GATE Environmental Science and Engineering

Sample Paper – 7

Duration: 128 Minutes **Maximum Marks: 72**

Instructions

- This paper contains **46 questions** covering the core **Environmental Science and Engineering** subject of the GATE paper conducted by the IITs and IISc (General Aptitude and Engineering Mathematics are provided as separate papers).
- **Q1–Q20 carry 1 mark each** and **Q21–Q46 carry 2 marks each**, for a total of **72 marks**.
- Each question carries **negative marking of one-third of its allotted marks**: a wrong 1-mark question costs **0.33** and a wrong 2-mark question costs **0.67**. Unattempted questions carry no penalty.
- Every question here is a single-correct **MCQ**. The real GATE paper also has Multiple Select (MSQ) and Numerical Answer Type (NAT) questions, and **those carry no negative marking**.
- Attempt this paper in one timed sitting of about **128 minutes**, the share this core subject earns at GATE's overall pace of 180 minutes for 65 questions. Unless stated otherwise take $g = 9.81$ m/s^2, unit weight of water $\gamma_w = 9.81$ kN/m^3, dynamic viscosity of water $\mu = 1.0 \times 10^{-3}$ Pa·s and $K_w = 1.0 \times 10^{-14}$ at 25°C.

Environmental Chemistry and Microbiology

Q1. At 25°C a water sample has a hydroxyl-ion concentration $[\mathrm{OH}^-] = 1 \times 10^{-4}$ mol/L. Taking the ion product of water $K_w = 1 \times 10^{-14}$, the pH of the sample is: **[1 mark]**

(A) 4

(B) 10

(C) 7

(D) 14

Q2. A water sample contains magnesium ions at a concentration of 24 mg/L (atomic mass of Mg $= 24$). Expressed as an equivalent concentration of calcium carbonate, the magnesium hardness is: **[1 mark]**

(A) 24 mg/L as $CaCO_3$

(B) 50 mg/L as $CaCO_3$

(C) 100 mg/L as $CaCO_3$

(D) 120 mg/L as $CaCO_3$

Q3. In the multiple-tube fermentation (MPN) procedure for coliforms, a tube is scored as positive in the presumptive test when the inoculated lactose broth shows: **[1 mark]**

(A) an increase in turbidity only

(B) production of acid and gas

(C) a shift of the medium to strongly alkaline

(D) formation of bacterial spores

Q4. A water sample has a hydrogen-ion concentration $[H^+] = 2 \times 10^{-5}$ mol/L at $25°$C. Using pH $= -\log_{10}[H^+]$ and $\log_{10} 2 = 0.301$, the pH is nearest to: **[1 mark]**

(A) 4.7

(B) 5.0

(C) 9.3

(D) 2.5

Q5. An MPN analysis of a drinking-water sample reports an MPN index of 50 coliforms per 100 mL. The estimated number of coliforms in one litre (1000 mL) of the same water is: **[1 mark]**

(A) 50

(B) 500

(C) 5

(D) 5000

Q6. In the biological nitrification of ammonia present in water, the genus of chemoautotrophic bacteria chiefly responsible for oxidising ammonia to nitrite is: **[1 mark]**

(A) *Nitrosomonas*

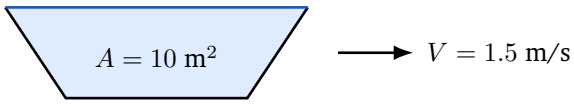
(B) *Nitrobacter*

(C) *Escherichia coli*

(D) *Pseudomonas*

Water Resources and Environmental Hydraulics

Q7. For the trapezoidal canal cross-section shown, the flow area is $A = 10\ \text{m}^2$ and the mean velocity of flow is $V = 1.5$ m/s. By the continuity equation $Q = A\,V$, the discharge carried by the canal is: **[1 mark]**



(A) $6.67\ \text{m}^3/\text{s}$

(B) $1.5\ \text{m}^3/\text{s}$

(C) $11.5\ \text{m}^3/\text{s}$

(D) $15\ \text{m}^3/\text{s}$

Q8. Water flows through a pipe of diameter $D = 0.2$ m and length $L = 100$ m at a mean velocity $V = 2$ m/s. Using the Darcy–Weisbach equation $h_f = \dfrac{f\,L\,V^2}{2\,g\,D}$ with friction factor $f = 0.02$, the head loss due to friction is nearest to: **[1 mark]**

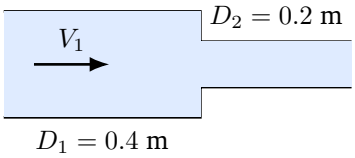
(A) 2.04 m

(B) 0.51 m

(C) 4.08 m

(D) 10.2 m

Q9. Water flows steadily through the contracting pipe shown. The upstream diameter is $D_1 = 0.4$ m with velocity $V_1 = 1$ m/s and the downstream diameter is $D_2 = 0.2$ m. By continuity $A_1V_1 = A_2V_2$, the downstream velocity V_2 is: **[1 mark]**



(A) 2 m/s

(B) 4 m/s

(C) 0.25 m/s

(D) 1 m/s

Q10. Flow in a wide channel is estimated using Chezy's formula $V = C\sqrt{RS}$. With Chezy's coefficient $C = 50$, hydraulic radius $R = 1.5$ m and bed slope $S = 1/2500 = 0.0004$, the mean velocity is nearest to: **[1 mark]**

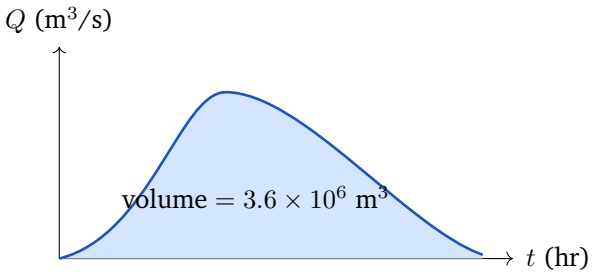
(A) 0.61 m/s

(B) 3.0 m/s

(C) 2.45 m/s

(D) 1.22 m/s

Q11. The direct-runoff hydrograph shown encloses a total direct-runoff volume of 3.6×10^6 m^3 over a catchment of area 100 km^2. The equivalent depth of direct runoff over the catchment is: **[1 mark]**



(A) 3.6 mm

(B) 36 mm

(C) 360 mm

(D) 3.6 m

Q12. Water of kinematic viscosity $\nu = 1 \times 10^{-6}$ m^2/s flows in a pipe of diameter $D = 0.05$ m at a mean velocity $V = 1$ m/s. The Reynolds number $Re = \dfrac{V\,D}{\nu}$ of the flow is: [1 mark]

(A) 500

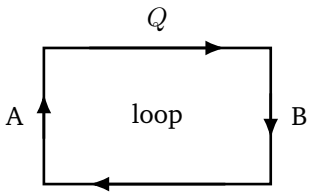
(B) 5000

(C) $50{,}000$

(D) 5×10^6

Water Supply and Water Treatment

Q13. In the single distribution loop shown, one Hardy–Cross iteration gives $\sum h_f = +6$ (head-loss units) and $\sum |h_f/Q| = 3$. For head loss modelled as $h_f = r\,Q^2$ (exponent $n = 2$), the flow correction $\Delta Q = -\dfrac{\sum h_f}{n \sum |h_f/Q|}$ is: [1 mark]



