GATE Environmental Science and Engineering

Sample Paper – 2

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. In a redox study of nitrogen in water, the oxidation state of nitrogen in the nitrate ion NO_3^- (taking oxygen as -2) is: **[1 mark]**

(A) $+3$

(B) -3

(C) $+5$

(D) $+2$

Q2. A water sample contains magnesium ions at a concentration of 12 mg/L (atomic mass of Mg $= 24$). Expressed as an equivalent concentration of calcium carbonate, the magnesium hardness is: **[1 mark]**

(A) 50 mg/L as $CaCO_3$

(B) 12 mg/L as $CaCO_3$

(C) 25 mg/L as $CaCO_3$

(D) 100 mg/L as $CaCO_3$

Q3. In the biological nitrogen cycle of a treatment system, the aerobic conversion of ammonia to nitrite and then to nitrate (nitrification) is carried out chiefly by: **[1 mark]**

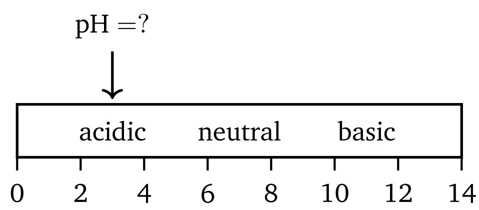
(A) methanogenic archaea

(B) coliform bacteria

(C) *Nitrosomonas* and *Nitrobacter*

(D) sulphate-reducing bacteria

Q4. On the pH scale shown, a water sample has a hydrogen-ion concentration $[H^+] = 1 \times 10^{-3}$ mol/L at 25°C. Its pH is: **[1 mark]**



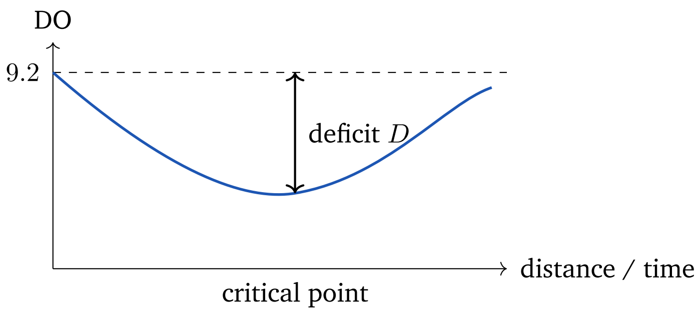
(A) 3

(B) 11

(C) 7

(D) 10

Q5. On the dissolved-oxygen sag curve shown, a river reach has a saturation dissolved-oxygen concentration of 9.2 mg/L while the measured dissolved oxygen at a point is 5.0 mg/L. The dissolved-oxygen deficit there is: **[1 mark]**



(A) 5.0 mg/L

(B) 9.2 mg/L

(C) 4.2 mg/L

(D) 14.2 mg/L

Q6. In an anaerobic digester treating sludge, the micro-organisms that decompose organic matter in the complete absence of oxygen and generate methane gas are the: **[1 mark]**

(A) aerobic heterotrophs

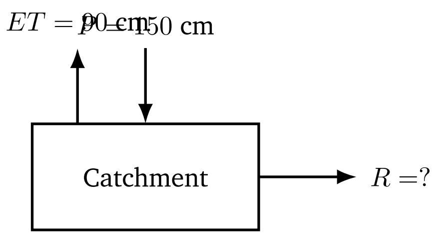
(B) methanogenic (methane-forming) bacteria

(C) algae

(D) nitrifying bacteria

Water Resources and Environmental Hydraulics

Q7. For the catchment water balance shown, the annual rainfall is $P = 150$ cm and the evapotranspiration loss is $ET = 90$ cm. If the change in storage over the year is negligible, the annual runoff $R = P - ET$ is: **[1 mark]**



(A) 240 cm

(B) 90 cm

(C) 150 cm

(D) 60 cm

Q8. Using the rational formula $Q = \dfrac{C\,i\,A}{360}$ (with i in mm/hr and A in hectares giving Q in m^3/s), a catchment has runoff coefficient $C = 0.5$, rainfall intensity $i = 72$ mm/hr and area $A = 50$ ha. The peak runoff Q is: **[1 mark]**

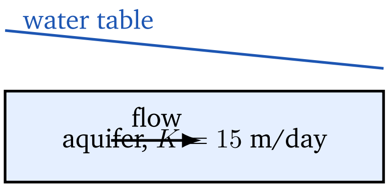
(A) 3.6 m^3/s

(B) 25 m^3/s

(C) 50 m^3/s

(D) 5 m^3/s

Q9. For the aquifer shown, Darcy's law gives the specific-discharge (Darcy) velocity as $v = K\,i$, where K is the hydraulic conductivity and i the hydraulic gradient. With $K = 15$ m/day and $i = 0.04$, the Darcy velocity is: **[1 mark]**



hydraulic gradient $i = 0.04$

(A) 0.06 m/day

(B) 6 m/day

(C) 0.6 m/day

(D) 60 m/day

Q10. A confined aquifer of thickness $b = 25$ m and hydraulic conductivity $K = 30$ m/day carries groundwater under a hydraulic gradient of $i = 0.002$ across a width $W = 500$ m. The volumetric flow $Q = K\,i\,(b\,W)$ through this section is: **[1 mark]**

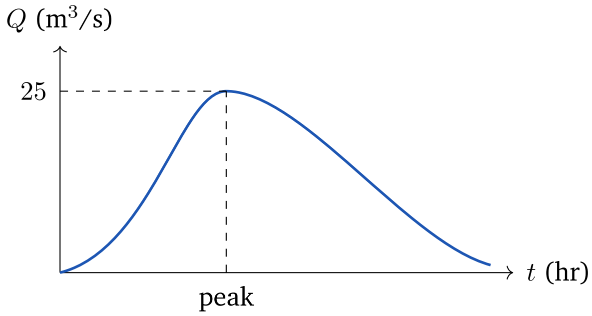
(A) 75 m^3/day

(B) 7500 m^3/day

(C) 750 m^3/day

(D) 7.5 m^3/day

Q11. A 3-hour unit hydrograph of a catchment has a peak ordinate of 25 m^3/s, as shown. For a rainfall excess of 3 cm occurring uniformly over the same 3-hour duration, the peak of the resulting direct-runoff hydrograph is: **[1 mark]**



