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Water Quality Laboratory Analyst

Solution key

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1. What is the primary regulated disinfection byproduct (DBP) formed when using Ozone as a disinfectant in water containing bromide?

A. 1.0 mg/L
B. 0.002 mg/L
C. 0.080 mg/L
D (correct). 0.010 mg/L (10 ppb)

Rationale: Bromate is a regulated DBP with an MCL of 0.010 mg/L (10 ppb) that can form when ozone reacts with bromide.

2. What is the primary purpose of calculating the Langelier Saturation Index (LSI) for a municipal water distribution system?

A. To calculate the total concentration of dissolved organic carbon
B (correct). To predict whether the water is corrosive (dissolves CaCO3) or scale-forming (deposits CaCO3)
C. To evaluate the aesthetic taste and odor properties of the water
D. To determine the required chlorine dosage for primary disinfection

Rationale: The LSI determines the calcium carbonate saturation status of water. A negative LSI indicates corrosive water that dissolves CaCO3, while a positive LSI indicates scale-forming water.

3. When preparing a calibration curve for a spectrophotometer, what does a correlation coefficient (r^2) of 0.999 indicate?

A (correct). A highly linear and strong correlation between standard concentrations and instrument response
B. The standards were prepared using contaminated reagents
C. The instrument needs immediate recalibration due to high error
D. A weak correlation where the instrument response does not match the concentration

Rationale: An r^2 value close to 1.000 (e.g., 0.999) indicates a very strong, highly linear relationship between the concentration of the standards and the instrument response (absorbance).

4. Which of the following physical parameters is used as an indirect, rapid measurement of the Total Dissolved Solids (TDS) concentration in a water sample?

A. Color
B. pH
C (correct). Specific conductance
D. Turbidity

Rationale: Specific conductance increases as the concentration of dissolved ionic solids increases, making it a reliable surrogate for TDS.

5. During the Confirmed Phase of the Multiple-Tube Fermentation (MTF) technique for total coliforms, positive presumptive tubes are transferred to which medium?

A. Nutrient Agar
B. Phosphate-buffered water
C (correct). Brilliant Green Lactose Bile (BGLB)
D. Lauryl Tryptose Broth (LTB)

Rationale: Presumptive positive LTB tubes are transferred to Brilliant Green Lactose Bile (BGLB) broth, which inhibits non-coliform bacteria to "confirm" the presence of coliforms.

6. If a water sample has a pH of 8.5, what can be inferred about the relationship between hydrogen ions [H+] and hydroxide ions [OH-]?

A (correct). [OH-] is greater than [H+]
B. [H+] and [OH-] are equal
C. There are no [H+] ions present
D. [H+] is greater than [OH-]

Rationale: A pH greater than 7 indicates a basic (alkaline) solution, meaning the concentration of hydroxide ions is greater than hydrogen ions.

7. According to the Lead and Copper Rule, what is the required minimum period of stagnation before a first-draw sample can be collected to accurately measure lead and copper levels?

A. 24 hours
B (correct). 6 hours
C. 12 hours
D. 1 hour

Rationale: To accurately measure the levels of lead and copper that may leach from household plumbing, the Lead and Copper Rule requires that the water must stand motionless (stagnant) in the pipes for a minimum of 6 hours.

8. In the Colilert Quanti-Tray method viewed under a 365 nm UV lamp, what specifically causes certain wells to fluoresce brightly, indicating a positive result for E. coli?

A (correct). The hydrolysis of the fluorogenic substrate MUG by the enzyme beta-glucuronidase
B. The reaction of free chlorine with the DPD indicator dye
C. The fermentation of lactose resulting in an acidic pH shift
D. The hydrolysis of the chromogenic substrate ONPG by beta-galactosidase

Rationale: E. coli produces the enzyme beta-glucuronidase, which specifically hydrolyzes the fluorogenic substrate MUG present in the Colilert reagent, causing the sample to fluoresce under UV light.

9. Specific conductance (conductivity) is a measure of the ability of an aqueous solution to carry an electric current. To what standard temperature must conductivity measurements be mathematically corrected?

A. It does not require temperature correction
B. 4.0 °C
C (correct). 25.0 °C
D. 20.0 °C

Rationale: Conductivity is highly dependent on temperature and is universally corrected to and reported at 25.0 °C.

10. How many significant figures are in the measurement "0.004050 mg/L"?

A. Six
B (correct). Four
C. Two
D. Three

Rationale: There are four significant figures (4, 0, 5, 0). Leading zeros are not significant, but trailing zeros after a decimal point are significant.

11. Which of the following is considered a primary safety hazard when working with dehydrated, powdered culture media?

A. Risk of radiation exposure
B (correct). Inhalation of fine dust causing respiratory irritation
C. Spontaneous combustion
D. Extreme flammability when exposed to air

Rationale: The fine dust from powdered media can be easily inhaled and cause respiratory irritation; it may also contain hazardous ingredients like bile salts or sodium azide.

12. What is the federal Maximum Contaminant Level (MCL) for Nitrite (measured as Nitrogen) in drinking water?

A. 10.0 mg/L
B. 5.0 mg/L
C (correct). 1.0 mg/L
D. 0.1 mg/L

Rationale: The MCL for Nitrite as N is 1.0 mg/L. Similar to Nitrates, elevated nitrites can cause health problems in infants.

13. Why must a drop of immersion oil be placed between the glass slide and the 100x objective lens when using an oil immersion objective on a light microscope?

A (correct). To prevent light rays from refracting and scattering, thereby improving image resolution
B. To cool the slide and prevent the high-intensity light source from cooking the bacteria
C. To physically adhere the objective lens to the slide so the focus does not drift
D. To stain the bacteria on the slide so they are visible under the microscope

Rationale: Immersion oil has the same refractive index as glass. It forms a continuous optical bridge that prevents light rays from refracting (bending) and scattering when passing from the glass slide into the air, thereby significantly improving the resolution of the image.