(A) -3

(B) -2

(C) -0.5

(D) -1

Q14. A city has an average daily water demand of 10 MLD. Taking the maximum daily demand as 1.8 times the average daily demand, the maximum daily demand of the city is: [1 mark]

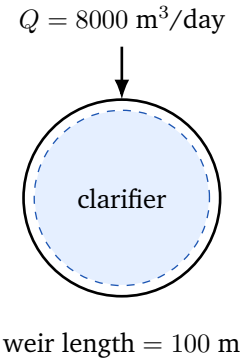
(A) 18 MLD

(B) 10 MLD

(C) 5.5 MLD

(D) 28 MLD

Q15. The circular clarifier shown has an effluent-weir length of 100 m along its periphery and treats a flow of 8000 m^3/day. The weir loading rate (weir overflow rate) $= Q/(\text{weir length})$ is: **[1 mark]**



(A) 800 m^3/day/m

(B) 8 m^3/day/m

(C) 0.0125 m^3/day/m

(D) 80 m^3/day/m

Q16. A rapid sand filter is designed for a filtration rate of 120 m^3/m^2/day and must treat a flow of 10 MLD ($= 10{,}000$ m^3/day). The plan area of filter media required is nearest to: **[1 mark]**

(A) 120 m^2

(B) 1200 m^2

(C) 83.3 m^2

(D) 8.33 m^2

Q17. Alum is dosed at 20 mg/L to coagulate a water-treatment plant flow of 4 MLD ($= 4 \times 10^6$ L/day). The mass of alum consumed per day is: **[1 mark]**

(A) 20 kg/day

(B) 800 kg/day

(C) 80 kg/day

(D) 8 kg/day

Q18. In a chlorine contact tank a free-chlorine residual of 0.5 mg/L is maintained for a contact time of 30 minutes. The disinfection CT value (residual $\times$ contact time) is: [1 mark]

(A) 0.5 mg·min/L

(B) 30 mg·min/L

(C) 60 mg·min/L

(D) 15 mg·min/L

Wastewater Treatment and Disposal

Q19. A waste-stabilisation pond of surface area 1 hectare ($10{,}000$ m^2) receives 1000 m^3/day of sewage having a BOD of 200 mg/L. The organic (BOD) surface loading applied to the pond is: [1 mark]

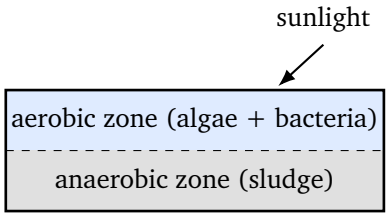
(A) 20 kg/ha/day

(B) 2000 kg/ha/day

(C) 100 kg/ha/day

(D) 200 kg/ha/day

Q20. In the facultative stabilisation pond shown, the dissolved oxygen that sustains the aerobic bacteria in the upper zone is supplied mainly by: [1 mark]



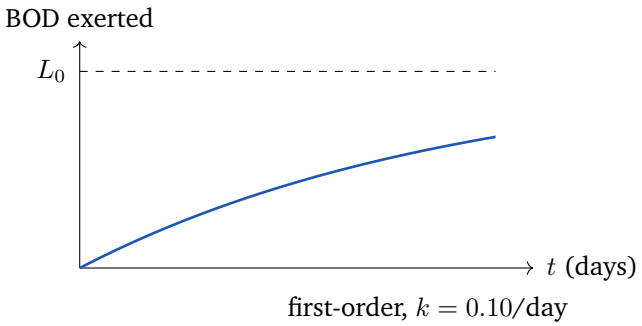
(A) photosynthetic activity of algae

(B) mechanical surface aerators

(C) diffused compressed air

(D) wind action alone

Q21. Sewage has an ultimate first-stage BOD of $L_0 = 250$ mg/L and a deoxygenation rate constant $k = 0.10$ day^{-1} (base e). Following the first-order exertion curve shown, the BOD exerted in 5 days, $y_5 = L_0\left(1 - e^{-kt}\right)$, is nearest to: **[2 marks]**



(A) 250 mg/L

(B) 152 mg/L

(C) 45 mg/L

(D) 98 mg/L

Q22. An aerated lagoon has a working volume of $V = 5000$ m^3 and receives a wastewater flow of $Q = 2500$ m^3/day. The hydraulic detention (retention) time $t_d = V/Q$ of the lagoon is: **[2 marks]**

(A) 0.5 day

(B) 5 days

(C) 2 days

(D) 20 days

Q23. An oxidation pond reduces the BOD of the wastewater from an influent value of 250 mg/L to an effluent value of 50 mg/L. The BOD-removal efficiency of the pond is: **[2 marks]**

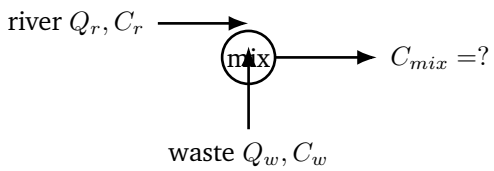
(A) 80%

(B) 20%

(C) 50%

(D) 200%

Q24. Treated effluent is discharged into a stream, as sketched. The waste stream carries $Q_w = 1$ m^3/s at a BOD of 150 mg/L, and the receiving river carries $Q_r = 9$ m^3/s at a BOD of 5 mg/L. Assuming complete mixing, the BOD just downstream of the outfall is nearest to: **[2 marks]**



(A) 155 mg/L

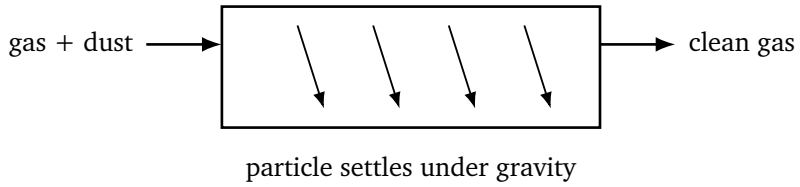
(B) 75 mg/L

(C) 30 mg/L

(D) 19.5 mg/L

Air Pollution and Control

Q25. In the gravity settling chamber shown, a spherical dust particle of diameter $d = 30\ \mu$m $= 3 \times 10^{-5}$ m and density $\rho_p = 1500$ kg/m^3 settles in air of viscosity $\mu = 1.8 \times 10^{-5}$ Pa·s. Neglecting air density, the terminal settling velocity $v_t = \dfrac{g\,\rho_p\,d^2}{18\mu}$ is nearest to: **[2 marks]**



(A) 0.41 m/s

(B) 0.041 m/s

(C) 0.0041 m/s

(D) 4.1 m/s

Q26. Photochemical smog is produced when, in the presence of strong sunlight, oxides of nitrogen (NO_x) react with which one of the following classes of pollutants? **[2 marks]**

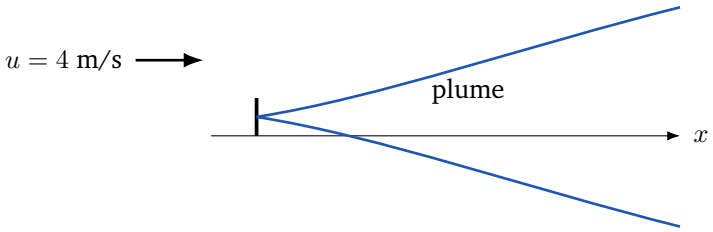
(A) sulphur dioxide

(B) volatile organic compounds (hydrocarbons)