(A) 75 m^3/s

(B) 25 m^3/s

(C) 8.33 m^3/s

(D) 50 m^3/s

Q12. Water flows in a wide open channel. By Manning's equation $V = \frac{1}{n} R^{2/3} S^{1/2}$, with Manning's roughness $n = 0.02$, hydraulic radius $R = 1$ m and bed slope $S = 0.0009$, the mean velocity of flow is: **[1 mark]**

(A) 0.03 m/s

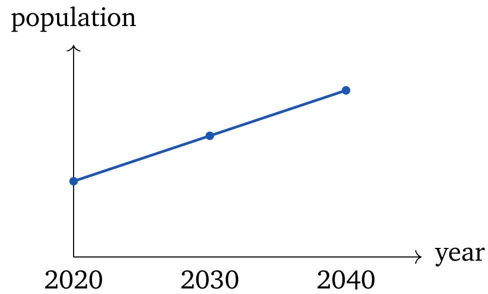
(B) 1.5 m/s

(C) 15 m/s

(D) 0.5 m/s

Water Supply and Water Treatment

Q13. A town's population in the year 2020 is 60,000 and its average decadal increase (arithmetic-increase method) is 8,000 persons, as trended below. The forecast population for the year 2040 is: **[1 mark]**



(A) 68,000

(B) 16,000

(C) 60,000

(D) 76,000

Q14. A city with a population of 200,000 has an average water demand of 150 litres per capita per day (lpcd). The average daily water demand of the city, expressed in million litres per day (MLD), is: **[1 mark]**

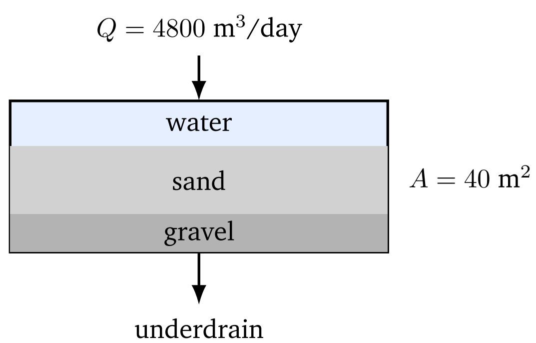
(A) 3.0 MLD

(B) 300 MLD

(C) 30 MLD

(D) 15 MLD

Q15. A rapid sand filter, shown schematically, treats a flow of $Q = 4800$ m^3/day through a bed of plan area $A = 40$ m^2. The filtration (loading) rate $= Q/A$ is: **[1 mark]**



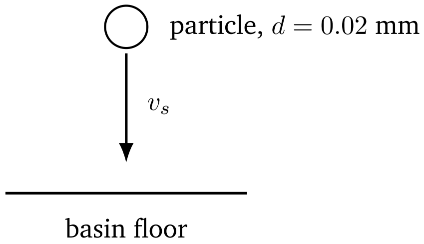
(A) 1200 m/day

(B) 12 m/day

(C) 120 m/day

(D) 60 m/day

Q16. A discrete spherical particle of diameter $d = 0.02$ mm $= 2 \times 10^{-5}$ m and submerged density $(\rho_s - \rho) = 1600$ kg/m^3 settles in still water. By Stokes' law $v_s = \dfrac{g(\rho_s - \rho)d^2}{18\mu}$ (with $\mu = 1.0 \times 10^{-3}$ Pa·s), the settling velocity is nearest to: **[1 mark]**



(A) 3.5×10^{-3} m/s

(B) 3.5×10^{-4} m/s

(C) 7.0×10^{-4} m/s

(D) 1.7×10^{-4} m/s

Q17. A flocculation basin of volume $V = 900$ m^3 receives a flow of $Q = 150$ m^3/hr. The theoretical hydraulic detention (retention) time $t_d = V/Q$ is: **[1 mark]**

(A) 0.17 hr

(B) 6 hr

(C) 3 hr

(D) 1.5 hr

Q18. In the disinfection of water, a chlorine dose of 6.0 mg/L is applied and a free chlorine residual of 0.8 mg/L is measured after the contact period. The chlorine demand of the water is: **[1 mark]**

(A) 5.2 mg/L

(B) 6.8 mg/L

(C) 0.8 mg/L

(D) 6.0 mg/L

Wastewater Treatment and Disposal

Q19. The influent to a secondary treatment unit has a BOD of 400 mg/L and the effluent leaving it has a BOD of 40 mg/L. The BOD-removal efficiency of the unit is: **[1 mark]**

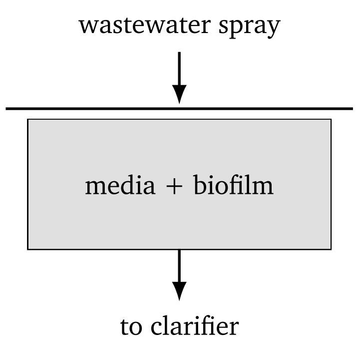
(A) 10%

(B) 45%

(C) 90%

(D) 80%

Q20. In the trickling filter whose flow scheme is shown, the biological slime layer (biofilm) growing on the media surface stabilises the dissolved organic matter chiefly by: **[1 mark]**