14. When calibrating a pH meter with standard buffers at pH 4.00, 7.00, and 10.00, what is the primary purpose of performing a multi-point calibration that brackets the expected pH of the samples?

A. To clean the electrode bulb of any biological or chemical fouling
B. To neutralize any residual acidity in the sample water before measurement
C (correct). To determine the actual slope and efficiency of the electrode across the measurement range
D. To permanently set the isopotential point of the meter to 0 mV

Rationale: A multi-point calibration determines the actual slope (efficiency) of the pH electrode across the specific range of interest, compensating for electrode aging and ensuring accurate measurements.

15. What is the federal Maximum Contaminant Level (MCL) for Nitrate measured as Nitrogen in drinking water?

A. 5.0 mg/L
B (correct). 10.0 mg/L
C. 15.0 mg/L

D. 1.0 mg/L

Rationale: The primary Maximum Contaminant Level (MCL) for Nitrate as N is 10.0 mg/L. High nitrate levels in drinking water can cause methemoglobinemia ("blue baby syndrome").

16. According to standard laboratory safety protocols, how should strong acids and strong bases be stored?

A. In a standard flammable storage cabinet to contain any fumes
B (correct). In separate, dedicated corrosive storage cabinets away from each other
C. In the same corrosive cabinet, provided they are in secondary containment
D. Alphabetically on the same shelf to ensure they are easy to locate

Rationale: Strong acids and strong bases are reactive and incompatible. They must be stored in separate, dedicated corrosive storage cabinets to prevent violent reactions in the event of a spill or leak.

17. When using the Colilert (enzyme substrate) method, what does a sample that turns yellow but does NOT fluoresce under a UV lamp indicate?

A. Positive for Total Coliforms, Positive for E. coli
B. Negative for Total Coliforms, Negative for E. coli
C (correct). Positive for Total Coliforms, Negative for E. coli
D. Negative for Total Coliforms, Positive for E. coli

Rationale: The yellow color indicates that the enzyme beta-galactosidase (produced by total coliforms) has hydrolyzed the ONPG substrate. The lack of fluorescence means E. coli is not present.

18. When using the streak plate technique for bacterial isolation, what is the primary objective of sterilizing the inoculation loop between streaking each of the four sequential quadrants?

A. To create an anaerobic environment in the final quadrant
B. To test the heat resistance of the bacterial strain being cultured
C (correct). To sequentially dilute the bacteria to yield distinct, pure isolated colonies
D. To prevent the agar from drying out during the incubation period

Rationale: Sterilizing the loop between quadrants sequentially dilutes the number of bacteria streaked onto the agar surface. The goal is to separate individual bacterial cells in the final quadrant so they grow into distinct, pure isolated colonies.

19. An Imhoff Cone is primarily used in water and wastewater analysis to measure which of the following physical parameters?

A. Total Dissolved Solids (TDS)
B. Volatile Suspended Solids (VSS)
C. Total Suspended Solids (TSS)
D (correct). Settleable Solids

Rationale: The Imhoff Cone is the standard apparatus used to determine the volume of settleable solids in a water or wastewater sample over a specified period (typically 45-60 minutes).

20. What is the Maximum Contaminant Level Goal (MCLG) for a known human carcinogen such as Benzene or Vinyl Chloride?

A. 0.005 mg/L
B. 1.0 mg/L
C (correct). Zero (0 mg/L)
D. The same as the MCL

Rationale: The EPA typically sets the MCLG (the non-enforceable health goal) at zero for any contaminant known or suspected to be a human carcinogen.

21. Which three primary anionic species contribute to the total alkalinity of a typical natural water sample?

A. Calcium, Magnesium, and Sodium
B. Chloride, Sulfate, and Nitrate
C. Iron, Manganese, and Aluminum
D (correct). Bicarbonate, Carbonate, and Hydroxide

Rationale: Total alkalinity is primarily composed of bicarbonate (HCO3-), carbonate (CO3--), and hydroxide (OH-) ions.

22. The Threshold Odor Number (TON) is calculated using the formula TON = (A + B) / A. What does "A" represent in this formula?

A. Total volume of the flask
B (correct). Volume of the sample in mL
C. Volume of odor-free water in mL
D. Number of analysts performing the test

Rationale: "A" is the volume of the sample in mL, and "B" is the volume of odor-free water used for dilution.

23. Which of the following describes the definition of the Coliform group of bacteria as used in drinking water testing?

A. Gram-positive bacteria that produce an acidic environment.
B. Gram-negative, spore-forming bacteria that do not ferment lactose.
C. Viruses capable of infecting and replicating within human host cells.
D (correct). Gram-negative, non-spore-forming bacteria that ferment lactose with gas within 48h at
35°C.

Rationale: Total coliforms are defined as all facultative anaerobic, gram-negative, non-spore-forming, rod-shaped bacteria that ferment lactose with gas and acid formation within 48 hours at 35 °C.

24. What is the correct technique for reading the volume of a clear aqueous liquid in a graduated glass cylinder to avoid parallax error?

A (correct). Read at the bottom of the meniscus at eye level
B. Read at the top edge of the liquid at a 45-degree angle
C. Read from above looking down on the meniscus
D. Read at the top of the meniscus at eye level

Rationale: Due to capillary action, water forms a concave curve. To avoid parallax error, the correct reading is taken at eye level, aligning with the lowest point (the bottom) of the meniscus.

25. In an amperometric titration for chlorine residual using PAO (Phenylarsine Oxide), what specific change in the electrical circuit indicates that the titration endpoint has been reached?

A. The microammeter needle deflects rapidly upwards (increases current)
B. The digital display flashes a red warning light
C. The sample liquid suddenly changes from pink to clear
D (correct). The microammeter needle ceases its downward deflection (current stops decreasing)

Rationale: In amperometric titration for chlorine, the endpoint is indicated by the cessation (stopping) of the downward deflection of the microammeter needle upon the addition of PAO, meaning all free iodine has been reduced.