(C) carbon dioxide

(D) methane only

Q27. A continuous ground-level point source emits a pollutant at $Q = 50$ g/s into a wind of speed $u = 4$ m/s. For the Gaussian plume shown, the ground-level centre-line concentration is $C = \dfrac{Q}{\pi\,\sigma_y\,\sigma_z\,u}$; at the receptor $\sigma_y = 20$ m and $\sigma_z = 10$ m, the concentration is nearest to: **[2 marks]**



(A) 19.9 mg/m^3

(B) 9.9 mg/m^3

(C) 39.8 mg/m^3

(D) 4.0 mg/m^3

Q28. Tropospheric (ground-level) ozone, a principal constituent of photochemical smog, is correctly classified as a: **[2 marks]**

(A) primary pollutant emitted directly by vehicle exhaust

(B) greenhouse gas with no adverse health effect

(C) naturally occurring stratospheric gas that is harmless at ground level

(D) secondary pollutant formed by photochemical reactions in the atmosphere

Q29. Ambient benzene, a volatile organic compound, is measured as 0.05 ppm by volume. At 25°C (1 atm) the molar volume of a gas is 24.45 litres and the molecular mass of benzene is 78. Using $\mu\text{g/m}^3 = \text{ppm} \times \dfrac{M}{24.45} \times 1000$, the mass concentration is nearest to: **[2 marks]**

(A) $160\ \mu\text{g/m}^3$

(B) $78\ \mu\text{g/m}^3$

(C) $320\ \mu\text{g/m}^3$

(D) $24.45\ \mu\text{g/m}^3$

Q30. Which one of the following is a typical volatile organic compound (VOC) released indoors from fresh paints, adhesives and solvents? **[2 marks]**

(A) carbon monoxide

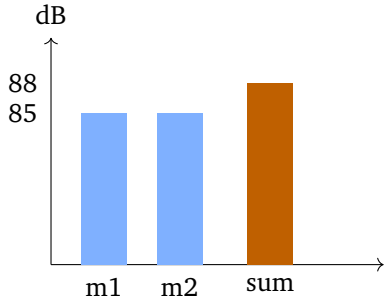
(B) formaldehyde

(C) ozone

(D) radon

Noise Pollution and Environmental Monitoring

Q31. Two identical machines each produce a sound-pressure level of 85 dB at a receiver. When both operate together, the combined level $L = 10\log_{10}\left(10^{L_1/10} + 10^{L_2/10}\right)$ is (as the energy addition below suggests): **[2 marks]**



(A) 85 dB

(B) 88 dB

(C) 170 dB

(D) 91 dB

Q32. A prediction model for a point source in a free field gives the sound level as $L_r = L_0 - 20\log_{10}(r/r_0)$. A source produces 100 dB at $r_0 = 1$ m. The predicted level at a distance of $r = 100$ m from the source is: **[2 marks]**

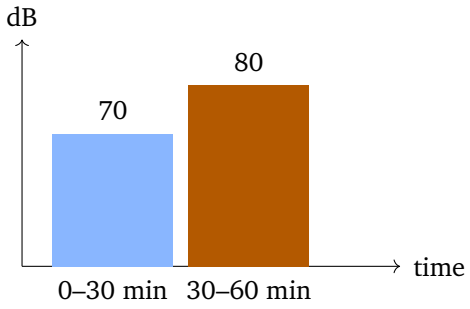
(A) 80 dB

(B) 94 dB

(C) 60 dB

(D) 40 dB

Q33. At a monitoring point a noise level of 70 dB is recorded for the first 30 minutes and 80 dB for the next 30 minutes of a one-hour period, as the level bars below show. The equivalent continuous level $L_{eq} = 10\log_{10}\left[\frac{1}{T}\sum t_i\, 10^{L_i/10}\right]$ over the hour is nearest to: **[2 marks]**



(A) 75.0 dB

(B) 80.0 dB

(C) 77.4 dB

(D) 70.0 dB

Q34. In statistical noise monitoring, the sound level that is exceeded for 90% of the measurement period, commonly taken to represent the residual background noise, is denoted: **[2 marks]**

(A) L_{90}

(B) L_{10}

(C) L_{eq}

(D) L_{max}

Solid and Hazardous Waste Management

Q35. A city generates 500 tonnes/day of municipal solid waste, of which 30% by mass is recyclable material. A material-recovery facility (MRF) recovers 80% of this recyclable fraction. The mass of recyclables actually recovered per day is: **[2 marks]**

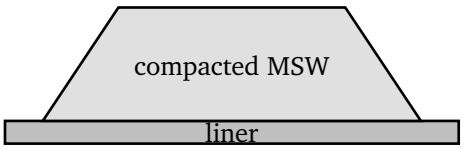
(A) 120 tonnes/day

(B) 150 tonnes/day

(C) 96 tonnes/day

(D) 400 tonnes/day

Q36. A sanitary landfill, shown in cross-section, receives 200 tonnes/day of MSW that is compacted to an in-place density of 800 kg/m^3. The airspace (volume) consumed by one year (365 days) of this waste is nearest to: **[2 marks]**



in-place density $= 800$ kg/m^3

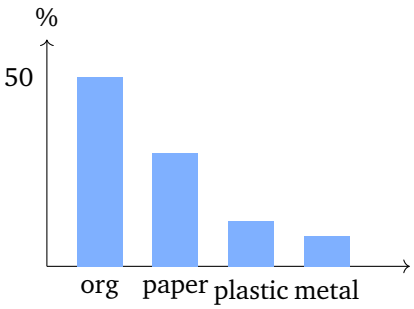
(A) $45{,}625$ m^3

(B) $26{,}645$ m^3

(C) $73{,}000$ m^3

(D) $91{,}250$ m^3

Q37. The bar chart shows the composition of a city's 200 tonnes/day of MSW: organic 50%, paper 30%, plastic 12% and metal 8%. The combined mass of the recyclable fraction (paper + plastic + metal) is: **[2 marks]**



(A) 100 tonnes/day

(B) 60 tonnes/day

(C) 24 tonnes/day

(D) 16 tonnes/day

Q38. Under the "cradle-to-grave" management of hazardous waste, the tracking document that must accompany the waste from the point of generation through transport to final disposal is called the: [2 marks]

(A) material safety data sheet

(B) bill of lading

(C) hazardous-waste manifest

(D) environmental clearance certificate

Q39. A material-recovery facility recovers 40 tonnes/day of waste paper for recycling. Taking the widely quoted figure that recycling one tonne of paper saves about 17 trees, the number of trees saved per day by this recovery is: [2 marks]

(A) 40

(B) 17

(C) 680

(D) 6800

Q40. In the integrated solid-waste-management hierarchy (the "waste-management pyramid"), the option assigned the highest priority is: [2 marks]

(A) sanitary landfilling

(B) source reduction (waste prevention)

(C) incineration with energy recovery

(D) open dumping

Environmental Management, Sustainability and Climate

Q41. Under the Kyoto Protocol, the flexibility mechanism that lets a developed (Annex-I) country earn Certified Emission Reduction (CER) credits by financing emission-reduction projects in developing countries is the: [2 marks]

(A) Emissions Trading Scheme

(B) Joint Implementation

(C) Clean Development Mechanism (CDM)

(D) Reducing Emissions from Deforestation (REDD)

