at 0.5 kg per capita per day. What is the daily generation?

A. 6 tonnes/day
B. 60 tonnes/day
C. 24 tonnes/day
D. 600 tonnes/day

62. A landfill receives 60 tonnes/day compacted to 600 kg/m3, with a waste-to-cover volume ratio of 4:1. What landfill volume is used per year?

A. 36,500 m3
B. 43,800 m3
C. 54,750 m3
D. 45,625 m3

63. A 10 kg sample of fresh refuse weighs 7 kg after oven drying. What is its moisture content on a wet-weight basis?

A. 43%
B. 70%
C. 3%
D. 30%

64. A 5.0 kg refuse sample weighs 3.2 kg after drying. What is its moisture content on a dry-weight basis?

A. 36.0%
B. 56.3%
C. 64.0%
D. 17.6%

65. Under RA 9003, the Ecological Solid Waste Management Act of 2000, which disposal practice is expressly prohibited?

A. Composting biodegradables
B. Operating open dumps
C. Recycling of plastics
D. Using sanitary landfills

66. Under RA 9003, which facility is to be set up in every barangay or cluster of barangays to receive and sort segregated wastes?

A. Hazardous waste incinerator
B. Regional sanitary landfill
C. Materials recovery facility
D. Transfer and baling plant

67. Which Philippine law regulates the importation, use and disposal of toxic chemicals and hazardous wastes?

A. RA 9275
B. RA 6969
C. RA 8749
D. RA 9003

68. A spent pickling liquor from a metal finishing plant has a pH of 1.5. Which hazardous waste characteristic does it clearly exhibit?

A. Ignitability
B. Reactivity
C. Corrosivity
D. Infectiousness

69. Which landfill design measure is most effective in reducing long-term leachate generation after closure?

A. Low-permeability final cover system
B. Larger daily working face area
C. Thinner daily soil cover layer
D. Faster filling of the cell

70. During the stable methanogenic phase of a municipal landfill, what is the approximate composition of landfill gas?

A. Mostly hydrogen with some oxygen
B. Mostly nitrogen with trace methane
C. Mostly carbon monoxide and ammonia
D. Roughly half methane, half CO2

71. Which initial carbon-to-nitrogen ratio is generally considered best for aerobic composting of mixed organic waste?

A. About 25-30 to 1
B. About 5 to 1
C. About 100 to 1
D. About 2 to 1

72. A town collects 60 tonnes of waste daily using trucks with a payload of 8 tonnes per trip. What is the minimum number of trips per day?

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

73. Refuse is 30% food waste (4.6 MJ/kg), 40% paper (16.7 MJ/kg), 10% plastics (32.6 MJ/kg) and 20% inerts (0 MJ/kg) by mass. What is the mixture's energy content?

A. 13.5 MJ/kg
B. 18.0 MJ/kg
C. 11.3 MJ/kg
D. 9.1 MJ/kg

74. To limit dioxin formation in a waste incinerator, how should flue gas be handled after the combustion chamber?

A. Quench it rapidly through 200-450 C
B. Cool it slowly through 200-450 C
C. Recirculate it at about 300 C
D. Hold it at 250 C in a large duct

75. What is the main purpose of a hazardous waste manifest system?

A. Set prices for treatment services
B. License the waste generator's staff
C. Track waste from generator to final disposal
D. Measure leachate at landfill sites

76. Which bottom liner arrangement best describes a composite liner in a modern sanitary landfill?

A. Geomembrane over compacted clay layer
B. Gravel layer laid over native sand
C. Daily soil cover over the waste
D. Geotextile laid over loose topsoil

77. Loose waste at 150 kg/m3 is compacted in a truck to 600 kg/m3. What percentage volume reduction is achieved?

A. 25%
B. 75%
C. 300%
D. 400%

78. How should used hypodermic needles from a rural health center be contained before treatment?

A. In ordinary black garbage bags
B. Mixed with kitchen waste for composting
C. In puncture-resistant sealed containers
D. In open bins for later sorting

79. In the solid waste management hierarchy, which option is the most preferred?

A. Source reduction or waste prevention
B. Energy recovery by incineration
C. Disposal in a sanitary landfill
D. Recycling of collected materials

80. A plating sludge rich in heavy metals is mixed with cement and other binders before landfilling. What is this treatment called?