26. Where should a laboratory worker find detailed information regarding the hazards, handling, and emergency response procedures for a specific chemical?

A. The Code of Federal Regulations (CFR)
B (correct). The Safety Data Sheet (SDS) for that chemical
C. Standard Methods for the Examination of Water and Wastewater
D. The Laboratory Quality Assurance Manual (QAM)

Rationale: The Safety Data Sheet (SDS), formerly known as MSDS, provides comprehensive information about a chemical's hazards, physical properties, toxicity, and safe handling procedures.

27. What is the fundamental difference between "Accuracy" and "Precision" in laboratory measurements?

A. Accuracy only applies to instrument calibration, while precision applies to sample analysis.
B. They mean the exact same thing in laboratory analytics.
C. Accuracy is how close repeated measurements are to each other; Precision is how close they are to the true value.
D (correct). Accuracy is how close a measurement is to the true value; Precision is how close repeated measurements are to each other.

Rationale: Accuracy refers to how close a measured value is to the true or accepted value, while precision refers to how close repeated measurements of the same sample are to each other.

28. In a titration setup, what is the primary function of the stopcock valve at the bottom of the burette?

A. To prevent the Erlenmeyer flask from overflowing
B. To measure the final pH of the solution automatically
C. To mix the titrant and analyte within the burette tube
D (correct). To precisely control the flow and drop-rate of the titrant into the analyte

Rationale: The stopcock valve allows the analyst to precisely control the flow rate of the titrant into the analyte, from a steady stream down to a single drop, ensuring an accurate endpoint determination.

29. What is the proper procedure for sterilizing glass pipettes and Petri dishes in a laboratory dry-heat oven?

A. 121 °C for 15 minutes
B (correct). 170 °C for 2 hours
C. 100 °C for 30 minutes
D. 250 °C for 5 minutes

Rationale: Dry-heat sterilization requires maintaining a temperature of 170 °C for at least 2 hours to ensure the destruction of all microbial life, including spores.

30. For optimal performance and safety, what is the recommended operating sash height for a standard chemical fume hood?

A. Fully open (all the way up) to maximize airflow and visibility
B (correct). Lowered to the indicated safe operating height (typically 12 to 18 inches)
C. At whatever height the user finds most comfortable for working standing up
D. Fully closed, opening it only just enough to reach hands inside

Rationale: Fume hoods should generally be operated with the sash lowered to the indicated safe operating height (usually 12 to 18 inches) to ensure adequate face velocity and provide a physical barrier between the user and the chemicals.

31. On a volumetric (transfer) pipette, what does the single calibration mark denoted "TD" indicate?

A (correct). The volume the pipette is calibrated "To Deliver" (TD) by free drainage
B. The volume that must be "blown out" after draining
C. The volume the pipette will "To Contain" (TC) before dispensing
D. The maximum volume that can be safely drawn into the bulb

Rationale: The single calibration mark indicates the volume the pipette is calibrated "To Deliver" (TD) at a specific temperature (usually 20°C) when allowed to drain freely by gravity.

32. Turbidity in drinking water is primarily monitored because suspended particles can cause which adverse effect?

A (correct). Shield pathogens from chemical disinfectants
B. Rapidly decrease the pH of the distribution system

C. Cause immediate acute toxicity if ingested
D. Increase the concentration of dissolved heavy metals

Rationale: The primary public health concern with turbidity is that particles can shield pathogenic microorganisms from chemical disinfectants like chlorine.

33. When performing a "Matrix Spike" (MS), what information is the analyst primarily trying to obtain?

A (correct). Whether the sample matrix interferes with the recovery of the analyte
B. Whether the laboratory reagents are contaminated
C. Whether the analyst followed the method accurately
D. Whether the instrument calibration curve is still valid

Rationale: A matrix spike involves adding a known amount of analyte to a real sample. The recovery of the spike indicates whether the sample matrix (the chemical makeup of the specific water sample) interferes with the analysis.

34. What is the maximum holding time and transport temperature for a drinking water sample collected for compliance bacteriological analysis?

A (correct). Cool (<10 °C, not frozen), analyzed within 30 hours
B. Room temperature, analyzed within 48 hours
C. Frozen solid, analyzed within 14 days
D. Cool (<10 °C), analyzed within 7 days

Rationale: Samples must be kept cool (ideally below 10 °C but not frozen) and analyzed within 30 hours of collection to meet compliance requirements under the RTCR.

35. Which of the following describes the relationship between water temperature and the solubility of dissolved oxygen (DO)?

A. As temperature increases, DO solubility increases
B. Temperature has no effect on DO solubility
C (correct). As temperature increases, DO solubility decreases
D. DO solubility peaks at 25 °C and decreases at higher or lower temperatures

Rationale: As water temperature increases, the solubility of gases like oxygen decreases.

36. When diluting a concentrated strong acid (such as sulfuric acid) to prepare a reagent, what is the correct safety procedure?

A. Rapidly pour the acid into the water, then seal the container immediately
B. Rapidly pour the water into the acid, then place it in an ice bath
C. Slowly add the water into the concentrated acid while stirring continuously
D (correct). Slowly add the concentrated acid into the water while stirring continuously

Rationale: Always add concentrated acid to water slowly while stirring ("Acid to Water"). Adding water to concentrated acid can cause a violent exothermic reaction that boils the water and spatters the acid.

37. For a public water system, what constitutes a "Tier 1" violation requiring notification within 24 hours?

A. Failing to report a lead sample on time
B (correct). E. coli MCL violation or Nitrate exceedance
C. Minor change in the fluoridation dosage
D. Exceeding a secondary MCL for iron

Rationale: Tier 1 violations are those with the potential to have serious adverse effects on human health as a result of short-term exposure, such as an E. coli MCL violation or a nitrate exceedance.

38. Why is a Sodium Thiosulfate tablet added to sterile sample bottles used for bacteriological sampling of chlorinated water?