Q42. One carbon credit corresponds to one tonne of CO_2-equivalent avoided. A CDM project avoids 5000 tonnes of CO_2-equivalent per year, and each credit trades at $\$10$. The annual revenue earned from selling these credits is: [2 marks]

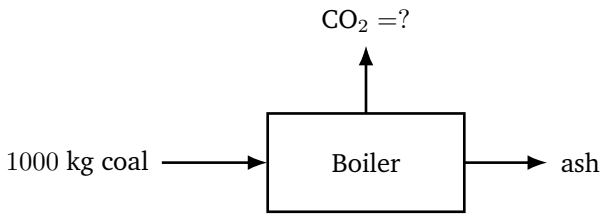
(A) $\$500$

(B) $\$5000$

(C) $\$50{,}000$

(D) $\$500{,}000$

Q43. For the combustion process shown, a boiler burns 1000 kg of coal per day, and the coal contains 60% carbon by mass. Assuming complete combustion $C + O_2 \rightarrow CO_2$ (carbon mass 12, CO_2 mass 44), the mass of CO_2 emitted per day, from the mass balance, is: [2 marks]



(A) 600 kg/day

(B) 1600 kg/day

(C) 44 kg/day

(D) 2200 kg/day

Q44. The total volume of freshwater consumed and polluted in producing a good or service, used as an indicator in water-resource sustainability accounting, is termed its: **[2 marks]**

(A) carbon footprint

(B) water footprint

(C) ecological reserve

(D) virtual runoff

Q45. The Paris Agreement (2015) sets the long-term goal of holding the rise in global average temperature this century to well below which value, relative to pre-industrial levels? **[2 marks]**

(A) 2°C

(B) 5°C

(C) 10°C

(D) 0.5°C

Q46. In a cap-and-trade emissions-trading scheme, a firm whose actual emissions fall below its allocated allowance is permitted to: **[2 marks]**

(A) be forced to shut down its operations

(B) sell its surplus allowances to other firms

(C) emit unlimited amounts thereafter

(D) receive no benefit from the surplus

Detailed Solutions

Q1.

Solution

Concept – pH from the hydroxyl-ion concentration: The two ion concentrations are linked by $K_w = [H^+][OH^-]$, and pH and pOH satisfy $pH + pOH = 14$ at $25°C$.

Step 1 – write the given value: $[OH^-] = 1 \times 10^{-4}$ mol/L

Step 2 – compute pOH: $pOH = -\log_{10}(1 \times 10^{-4})$

$pOH = 4$

Step 3 – use the pH–pOH relation: $pH = 14 - pOH$

Step 4 – substitute: $pH = 14 - 4$

$pH = 10$

Step 5 – cross-check via $[H^+]$: $[H^+] = \dfrac{K_w}{[OH^-]} = \dfrac{10^{-14}}{10^{-4}} = 10^{-10}$, giving $pH = 10$, which agrees.

Final Answer: $pH = 10 \Rightarrow \boxed{B}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept – expressing hardness as $CaCO_3$: Hardness due to any ion equals its concentration multiplied by the ratio of the equivalent weight of $CaCO_3$ (50) to the equivalent weight of that ion.

Step 1 – equivalent weight of magnesium: Magnesium has valency 2, so its equivalent weight is $\dfrac{24}{2} = 12$

Step 2 – form the conversion factor: $\text{factor} = \dfrac{50}{12} = 4.1667$

Step 3 – multiply the magnesium concentration by the factor: Hardness $= 24 \times 4.1667$

Step 4 – evaluate: Hardness $= 100$ mg/L as $CaCO_3$

Final Answer: 100 mg/L as $CaCO_3 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q2

Q3.

Solution

Concept – presumptive test of the MPN procedure: In the multiple-tube fermentation test, coliforms ferment lactose and produce gas, so a tube is presumptively positive when gas collects in the inverted Durham tube together with acid.

Step 1 – recall the coliform definition: Coliforms are defined as bacteria that ferment lactose with production of **acid and gas** within 48 hours at 35°C.

Step 2 – match to the observable in the tube: The visible signature is gas trapped in the Durham tube plus an acid colour change, so option B is the presumptive-positive indication.

Why the other options are wrong:

- A, turbidity alone: growth turbidity can occur without lactose fermentation, so it is not confirmatory.
- C, alkaline shift: lactose fermentation produces acid, not alkali.
- D, spore formation: coliforms are non-spore-forming, so this is irrelevant.

Final Answer: production of acid and gas $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q3

Q4.

Solution

Concept – pH from the hydrogen-ion concentration: $\text{pH} = -\log_{10}[\text{H}^+]$.

Step 1 – write the given value: $[\text{H}^+] = 2 \times 10^{-5}$ mol/L

Step 2 – split the logarithm: $\log_{10}(2 \times 10^{-5}) = \log_{10} 2 + \log_{10} 10^{-5}$

Step 3 – insert the numerical values: $\log_{10} 2 = 0.301$ and $\log_{10} 10^{-5} = -5$

Step 4 – add: $\log_{10}(2 \times 10^{-5}) = 0.301 - 5 = -4.699$

Step 5 – take the negative: $\text{pH} = -(-4.699) = 4.699 \approx 4.7$

Final Answer: $\text{pH} \approx 4.7 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q4

Q5.

Solution

Concept – MPN index and volume scaling: The MPN index is reported per 100 mL of sample; the count in any other volume scales in direct proportion.

Step 1 – state the reported density: 50 coliforms per 100 mL.

Step 2 – find the scaling factor to 1000 mL: $\dfrac{1000\ \text{mL}}{100\ \text{mL}} = 10$

Step 3 – multiply the count by the factor: $50 \times 10 = 500$

Step 4 – state the result: There are about 500 coliforms per litre.

Final Answer: 500 per litre $\Rightarrow$ B

Answer: (B) Go Back to Q5

Q6.

Solution

Concept – two-stage nitrification: Nitrification proceeds in two microbial steps: ammonia is first oxidised to nitrite, then nitrite to nitrate, each carried out by a different genus.

Step 1 – identify the first oxidation step: Ammonia to nitrite: $NH_4^+ \rightarrow NO_2^-$, performed by *Nitrosomonas*.

Step 2 – identify the second step for contrast: Nitrite to nitrate: $NO_2^- \rightarrow NO_3^-$, performed by *Nitrobacter*.

Step 3 – select the genus asked for: The question asks for the ammonia-to-nitrite oxidiser, which is *Nitrosomonas*.

Why the other options are wrong:

- B, *Nitrobacter*: oxidises nitrite to nitrate, the second step.
- C, *E. coli*: is a faecal indicator, not a nitrifier.
- D, *Pseudomonas*: is associated with denitrification, not ammonia oxidation.

Final Answer: *Nitrosomonas* $\Rightarrow$ A

Answer: (A) Go Back to Q6

Q7.

Solution

Concept – continuity equation for open-channel flow: The discharge equals the flow area multiplied by the mean velocity, $Q = A\,V$.

Step 1 – list the data: $A = 10$ m^2, $V = 1.5$ m/s.

Step 2 – substitute into $Q = A\,V$: $Q = 10 \times 1.5$

Step 3 – evaluate: $Q = 15$ m^3/s

Final Answer: $Q = 15$ m^3/s $\Rightarrow$ D

Answer: (D) Go Back to Q7

Q8.

Solution

Concept – Darcy–Weisbach head loss: $h_f = \dfrac{f\,L\,V^2}{2\,g\,D}$.