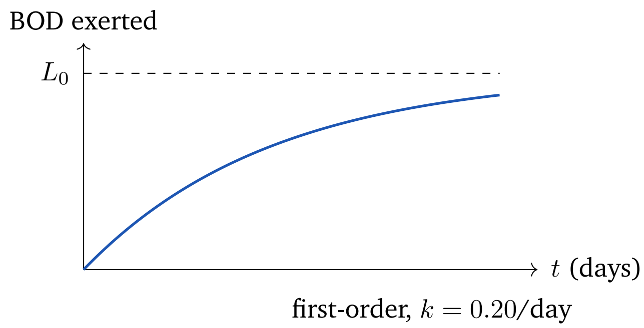
(A) aerobic microbial oxidation within the biofilm

(B) anaerobic digestion only

(C) chemical precipitation of the organics

(D) physical straining by the media only

Q21. Wastewater has an ultimate (first-stage) BOD of $L_0 = 250$ mg/L and a deoxygenation rate constant $k = 0.20$ day^{-1} (base e). Following the first-order model of the BOD-exertion curve shown, the BOD exerted in 5 days, $y_5 = L_0\left(1 - e^{-kt}\right)$, is nearest to: **[2 marks]**



(A) 92 mg/L

(B) 250 mg/L

(C) 205 mg/L

(D) 158 mg/L

Q22. An activated-sludge aeration tank of volume $V = 1000$ m^3 operates with a mixed-liquor suspended-solids concentration of $X = 1000$ mg/L. It receives $Q = 1200$ m^3/day of wastewater at an applied BOD of $S_0 = 250$ mg/L. The food-to-microorganism ratio $F/M = \dfrac{Q\,S_0}{V\,X}$ is: **[2 marks]**

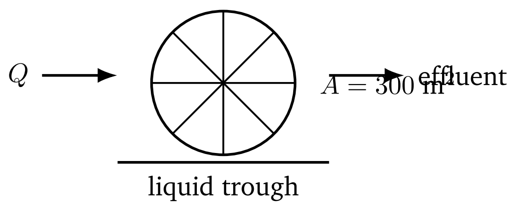
(A) 3.0 per day

(B) 0.03 per day

(C) 0.3 per day

(D) 0.6 per day

Q23. A rotating biological contactor / trickling filter unit, shown below, has a media surface (plan) area of $A = 300$ m^2 and receives a wastewater flow of $Q = 9 \times 10^6$ L/day. The hydraulic loading rate $HLR = Q/A$ is: **[2 marks]**



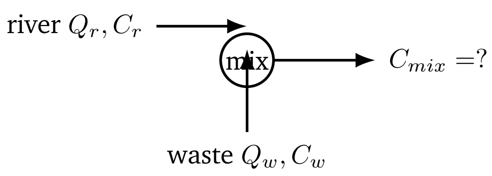
(A) 0.033 m/day

(B) 30 m/day

(C) 300 m/day

(D) 3 m/day

Q24. Treated wastewater is discharged into a stream, as sketched. The waste stream carries $Q_w = 1.0$ m^3/s at a BOD of 180 mg/L and the receiving river carries $Q_r = 9.0$ m^3/s at a BOD of 1 mg/L. Assuming complete mixing, the BOD just downstream of the outfall is nearest to: **[2 marks]**



(A) 18.9 mg/L

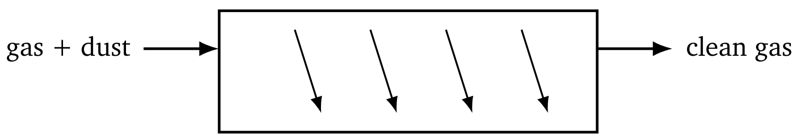
(B) 90 mg/L

(C) 181 mg/L

(D) 36 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 $\rho_p = 2500$ kg/m^3 settles in air of viscosity $\mu = 1.8 \times 10^{-5}$ Pa·s. Neglecting the air density, the terminal settling velocity $v_t = \dfrac{g\,\rho_p\,d^2}{18\mu}$ is nearest to: **[2 marks]**



particle settles under gravity

(A) 0.68 m/s

(B) 6.8 m/s

(C) 0.068 m/s

(D) 0.0068 m/s

Q26. A wet scrubber receives a gas carrying a particulate loading of 8 g/m^3 and discharges it at 0.8 g/m^3. The overall collection (removal) efficiency of the scrubber is: **[2 marks]**

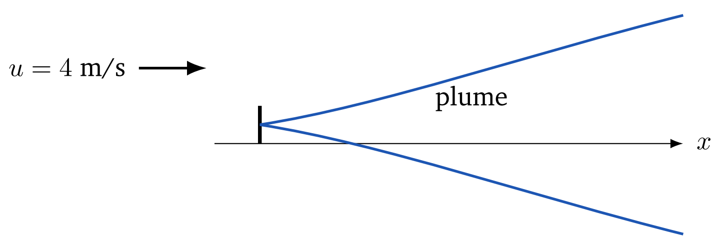
(A) 95%

(B) 10%

(C) 80%

(D) 90%

Q27. A continuous ground-level point source emits a pollutant at $Q = 120$ 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 downwind location $\sigma_y = 40$ m and $\sigma_z = 20$ m, the concentration is nearest to: **[2 marks]**



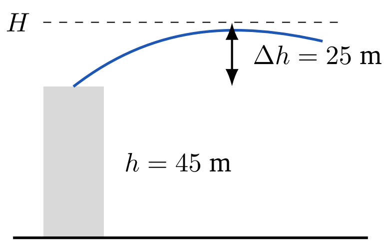
(A) 11.9 mg/m^3

(B) 5.97 mg/m^3

(C) 23.9 mg/m^3

(D) 1.19 mg/m^3

Q28. For the chimney shown, the physical stack height is $h = 45$ m and the buoyant plume rises a further $\Delta h = 25$ m above the stack top before levelling off. The effective stack height $H = h + \Delta h$ is: **[2 marks]**