A. Aerobic composting
B. Air stripping
C. Anaerobic digestion
D. Stabilization and solidification

Environmental Sanitation and Public Health

81. Presidential Decree No. 856 is better known by what title?

A. Philippine Environmental Code
B. Philippine Water Code
C. Code on Sanitation of the Philippines
D. Philippine Clean Air Act

82. During a dengue outbreak, where should vector control teams concentrate their search for larvae?

A. Fast-flowing streams and rivers
B. Water-holding containers around houses
C. Brackish coastal fish ponds
D. Dry soil under building floors

83. Which mosquito genus transmits human malaria?

A. Aedes
B. Anopheles
C. Culex
D. Mansonia

84. After a typhoon, several residents who waded through floodwater develop fever, muscle pain and jaundice. Which disease is most likely?

A. Malaria
B. Tuberculosis
C. Hepatitis B
D. Leptospirosis

85. Control of schistosomiasis includes measures against which intermediate host?

A. Rodents
B. Houseflies
C. Cockroaches
D. Freshwater snails

86. An outbreak of profuse watery diarrhea is traced to a contaminated community well. Which pathogen is most likely responsible?

A. Clostridium tetani
B. Vibrio cholerae
C. Mycobacterium leprae
D. Plasmodium vivax

87. Why are coliform bacteria, especially E. coli, used to judge the bacteriological safety of drinking water?

A. They are the main cause of waterborne disease
B. They are killed only by boiling the water
C. They indicate high mineral content in water
D. They indicate fecal contamination is present

88. A 50 mL water sample is passed through a membrane filter and 34 typical coliform colonies grow. What is the count per 100 mL?

A. 34 per 100 mL
B. 68 per 100 mL
C. 17 per 100 mL
D. 170 per 100 mL

89. At a fiesta, 150 guests ate a particular dish and 45 of them became ill. What is the attack rate for that dish?

A. 45%
B. 15%
C. 70%
D. 30%

90. A chronic disease has a stable incidence of 4 per 1,000 per year and an average duration of 2.5 years. What is the approximate prevalence?

A. 10 per 1,000
B. 1.6 per 1,000
C. 6.5 per 1,000
D. 4 per 1,000

91. Food safety guidance treats which temperature range as the danger zone where bacteria multiply rapidly?

A. 5 C to 60 C
B. -18 C to 0 C
C. 60 C to 100 C
D. 0 C to 2 C

92. High-temperature short-time (HTST) pasteurization of milk uses approximately which time-temperature combination?

A. 63 C for 15 seconds
B. 100 C for 30 minutes
C. 121 C for 15 minutes
D. 72 C for 15 seconds

93. Which disease is primarily spread by the fecal-oral route through contaminated food and water?

A. Hepatitis A
B. Hepatitis B
C. Tetanus
D. Measles

94. Which measure gives the most lasting control of housefly populations in a market area?

A. Daily fogging with insecticide
B. Placing sticky ribbons near stalls
C. Spraying perfume to mask odors
D. Eliminating garbage and other breeding sites

95. In environmental rodent control, what does rat-proofing a building mean?

A. Setting baited traps in the rooms
B. Applying poison along the walls
C. Sealing openings so rats cannot enter
D. Keeping cats inside the building

96. Swimmers complain of eye irritation and a strong chlorine smell even though free chlorine is low. What is the most likely cause?

A. Combined chlorine as chloramines
B. Excess free chlorine residual
C. Very low pool water turbidity
D. Water temperature being too cold

97. A dug well 1.0 m in diameter holds 8 m of water. How much 70% calcium hypochlorite is needed for a 50 mg/L chlorine dose?