Step 1 – list the data: $f = 0.02$, $L = 100$ m, $V = 2$ m/s, $D = 0.2$ m, $g = 9.81$ m/s^2.

Step 2 – form the numerator: $f\,L\,V^2 = 0.02 \times 100 \times 2^2$

$= 0.02 \times 100 \times 4 = 8$

Step 3 – form the denominator: $2\,g\,D = 2 \times 9.81 \times 0.2 = 3.924$

Step 4 – divide: $h_f = \dfrac{8}{3.924}$

$h_f = 2.038 \approx 2.04$ m

Final Answer: $h_f \approx 2.04$ m $\Rightarrow$ A

Answer: (A) Go Back to Q8

Q9.

Solution

Concept – continuity through a contraction: For an incompressible fluid $A_1V_1 = A_2V_2$; since area is proportional to diameter squared, $V_2 = V_1 \left(\dfrac{D_1}{D_2}\right)^2$.

Step 1 – list the data: $D_1 = 0.4$ m, $V_1 = 1$ m/s, $D_2 = 0.2$ m.

Step 2 – form the diameter ratio: $\dfrac{D_1}{D_2} = \dfrac{0.4}{0.2} = 2$

Step 3 – square the ratio: $(2)^2 = 4$

Step 4 – multiply by V_1: $V_2 = 1 \times 4$

$V_2 = 4$ m/s

Final Answer: $V_2 = 4$ m/s $\Rightarrow$ B

Answer: (B) Go Back to Q9

Q10.

Solution

Concept – Chezy's velocity formula: $V = C\sqrt{RS}$.

Step 1 – list the data: $C = 50$, $R = 1.5$ m, $S = 0.0004$.

Step 2 – form the product RS: $RS = 1.5 \times 0.0004 = 0.0006$

Step 3 – take the square root: $\sqrt{0.0006} = 0.02449$

Step 4 – multiply by C: $V = 50 \times 0.02449$

$V = 1.2247 \approx 1.22$ m/s

Final Answer: $V \approx 1.22$ m/s $\Rightarrow$ D

Answer: (D) Go Back to Q10

Q11.

Solution

Concept – runoff depth from runoff volume: The equivalent runoff depth is the direct-runoff volume spread uniformly over the catchment area, $d = \dfrac{\text{Volume}}{\text{Area}}$.

Step 1 – list the data: Volume $= 3.6 \times 10^6$ m^3, Area $= 100$ km^2.

Step 2 – convert the area to m^2: 100 km^2 $= 100 \times 10^6 = 1 \times 10^8$ m^2

Step 3 – divide volume by area: $d = \dfrac{3.6 \times 10^6}{1 \times 10^8} = 0.036$ m

Step 4 – convert to millimetres: $d = 0.036 \times 1000 = 36$ mm

Final Answer: $d = 36$ mm $\Rightarrow$ B

Answer: (B) Go Back to Q11

Q12.

Solution

Concept – Reynolds number in a pipe: $Re = \dfrac{V\,D}{\nu}$, a dimensionless measure of the ratio of inertial to viscous forces.

Step 1 – list the data: $V = 1$ m/s, $D = 0.05$ m, $\nu = 1 \times 10^{-6}$ m^2/s.

Step 2 – form the numerator: $V\,D = 1 \times 0.05 = 0.05$

Step 3 – divide by ν: $Re = \dfrac{0.05}{1 \times 10^{-6}}$

Step 4 – evaluate: $Re = 50{,}000$

Step 5 – interpret: Since $Re > 4000$, the flow is turbulent, as expected in a water-supply pipe.

Final Answer: $Re = 50{,}000 \Rightarrow$ C

Answer: (C) Go Back to Q12

Q13.

Solution

Concept – Hardy–Cross flow correction: For a pipe loop with head loss $h_f = r\,Q^n$, the correction per iteration is $\Delta Q = -\dfrac{\sum h_f}{n \sum |h_f/Q|}$, with $n = 2$ for the Darcy/Hazen form.

Step 1 – list the data: $\sum h_f = +6$, $\sum |h_f/Q| = 3$, $n = 2$.

Step 2 – form the denominator: $n \sum |h_f/Q| = 2 \times 3 = 6$

Step 3 – substitute into the correction formula: $\Delta Q = -\dfrac{6}{6}$

Step 4 – evaluate: $\Delta Q = -1$

Step 5 – interpret the sign: The negative sign means the assumed clockwise flow must be reduced by 1 unit to balance the loop.

Final Answer: $\Delta Q = -1 \Rightarrow$ D

Answer: (D) Go Back to Q13

Q14.

Solution

Concept – maximum daily demand factor: Peak demands are estimated as multiples of the average daily demand; here the maximum daily demand is 1.8 times the average.

Step 1 – list the data: Average daily demand $= 10$ MLD, factor $= 1.8$.

Step 2 – multiply: Max daily $= 1.8 \times 10$

Step 3 – evaluate: Max daily $= 18$ MLD

Final Answer: 18 MLD $\Rightarrow$ A

Answer: (A) Go Back to Q14

Q15.

Solution

Concept – weir loading (overflow) rate: The weir loading rate is the flow discharged per unit length of effluent weir, $= \dfrac{Q}{\text{weir length}}$.

Step 1 – list the data: $Q = 8000$ m^3/day, weir length $= 100$ m.

Step 2 – divide: Weir loading $= \dfrac{8000}{100}$

Step 3 – evaluate: Weir loading $= 80$ m^3/day/m

Final Answer: 80 m^3/day/m $\Rightarrow$ D

Answer: (D) Go Back to Q15

Q16.

Solution

Concept – filter area from filtration rate: The required plan area equals the design flow divided by the filtration (loading) rate, $A = \dfrac{Q}{\text{rate}}$.

Step 1 – list the data: $Q = 10{,}000$ m^3/day, filtration rate $= 120$ m^3/m^2/day.

Step 2 – substitute: $A = \dfrac{10{,}000}{120}$

Step 3 – evaluate: $A = 83.33$ m^2

Final Answer: $A \approx 83.3$ m^2 $\Rightarrow$ C

Answer: (C) Go Back to Q16

Q17.

Solution

Concept – chemical mass dosing per day: The daily mass of a coagulant equals its dose (mass per volume) times the volume of water treated per day.

Step 1 – list the data: Dose $= 20$ mg/L, flow $= 4 \times 10^6$ L/day.

Step 2 – multiply dose by flow: Mass $= 20 \dfrac{\text{mg}}{\text{L}} \times 4 \times 10^6 \dfrac{\text{L}}{\text{day}}$

Step 3 – evaluate in milligrams: Mass $= 80 \times 10^6$ mg/day

Step 4 – convert to kilograms (1 kg $= 10^6$ mg): Mass $= \dfrac{80 \times 10^6}{10^6} = 80$ kg/day

Final Answer: 80 kg/day $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q17

Q18.

Solution

Concept – disinfection CT value: Disinfection effectiveness is measured by the product of disinfectant residual concentration and contact time, $CT = C \times t$.

Step 1 – list the data: $C = 0.5$ mg/L, $t = 30$ min.

Step 2 – multiply: $CT = 0.5 \times 30$

Step 3 – evaluate: $CT = 15$ mg·min/L

Final Answer: $CT = 15$ mg·min/L $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q18

Q19.

Solution

Concept – organic surface loading of a pond: The BOD surface loading equals the daily mass of BOD applied divided by the pond surface area, usually expressed per hectare.

