4 CHAPTER

Quality Control of Water Supply

Q.1 The most common cause of acidity in water is
(a) carbon dioxide (b) oxygen
(c) hydrogen (d) nitrogen

Q.2 The maximum permissible limit for fluoride in drinking water is
(a) 0.1 mg/litre (b) 1.5 mg/litre
(c) 5 mg/litre (d) 10 mg/litre

Q.3 The range of size of colloidal particles is
(a) 1 μm-100 μm (b) 1 μm-10^{-2} μm
(c) 1 μm-10^{-3} μm (d) 1 μm-1000 μm

Q.4 Consider the following statements:
Assertion (A): Suspended material are seldom a constituent of ground water.
Reason (R): Soils have very good filtering capacity.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.5 Consider the following statements:
1. Inorganic solids are non-biodegradable solids.
2. Suspended solids and colloidal particles are combinedely called dispersed solids.
3. Acceptable limit of turbidity is 1 NTU and cause for rejection is 10 NTU.
4. Mass of suspended solids is obtained by filtration and heating the residue on filter at 100°C.

Which of these statements are correct?
(a) 1 and 2 (b) 1, 2 and 3
(c) 1, 2 and 4 (d) 1, 2, 3 and 4

Q.6 The permissible limit of suspended solids for drinking water is
(a) 25 mg/l (b) 30 mg/l
(c) 200 mg/l (d) 50 mg/l

Q.7 A filterable residue analysis is run on a sample of water as follows. Prior to filtering, the crucible and filter pad are kept overnight in the drying oven, cooled and the dry mass of the pair was determined to be 62.319 g. Two hundred and fifty milliliters of the sample is drawn through a filter pad contained in the porous bottom crucible. The crucible and filter pad are then placed in drying oven at 104°C and dried until a constant mass of 62.382 g is reached. The suspended solid concentration of the sample is
(a) 315 mg/l (b) 323 mg/l
(c) 289 mg/l (d) 252 mg/l

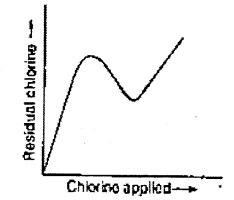
Q.8 In Baylis turbidity meter, light intensity is measured
(a) in the direction of incident light
(b) at right angles to the incident ray
(c) based on scattering principle
(d) by use of chemicals

Q.9 After suspended matter causing colour is removed by centrifugation, the colour obtained is called
(a) True colour (b) Apparent colour
(c) Brackish colour (d) Pure colour

Q.10 Turbidity is measured on
(a) standard silica scale
(b) standard cobalt scale
(c) standard platinum scale
(d) platinum cobalt scale

Q.11 The percentage of chlorine in fresh bleaching powder is about
(a) 10 to 15 (b) 20 to 25
(c) 25 to 30 (d) 40 to 50

Q.12 In the plot of residual chlorine versus chlorine dose applied as shown in figure, the curve will not have any (0, 0) point because



(a) of experimental error
(b) chlorine escapes into the atmosphere
(c) chlorine requires some contact time
(d) chlorine is consumed for disinfection

Q.13 The normal value of over flow rate for plain primary sedimentation tank ranges between
(a) 25,000 to 35,000 litres/sqm/day
(b) 40,000 to 50,000 litres/sqm/day
(c) 50,000 to 60,000 litres/sqm/day
(d) 80,000 to 100,000 litres/sqm/day

Q.14 The temperature at which the specific conductivity of water is determined by means of a portable dionic water tester is
(a) 15°C (b) 20°C
(c) 25°C (d) 30°C

Q.15 Which of the following is a minor source of TDS?
(a) Fe (b) NaCl
(c) SO_4^{-2} (d) Cl^-

Q.16 OH^- ions may not be present in water if pH of water is
(a) Greater than 9 (b) Less than 9
(c) Greater than 10 (d) Less than 10

Q.17 Two samples of water, *A* and *B*, have pH values of 3.6 and 6.6 respectively. How many times is sample *A* more acidic than sample *B*?
(a) 1000 (b) 300
(c) 30 (d) 3000