A. 449 g
B. 314 g
C. 220 g
D. 1795 g

98. A disease has a basic reproduction number (R0) of 5. What minimum immune proportion is needed for herd immunity?

A. 20%
B. 80%
C. 50%
D. 95%

99. Guests develop sudden vomiting and cramps 2 to 4 hours after eating cream-filled pastries left unrefrigerated. Which agent is most likely?

A. Staphylococcus aureus toxin
B. Salmonella Typhi infection
C. Hepatitis A virus
D. Clostridium tetani

100. What is the primary purpose of a sanitary survey of a water supply system?

A. Set the water tariff for consumers
B. Measure the pump efficiency only
C. Count the number of service taps
D. Identify actual and potential contamination sources

Air Pollution Control and Industrial Hygiene

101. Which Republic Act is the Philippine Clean Air Act of 1999?

A. RA 9275
B. RA 8749
C. RA 9003
D. RA 6969

102. Convert a carbon monoxide concentration of 9 ppm to mg/m3 at 25 C and 1 atm (molar volume 24.45 L).

A. 10.3 mg/m3
B. 7.9 mg/m3
C. 11.3 mg/m3
D. 16.2 mg/m3

103. A stack emits SO2 at 100 g/s with an effective height of 60 m; wind speed is 5 m/s. At a receptor where sigma-y = 100 m and sigma-z = 50 m, what is the ground-level centerline concentration?

A. 1273 micrograms/m3
B. 310 micrograms/m3
C. 349 micrograms/m3
D. 620 micrograms/m3

104. A stack plume stays narrow and spreads little vertically while drifting far downwind at night. What atmospheric condition does this indicate?

A. Strongly unstable, convective air
B. Stable air, as under an inversion
C. Neutral air with strong winds
D. Rapid vertical mixing by daytime heat

105. Which particulate control device charges particles and collects them on oppositely charged plates?

A. Cyclone separator
B. Settling chamber
C. Electrostatic precipitator
D. Venturi scrubber

106. A coal-fired boiler must reduce sulfur dioxide emissions. Which control approach directly removes SO2 from the flue gas?

A. Wet limestone scrubbing
B. Fabric filter baghouse
C. Cyclone separator
D. Low-NOx burner retrofit

107. Why is ground-level ozone called a secondary pollutant?

A. It is emitted directly from car exhausts
B. It forms from NOx and VOCs in sunlight
C. It is released mainly by volcanoes
D. It forms only inside closed buildings

108. A cyclone with 85% efficiency is followed by a fabric filter with 90% efficiency on the remaining dust. What is the overall collection efficiency?

A. 98.5%
B. 87.5%
C. 76.5%
D. 99.5%

109. Two machines each produce 85 dB at a worker's position. What is the combined sound pressure level?

A. 170 dB
B. 88 dB
C. 85 dB
D. 91 dB

110. Three identical fans each produce 80 dB at a point. What is the combined level when all three run?

A. 84.8 dB
B. 240.0 dB
C. 83.0 dB
D. 89.5 dB

111. A worker is exposed to toluene at 50 ppm for 3 h, 20 ppm for 4 h, and 0 ppm for 1 h. What is the 8-hour time-weighted average?

A. 32.86 ppm
B. 23.33 ppm
C. 28.75 ppm
D. 35.00 ppm

112. Air contains three solvents with additive effects at 40, 25 and 50 ppm; their TLVs are 100, 50 and 200 ppm. What is the mixture exposure index?

A. 1.15; limit exceeded
B. 0.65; within limit
C. 0.90; within limit
D. 2.30; limit exceeded

113. In the hierarchy of controls for a hazardous chemical, which measure is the most effective?

A. Issuing respirators to the workers
B. Rotating workers to limit exposure
C. Eliminating or substituting the chemical
D. Posting warning signs in the area

114. A plain open hood with face area 0.04 m2 must create a capture velocity of 0.5 m/s at 0.3 m from the face. Using Q = V(10x^2 + A), what airflow is needed?