(A) 45 m

(B) 25 m

(C) 20 m

(D) 70 m

Q29. In a packed-bed absorption column (wet scrubber) used to remove a soluble gaseous pollutant such as SO_2 from a gas stream, the packing material (rings or saddles) is provided mainly to: **[2 marks]**

(A) increase the gas–liquid interfacial contact area

(B) filter out particulate matter by straining

(C) burn the pollutant gas by combustion

(D) adsorb the gas onto an activated-carbon surface

Q30. Ambient sulphur dioxide is measured as 0.2 ppm by volume. At $25°$C (1 atm) the molar volume of a gas is 24.45 litres and the molecular mass of SO_2 is 64. Using $\mu g/m^3 = \text{ppm} \times \dfrac{M}{24.45} \times 1000$, the mass concentration is nearest to: **[2 marks]**

(A) $64\ \mu g/m^3$

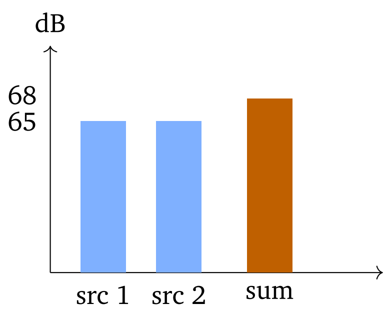
(B) $523\ \mu g/m^3$

(C) $262\ \mu g/m^3$

(D) $128\ \mu g/m^3$

Noise Pollution and Environmental Monitoring

Q31. Two identical machines each produce a sound-pressure level of 65 dB at a point. When both operate together, the combined level $L = 10\log_{10}\big(10^{L_1/10} + 10^{L_2/}$ is (as suggested by the energy addition shown): **[2 marks]**



(A) 68 dB

(B) 130 dB

(C) 65 dB

(D) 71 dB

Q32. At a receiver, one source produces 85 dB and a second produces 79 dB. The combined sound level, using $L = 10\log_{10}(10^{8.5} + 10^{7.9})$, is nearest to: **[2 marks]**

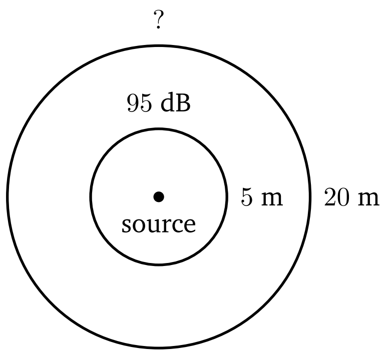
(A) 82 dB

(B) 164 dB

(C) 85 dB

(D) 86 dB

Q33. A point noise source produces 95 dB at a distance of 5 m. In a free field the level falls by 6 dB for every doubling of distance, as the contours below suggest. The sound level at 20 m from the source is: **[2 marks]**



(A) 89 dB

(B) 77 dB

(C) 95 dB

(D) 83 dB

Q34. In environmental noise monitoring, the day-night average sound level L_{dn} is computed by adding a fixed penalty to the measured night-time levels (typically 2200 to 0700 hours). This night-time penalty is: **[2 marks]**

(A) 10 dB added to night-time levels

(B) 5 dB added to night-time levels

(C) 3 dB added to night-time levels

(D) no penalty is added

Solid and Hazardous Waste Management

Q35. A city has a population of 300,000 and a per-capita municipal solid-waste (MSW) generation rate of 0.6 kg/person/day. The total MSW generated per day, expressed in tonnes, is: **[2 marks]**

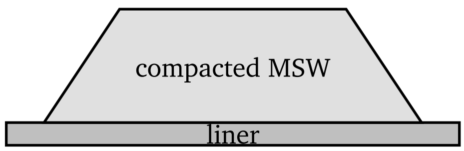
(A) 500 tonnes/day

(B) 180 tonnes/day

(C) 90 tonnes/day

(D) 300 tonnes/day

Q36. A sanitary landfill, shown in cross-section, receives 150 tonnes/day of MSW that is compacted to an in-place density of 600 kg/m^3. The landfill airspace (volume) needed for one year (365 days) of this waste is nearest to: **[2 marks]**



in-place density = 600 kg/m^3

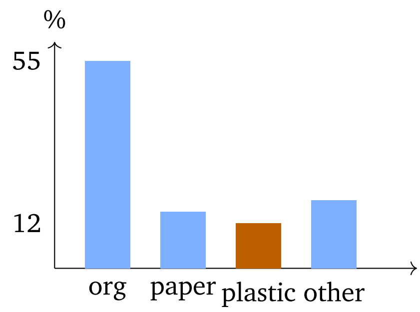
(A) 45,625 m^3

(B) 22,812 m^3

(C) 18,250 m^3

(D) 91,250 m^3

Q37. The bar chart shows the composition of a city's MSW: organic (compostable) 55%, paper 15%, plastic 12% and other 18%. If the total MSW is 150 tonnes/day, the mass of the plastic fraction is: **[2 marks]**



(A) 90 tonnes/day

(B) 18 tonnes/day

(C) 30 tonnes/day

(D) 150 tonnes/day

Q38. Under the standard framework for characterising a waste as hazardous, which one of the following IS a recognised defining characteristic? **[2 marks]**

(A) reactivity

(B) biodegradability

(C) high moisture content

(D) low calorific value

Q39. A mass-burn incinerator receives 150 tonnes/day of MSW and leaves an ash residue equal to 25% of the input mass. The mass of ash (bottom + fly ash) produced per day is: **[2 marks]**

(A) 112.5 tonnes/day

(B) 25 tonnes/day

(C) 150 tonnes/day

(D) 37.5 tonnes/day

Q40. For efficient aerobic composting of organic solid waste, the initial carbon-to-nitrogen (C/N) ratio of the feedstock should be closest to: **[2 marks]**

(A) $1:1$

(B) $25:1$

(C) $150:1$

(D) $3:1$

Environmental Management, Sustainability and Climate

Q41. The technique that evaluates the environmental impacts of a product over all stages of its life, from raw-material extraction through manufacture and use to final disposal ("cradle to grave"), is called: **[2 marks]**