Q.18 A 250 ml of sample of water has initial pH of 10. 40 ml of 0.02 N H_2SO_4 is required to titrate the sample to pH = 5.0. What is the total alkalinity of water in mg/l as $CaCO_3$?
(a) 150 mg/l (b) 160 mg/l
(c) 180 mg/l (d) 200 mg/l

Q.19 pH range of methyl orange is
(a) 8.6-10.3 (b) 2.8-4.4
(c) 8.6-10.5 (d) 2.8-4.9

Q.20 In the determination of hardness, Erichrome black-T forms wine red colour and the titration changes the colour to
(a) Brown (b) Colourless
(c) Black (d) Blue

Q.21 Total hardness (in mg/l of $CaCO_3$) present in water sample with 18 mg/l of Mg^{2+} and 120 mg/l of Ca^{2+} is
(a) 375 mg/l (b) 275 mg/l
(c) 300 mg/l (d) 400 mg/l

Q.22 Consider the following statements:
Assertion (A): If the hardness is less than 150 mg/l it is not advised to soften the water.
Reason (R): The problems caused by excessive hardness gives rise to formation of scale in boilers and hot water system.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.23 Acceptable limit for total hardness is
(a) 200 mg/l (b) 300 mg/l
(c) 500 mg/l (d) 600 mg/l

Q.24 Match List-I (Hardness range) with List-II (Hardness) and select the correct answer using the codes given below the lists:

List-I (mg/l as $CaCO_3$)	List-II
A. 0-55	1. Soft
B. 56-100	2. Slightly hard
C. 101-200	3. Moderately hard
D. 201-500	4. Very hard

Codes:

	A	B	C	D
(a)	2	1	3	4
(b)	1	2	4	3
(c)	1	2	3	4
(d)	2	1	4	3

Q.25 BOD of treated water should be
(a) 10 ppm (b) 25 ppm
(c) 20 ppm (d) Nil

Q.26 The maximum permissible hardness for public supply is
(a) 95 mg/litre (b) 105 mg/litre
(c) 115 mg/litre (d) 125 mg/litre

Q.27 For evaporation and measurement of settleable solids, the apparatus used, is
(a) a jar (b) a beaker
(c) a test tube (d) an Imhoff cone

Q.28 Match List-I with List-II and select correct answer using codes given below the lists:

List-I
A. Coefficient of drag for viscous flow and small particles
B. Stream line settling
C. Turbulent settling
D. Discrete

List-II
1. Particles which do not change their size, shape and weight
2. Settling particles larger than 1.0 mm
3. 24/Reynolds number
4. Viscous force is greater than inertial force

Codes:

	A	B	C	D
(a)	1	2	3	4
(b)	3	2	1	4
(c)	3	4	2	1
(d)	4	2	1	3

Q.29 Which cation, if present in water, imparts pseudo-hardness to the water?
(a) Sodium
(b) Potassium
(c) Calcium
(d) Both (a) and (b)

Q.30 The limiting value of organic ammonia in potable water is
(a) 1 mg/l
(b) Nil
(c) 0.3 mg/l
(d) 0.15 mg/l

Q.31 Concentration of nitrite in water is measured by
(a) Tintometer
(b) Colour matching technique
(c) Measuring the amount of ammonia liberated after titration with $kMnO_4$
(d) None of these

Q.32 A 13 ml sample of treated water requires 208 ml of odour free distrilled water to reduce odour to a level that is just perciptible. What is the Threshold odour number for water sample.
(a) 17 (b) 16
(c) 15 (d) 18

Q.33 Which of the following are the least soluble forms of calcium and magnesium at normal water temperature?
(a) $CaCl_2$ and $MgCO_3$
(b) $CaCH(O_3)_2$ and $MgCl_2$
(c) $CaCO_3$ and $Mg(OH)_2$
(d) $Ca(OH)_2$ and $MgCH(O_3)_2$

Q.34 If the total hardness and alkalinity of a water sample are 150 mg/l as $CaCO_3$ and 230 mg/l as $CaCO_3$ respectively, then what are the values of carbonate and non-carbonate hardness?
(a) 150 mg/l and Zero
(b) 150 mg/l and 80 mg/l
(c) Zero and 150 mg/l
(d) 80 mg/l and 150 mg/l