A. 1.52 m3/s
B. 0.47 m3/s
C. 0.02 m3/s
D. 0.065 m3/s

115. A 10 m x 8 m x 3 m workroom receives 0.4 m3/s of fresh air. How many air changes per hour does this provide?

A. 1.7
B. 6
C. 10
D. 0.1

116. Textile mill workers develop chest tightness that is worst on the first workday of the week. Which occupational disease does this suggest?

A. Silicosis
B. Byssinosis
C. Asbestosis
D. Siderosis

117. Outdoors in sunlight, the natural wet-bulb temperature is 26 C, globe temperature 40 C and dry-bulb 32 C. What is the WBGT index?

A. 30.2 C
B. 32.7 C
C. 28.6 C
D. 29.4 C

118. Why is carbon monoxide dangerous to workers in enclosed garages?

A. It binds hemoglobin and blocks oxygen transport
B. It corrodes the lining of the lungs
C. It displaces nitrogen in the blood
D. It sensitizes the skin to sunlight

119. Which particulate size fraction penetrates deepest into the lungs, reaching the alveolar region?

A. Particles above 50 micrometers
B. Coarse sand-size grit
C. PM2.5 fine particles
D. Large pollen grains

120. A compressor produces 94 dB at 2 m in a free field. Assuming a point source, what level is expected at 16 m?

A. 82 dB
B. 70 dB
C. 76 dB
D. 86 dB

Answer key

Sanitary Engineering

1. C. 84.8 L/s

Q = AV = (pi/4)(0.3^2)(1.2) = 0.0848 m3/s = 84.8 L/s.

2. B. 7.52 m

hf = 10.67 L Q^1.852 / (C^1.852 D^4.87) = 10.67(1500)(0.05^1.852)/(120^1.852 x 0.25^4.87) = 7.52 m.

3. B. 9.17 m

hf = f(L/D)(V^2/2g) = 0.02(800/0.2)(1.5^2/19.62) = 9.17 m.

4. D. 50,000; turbulent

Re = VD/nu = 0.5(0.1)/1.0e-6 = 50,000, far above about 4,000, so the flow is turbulent.

5. C. 4.0 kPa

From Bernoulli, dP = rho(V2^2 - V1^2)/2 = 1000(9 - 1)/2 = 4,000 Pa = 4.0 kPa.

6. B. 31.4 kW

P = gamma Q H / eff = 9.81(0.06)(40)/0.75 = 31.4 kW.

7. D. 1.96 m3/s

R = A/P = 1.6/3.6 = 0.444 m; V = (1/n)R^(2/3)S^(1/2) = 1.228 m/s; Q = VA = 1.96 m3/s.

8. C. 3.33 m3/s

Q = CiA/360 = 0.6(80)(25)/360 = 3.33 m3/s.

9. C. 7.63 L/s

Q = Cd A sqrt(2gh) = 0.62(0.001963)(6.264) = 0.00763 m3/s = 7.63 L/s.

10. D. 0.454 m3/s

Q = 1.84(1.5)(0.30^1.5) = 1.84(1.5)(0.1643) = 0.454 m3/s.

11. A. Discharge rises at about the same head

Parallel pumps add their flows at a common head; series pumps add their heads at a common flow.

12. A. 1.80 MPa

By Joukowsky, dP = rho c dV = 1000(1200)(1.5) = 1.8 x 10^6 Pa = 1.80 MPa.

13. D. NPSH available is below NPSH required

Cavitation occurs when available net positive suction head falls below what the pump needs, so vapor bubbles form and collapse on the impeller.

14. C. Direct runoff from one unit of excess rain in 2 h

A unit hydrograph is the direct runoff response to one unit depth of effective rainfall falling uniformly over the basin in the stated duration.

15. C. 18.3%

Risk = 1 - (1 - 1/T)^n = 1 - (0.98)^10 = 0.1829, or about 18.3%.

16. B. 0.20 m/day

Darcy flux = Ki = 30(0.002) = 0.06 m/day; seepage velocity = Ki/n = 0.06/0.30 = 0.20 m/day.