A (correct). To neutralize any residual chlorine and stop the disinfection process
B. To act as a preservative for heavy metals analysis
C. To provide a nutrient source for the bacteria to grow during transport

D. To adjust the pH of the sample to exactly 7.0

Rationale: Chlorine is a disinfectant that kills bacteria. Sodium thiosulfate is added to neutralize any residual chlorine in the sample at the time of collection, preventing the chlorine from continuing to kill bacteria during transport to the lab.

39. Which analytical instrument is best suited for the rapid, simultaneous determination of multiple trace metals (e.g., Lead, Copper, Arsenic) in a drinking water sample?

A. Gas Chromatography - Mass Spectrometry (GC-MS)
B (correct). Inductively Coupled Plasma - Mass Spectrometry (ICP-MS)
C. Amperometric Titrator
D. Ion Chromatography (IC)

Rationale: Inductively Coupled Plasma - Mass Spectrometry (ICP-MS) or ICP-OES is the standard method for rapid, highly sensitive, multi-element trace metal analysis.

40. The "Chlorine Demand" of a water sample is defined as the difference between which two values?

A (correct). The difference between the amount of chlorine dosed and the chlorine residual remaining
B. The difference between Free Chlorine and Total Chlorine
C. The regulatory minimum limit for chlorine in the distribution system
D. The total amount of chlorine added at the treatment plant in one day

Rationale: Chlorine demand is the difference between the amount of chlorine dosed (added) to the water and the amount of chlorine residual remaining after a specified contact time.

41. Which of the following chemicals is regulated under the EPA Lead and Copper Rule (LCR) via an "Action Level" rather than an MCL?

A. Mercury
B (correct). Lead
C. Barium
D. Arsenic

Rationale: The EPA regulates Lead (Action Level = 0.015 mg/L) and Copper (Action Level = 1.3 mg/L) through treatment technique requirements triggered by an action level exceedance.

42. When preparing a serial dilution (e.g., 1:10) of a highly contaminated wastewater sample for plating, what diluent should be used?

A. Sterile, pure deionized water
B. Tap water that has been boiled
C. A strong 10% bleach solution
D (correct). Sterile, buffered diluent (like phosphate-buffered water)

Rationale: Standard Methods requires the use of a sterile, buffered diluent (like phosphate-buffered water or peptone water) to maintain cell viability and osmotic balance, rather than pure distilled water.

43. When a public water system (PWS) detects a contaminant at a level exceeding an MCL, what is the required first step according to the EPA Public Notification Rule?

A. Rinse the pipes with distilled water
B (correct). Notify the public of the violation
C. Double the chlorine dose automatically
D. Immediately shut down the entire water system

Rationale: PWSs must notify the public when an MCL violation occurs. The timing and method of notification depend on the severity of the health risk (Tier 1, 2, or 3).

44. Which of the following describes the difference between a "Primary" MCL and a "Secondary" MCL?

A. Primary MCLs apply to industrial water; Secondary MCLs apply to drinking water.
B. There is no difference; both are legally enforceable by the EPA.
C (correct). Primary MCLs are health-based and enforceable; Secondary MCLs are aesthetic-based and non-mandatory.
D. Secondary MCLs are for surface water only; Primary MCLs are for groundwater.

Rationale: Primary MCLs are legally enforceable standards for contaminants that affect human health. Secondary MCLs are non-mandatory guidelines for contaminants that affect the aesthetic (taste, odor, appearance) qualities of water.

45. What is the required frequency for a large public water system to sample for asbestos, assuming no waivers are granted?

A. Monthly
B. Once per year
C. Once every three years
D (correct). Once every nine years (compliance cycle)

Rationale: Standard monitoring for asbestos is typically once every nine-year compliance cycle.

46. When using a DPD (N,N-Diethyl-p-phenylenediamine) colorimetric test for chlorine residual, what does the development of a pink color in the sample cell indicate?

A. Total Dissolved Solids (TDS)
B. Fluoride residual
C. Hardness
D (correct). Free or Total Chlorine residual

Rationale: DPD reagent reacts with chlorine to produce a pink-colored solution. The intensity of the color is proportional to the concentration of free available chlorine (or total chlorine if potassium iodide is added).

47. During a settleable solids test using an Imhoff cone, the analyst observes pockets of liquid trapped between settled solids. How should the analyst record the volume?

A. Vigorously stir the cone and restart the 45-minute settling period
B. Include the liquid pockets in the final reading
C. Add more sample to displace the trapped liquid
D (correct). Subtract the volume of the liquid pockets from the total settled volume

Rationale: Standard practice dictates that the analyst must subtract the volume of any large pockets of liquid from the total volume of settled solids.

48. During BOD analysis, why is it critical that the 300-mL glass BOD bottle be completely filled with the liquid sample, leaving absolutely no headspace or air bubbles?

A. To prevent the glass bottle from shattering due to gas pressure buildup
B. To ensure the dissolved oxygen probe fits tightly without leaking
C. To create an anaerobic environment necessary for rapid bacterial respiration
D (correct). To prevent atmospheric oxygen from dissolving into the sample and skewing the BOD result

Rationale: Any trapped air bubbles or headspace in the BOD bottle will introduce atmospheric oxygen into the sample during the 5-day incubation period, resulting in an artificially low BOD measurement.

49. According to Standard Methods, what is the primary reference standard used to calibrate a nephelometric turbidimeter?

A. Styrene divinylbenzene
B. Kaolin clay
C. Silica
D (correct). Formazin

Rationale: Formazin polymer suspensions are the primary accepted standard for calibrating

turbidimeters due to their reproducibility.

50. The Revised Total Coliform Rule (RTCR) requires a system to perform a "Level 1 Assessment" when which of the following occurs?

A (correct). Detection of more than one total coliform positive sample in a month
B. Any detection of E. coli in the water system
C. When the turbidity exceeds 5.0 NTU
D. When the water pressure drops below 20 psi

Rationale: A Level 1 Assessment is triggered if a system has more than one Total Coliform positive sample in a month (or one positive for systems collecting fewer than 40 samples per month).