Q.35 Match List-I (Metals) with List-II (Acceptable limit in drinking water) and select the correct answer using the codes given below the lists:

List-I	List-II
A. Calcium	1. 5 mg/l
B. Sulphate	2. 200 mg/l
C. Zinc	3. 75 mg/l
D. Arsenic	4. 0.01 mg/l

Codes:

	A	B	C	D
(a)	2	3	1	4
(b)	3	2	1	4
(c)	3	2	4	1
(d)	2	3	4	1

Q.36 Higher concentration of which of the following cause phytotoxicity?
(a) Lithium (b) Molybdenum
(c) Phenol (d) Selenium

Q.37 Which of the following is not toxic to aquatic life?
(a) Sulphide (b) Uranium
(c) Silver (d) Bromine

Q.38 Which of the following is not a nutrient which helps in growth of plants?
(a) Carbon (b) Phosphorus
(c) Fluorine (d) Nitrogen

Q.39 Match List-I with List-II and select the correct answer using codes given below the lists:

List-I
A. Absence of fluorides
B. Excess of lead
C. Presence of excess nitrates
D. Deficiency of iodide

List-II
1. Methemoglobinemia
2. Goitre
3. Dental caries
4. Anaemia

Codes:

	A	B	C	D
(a)	3	4	2	1
(b)	2	3	4	1
(c)	3	4	1	2
(d)	1	2	4	3

Q.40 An ideal settling basin is designed with surface overflow rate (SOR) of 1 $m^3/m^2/h$. Particles have their discrete settling velocities and concentration as follows:

Particle type	Settling velocity (m/h)	Initial concentration (mg/l)
1.	1.0	100
2.	0.5	100
3.	0.1	100
4.	0.05	100

Which one of the following gives correct estimate of the overall removal of particles per hour?
(a) 65 mg/l (b) 165 mg/l
(c) 265 mg/l (d) 365 mg/l

Q.41 Match List-I (Bacteria) with List-II (Shape) and select the correct answer using the codes given below the lists:

List-I	List-II
A. Cocci	1. Comma shape
B. Vibro	2. Rhombus shape
C. Bacilli	3. Helical shape
D. Spirillum	4. Rod shape
	5. Round shape

Codes:

	A	B	C	D
(a)	5	1	4	3
(b)	3	4	2	5
(c)	3	1	4	5
(d)	5	4	2	3

Q.42 Match List-I (Water-born disease) with List-II (Pollutant causing) and select the correct answer using the codes given below the lists:

List-I	List-II
A. Mottling of teeth	1. Salmonella bacteria
B. Hepatitis	2. Vibrio bacteria
C. Typhoid	3. Virus
D. Cholera	4. Fluoride

Codes:

	A	B	C	D
(a)	4	3	1	2
(b)	2	1	3	4
(c)	4	1	3	2
(d)	2	3	1	4

Q.43 Higher quantities of copper, more than 2.5 mg/l or so, may cause diseases pertaining to
(a) kidneys (b) lungs
(c) liver (d) arsenic

Q.44 The commonly used indicator for measuring iron concentration in water is
(a) Eriochrome black-T
(b) 1, 10-phenanthroline
(c) Phenolphthalein
(d) Blue litmus

Q.45 Presence of nitrogen in a waste water sample is due to the decomposition of
(a) carbohydrates (b) proteins
(c) fats (d) vitamins

Q.46 A rapid test to indicate the intensity of water pollution is
(a) BOD
(b) Dissolved Oxygen
(c) MPN
(d) Total dissolved solids

Q.47 Which of the following methods is used to determine colour in waste water?
(a) ADMI method
(b) Pt-Co method
(c) Threshold scale method
(d) JTU method

Q.48 Which of the following is/are the characteristics of coliform organism?
1. Bacillus
2. Gram-negative
3. Ferments lactose
4. Spore-forming
Select the correct answer using the codes given below:
(a) 1 alone (b) 1, 2 and 4
(c) 1, 2 and 3 (d) 2, 3 and 4