Step 1 – compute the daily BOD mass: BOD load $=$ flow $\times$ concentration $=$ $1000 \dfrac{\text{m}^3}{\text{day}} \times 200 \dfrac{\text{g}}{\text{m}^3}$

$= 200{,}000$ g/day $= 200$ kg/day

Step 2 – note the pond area: 1 hectare $= 10{,}000$ m^2.

Step 3 – divide load by area (in hectares): Surface loading $= \dfrac{200 \text{ kg/day}}{1 \text{ ha}}$

Step 4 – evaluate: Surface loading $= 200$ kg/ha/day

Final Answer: 200 kg/ha/day $\Rightarrow$ D

Answer: (D) Go Back to Q19

Q20.

Solution

Concept – oxygen source in a facultative pond: A facultative stabilisation pond depends on an algal–bacterial symbiosis: algae photosynthesise in daylight, releasing oxygen that aerobic bacteria use to stabilise the organic matter.

Step 1 – identify the aerobic-zone process: In the upper, sunlit layer, algae carry out photosynthesis and release dissolved oxygen.

Step 2 – link to bacterial demand: Aerobic heterotrophic bacteria consume that oxygen while oxidising the organic waste, so the oxygen supply is essentially photosynthetic.

Why the other options are wrong:

- B and C, mechanical/diffused aeration: describe aerated lagoons or activated sludge, not a natural facultative pond.
- D, wind alone: surface re-aeration is minor compared with algal oxygen production.

Final Answer: photosynthetic activity of algae $\Rightarrow$ A

Answer: (A) Go Back to Q20

Q21.

Solution

Concept – first-order BOD exertion: The BOD exerted by time t follows $y_t = L_0\left(1 - e^{-kt}\right)$, where L_0 is the ultimate BOD and k the deoxygenation constant.

Step 1 – list the data: $L_0 = 250$ mg/L, $k = 0.10$/day, $t = 5$ days.

Step 2 – form the exponent: $kt = 0.10 \times 5 = 0.5$

Step 3 – evaluate the exponential: $e^{-0.5} = 0.6065$

Step 4 – form the fraction exerted: $1 - 0.6065 = 0.3935$

Step 5 – multiply by L_0: $y_5 = 250 \times 0.3935$

$y_5 = 98.4 \approx 98$ mg/L

Final Answer: $y_5 \approx 98$ mg/L $\Rightarrow$ D

Answer: (D) Go Back to Q21

Q22.

Solution

Concept – hydraulic detention time: The detention time is the tank (lagoon) working volume divided by the volumetric flow through it, $t_d = \dfrac{V}{Q}$.

Step 1 – list the data: $V = 5000$ m^3, $Q = 2500$ m^3/day.

Step 2 – substitute: $t_d = \dfrac{5000}{2500}$

Step 3 – evaluate: $t_d = 2$ days

Final Answer: $t_d = 2$ days $\Rightarrow$ C

Answer: (C) Go Back to Q22

Q23.

Solution

Concept – BOD-removal efficiency: Removal efficiency $= \dfrac{\text{influent} - \text{effluent}}{\text{influent}} \times 100\%$.

Step 1 – list the data: Influent BOD $= 250$ mg/L, effluent BOD $= 50$ mg/L.

Step 2 – find the BOD removed: $250 - 50 = 200$ mg/L

Step 3 – divide by the influent value: $\dfrac{200}{250} = 0.8$

Step 4 – express as a percentage: $0.8 \times 100 = 80\%$

Final Answer: $80\% \Rightarrow$ A

Answer: (A) Go Back to Q23

Q24.

Solution

Concept – flow-weighted mixing (mass balance): When two streams mix completely, the resulting concentration is the mass-flow-weighted mean, $C_{mix} = \dfrac{Q_w C_w + Q_r C_r}{Q_w + Q_r}$.

Step 1 – list the data: $Q_w = 1$ m^3/s, $C_w = 150$ mg/L; $Q_r = 9$ m^3/s, $C_r = 5$ mg/L.

Step 2 – compute the mass flows: $Q_w C_w = 1 \times 150 = 150$

$Q_r C_r = 9 \times 5 = 45$

Step 3 – add the mass flows: $150 + 45 = 195$

Step 4 – add the discharges: $Q_w + Q_r = 1 + 9 = 10$

Step 5 – divide: $C_{mix} = \dfrac{195}{10} = 19.5$ mg/L

Final Answer: $C_{mix} = 19.5$ mg/L $\Rightarrow$ D

Answer: (D) Go Back to Q24

Q25.

Solution

Concept – Stokes-law terminal settling velocity: For a small particle in the laminar regime, $v_t = \dfrac{g\,\rho_p\,d^2}{18\,\mu}$ (air density neglected).

Step 1 – list the data: $g = 9.81$ m/s^2, $\rho_p = 1500$ kg/m^3, $d = 3 \times 10^{-5}$ m, $\mu = 1.8 \times 10^{-5}$ Pa·s.

Step 2 – square the diameter: $d^2 = (3 \times 10^{-5})^2 = 9 \times 10^{-10}$ m^2

Step 3 – form the numerator: $g\,\rho_p\,d^2 = 9.81 \times 1500 \times 9 \times 10^{-10}$

$= 14715 \times 9 \times 10^{-10} = 1.324 \times 10^{-5}$

Step 4 – form the denominator: $18\,\mu = 18 \times 1.8 \times 10^{-5} = 3.24 \times 10^{-4}$

Step 5 – divide: $v_t = \dfrac{1.324 \times 10^{-5}}{3.24 \times 10^{-4}}$

$v_t = 0.0409 \approx 0.041$ m/s

Final Answer: $v_t \approx 0.041$ m/s $\Rightarrow$ B

Answer: (B) Go Back to Q25

Q26.

Solution

Concept – formation of photochemical smog: Photochemical smog is a secondary-pollutant mixture formed when nitrogen oxides and reactive hydrocarbons undergo sunlight-driven reactions, producing ozone and peroxyacetyl nitrate (PAN).

Step 1 – identify the two essential precursors: Oxides of nitrogen (NO_x) from combustion, and volatile organic compounds (VOCs / hydrocarbons) from fuels and solvents.

Step 2 – note the role of sunlight: Ultraviolet light drives the photochemical

chain that converts these precursors into ozone-rich smog.

Why the other options are wrong:

- A, SO_2: leads to industrial (sulphurous) smog, not photochemical smog.
- C, CO_2: is unreactive in this photochemistry.
- D, methane only: is a slow-reacting VOC; the broad class of reactive hydrocarbons is what matters.

Final Answer: volatile organic compounds (hydrocarbons) $\Rightarrow$ B

Answer: (B) Go Back to Q26

Q27.

Solution

Concept – Gaussian ground-level concentration: For a ground-level source with the receptor on the plume centre line, $C = \dfrac{Q}{\pi\,\sigma_y\,\sigma_z\,u}$.

Step 1 – list the data: $Q = 50$ g/s, $u = 4$ m/s, $\sigma_y = 20$ m, $\sigma_z = 10$ m.

Step 2 – form the denominator step by step: $\sigma_y\,\sigma_z = 20 \times 10 = 200$

$\sigma_y\,\sigma_z\,u = 200 \times 4 = 800$

$\pi \times 800 = 2513.3$

Step 3 – divide: $C = \dfrac{50}{2513.3}$

$C = 0.0199$ g/m^3

Step 4 – convert to milligrams: $C = 0.0199 \times 1000 = 19.9$ mg/m^3

Final Answer: $C \approx 19.9$ mg/m^3 $\Rightarrow$ A

Answer: (A) Go Back to Q27

Q28.