17. A. 3,275 m3/day

Thiem: Q = 2 pi K b (h2 - h1)/ln(r2/r1) = 2 pi(40)(20)(1.5)/ln 10 = 3,275 m3/day.

18. C. Same flow in each; head losses add up

For pipes in series, continuity gives the same discharge through each, and the total head loss is the sum of the individual losses.

19. C. 1.81; supercritical

Fr = V/sqrt(gy) = 4/sqrt(9.81 x 0.5) = 1.81; Fr > 1 means supercritical flow.

20. B. 58.9 kPa

p = gamma h = 9.81 kN/m3 x 6 m = 58.9 kPa (gauge).

21. A. 69,120

The decade growth factor is 48,000/40,000 = 1.2; two more decades give 48,000(1.2^2) = 69,120.

22. B. 5,625 m3/day

Average = 25,000 x 0.150 = 3,750 m3/day; maximum day = 1.5 x 3,750 = 5,625 m3/day.

23. D. Alum consumes alkalinity and needs a buffer

Aluminum sulfate reacts with alkalinity to form the hydroxide floc; without enough alkalinity the pH drops and floc formation fails.

24. D. 387 per s

G = sqrt(P/(mu V)) = sqrt(1500/(0.001 x 10)) = 387 per s.

25. B. 37.5 m3/m2-day

Overflow rate = Q/surface area = 6,000/(20 x 8) = 6,000/160 = 37.5 m3/m2-day.

26. A. 3.75 h

Volume = 750 m3; t = V/Q = 750/4,800 day = 0.15625 day = 3.75 h.

27. C. 2.24 mm/s

vs = g(rho_p - rho_w)d^2/(18 mu) = 9.81(1650)(5e-5)^2/(18 x 1.002e-3) = 0.00224 m/s = 2.24 mm/s.

28. D. 50%

For particles slower than the overflow rate, removal = vs/vo = 0.8/1.6 = 0.50.

29. D. 100 m2

Area = Q/rate = 12,000/120 = 100 m2 (before allowing a standby unit).

30. D. 23 kg/day

Dose = 1.8 + 0.5 = 2.3 mg/L = 2.3 g/m3; 2.3 x 10,000 = 23,000 g = 23 kg/day.

31. D. Free chlorine residual begins to build up

Past the breakpoint the chloramines have been oxidized, so further chlorine appears as free available residual.

32. C. pH 6.0

HOCl dissociates to the weaker OCl- ion as pH rises (pKa near 7.5), so lower pH favors HOCl.

33. D. 36 mg-min/L

CT = C x T = 0.8 mg/L x 45 min = 36 mg-min/L.

34. C. 224 mg/L

Ca: 60 x 50/20.04 = 149.7; Mg: 18 x 50/12.15 = 74.1; total = 224 mg/L as CaCO3.

35. C. To remove noncarbonate hardness

Lime precipitates carbonate hardness; calcium noncarbonate hardness requires soda ash to supply carbonate ions.

36. C. Aeration followed by filtration

Aeration strips hydrogen sulfide and oxidizes ferrous iron to insoluble ferric hydroxide, which a filter then removes.

37. B. Equalize demand and keep system pressure

Elevated storage supplies peak hourly demand, maintains pressure by elevation, and provides reserve for fire fighting.

38. A. Hardy Cross method

The Hardy Cross method applies successive flow corrections so that the algebraic sum of head losses around each loop approaches zero.

39. A. Finding the optimum coagulant dose

The jar test simulates coagulation, flocculation and settling to select the most effective chemical dose and pH.

40. A. Reverse osmosis

Reverse osmosis forces water through a semipermeable membrane against the osmotic gradient, rejecting most dissolved ions.

41. C. 220 mg/L

P = 6/300 = 0.02; BOD5 = (8.6 - 4.2)/0.02 = 4.4/0.02 = 220 mg/L.