51. In spectrophotometric analysis, what does Beer's Law (the Beer-Lambert Law) state regarding the relationship between absorbance and concentration?

A. Transmittance increases exponentially as concentration increases
B (correct). Absorbance is directly and linearly proportional to the concentration of the absorbing species
C. Concentration can only be determined by boiling the sample first
D. Absorbance is inversely proportional to concentration

Rationale: Beer's Law states that the absorbance of light by a solution is directly and linearly proportional to the concentration of the absorbing chemical species in that solution.

52. What is a Laboratory Control Sample (LCS) used for in a quality assurance/quality control (QA/QC) program?

A (correct). To verify that the analytical method accurately measures the analyte in an ideal, clean matrix
B. To calibrate the instrument across a range of different concentrations
C. To determine the background level of contamination in the laboratory
D. To test if the sample matrix causes interference with the analyte recovery

Rationale: An LCS is a clean matrix (like reagent water) spiked with a known concentration of target analytes. Analyzing the LCS verifies that the analytical method is capable of accurately measuring the analytes under ideal conditions.

53. What is the regulated Maximum Residual Disinfectant Level (MRDL) for Chlorine (as Cl2)?

A. 10.0 mg/L
B (correct). 4.0 mg/L
C. 0.2 mg/L
D. 1.0 mg/L

Rationale: The MRDL for Chlorine (free or total) is 4.0 mg/L, which is the highest level of disinfectant allowed in the distribution system.

54. When preparing a dilution for a BOD5 test on a sample with an expected BOD of 200 mg/L, what must be added to the dilution water to ensure the bacteria have the necessary nutrients to metabolize the organic matter?

A. A heavy metal inhibitor to stop toxic interference
B (correct). A nutrient buffer solution containing phosphate, magnesium, calcium, and iron
C. Sodium thiosulfate to neutralize any organic matter
D. Concentrated sulfuric acid to lower the pH

Rationale: Standard BOD dilution water must be fortified with a nutrient buffer solution containing phosphate, magnesium sulfate, calcium chloride, and ferric chloride.

55. What is the Maximum Contaminant Level (MCL) for Haloacetic Acids (HAA5) in drinking water?

A. 0.080 mg/L (80 ppb)
B. 0.010 mg/L
C (correct). 0.060 mg/L (60 ppb)
D. 0.150 mg/L

Rationale: The MCL for HAA5 is 0.060 mg/L (60 ppb).

56. Why are Total Coliform bacteria used as an "indicator organism" for drinking water safety rather than testing directly for specific pathogens?

A. Testing for them takes only a few minutes compared to other bacteria.
B. Coliforms are the most lethal type of pathogen found in water.
C (correct). They are easy to detect, abundant in feces, and their absence generally indicates the absence of harder-to-detect pathogens.
D. They are the only type of bacteria that can survive the chlorination process.

Rationale: Testing directly for the multitude of pathogens (viruses, bacteria, protozoa) is impractical, time-consuming, and expensive. Coliforms are abundant in feces, easier to detect, and more resistant to disinfection than most bacterial pathogens.

57. A laboratory worker accidentally spills a broth culture of E. coli on the benchtop. What is the immediate, correct protocol for cleaning the spill?

A. Leave the lab immediately and call a hazardous materials (HAZMAT) team
B (correct). Cover with paper towels soaked in a laboratory disinfectant, wait 15-30 mins, then wipe up
C. Immediately wipe it up with dry paper towels and throw them in the regular trash
D. Pour concentrated sulfuric acid on the spill to instantly kill the bacteria

Rationale: The area should be covered with paper towels soaked in a suitable laboratory disinfectant (e.g., 10% bleach solution), left for a contact time of at least 15-30 minutes, and then wiped up.

58. Which type of laboratory glassware provides the highest level of accuracy and precision for preparing a standard solution of a specific concentration?

A. Griffin Beaker
B (correct). Class A Volumetric Flask
C. Erlenmeyer Flask
D. Graduated Cylinder

Rationale: Class A volumetric flasks are calibrated "To Contain" (TC) a specific volume at 20°C with a very high degree of precision, making them the standard for preparing solutions of known concentration.

59. In laboratory quality control (QC), what is the primary purpose of analyzing a "Method Blank"?

A (correct). To verify that no contamination is introduced by reagents or the laboratory environment
B. To check for interferences caused by the sample matrix
C. To calibrate the analytical instrument at the zero point
D. To verify the accuracy of the standard stock solutions

Rationale: A method blank consists of reagent water processed through all the steps of the analytical procedure. Its purpose is to verify that no contamination is being introduced by the reagents, glassware, or the laboratory environment.

60. Which type of pipette is marked to deliver variable volumes and has graduations that extend all the way down to the tip?

A (correct). Serological Pipette
B. Volumetric Transfer Pipette
C. Mohr Pipette
D. Pasteur Pipette

Rationale: A serological pipette has graduations that extend to its tip. It is a "blow-out" pipette, meaning the last drop must be expelled to deliver the full volume.

61. When adding the measurements 12.11 mL and 4.3 mL together, how should the final result be correctly reported using significant figures?

A. 16 mL
B. 16.41 mL
C. 16.410 mL
D (correct). 16.4 mL

Rationale: When adding or subtracting, the result should be rounded to the same number of decimal places as the measurement with the fewest decimal places (4.3 has one decimal place). 12.11 + 4.3 = 16.41, rounded to 16.4 mL.

62. In addition to health-based MCLs, the EPA Surface Water Treatment Rule requires a "Treatment Technique" for which parameter to ensure pathogen removal?

A (correct). Turbidity
B. TDS
C. Alkalinity
D. Iron and Manganese

Rationale: Turbidity is regulated as a treatment technique for surface water systems to ensure that filtration processes are effectively removing pathogens like Cryptosporidium.