(A) Life Cycle Assessment

(B) Environmental Impact Assessment

(C) Environmental Audit

(D) Risk Assessment

Q42. On a 100-year time horizon, the global-warming potential (GWP) of methane (CH_4) relative to an equal mass of carbon dioxide (CO_2, GWP $=1$) is approximately: **[2 marks]**

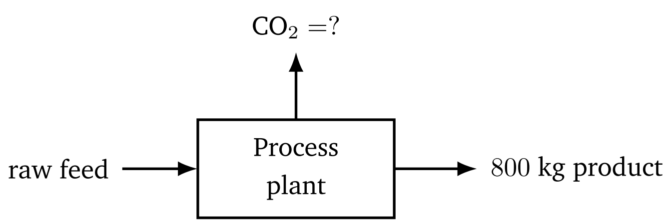
(A) 1

(B) 28

(C) 265

(D) 23,900

Q43. For the process shown, a plant emits 1.5 kg of CO_2 for every kilogram of product and manufactures 800 kg of product each day. The daily CO_2 emission (carbon footprint), obtained from the mass balance, is: **[2 marks]**



(A) 400 kg/day

(B) 800 kg/day

(C) 1.2 tonnes/day

(D) 2.4 tonnes/day

Q44. A "carbon footprint" of an activity or product is most correctly expressed in units of: **[2 marks]**

(A) kilowatt-hours of energy consumed

(B) tonnes of carbon-dioxide equivalent (CO_2-e)

(C) litres of fuel burned

(D) hectares of land occupied

Q45. The international climate agreement adopted in 2015, under which participating countries set their own Nationally Determined Contributions to hold the rise in global average temperature to well below 2°C, is the: **[2 marks]**

(A) Montreal Protocol

(B) Paris Agreement

(C) Kyoto Protocol

(D) Basel Convention

Q46. Among the following, the synthetic greenhouse gas with the highest global-warming potential per unit mass (about 23,900 times that of CO_2 over 100 years) and a very long atmospheric lifetime is: **[2 marks]**

(A) carbon dioxide (CO_2)

(B) methane (CH_4)

(C) nitrous oxide (N_2O)

(D) sulphur hexafluoride (SF_6)

Detailed Solutions

Q1.

Solution

Concept – oxidation state in a polyatomic ion: The sum of the oxidation states of all atoms in an ion equals the net charge of that ion.

Step 1 – assign the known oxidation state: Each oxygen atom carries an oxidation state of -2.

Step 2 – add up the oxygen contribution: There are three oxygen atoms, so their total is $3 \times (-2) = -6$.

Step 3 – write the charge-balance equation: Let the oxidation state of nitrogen be x; the ion NO_3^- has a net charge of -1, so $x + (-6) = -1$

Step 4 – solve for x: $x = -1 + 6$

$x = +5$

Step 5 – interpret: Nitrogen is in its highest (fully oxidised) state $+5$ in nitrate, which is why nitrate acts as an electron acceptor (oxidant) in denitrification.

Final Answer: $+5 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept – expressing hardness as $CaCO_3$: The hardness caused by an 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: $\text{factor} = \dfrac{50}{12} = 4.167$

Step 3 – multiply the magnesium concentration by the factor: $\text{Hardness} = 12 \times 4.167$

Step 4 – evaluate: $\text{Hardness} = 50$ mg/L as $CaCO_3$

Final Answer: 50 mg/L as $CaCO_3 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept – nitrifying bacteria: Nitrification is a two-step aerobic, chemo-autotrophic oxidation of nitrogen.

Step 1 – first oxidation step: *Nitrosomonas* oxidise ammonia (NH_4^+) to nitrite (NO_2^-).

Step 2 – second oxidation step: *Nitrobacter* then oxidise nitrite (NO_2^-) to nitrate (NO_3^-).

Why the other options are wrong:

- A, methanogenic archaea: work anaerobically and produce methane, not nitrate.
- B, coliforms: are faecal indicators, not nitrifiers.
- D, sulphate-reducing bacteria: reduce sulphate to sulphide under anaerobic conditions.

Final Answer: *Nitrosomonas* and *Nitrobacter* $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept – definition of pH: pH is the negative base-10 logarithm of the hydrogen-ion concentration, $\text{pH} = -\log_{10}[\text{H}^+]$.

Step 1 – write the given concentration: $[\text{H}^+] = 1 \times 10^{-3}$ mol/L

Step 2 – substitute into the definition: $\text{pH} = -\log_{10}(1 \times 10^{-3})$

Step 3 – apply the logarithm: $\log_{10}(10^{-3}) = -3$

Step 4 – take the negative: $\text{pH} = -(-3)$

$\text{pH} = 3$

Step 5 – interpret: A pH of 3 is well below 7, so the water is strongly acidic, consistent with a high $[\text{H}^+]$.

Final Answer: $\text{pH} = 3 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q4

Q5.

Solution

Concept – dissolved-oxygen deficit: The DO deficit is the amount by which the actual dissolved oxygen falls short of the saturation value, $D = DO_{sat} - DO_{actual}$.

Step 1 – list the data: $DO_{sat} = 9.2$ mg/L, $DO_{actual} = 5.0$ mg/L.

Step 2 – substitute into the deficit equation: $D = 9.2 - 5.0$

Step 3 – evaluate: $D = 4.2$ mg/L

Step 4 – interpret with the sag curve: This deficit is largest near the critical point of the Streeter–Phelps sag curve, where deoxygenation just balances reaeration.

Final Answer: $D = 4.2$ mg/L $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q5

Q6.

Solution

Concept – methanogenesis: The final stage of anaerobic digestion converts simple organic acids and hydrogen to methane and carbon dioxide.

Step 1 – recall the environment: Digesters operate with no free oxygen, so only obligate anaerobes can survive.