42. B. 263 mg/L

BODu = BOD5/(1 - e^(-kt)) = 180/(1 - e^(-1.15)) = 180/0.6834 = 263 mg/L.

43. B. 7,500 persons

Load = 500 x 0.900 = 450 kg/day; PE = 450/0.06 = 7,500 persons.

44. C. 0.26 per day

F/M = QS0/(VX) = 8,000(200)/(2,500 x 2,500) = 0.256, about 0.26 per day.

45. C. 120 mL/g

SVI = settled volume (mL/L) x 1000 / MLSS (mg/L) = 300 x 1000/2,500 = 120 mL/g.

46. D. 15 days

SRT = VX/(QwXr) = 3,000(3,000)/(60 x 10,000) = 9,000,000/600,000 = 15 days.

47. B. 6 h

HRT = V/Q = 3,000/12,000 day = 0.25 day = 6 h.

48. D. Remove sand and gravel to protect equipment

Grit chambers settle heavy inorganic particles that would abrade pumps and accumulate in tanks and digesters.

49. D. TSS 50-70% and BOD 25-40%

Primary sedimentation removes settleable solids, typically about half to two-thirds of TSS and roughly a quarter to two-fifths of BOD.

50. D. Nitrosomonas

Nitrosomonas convert ammonium to nitrite; Nitrobacter then oxidize nitrite to nitrate.

51. C. Anoxic zone with nitrate and a carbon source

Denitrifiers use nitrate instead of oxygen as electron acceptor when DO is absent, oxidizing organic carbon and releasing nitrogen gas.

52. D. Anaerobic zone followed by aerobic zone

Phosphorus-accumulating organisms release P and store carbon under anaerobic conditions, then take up excess P in the aerobic zone.

53. A. Methane-forming archaea

Methanogens are slow-growing and sensitive to low pH; when inhibited, acids from fermentation accumulate.

54. A. 33.3 m3

Volume varies inversely with solids content: V2 = 100(2/6) = 33.3 m3.

55. C. Algal photosynthesis

Algae produce oxygen by photosynthesis, which bacteria use to oxidize organics, while the bottom layer stays anaerobic.

56. D. 9.6 mg/L

C = (2.0 x 2 + 0.5 x 40)/(2.0 + 0.5) = 24/2.5 = 9.6 mg/L.

57. A. Deoxygenation rate equals reaeration rate

The minimum DO occurs where oxygen consumption by BOD is just balanced by atmospheric reaeration.

58. B. 12.7 m3/m2-day

Total flow = 2,000(1 + 1) = 4,000 m3/day; area = pi(20^2)/4 = 314.2 m2; loading = 12.7 m3/m2-day.

59. A. Strong oxidant also attacks resistant organics

The dichromate COD test oxidizes biodegradable and nonbiodegradable organics, whereas BOD5 reflects only part of the biodegradable fraction.

60. B. RA 9275, Philippine Clean Water Act

Republic Act 9275, the Philippine Clean Water Act of 2004, governs water quality management and discharge permitting.

61. B. 60 tonnes/day

120,000 x 0.5 kg = 60,000 kg/day = 60 tonnes/day.

62. D. 45,625 m3

Waste = 60,000/600 = 100 m3/day; with cover 100 x 1.25 = 125 m3/day; 125 x 365 = 45,625 m3/year.

63. D. 30%

Wet-basis moisture = (10 - 7)/10 x 100 = 30%.

64. B. 56.3%

Dry-basis moisture = (5.0 - 3.2)/3.2 x 100 = 56.25%, about 56.3%; the wet-basis value would be 36%.

65. B. Operating open dumps

RA 9003 prohibits the establishment or operation of open dumps and directs disposal to properly engineered facilities.

66. C. Materials recovery facility

RA 9003 requires a materials recovery facility (MRF) in each barangay or cluster of barangays for sorting, composting and recovery.

67. B. RA 6969

RA 6969, the Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990, covers toxic chemicals and hazardous wastes.