Solution

Concept – primary versus secondary pollutants: A primary pollutant is emitted directly; a secondary pollutant is formed in the atmosphere by chemical or photochemical reactions among primary pollutants.

Step 1 – recall how ground-level ozone forms: Tropospheric ozone is generated by sunlight-driven reactions of NO_x and VOCs, so it is not emitted directly.

Step 2 – classify it: Because it is created in the air rather than released from a

stack or tailpipe, ground-level ozone is a secondary pollutant.

Why the other options are wrong:

- A, primary pollutant: incorrect, vehicles emit the precursors, not ozone itself.
- B, harmless: ground-level ozone irritates the respiratory system.
- C, harmless stratospheric gas: stratospheric ozone is beneficial, but at ground level ozone is a harmful secondary pollutant.

Final Answer: secondary pollutant $\Rightarrow$ D

Answer: (D) Go Back to Q28

Q29.

Solution

Concept – ppm to μg/m^3 conversion: $\mu\text{g/m}^3 = \text{ppm} \times \dfrac{M}{24.45} \times 1000$, where M is the molecular mass and 24.45 L is the molar volume at 25°C.

Step 1 – list the data: ppm $= 0.05$, $M = 78$, molar volume $= 24.45$ L.

Step 2 – form ppm $\times M$: $0.05 \times 78 = 3.9$

Step 3 – divide by 24.45: $\dfrac{3.9}{24.45} = 0.1595$

Step 4 – multiply by 1000: $0.1595 \times 1000 = 159.5 \approx 160\ \mu\text{g/m}^3$

Final Answer: $\approx 160\ \mu\text{g/m}^3 \Rightarrow$ A

Answer: (A) Go Back to Q29

Q30.

Solution

Concept – indoor volatile organic compounds: VOCs are carbon-based compounds that evaporate readily at room temperature; formaldehyde is a classic VOC off-gassed by paints, adhesives, resins and pressed-wood products.

Step 1 – test each option against the VOC definition: Formaldehyde is a volatile organic compound emitted indoors from solvents and adhesives.

Why the other options are wrong:

- A, carbon monoxide: is an inorganic combustion gas, not a VOC.
- C, ozone: is an inorganic secondary pollutant.
- D, radon: is a radioactive noble gas from soil, not organic.

Final Answer: formaldehyde $\Rightarrow$ B

Answer: (B) Go Back to Q30

Q31.

Solution

Concept – logarithmic addition of sound levels: Sound levels combine on an energy (not decibel) basis: $L = 10\log_{10}\left(10^{L_1/10} + 10^{L_2/10}\right)$. Doubling equal sources adds $10\log_{10} 2 \approx 3$ dB.

Step 1 – list the data: $L_1 = L_2 = 85$ dB.

Step 2 – add the energy terms: $10^{85/10} + 10^{85/10} = 2 \times 10^{8.5}$

Step 3 – take the logarithm: $L = 10\log_{10}(2 \times 10^{8.5}) = 10\,(\log_{10} 2 + 8.5)$

Step 4 – insert $\log_{10} 2 = 0.301$**:** $L = 10\,(0.301 + 8.5) = 10 \times 8.801$

Step 5 – evaluate: $L = 88.01 \approx 88$ dB

Final Answer: $L \approx 88$ dB $\Rightarrow$ B

Answer: (B) Go Back to Q31

Q32.

Solution

Concept – distance attenuation of a point source: In a free field the level drops with distance as $L_r = L_0 - 20\log_{10}\left(\dfrac{r}{r_0}\right)$, which is 6 dB per doubling of distance.

Step 1 – list the data: $L_0 = 100$ dB, $r_0 = 1$ m, $r = 100$ m.

Step 2 – form the distance ratio: $\dfrac{r}{r_0} = \dfrac{100}{1} = 100$

Step 3 – take the logarithm: $\log_{10} 100 = 2$

Step 4 – compute the attenuation: $20 \times 2 = 40$ dB

Step 5 – subtract from the source level: $L_r = 100 - 40 = 60$ dB

Final Answer: $L_r = 60$ dB $\Rightarrow$ C

Answer: (C) Go Back to Q32

Q33.

Solution

Concept – equivalent continuous level L_{eq}: L_{eq} is the single steady level with the same energy as the fluctuating noise: $L_{eq} = 10\log_{10}\left[\frac{1}{T}\sum t_i\, 10^{L_i/10}\right]$.

Step 1 – list the data: 70 dB for 30 min and 80 dB for 30 min over $T = 60$ min, so each fraction $= 0.5$.

Step 2 – convert each level to energy: $10^{70/10} = 10^7 = 1 \times 10^7$

$10^{80/10} = 10^8 = 1 \times 10^8$

Step 3 – form the time-weighted mean energy: $\overline{E} = 0.5\,(1 \times 10^7) + 0.5\,(1 \times 10^8)$

$= 0.5 \times 10^7 + 5 \times 10^7 = 5.5 \times 10^7$

Step 4 – take $10\log_{10}$: $L_{eq} = 10\log_{10}(5.5 \times 10^7)$

$\log_{10}(5.5 \times 10^7) = 7 + \log_{10} 5.5 = 7 + 0.740 = 7.740$

Step 5 – evaluate: $L_{eq} = 10 \times 7.740 = 77.4$ dB

Final Answer: $L_{eq} \approx 77.4$ dB $\Rightarrow$ C

Answer: (C) Go Back to Q33

Q34.

Solution

Concept – statistical (percentile) noise levels: L_N is the level exceeded for $N\%$ of the measurement time. L_{90}, exceeded 90% of the time, is low and represents the residual background; L_{10} is high and represents intrusive peaks.

Step 1 – interpret the definition asked: The level exceeded for 90% of the period is by definition L_{90}.

Step 2 – confirm its meaning: Because it is present almost all the time, L_{90} is taken as the background (residual) noise.

Why the other options are wrong:

- B, L_{10}: exceeded only 10% of the time, it indexes the loud peaks.
- C, L_{eq}: is an energy-average, not a percentile.
- D, L_{max}: is the single highest instantaneous level.

Final Answer: $L_{90} \Rightarrow$ A

Answer: (A) Go Back to Q34

Q35.

Solution

Concept – recyclables actually recovered: The recovered mass is the total waste multiplied by the recyclable fraction and then by the recovery efficiency of the MRF.

Step 1 – list the data: Total MSW $= 500$ tonnes/day, recyclable fraction $= 30\% = 0.30$, recovery efficiency $= 80\% = 0.80$.

Step 2 – find the recyclable mass present: $500 \times 0.30 = 150$ tonnes/day

Step 3 – apply the recovery efficiency: $150 \times 0.80 = 120$ tonnes/day

Step 4 – state the result: 120 tonnes/day of recyclables are actually recovered.

Final Answer: 120 tonnes/day $\Rightarrow$ A

Answer: (A) Go Back to Q35

Q36.

Solution

Concept – landfill airspace from mass and density: The volume consumed equals the total mass of compacted waste divided by its in-place density, $V = \frac{\text{mass}}{\rho}$.