Step 2 – identify the methane producers: Methanogenic (methane-forming) bacteria/archaea carry out the terminal step, releasing CH_4 as biogas.

Why the other options are wrong:

- A, aerobic heterotrophs: need oxygen and do not make methane.
- C, algae: are photosynthetic and require light and oxygen.
- D, nitrifiers: are aerobic and oxidise ammonia, producing no methane.

Final Answer: methanogenic bacteria $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept – catchment water balance: Over a period with negligible change in storage, rainfall is partitioned into evapotranspiration and runoff, so $R = P - ET$.

Step 1 – list the data: $P = 150$ cm, $ET = 90$ cm, $\Delta S \approx 0$.

Step 2 – write the balance: $R = P - ET$

Step 3 – substitute the values: $R = 150 - 90$

Step 4 – evaluate: $R = 60$ cm

Final Answer: $R = 60 \text{ cm} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q7

Q8.

Solution

Concept – rational formula for peak runoff: $Q = \dfrac{C\,i\,A}{360}$ gives Q in m^3/s when i is in mm/hr and A in hectares.

Step 1 – list the data: $C = 0.5$, $i = 72$ mm/hr, $A = 50$ ha.

Step 2 – form the numerator: $C\,i\,A = 0.5 \times 72 \times 50$

Step 3 – multiply step by step: $0.5 \times 72 = 36$

$36 \times 50 = 1800$

Step 4 – divide by 360**:** $Q = \dfrac{1800}{360}$

$Q = 5 \text{ m}^3/\text{s}$

Final Answer: $Q = 5 \text{ m}^3/\text{s} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept – Darcy's law: The specific discharge (Darcy velocity) is the product of hydraulic conductivity and hydraulic gradient, $v = K\,i$.

Step 1 – list the data: $K = 15$ m/day, $i = 0.04$.

Step 2 – substitute: $v = 15 \times 0.04$

Step 3 – evaluate: $v = 0.6$ m/day

Step 4 – note: This is the Darcy (bulk) velocity; the actual seepage velocity through the pores would be higher, equal to v/porosity.

Final Answer: $v = 0.6$ m/day $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q9

Q10.

Solution

Concept – Darcy discharge through an aquifer section: The flow equals the Darcy velocity times the cross-sectional area, $Q = K\,i\,(b\,W)$, where $b\,W$ is the area normal to flow.

Step 1 – list the data: $K = 30$ m/day, $i = 0.002$, $b = 25$ m, $W = 500$ m.

Step 2 – compute the cross-sectional area: $A = b\,W = 25 \times 500 = 12500$ m^2

Step 3 – compute the Darcy velocity: $v = K\,i = 30 \times 0.002 = 0.06$ m/day

Step 4 – multiply velocity by area: $Q = 0.06 \times 12500$

$Q = 750$ m^3/day

Final Answer: $Q = 750$ m^3/day $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept – linearity of the unit hydrograph: A unit hydrograph is defined for 1 cm of rainfall excess. For P cm of excess over the same duration, every ordinate is scaled by P (principle of proportionality).

Step 1 – list the data: Unit-hydrograph peak $= 25$ m^3/s, rainfall excess $P = 3$ cm.

Step 2 – apply the scaling factor: $Q_{peak} = P \times$ (unit peak)

Step 3 – substitute: $Q_{peak} = 3 \times 25$

Step 4 – evaluate: $Q_{peak} = 75$ m^3/s

Final Answer: $Q_{peak} = 75$ m^3/s $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q11

Q12.

Solution

Concept – Manning's velocity equation: $V = \dfrac{1}{n} R^{2/3} S^{1/2}$.

Step 1 – list the data: $n = 0.02$, $R = 1$ m, $S = 0.0009$.

Step 2 – evaluate $R^{2/3}$: $R^{2/3} = 1^{2/3} = 1$

Step 3 – evaluate $S^{1/2}$: $S^{1/2} = \sqrt{0.0009} = 0.03$

Step 4 – form the coefficient: $\dfrac{1}{n} = \dfrac{1}{0.02} = 50$

Step 5 – multiply the three factors: $V = 50 \times 1 \times 0.03$

$V = 1.5$ m/s

Final Answer: $V = 1.5$ m/s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q12

Q13.

Solution

Concept – arithmetic-increase method of population forecast: Population grows by a constant amount each decade, so $P_n = P_0 + n\,\overline{x}$, where $\overline{x}$ is the average decadal increase and n the number of decades.

Step 1 – count the decades from 2020 to 2040: $n = \dfrac{2040 - 2020}{10} = 2$ decades

Step 2 – compute the total increase: $n\,\overline{x} = 2 \times 8000 = 16000$

Step 3 – add to the base population: $P = 60000 + 16000$

$P = 76000$

Final Answer: $P = 76{,}000 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q13

Q14.

Solution

Concept – average daily water demand: Total demand equals per-capita demand times population.

Step 1 – list the data: Per-capita demand $=$ 150 L/person/day, population $=$ 200000.

Step 2 – multiply: Demand $= 150 \times 200000$

Step 3 – evaluate in litres per day: Demand $= 30{,}000{,}000$ L/day

Step 4 – convert to million litres per day: Demand $= \dfrac{30{,}000{,}000}{10^6} = 30$ MLD

Final Answer: 30 MLD $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q14

Q15.

Solution

Concept – filtration (surface loading) rate: The filtration rate of a sand filter is the flow divided by the plan area of the bed, $= Q/A$, which has units of $\text{m}^3/\text{m}^2/\text{day}$, i.e. m/day.

Step 1 – list the data: $Q = 4800$ m^3/day, $A = 40$ m^2.