Q.49 A standard multiple-tube fermentation test was conducted on a sample of water. The result of the analysis for the confirmed test are given below:

Sample size (ml)	No. of positive results out of 5 tubes	No. of negative results out of 5 tubes
10	4	1
1.0	2	3
0.1	1	4
0.01	0	5

MPN index for combinations of positive results when 5 tubes are used per dilution (10 ml, 1.0 ml, 0.1 ml) is as follows:

Combination of positive	MPN index per 100 mL
5-4-3	280
4-3-1	33
4-2-1	26
2-1-0	7

Using the above MPN index table, what is the most probable number (MPN) of the sample?
(a) 7 (b) 26
(c) 260 (d) 70

Q.50 Which one of the following treatment is economically effective in the control of guinea worm disease?
(a) Sedimentation (b) Filtration
(c) Chlorination (d) Ozonation

Q.51 Assertion (A): Fluorides should always be present in drinking water upto a value 1.5 mg/l.
Reason (R): Such a water helps to keep the teeth clean.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.52 Match List-I (type of impurity) with List-II (harm caused) and select the correct answer using the codes given below the lists:
List-I
A. Excess of nitrates
B. Excess of fluorides
C. Lack of iodides
D. Excess of chlorides
List-II
1. Brackish water
2. Goiter
3. Fragile bones
4. Blue baby diesease
Codes:

	A	B	C	D
(a)	4	2	3	1
(b)	1	2	3	4
(c)	4	3	2	1
(d)	1	3	2	4

Q.53 Which of the following is not correct?
(a) pH value for pure water is nearly 7.
(b) In order to be safe against pathogenic bacteria residual chlorine should remain between 0.05 ppm and 0.2 ppm.
(c) Presence of iron and manganese in excess of 0.3 ppm in drinking water is objectionable.
(d) Chlorides in potable water may be present from 300 ppm to 500 ppm.

Q.54 What is the maximum permissible threshold odour number for a domestic water supply source?
(a) 1 (b) 3
(c) 7 (d) 10

Q.55 The pH of water admitted into a treatment plant was 6.0 in the morning. Consequent to inflow of raw water from a different source, it changed to 8.0 in the next 24 hrs. Assuming linear variation in time of the pH concentration, the time mean pH value of the water over this 24 hrs period is
(a) 6 (b) 7
(c) 6.3 (d) 6.8

Q.56 Assertion (A): Rainwater harvesting or artificial recharging of groundwater minimizes the TDS level in subsurface water.
Reason (R): TDS level falls in subsurface water due to dilution.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.57 The theoretical oxygen demand in litres of air for a 300 mg/l solution of methylamine, CH_3NH_2 to decompose completely is
(a) 1.55 L air/L solution
(b) 3.6 L air / L it solution
(c) 2.06 L air/L solution
(d) 1.46 L air / L it solution

Q.58 The BOD_5 if the temperature of the sample and seeded solution water are 20°C (saturation is 9.07 mg/L), the initial DO_5 are saturation and sample dilution is 1:30 with seeded solution. The final DO of seeded dilution water is 8 mg/l and final DO of seeded dilution water is 2 mg/L assuming volume of BOD bottle is 300 mL.
(a) 181 mg/l (b) 281 mg/l
(c) 251 mg/l (d) 290 mg/l

Q.59 The BOD versus time data for first five days of BOD test are obtained as

Time BOD (in t days)	BOD, y (mg/l)
2	10
4	15
6	20

From graph, the intercept $b = 0.545$ and slope is $m = 0.021$. The deoxygenation constant, K and ultimate BOD, L are respectively.
(a) 0.23 d^{-1}, 17 mg/l (b) 0.21 d^{-1}, 27 mg/l
(c) 0.21 d^{-1}, 17 mg/l (d) 0.23 d^{-1}, 27 mg/l