Step 1 – compute the annual mass: $200\ \frac{\text{tonnes}}{\text{day}} \times 365$ days $= 73{,}000$ tonnes/year

Step 2 – convert to kilograms: $73{,}000 \times 1000 = 7.3 \times 10^7$ kg

Step 3 – divide by the in-place density: $V = \frac{7.3 \times 10^7\ \text{kg}}{800\ \text{kg/m}^3}$

Step 4 – evaluate: $V = 91{,}250\ \text{m}^3$

Final Answer: $V \approx 91{,}250\ \text{m}^3 \Rightarrow$ D

Answer: (D) Go Back to Q36

Q37.

Solution

Concept – recyclable fraction by mass: The recyclable mass is the sum of the recyclable component percentages applied to the total waste mass.

Step 1 – add the recyclable percentages: paper + plastic + metal $= 30\% + 12\% + 8\% = 50\%$

Step 2 – express as a fraction: $50\% = 0.50$

Step 3 – multiply by the total waste: $0.50 \times 200 = 100$ tonnes/day

Step 4 – cross-check with the organic balance: Organic is 50%, i.e. 100 tonnes/day, and the recyclables make up the remaining 100 tonnes/day, which is consistent.

Final Answer: 100 tonnes/day $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q37

Q38.

Solution

Concept – hazardous-waste manifest: Cradle-to-grave control of hazardous waste requires a shipping document, the manifest, that records the waste from generation through every transporter to the final treatment/disposal facility.

Step 1 – identify the tracking document: The uniform hazardous-waste **manifest** accompanies each shipment and is signed at every hand-off.

Why the other options are wrong:

- A, material safety data sheet: describes a chemical's hazards, it does not track a shipment.
- B, bill of lading: is a general freight receipt, not the regulated hazardous-waste record.
- D, environmental clearance certificate: is a project-approval document, unrelated to shipment tracking.

Final Answer: hazardous-waste manifest $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q38

Q39.

Solution

Concept – material-recovery benefit (proportional estimate): The trees saved equal the mass of paper recycled multiplied by the trees saved per tonne.

Step 1 – list the data: Paper recovered $= 40$ tonnes/day, saving $= 17$ trees per tonne.

Step 2 – multiply: $40 \times 17 = 680$

Step 3 – state the result: About 680 trees are saved per day.

Final Answer: 680 trees/day $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q39

Q40.

Solution

Concept – waste-management hierarchy: Integrated solid-waste management ranks options from most to least preferred: source reduction (prevention) > reuse > recycling/composting > energy recovery > landfilling.

Step 1 – identify the top of the hierarchy: Preventing waste at the source (source reduction) is the highest-priority option because it avoids generation altogether.

Why the other options are wrong:

- A, landfilling and C, incineration: sit near the bottom of the hierarchy, used only after prevention and recovery.
- D, open dumping: is the least acceptable, environmentally unsound practice.

Final Answer: source reduction (waste prevention) $\Rightarrow$ B

Answer: (B) Go Back to Q40

Q41.

Solution

Concept – Kyoto flexibility mechanisms: The Kyoto Protocol offers three market mechanisms; the Clean Development Mechanism (CDM) lets Annex-I countries invest in emission-cutting projects in developing countries and earn Certified Emission Reductions (CERs).

Step 1 – match the description to the mechanism: "Developed country earns CERs from projects in developing countries" is exactly the CDM.

Why the other options are wrong:

- A, Emissions Trading: is the buying and selling of allowances among Annex-I countries.
- B, Joint Implementation: involves projects between two developed (Annex-I) countries.
- D, REDD: rewards avoided deforestation and is outside the three core Kyoto mechanisms.

Final Answer: Clean Development Mechanism (CDM) $\Rightarrow$ C

Answer: (C) Go Back to Q41

Q42.

Solution

Concept – carbon-credit revenue: Revenue equals the number of credits (one per tonne of CO_2-equivalent avoided) multiplied by the price per credit.

Step 1 – list the data: Credits $= 5000$ per year (one per tonne CO_2e), price $= \$10$ per credit.

Step 2 – multiply: Revenue $= 5000 \times 10$

Step 3 – evaluate: Revenue $= \$50{,}000$ per year

Final Answer: $\$50{,}000 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q42

Q43.

Solution

Concept – CO_2 from carbon combustion (mass balance): On complete combustion, each mole of carbon (mass 12) yields one mole of CO_2 (mass 44), so the CO_2 mass is the carbon mass times $\frac{44}{12}$.

Step 1 – find the carbon burned per day: Carbon $= 0.60 \times 1000 = 600$ kg/day

Step 2 – write the stoichiometric ratio: $\frac{\text{mass } CO_2}{\text{mass C}} = \frac{44}{12} = 3.667$

Step 3 – multiply carbon mass by the ratio: $CO_2 = 600 \times 3.667$

Step 4 – evaluate: $CO_2 = 2200$ kg/day

Final Answer: 2200 kg/day $\Rightarrow \boxed{D}$

Answer: (D) Go Back to Q43

Q44.

Solution

Concept – water footprint: The water footprint measures the total volume of freshwater used (consumed and polluted) to produce a good or service, and is a standard water-sustainability indicator.

Step 1 – match the definition: "Freshwater consumed and polluted to make a product" is precisely the water footprint.

Why the other options are wrong:

- A, carbon footprint: measures greenhouse-gas emissions, not water use.
- C, ecological reserve: is the water set aside for ecosystems, a different concept.
- D, virtual runoff: is not a recognised indicator; the trade term is "virtual water".

Final Answer: water footprint $\Rightarrow$ B

Answer: (B) Go Back to Q44

Q45.

Solution

Concept – temperature goal of the Paris Agreement: The 2015 Paris Agreement sets the goal of holding the global average temperature rise to well below $2°C$ above pre-industrial levels, while pursuing efforts to limit it to $1.5°C$.

Step 1 – recall the headline target: "Well below $2°C$" is the primary long-term temperature goal.

Why the other options are wrong:

- B, $5°C$ and C, $10°C$: correspond to catastrophic warming, far beyond any target.
- D, $0.5°C$: has already been exceeded and is not the stated limit.

Final Answer: $2°C \Rightarrow$ A

Answer: (A) Go Back to Q45

Q46.

Solution

Concept – cap-and-trade emissions trading: Under a cap, each firm receives a limited allowance. A firm emitting below its allowance holds surplus allowances, which have market value and can be sold to firms that need more.

Step 1 – identify the position of a low-emitting firm: Its actual emissions are below its allocated allowance, leaving unused allowances.

Step 2 – determine the permitted action: It may sell (trade) the surplus allowances to other firms, which is the "trade" half of cap-and-trade and creates the

incentive to cut emissions.

Why the other options are wrong:

- A, forced shutdown: staying under the cap is rewarded, not penalised.
- C, emit unlimited amounts: the cap always applies.
- D, no benefit: the tradable value of surplus allowances is the whole point of the scheme.

Final Answer: sell its surplus allowances to other firms $\Rightarrow$ B

Answer: (B) Go Back to Q46

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	C	3	B	4	A	5	B
6	A	7	D	8	A	9	B	10	D
11	B	12	C	13	D	14	A	15	D
16	C	17	C	18	D	19	D	20	A
21	D	22	C	23	A	24	D	25	B
26	B	27	A	28	D	29	A	30	B
31	B	32	C	33	C	34	A	35	A
36	D	37	A	38	C	39	C	40	B
41	C	42	C	43	D	44	B	45	A
46	B								