Step 2 – write the loading equation: Rate $= \dfrac{Q}{A}$

Step 3 – substitute the values: Rate $= \dfrac{4800}{40}$

Step 4 – evaluate: Rate $= 120$ m/day

Step 5 – reasonableness check: 120 m/day (about 5000 L/m^2/hr) is typical of a rapid sand filter, far above the 2–3 m/day of a slow sand filter.

Final Answer: 120 m/day $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept – Stokes' law settling velocity: $v_s = \dfrac{g(\rho_s - \rho)d^2}{18\mu}$ for a discrete particle in the laminar (Stokes) range.

Step 1 – list the data: $g = 9.81$ m/s^2, $(\rho_s - \rho) = 1600$ kg/m^3, $d = 2 \times 10^{-5}$ m, $\mu = 1.0 \times 10^{-3}$ Pa·s.

Step 2 – square the diameter: $d^2 = (2 \times 10^{-5})^2 = 4 \times 10^{-10}$ m^2

Step 3 – build the numerator: $g(\rho_s - \rho)d^2 = 9.81 \times 1600 \times 4 \times 10^{-10}$

$9.81 \times 1600 = 15696$

$15696 \times 4 \times 10^{-10} = 6.278 \times 10^{-6}$

Step 4 – build the denominator: $18\mu = 18 \times 1.0 \times 10^{-3} = 0.018$

Step 5 – divide: $v_s = \dfrac{6.278 \times 10^{-6}}{0.018}$

$v_s = 3.49 \times 10^{-4}$ m/s

Final Answer: $v_s \approx 3.5 \times 10^{-4}$ m/s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q16

Q17.

Solution

Concept – hydraulic detention time: The theoretical detention time is the tank volume divided by the throughput flow, $t_d = V/Q$.

Step 1 – list the data: $V = 900\ \text{m}^3$, $Q = 150\ \text{m}^3/\text{hr}$.

Step 2 – substitute: $t_d = \dfrac{900}{150}$

Step 3 – evaluate: $t_d = 6$ hr

Final Answer: $t_d = 6$ hr $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept – chlorine demand: Chlorine demand is the chlorine consumed by reaction with impurities, equal to the applied dose minus the measured residual, demand = dose − residual.

Step 1 – list the data: Dose $= 6.0$ mg/L, residual $= 0.8$ mg/L.

Step 2 – substitute: demand $= 6.0 - 0.8$

Step 3 – evaluate: demand $= 5.2$ mg/L

Final Answer: 5.2 mg/L $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q18

Q19.

Solution

Concept – BOD-removal efficiency: $\eta = \dfrac{\text{BOD}_{in} - \text{BOD}_{out}}{\text{BOD}_{in}} \times 100\%$.

Step 1 – list the data: $\text{BOD}_{in} = 400$ mg/L, $\text{BOD}_{out} = 40$ mg/L.

Step 2 – compute the BOD removed: $400 - 40 = 360$ mg/L

Step 3 – divide by the influent BOD: $\dfrac{360}{400} = 0.9$

Step 4 – convert to a percentage: $0.9 \times 100 = 90\%$

Final Answer: $90\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q19

Q20.

Solution

Concept – mechanism of a trickling filter: A trickling filter is an attached-growth aerobic process; wastewater trickles over media coated with a microbial biofilm.

Step 1 – identify the active zone: Micro-organisms in the outer biofilm take up dissolved organic matter as their food source.

Step 2 – identify the metabolic route: With air passing through the void spaces, these organisms oxidise the organics aerobically to CO_2, water and new cell mass.

Why the other options are wrong:

- B, anaerobic digestion: only occurs deep inside very thick biofilms, not the main removal route.
- C, chemical precipitation: is not the mechanism of a biological filter.
- D, physical straining: the coarse media do not sieve dissolved BOD.

Final Answer: aerobic microbial oxidation within the biofilm $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q20

Q21.

Solution

Concept – first-order BOD exertion: The BOD exerted up to time t follows $y_t = L_0\left(1 - e^{-kt}\right)$ with k to base e.

Step 1 – list the data: $L_0 = 250$ mg/L, $k = 0.20$ day^{-1}, $t = 5$ days.

Step 2 – form the exponent: $kt = 0.20 \times 5 = 1.0$

Step 3 – evaluate the exponential term: $e^{-1.0} = 0.3679$

Step 4 – compute the bracket: $1 - 0.3679 = 0.6321$

Step 5 – multiply by L_0: $y_5 = 250 \times 0.6321$

$y_5 = 158.0$ mg/L

Final Answer: $y_5 \approx 158$ mg/L $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q21

Q22.

Solution

Concept – food-to-microorganism ratio: $\frac{F}{M} = \frac{Q\,S_0}{V\,X}$, the mass of BOD applied per day per unit mass of MLSS held in the tank.

Step 1 – list the data: $Q = 1200$ m^3/day, $S_0 = 250$ mg/L, $V = 1000$ m^3, $X = 1000$ mg/L.

Step 2 – form the numerator: $Q\,S_0 = 1200 \times 250 = 300000$

Step 3 – form the denominator: $V\,X = 1000 \times 1000 = 1000000$

Step 4 – divide: $\frac{F}{M} = \frac{300000}{1000000}$

$\frac{F}{M} = 0.3$ per day

Final Answer: 0.3 per day $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q22

Q23.

Solution

Concept – hydraulic loading rate: $HLR = Q/A$, the flow per unit plan area, in m^3/m^2/day = m/day. Convert the flow to m^3 first.

Step 1 – convert the flow to m^3/day: $Q = 9 \times 10^6$ L/day $= \frac{9 \times 10^6}{1000} = 9000$ m^3/day

Step 2 – list the area: $A = 300$ m^2.

Step 3 – divide: $HLR = \frac{9000}{300}$

Step 4 – evaluate: $HLR = 30$ m/day

Final Answer: $HLR = 30$ m/day $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q23

Q24.

Solution

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

Step 1 – list the data: $Q_w = 1.0$ m^3/s, $C_w = 180$ mg/L, $Q_r = 9.0$ m^3/s, $C_r = 1$

mg/L.