63. When measuring Free Chlorine Residual using the DPD colorimetric method (Standard Method 4500-Cl G), how quickly should the reading be taken after adding the DPD reagent to the sample?

A. Wait 15 minutes in total darkness
B. The timing does not matter as long as the color turns pink
C (correct). Read immediately (within 1 minute) before combined chlorine begins to react
D. Wait exactly 5 minutes for full color development

Rationale: For free chlorine, the reading must be taken immediately (within 1 minute) after adding the DPD reagent, as waiting longer can allow combined chlorine species to begin reacting and artificially inflating the free chlorine result.

64. What is the function of a "Blank" cuvette when "zeroing" a spectrophotometer before analyzing a batch of samples?

A (correct). To zero the instrument by subtracting the background absorbance of the reagents and
the glass
B. To clean the optical path before inserting the actual sample
C. To provide a colored standard for visual comparison
D. To safely dispose of the highly concentrated standard solution

Rationale: A blank cuvette contains all the reagents and solvents used in the sample preparation, but none of the actual analyte. Zeroing with the blank subtracts the background absorbance of the reagents and the glass itself.

65. According to Standard Methods, a Biochemical Oxygen Demand (BOD5) test requires the sample to be incubated in the dark at what temperature and for how many days?

A. 4 °C for 14 days
B (correct). 20 ± 1 °C for 5 days
C. 35 ± 0.5 °C for 24 hours
D. 103 °C for 1 hour

Rationale: The standard BOD test requires a 5-day incubation period (BOD5) at a constant temperature of 20 ± 1 °C in the dark to prevent photosynthetic oxygen production.

66. What is the primary purpose of the desiccant material in the bottom chamber of a laboratory desiccator?

A. To prevent the sample from oxidizing during the cooling process
B. To safely contain hazardous fumes emitted by the hot sample
C (correct). To provide a dry environment so the sample cools without absorbing moisture
D. To rapidly cool the sample using a chemical endothermic reaction

Rationale: The desiccant absorbs atmospheric moisture, creating a dry environment that allows heated samples (like those for solids analysis) to cool to room temperature without absorbing ambient humidity before weighing.

67. When measuring the temperature of a water sample according to Standard Methods, what is the required accuracy of the thermometer or thermistor?

A. ± 1.0 °C
B (correct). ± 0.1 °C
C. ± 2.0 °C
D. ± 0.5 °C

Rationale: Standard Method 2550 requires temperature measurement devices to be accurate to ± 0.1 °C.

68. When evaluating an autoclave's performance, which biological indicator is considered the gold standard to ensure sterility was achieved?

A. Escherichia coli (E. coli)
B (correct). Geobacillus stearothermophilus spores
C. A chemical tape that turns black
D. A thermometer placed in the center of the load

Rationale: Geobacillus stearothermophilus spores are highly resistant to heat. If these spores are killed during an autoclave cycle, it provides definitive proof that sterilization conditions were met.

69. What is the primary difference between "True Color" and "Apparent Color" when analyzing a water sample?

A. There is no difference; the terms are used interchangeably
B. True color measures only the inorganic compounds in the water
C. Apparent color is measured using a spectrophotometer, while true color is visual
D (correct). True color requires the sample to be filtered or centrifuged prior to analysis

Rationale: True color is the color of water from which turbidity (suspended matter) has been removed, whereas apparent color includes both dissolved substances and suspended matter.

70. What is the standard sterilization temperature and pressure used in a laboratory autoclave?

A. 70 °C (158 °F) at 10 psi for 45 minutes
B. 180 °C (356 °F) at 30 psi for 5 minutes
C (correct). 121 °C (250 °F) at 15 psi for 15 to 30 minutes
D. 100 °C (212 °F) at 0 psi for 60 minutes

Rationale: Standard autoclave sterilization requires steam under pressure, typically at 121 °C (250 °F) and 15 psi for a minimum of 15 to 30 minutes to effectively kill microorganisms and spores.

71. In the presence-absence (P-A) coliform test, what volume of water sample is analyzed?

A. 10 mL
B (correct). 100 mL
C. 50 mL
D. 1000 mL (1 Liter)

Rationale: The standard volume for drinking water compliance testing using P-A methods (like Colilert) is 100 mL.

72. For the determination of Total Dissolved Solids (TDS) per Standard Method 2540C, at what temperature is the filtered sample dried?

A. 550 ± 50 °C
B. 100 °C
C. 103 to 105 °C
D (correct). 180 ± 2 °C

Rationale: Standard Method 2540C requires drying the filtrate in an evaporating dish at 180 ± 2 °C to ensure the removal of mechanically occluded water.

73. In a spectrophotometer, what is the primary function of the monochromator — such as a prism or diffraction grating?

A. To convert the absorbed light energy directly into a digital concentration reading
B. To hold the liquid sample in a perfectly square optical path
C (correct). To separate the light source into its component wavelengths for specific selection
D. To amplify the electrical signal generated by the photodetector

Rationale: The monochromator separates the broad-spectrum white light from the source into its component colors (wavelengths) so that only a specific, narrow band of light passes through the slit to the sample.

74. What is the required incubation temperature and time for the Total Coliform Membrane Filtration (MF) technique using m-Endo medium?

A (correct). 35 ± 0.5 °C for 22 to 24 hours
B. 44.5 ± 0.2 °C for 24 hours
C. 20 °C for 5 days
D. 121 °C for 15 minutes

Rationale: Standard Method 9222B specifies incubating the m-Endo plates at 35 ± 0.5 °C for 22 to 24 hours.

75. When determining the Threshold Odor Number (TON) of a water sample, the test is typically conducted at what temperature?

A (correct). 60 °C
B. 25 °C
C. 100 °C
D. 40 °C

Rationale: Standard Method 2150B specifies conducting the odor test at 60 °C to volatilize odor-causing compounds effectively without causing discomfort to the analyst.