Answers Quality Control of Water Supply

1. (a)	2. (b)	3. (c)	4. (a)	5. (b)	6. (b)	7. (d)	8. (a)	9. (a)	10. (a)
11. (c)	12. (d)	13. (b)	14. (c)	15. (a)	16. (b)	17. (a)	18. (b)	19. (b)	20. (d)
21. (a)	22. (b)	23. (a)	24. (c)	25. (d)	26. (c)	27. (d)	28. (c)	29. (a)	30. (c)
31. (b)	32. (a)	33. (c)	34. (a)	35. (b)	36. (a)	37. (d)	38. (c)	39. (c)	40. (b)
41. (a)	42. (a)	43. (b)	44. (b)	45. (b)	46. (d)	47. (b)	48. (c)	49. (d)	50. (b)
51. (c)	52. (c)	53. (d)	54. (b)	55. (c)	56. (a)	57. (b)	58. (a)	59. (d)	

Explanations Quality Control of Water Supply

1. (a)
Acidity is caused by the presence of mineral acids, free carbon dioxide, sulphates of iron, aluminium etc.

2. (b)
Maximum permissible limit of fluoride in drinking water is 1.5 mg/l
Minimum permissible limit of fluoride in drinking water is 1.0 mg/l
If it is less than 1.0 mg/l it causes dental carries & if it is greater than 1.5 mg/l it causes fluorosis.

5. (b)
Mass of suspended solids is obtained by filtration and heating the residue on filter at 104°C.

7. (d)
Dry mass + solids = 62.382 g
Dry mass = 62.319 g
So, mass of solids = 62.382 – 62.319
= 0.063 g = 63 mg
Volume of sample = 250 ml
So, concentration of solids

$$= \frac{63 \times 1000}{250} = 252 \text{ mg/l}$$

10. (a)
The standard unit of turbidity is the one which is produced by 1 milligram of finely divided silica in 1 litre of distilled water.

11. (c)
Bleaching powder is calcium oxychlorite having molecular formula as $CaOCl_2$. When freshly made, it contains about 30% of available chlorine. It is however, an unstable compound, and on exposure to air, light and moisture, it losses its chloride content.

13. (b)
Over flow rate for plain sedimentation tank ranges between 40, 000 to 50, 000 liters/sqm/day.
Over flow rate for coagulation sedimentation tank ranges between 50,000 to 60,000 liters/sqm/day.

15. (a)
Major sources of TDS :
Na^+, Ca^{2+}, Mg^{2+}, CO_3^{2-}, SO_4^{-2}, Cl^-
Minor source of TDS:
Fe, K, CO_3^{2-}, NO_3^-, Fluoride, Boron, Silica

17. (a)

$$pH = \log_{10}[H^+]$$

So, $[H^+] = 10^{-pH}$

So, $[H^+]_A = 10^{-3.6}$

$$\therefore \frac{[H^+]_A}{[H^+]_B} = \frac{10^{-3.6}}{10^{-6.6}} = 1000$$

So sample *A* is 1000 times more acid than sample *B*.

18. (b)
40 ml of 0.02 N H_2SO_4 is required to reduce the pH upto 5.0.
∴ Total alkalinity of 250 ml of water sample
= 40 mg as $CaCo_3$
So, total alkalinity of water is mg/l

$$= 40 \times \frac{1000}{250} = 160 \text{ mg/l as } CaCO_3$$

19. (b)
pH range of methyl orange is 2.8-4.4
pH range of phenolphthalein is 8.6-10.3

21. (a)
Total hardness

$$= [Mg^{2+}] * \frac{\text{eq. wt. of } CaCO_3}{\text{eq. wt. of } Mg^{2+}}$$

$$+ \left[Ca^{+2}\right] \times \frac{\text{eq. wt. of } CaCO_3}{\text{eq. wt of } Ca^{2+}}$$

$$= 18 \times \frac{50}{12} + 120 \times \frac{50}{20}$$

= 375 mg/l

22. (b)
If the hardness is less than 150 mg/l then it is not advised to soften the water because it proves to be uneconomical.

26. (c)
Prescribed limit of hardness for drinking wate is 75 - 115 mg/l.

27. (d)
For evaporation & measurement of settleable solids, imhoff cone is used.