68. C. Corrosivity

Strongly acidic or alkaline wastes are classed as corrosive because they attack tissue and container materials.

69. A. Low-permeability final cover system

Leachate comes mainly from infiltrating precipitation, so a well-built impermeable cap with drainage minimizes it.

70. D. Roughly half methane, half CO2

In the stable phase landfill gas is typically about 45-60% methane with most of the balance carbon dioxide.

71. A. About 25-30 to 1

A C:N ratio near 25-30:1 balances microbial energy and protein needs; lower ratios lose ammonia and higher ones compost slowly.

72. A. 8 trips

60/8 = 7.5 trips, which must be rounded up to 8 trips.

73. C. 11.3 MJ/kg

Weighted average = 0.3(4.6) + 0.4(16.7) + 0.1(32.6) + 0.2(0) = 11.3 MJ/kg.

74. A. Quench it rapidly through 200-450 C

Dioxins and furans re-form on fly ash in roughly 200-450 C, so rapid quenching through that window reduces their formation.

75. C. Track waste from generator to final disposal

A manifest documents each transfer so the waste can be traced from cradle to grave.

76. A. Geomembrane over compacted clay layer

A composite liner places a geomembrane in direct contact with low-permeability compacted clay, so each covers the other's weaknesses.

77. B. 75%

Volume reduction = (1 - 150/600) x 100 = 75%.

78. C. In puncture-resistant sealed containers

Sharps must be placed in rigid, puncture-resistant, leak-proof containers to prevent needle-stick injuries and infection.

79. A. Source reduction or waste prevention

Avoiding waste generation ranks above reuse, recycling, recovery and disposal because it eliminates impacts at the source.

80. D. Stabilization and solidification

Stabilization/solidification binds metals in a low-solubility, solid matrix to reduce leaching.

81. C. Code on Sanitation of the Philippines

PD 856 (1975) is the Code on Sanitation of the Philippines; the Water Code is PD 1067 and the Environment Code is PD 1152.

82. B. Water-holding containers around houses

Aedes aegypti, the main dengue vector, breeds in clean standing water in jars, tires, flower vases and similar containers.

83. B. Anopheles

Malaria parasites (Plasmodium) are transmitted by female Anopheles mosquitoes.

84. D. Leptospirosis

Leptospira shed in rat urine contaminates floodwater and enters through skin breaks or mucous membranes.

85. D. Freshwater snails

Schistosome larvae develop in freshwater snails before being released into water where they penetrate human skin.

86. B. Vibrio cholerae

Cholera is a waterborne fecal-oral disease that produces profuse rice-water diarrhea.

87. D. They indicate fecal contamination is present

Coliforms are abundant in feces and easy to detect, so their presence signals possible contamination with fecal pathogens.

88. B. 68 per 100 mL

Count = colonies x 100/volume filtered = 34 x 100/50 = 68 per 100 mL.

89. D. 30%

Attack rate = ill/exposed x 100 = 45/150 x 100 = 30%.

90. A. 10 per 1,000

Under steady state, prevalence is about incidence x duration = 4 x 2.5 = 10 per 1,000.

91. A. 5 C to 60 C

Most pathogenic bacteria grow quickly between about 5 C and 60 C, so food should be kept colder or hotter than this range.

92. D. 72 C for 15 seconds

HTST heats milk to about 72 C for 15 seconds; batch pasteurization uses about 63 C for 30 minutes.

93. A. Hepatitis A

Hepatitis A virus is excreted in feces and transmitted by ingestion; hepatitis B spreads through blood and body fluids.

94. D. Eliminating garbage and other breeding sites

Flies breed in decaying organic matter; removing and properly storing refuse attacks the source rather than adult flies only.

95. C. Sealing openings so rats cannot enter

Rat-proofing uses construction measures such as sealing gaps and screening vents to deny rodents entry and harborage.

96. A. Combined chlorine as chloramines

Chloramines form when chlorine reacts with ammonia from bathers and cause the irritating chlorine odor; breakpoint chlorination removes them.