76. According to Standard Methods, what is the standard pore size of the gridded membrane filter used in the Membrane Filtration (MF) technique for isolating coliform bacteria from water?

A (correct). 0.45 ;ÆÐ
B. 1.20 ;ÆÐ
C. 0.10 ;ÆÐ
D. 0.22 ;ÆÐ

Rationale: The standard pore size for bacteriological membrane filtration is 0.45 micrometers (;ÆÒ'À which is small enough to reliably retain all coliform bacteria while allowing the water sample to pass through.

77. Total Hardness is conventionally expressed in terms of an equivalent concentration of which chemical compound?

A (correct). Calcium carbonate (CaCO3)
B. Sodium chloride (NaCl)
C. Calcium hydroxide (Ca(OH)2)
D. Magnesium sulfate (MgSO4)

Rationale: Total hardness, regardless of the specific multivalent cations present (primarily Ca++ and Mg++), is always reported as an equivalent concentration of calcium carbonate (CaCO3) in mg/L.

78. In the Multiple-Tube Fermentation (MTF) technique, the Presumptive Phase utilizes which culture medium?

A (correct). Lauryl Tryptose Broth (LTB)
B. m-Endo Medium
C. Brilliant Green Lactose Bile (BGLB)
D. EC Broth

Rationale: The presumptive phase uses Lauryl Tryptose Broth (LTB). Tubes showing turbidity and gas production after 24 or 48 hours at 35 °C are considered "presumptively" positive for total coliforms.

79. What is the primary legal and regulatory purpose of the signature and time-stamp fields in the relinquished/received sections of a laboratory Chain of Custody (COC) form?

A. To indicate the cost of the analytical testing performed
B (correct). To provide a legally defensible record of sample possession and transfer
C. To record the GPS coordinates of the sampling location
D. To verify the identity of the bacteria found in the sample

Rationale: The Chain of Custody provides a legally defensible, continuous record of the possession and handling of a sample from collection through analysis to disposal.

80. When counting colonies on an m-Endo agar plate after Membrane Filtration, which colonies are counted as typical Total Coliforms?

A. Opaque white with fuzzy borders
B. Clear and colorless
C. Blue and fluorescing under UV light
D (correct). Dark red with a metallic (golden-green) surface sheen

Rationale: Typical coliform colonies on m-Endo medium are dark red and have a distinct metallic (golden-green) surface sheen.

81. When calculating Volatile Suspended Solids (VSS), a filtered sample (previously dried for TSS) is ignited in a muffle furnace. What is the standard temperature and duration for this ignition?

A. 180 ± 2 °C for 1 hour
B. 103 to 105 °C for 24 hours
C (correct). 550 ± 50 °C for 15-20 minutes
D. 1000 °C for 5 minutes

Rationale: VSS is determined by igniting the TSS residue at 550 ± 50 °C for 15 to 20 minutes to burn off the organic (volatile) fraction.

82. According to EPA Method 180.1 and Standard Methods for the Examination of Water and Wastewater, at what angle to the incident light beam is scattered light detected in a nephelometric turbidimeter?

A. 360 degrees
B. 45 degrees
C. 180 degrees
D (correct). 90 degrees

Rationale: Nephelometric turbidity is measured by the intensity of light scattered at a 90-degree angle to the incident beam, which provides the best sensitivity for particle detection.

83. In Ion Chromatography (IC), what fundamental property of the analytes determines the speed at which they travel through the stationary phase column and separate into distinct bands?

A (correct). The differential affinity of each ion for the charged exchange sites on the resin
B. The physical size of the ions compared to the pore size of the column filter
C. The boiling point of each compound as it passes through the heated column
D. The speed of the motorized pump pushing the eluent fluid

Rationale: In ion chromatography, separation is based on the differential affinity (or ionic attraction) of each specific analyte ion for the charged exchange sites on the resin beads in the stationary phase column.

84. In the Winkler titration method (Azide Modification) for Dissolved Oxygen, what chemical is used as the final titrant, and what indicator is added near the endpoint?

A (correct). Sodium thiosulfate titrant; Starch indicator
B. EDTA titrant; Eriochrome Black T indicator
C. Sodium hydroxide titrant; Phenolphthalein indicator
D. Phenylarsine oxide (PAO) titrant; DPD indicator

Rationale: The Winkler method uses sodium thiosulfate ($Na_2S_2O_3$) as the standard titrant to reduce iodine to iodide. Starch indicator is added near the endpoint, turning the blue-black solution colorless.

85. Which chemical preservation method is required for a sample collected for Total Metals analysis (e.g., Iron or Manganese) to keep the metals dissolved in solution during transport?

A. Add Sodium Thiosulfate to remove chlorine
B. Store the sample at 35 °C
C (correct). Add Nitric Acid (HNO_3) to lower the pH to < 2.0
D. Add Sodium Hydroxide (NaOH) to raise the pH to > 12.0

Rationale: Samples for total metals must be preserved immediately by adding concentrated Nitric Acid (HNO_3) to lower the sample pH to less than 2.0.

86. What is the maximum holding time for a sample collected for pH analysis?

A. 24 hours
B. 48 hours
C (correct). 15 minutes (Immediately)
D. 14 days

Rationale: pH must be analyzed "immediately" (typically within 15 minutes of collection) because biological and chemical activity can rapidly change the pH.

87. When using a visual color comparator block to determine the color of a water sample, in which standard units are results typically reported?

A. Threshold Odor Number (TON)
B. Nephelometric Turbidity Units (NTU)
C. Milligrams per Liter (mg/L)
D (correct). Platinum-Cobalt (Pt-Co) Units

Rationale: Visual color comparators use the Platinum-Cobalt (Pt-Co) scale. Results are reported in True Color Units (TCU) or simply Pt-Co color units.

88. When performing a total alkalinity titration using Standard Method 2320B, what is the standard titrant used and what is the typical pH endpoint for a water sample with alkalinity around 150 mg/L?