32. (a)

$$TON = \frac{A+B}{A}$$

Where,
A = sample of water to be tested
B = odour free distilled water

$$TON = \frac{13.0 + 208}{13} = 17$$

34. (a)
Since alkalinity > Total hardness
Hence, carbonate hardness = Total hardness = 150 mg/l
and non-carbonate headness = Total hardness in excess of alkalinity = 0

37. (d)
Free bromine (Br_2) is a strong oxidant not found naturally. Bromine salts are harmless.

40. (b)
Overall removal of particles per hour
= 1 × 100 + 0.5 × 100 + 0.1 × 100 + 0.05 × 100
= 165 mg/l

43. (b)
High quantities of copper are likely to affect human lungs and other respiratory organs.

44. (b)
Eriochrome black *T* is used to measure hardness.
Phenolphthalein is used to measure alkalinity.
Blue litmus is used to measure acidity of water.

48. (c)
Coliform bacteria are commonly used indicator of sanitary quality of foods and water. They are defined as rod-shaped, gram-negative non-spore forming and motile or non-motile bacteria which can ferment lactose with production of acid and gas when incubated at 35 – 37°C.

49. (d)
In this problem we have more than three dilutions. So, we will choose three consecutive dilution samples which start from maximum positive result to closer to extinction value. Thus 4-2-1 will be better representation. Corresponding MPN per 100 ml = 26 as shown in table for 10 ml, 1 ml and 0.1 ml dilution. If however it is taken to find out MPN per 100 ml in the dilution 1 ml, 0.1 ml and 0.01 ml then, it will correspond to 2-1-0 value. The corresponding MPN from table is 7 × 10 = 70 because sample is $1/10^{th}$ of the 10, 1 and 0.1 ml sample size, used in table.
MPN of coliform organism is the maximum of these two values, i.e., 70.

51. (d)
Upto 1 mg/l of fluoride helps to prevent dental cavities.
Acceptable limit is upto 1 mg/l and greater than 1.5 mg/l is cause for rejection.

53. (d)
Acceptable limit of chloride in water is 200 mg/l and is cause for rejections if it exceeds 1000 mg/l.

55. (c)
Average

$$H^+ = \frac{10^{-6}+10^{-5}}{2} = 5.05\times10^{-7}$$

Time mean pH = $-\log 5.05 \times 10^{-7} = 6.3$

57. (b)
As $CH_3NH_2 + 1.5\ O_2 \rightarrow 1\ CO_2 + 1\ H_2O + 1\ NH_3$
i.e. for energy mole of methylamine decomposed, 1.5 mole of oxygen required for C – ThoD.

$$C\text{-ThoD} = \left[\frac{300mg\ CH_3NH_2}{L}\right]\times\frac{g}{(1000mg)}$$

$$\times\left[\frac{mol\ CH_3NH_2}{31.058g\ CH_3NH_2}\right]\times\frac{1.5mol\ of\ O_2}{mol\ CH_3NH_2}$$

$$\times\frac{22.41\ O_2}{mol\ O_2}\times\frac{L\ air}{0.21LO_2}$$

C–ThoD = 1.155
But NH_3 will also use O_2
$NH_3 + 2\ O_2 \rightarrow HNO_3 + H_2O$, so there will be an N – ThoD.

$$N\text{-ThoD} = \frac{300}{1000}\times\frac{1}{31.058}\times1\times2\times\frac{22.4}{0.21}$$

$$= 2.06\frac{L\ air}{L\ solution}$$

$\Rightarrow$ ThoD = 1.55 + 2.06
= 3.6 L air per L solution

58. (a)

$$Dilution = \frac{30ml}{V_s}$$

$$BOD_5 = \left[(9.07-2)-(9.07-8)\times\frac{290}{300}\right]\times30$$

= 181 mg/l
[$\because V_s = 10$ ml and $X = 300$ ml – 10 ml = 290 ml]

59. (d)

$$K_1 = \frac{6\times0.021}{0.545} = 0.23\ d^{-1}$$

$$L = \frac{1}{6(0.021)(0.545)^2} = 27\ mg/l$$

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