97. A. 449 g

Volume = (pi/4)(1^2)(8) = 6.283 m3; chlorine = 6.283 x 50 = 314.2 g; product = 314.2/0.70 = 449 g.

98. B. 80%

Herd immunity threshold = 1 - 1/R0 = 1 - 1/5 = 0.80.

99. A. Staphylococcus aureus toxin

The short incubation and vomiting point to preformed staphylococcal enterotoxin in food handled and held warm.

100. D. Identify actual and potential contamination sources

A sanitary survey is an on-site inspection of source, treatment and distribution to find hazards that could contaminate the water.

101. B. RA 8749

RA 8749 is the Philippine Clean Air Act of 1999; RA 9275 covers water, RA 9003 solid waste and RA 6969 toxic substances.

102. A. 10.3 mg/m3

mg/m3 = ppm x MW/24.45 = 9 x 28.01/24.45 = 10.3 mg/m3.

103. D. 620 micrograms/m3

C = Q/(pi u sy sz) exp(-H^2/(2 sz^2)) = 100/(pi x 5 x 100 x 50) x exp(-0.72) = 0.000620 g/m3, about 620 micrograms/m3.

104. B. Stable air, as under an inversion

This fanning plume forms in stable air, where vertical motion is suppressed and dispersion is poor.

105. C. Electrostatic precipitator

An electrostatic precipitator uses corona discharge to charge particles, which migrate to collecting electrodes.

106. A. Wet limestone scrubbing

Flue gas desulfurization with limestone slurry absorbs SO2 and forms calcium sulfite or sulfate.

107. B. It forms from NOx and VOCs in sunlight

Ozone is not emitted directly; photochemical reactions of nitrogen oxides and volatile organic compounds produce it.

108. A. 98.5%

Penetration = (1 - 0.85)(1 - 0.90) = 0.015, so overall efficiency = 1 - 0.015 = 98.5%.

109. B. 88 dB

L = 10 log(10^8.5 + 10^8.5) = 85 + 10 log 2 = 88 dB.

110. A. 84.8 dB

L = 80 + 10 log 3 = 80 + 4.77 = 84.8 dB.

111. C. 28.75 ppm

TWA = (50 x 3 + 20 x 4 + 0 x 1)/8 = 230/8 = 28.75 ppm.

112. A. 1.15; limit exceeded

Index = 40/100 + 25/50 + 50/200 = 0.40 + 0.50 + 0.25 = 1.15, which is above 1.

113. C. Eliminating or substituting the chemical

Elimination and substitution remove the hazard itself; administrative controls and PPE rank lowest.

114. B. 0.47 m3/s

Q = 0.5(10 x 0.09 + 0.04) = 0.5(0.94) = 0.47 m3/s.

115. B. 6

Q = 0.4 x 3,600 = 1,440 m3/h; volume = 240 m3; ACH = 1,440/240 = 6.

116. B. Byssinosis

Byssinosis is caused by cotton, flax or hemp dust and classically produces Monday chest tightness.

117. D. 29.4 C

Outdoor WBGT = 0.7 NWB + 0.2 GT + 0.1 DB = 18.2 + 8.0 + 3.2 = 29.4 C.

118. A. It binds hemoglobin and blocks oxygen transport

CO has much greater affinity for hemoglobin than oxygen, forming carboxyhemoglobin and causing tissue hypoxia.

119. C. PM2.5 fine particles

Fine particles of 2.5 micrometers and smaller can reach the gas-exchange region; larger particles are trapped in the upper airways.

120. C. 76 dB

Each doubling of distance reduces the level by 6 dB; 2 to 16 m is three doublings, so 94 - 18 = 76 dB.

Topics to review

• Water supply and treatment processes

• Wastewater collection and treatment

• Solid waste and environmental health

• Hydraulics, facility design and regulations

Online question banks and study resources

Sanitary Engineering - Pass Harbor (Question bank)

Official PRC board information

Current PRC exam programs

Independent study material prepared by Board Exam Desk.