A. 0.1 N Sodium Hydroxide; endpoint pH 8.3
B. 0.1 N EDTA; endpoint pH 10.0
C. 0.05 N Silver Nitrate; endpoint pH 7.0
D (correct). 0.02 N Sulfuric Acid; endpoint pH 4.5

Rationale: Alkalinity is determined by titrating the sample with a standard 0.02 N sulfuric acid (H_2SO_4) or hydrochloric acid solution to an electrometrically determined pH endpoint of 4.5.

89. A Secchi disk is lowered into a water body until it is no longer visible. What physical characteristic of the water does this measurement primarily indicate?

A. Dissolved Oxygen Profile
B (correct). Transparency (Clarity)
C. Specific Conductance
D. Total Dissolved Solids

Rationale: The Secchi disk is lowered into a water body until it is no longer visible. The depth at which it disappears is a measure of the water's transparency (or clarity), which is inversely related to turbidity.

90. What is the primary function of a buffer solution used in analytical chemistry?

A (correct). To resist significant changes in pH upon the addition of small amounts of an acid or a base
B. To completely neutralize an acid or base to a pH of exactly 7.0
C. To act as a universal indicator that changes color based on pH
D. To rapidly lower the pH of a strongly alkaline solution

Rationale: A buffer solution is composed of a weak acid and its conjugate base (or vice versa). Its primary function is to resist significant changes in pH upon the addition of small amounts of an acid or a base.

91. Which sterilization method relies on steam under pressure and is most commonly used for liquids, culture media, and biohazardous waste?

A. Ultraviolet (UV) light chamber
B (correct). Autoclave
C. Dry-heat oven
D. Bunsen burner flaming

Rationale: Autoclaving uses saturated steam under pressure (typically 121 °C at 15 psi for 15-30 mins) and is highly effective for penetrating liquids and porous materials.

92. During Total Suspended Solids (TSS) analysis using vacuum filtration, what drying temperature does Standard Methods 2540D require for the filter after the sample has been processed?

A. 35 ± 0.5 °C
B. 550 ± 50 °C
C. 180 ± 2 °C
D (correct). 103 to 105 °C

Rationale: Standard Method 2540D requires that the filter used for TSS analysis be dried in an oven at 103 to 105 degrees Celsius until a constant weight is achieved.

93. Which of the following is the standard Maximum Contaminant Level (MCL) for Fluoride in drinking water to prevent dental fluorosis and skeletal damage?

A (correct). 4.0 mg/L
B. 0.7 mg/L
C. 10.0 mg/L
D. 1.0 mg/L

Rationale: The Primary MCL for Fluoride is 4.0 mg/L. There is also a Secondary MCL of 2.0 mg/L for aesthetic/cosmetic concerns.

94. The standard unit of measurement for color in water analysis is based on the platinum-cobalt (Pt-Co) method. One color unit is equivalent to the color produced by 1 mg/L of which substance?

A. Iron
B (correct). Platinum
C. Cobalt
D. Manganese

Rationale: The standard color unit is equivalent to the color produced by 1 mg/L of platinum in the form of the chloroplatinate ion.

95. According to the EPA Stage 2 Disinfectants and Disinfection Byproducts Rule, what is the Maximum Contaminant Level (MCL) for Total Trihalomethanes (TTHMs)?

A. 0.100 mg/L
B (correct). 0.080 mg/L (80 ppb)
C. 1.0 mg/L
D. 0.060 mg/L (60 ppb)

Rationale: The MCL for TTHMs, which are formed when chlorine reacts with organic matter, is 0.080 mg/L (80 ppb).

96. When analyzing a water sample for Orthophosphate (Reactive Phosphorus) using the ascorbic acid method, what color is developed in the sample prior to spectrophotometric measurement?

A (correct). Molybdenum Blue
B. DPD Pink
C. Yellow-Green
D. Red-wine

Rationale: The ascorbic acid method reacts with orthophosphate to form a phosphomolybdenum blue complex, which is then measured colorimetrically at a wavelength of 880 nm.

97. In the EDTA titrimetric method for Total Hardness (Standard Method 2340C), what color change indicates that the endpoint of the titration has been reached?

A. Blue to yellow
B (correct). Red-wine (pinkish-red) to distinct blue
C. Clear to cloudy white
D. Colorless to faint pink

Rationale: The Eriochrome Black T indicator forms a red-wine complex with calcium and magnesium. As EDTA chelates these ions, the indicator is freed, and the solution turns a distinct blue color at the endpoint.

98. Which contaminant is a regulated volatile organic compound (VOC) often found in groundwater contaminated by dry cleaning solvents or degreasers?

A (correct). Trichloroethylene (TCE)
B. Total Coliform
C. Nitrate
D. Lead

Rationale: Trichloroethylene (TCE) and Tetrachloroethylene (PCE) are common VOCs regulated by the EPA due to their health risks.

99. What is the primary purpose of the glass draft shield surrounding the weighing pan on a precision analytical balance?

A. To create a vacuum environment for weighing volatile samples
B (correct). To prevent air currents and environmental factors from causing reading fluctuations
C. To protect the operator from hazardous or explosive samples
D. To maintain the sample at a constant temperature of 25°C

Rationale: The draft shield protects the highly sensitive weighing mechanism from air currents, dust, and temperature fluctuations, which can cause significant fluctuations in readings.

100. In the Multiple-Tube Fermentation (MTF) technique for total coliform analysis, what is the primary purpose of the small inverted Durham tube inside the culture broth tube?

A. To provide a separate environment for anaerobic bacterial growth
B. To concentrate the bacteria into a smaller volume for easier counting
C. To maintain a constant pH within the culture medium during incubation
D (correct). To physically trap and indicate the production of gas from lactose fermentation

Rationale: The inverted Durham tube is used to physically trap and indicate the production of gas, which is a key physiological indicator that coliform bacteria have fermented the lactose or lauryl tryptose in the broth.