Step 2 – compute the mass loads: $Q_w C_w = 1.0 \times 180 = 180$

$Q_r C_r = 9.0 \times 1 = 9$

Step 3 – add the loads: $180 + 9 = 189$

Step 4 – add the flows: $Q_w + Q_r = 1.0 + 9.0 = 10 \text{ m}^3/\text{s}$

Step 5 – divide: $C_{mix} = \dfrac{189}{10}$

$C_{mix} = 18.9 \text{ mg/L}$

Final Answer: $C_{mix} \approx 18.9 \text{ mg/L} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q24

Q25.

Solution

Concept – terminal settling velocity of a dust particle (Stokes' law): $v_t = \dfrac{g\,\rho_p\,d^2}{18\mu}$, neglecting the density of air.

Step 1 – list the data: $g = 9.81 \text{ m/s}^2$, $\rho_p = 2500 \text{ kg/m}^3$, $d = 3 \times 10^{-5}$ m, $\mu = 1.8 \times 10^{-5}$ Pa·s.

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

Step 3 – build the numerator: $g\,\rho_p\,d^2 = 9.81 \times 2500 \times 9 \times 10^{-10}$

$9.81 \times 2500 = 24525$

$24525 \times 9 \times 10^{-10} = 2.207 \times 10^{-5}$

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

Step 5 – divide: $v_t = \dfrac{2.207 \times 10^{-5}}{3.24 \times 10^{-4}}$

$v_t = 0.0681 \text{ m/s}$

Final Answer: $v_t \approx 0.068 \text{ m/s} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q25

Q26.

Solution

Concept – collection efficiency: $\eta = \dfrac{C_{in} - C_{out}}{C_{in}} \times 100\%$.

Step 1 – list the data: $C_{in} = 8 \text{ g/m}^3$, $C_{out} = 0.8 \text{ g/m}^3$.

Step 2 – compute the mass removed: $8 - 0.8 = 7.2 \text{ g/m}^3$

Step 3 – divide by the inlet loading: $\dfrac{7.2}{8} = 0.9$

Step 4 – convert to a percentage: $0.9 \times 100 = 90\%$

Final Answer: $90\% \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q26

Q27.

Solution

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

Step 1 – list the data: $Q = 120$ g/s, $u = 4$ m/s, $\sigma_y = 40$ m, $\sigma_z = 20$ m.

Step 2 – form the denominator: $\pi\,\sigma_y\,\sigma_z\,u = \pi \times 40 \times 20 \times 4$

$40 \times 20 = 800$

$800 \times 4 = 3200$

$\pi \times 3200 = 10053$

Step 3 – divide: $C = \dfrac{120}{10053}$

$C = 0.01194$ g/m^3

Step 4 – convert to mg/m^3: $C = 0.01194 \times 1000 = 11.9$ mg/m^3

Final Answer: $C \approx 11.9$ mg/m$^3 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q27

Q28.

Solution

Concept – effective stack height: The effective height at which the plume behaves as if released is the sum of the physical stack height and the plume rise, $H = h + \Delta h$.

Step 1 – list the data: $h = 45$ m, $\Delta h = 25$ m.

Step 2 – add: $H = 45 + 25$

Step 3 – evaluate: $H = 70$ m

Step 4 – note: A larger H lowers the maximum ground-level concentration, which is why tall stacks with buoyant, high-velocity plumes are used.

Final Answer: $H = 70 \text{ m} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q28

Q29.

Solution

Concept – role of packing in an absorption column: A wet scrubber transfers a soluble gas into a liquid; the rate of transfer is proportional to the gas–liquid interfacial area.

Step 1 – identify the purpose of the packing: Rings and saddles spread the liquid into thin films and break the gas into many channels, greatly enlarging the wetted contact surface.

Step 2 – link to performance: More interfacial area raises the mass-transfer rate, so more SO_2 dissolves per unit height of column.

Why the other options are wrong:

- B, straining: absorption removes gases, not particulates by sieving.
- C, combustion: no burning occurs in a scrubber.
- D, activated-carbon adsorption: that is a different (dry) process, not the role of inert packing.

Final Answer: increase the gas–liquid interfacial contact area $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q29

Q30.

Solution

Concept – converting ppm(v) to mass concentration: $\mu\text{g/m}^3 = \text{ppm} \times \dfrac{M}{24.45} \times 1000$ at 25°C and 1 atm.

Step 1 – list the data: ppm $= 0.2$, $M = 64$, molar volume $= 24.45$ L.

Step 2 – form the ratio $M/24.45$: $\dfrac{64}{24.45} = 2.617$

Step 3 – multiply by the ppm value: $0.2 \times 2.617 = 0.5235$

Step 4 – multiply by 1000: $0.5235 \times 1000 = 523.5$

Step 5 – state the result: $\approx 523\ \mu\text{g/m}^3$

Final Answer: $\approx 523\ \mu\text{g/m}^3 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q30

Q31.

Solution

Concept – adding two equal sound levels: Sound levels add on an energy (intensity) basis, $L = 10\log_{10}\left(10^{L_1/10} + 10^{L_2/10}\right)$. Doubling the acoustic energy raises the level by about 3 dB.

Step 1 – list the data: $L_1 = L_2 = 65$ dB.

Step 2 – convert each to relative energy: $10^{65/10} = 10^{6.5}$ for each source.

Step 3 – add the energies: $10^{6.5} + 10^{6.5} = 2 \times 10^{6.5}$

Step 4 – take the logarithm: $L = 10\log_{10}(2 \times 10^{6.5}) = 10\,(6.5 + \log_{10} 2)$

Step 5 – evaluate ($\log_{10} 2 = 0.301$): $L = 10\,(6.5 + 0.301) = 10 \times 6.801 = 68.0$ dB

Final Answer: 68 dB $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q31

Q32.

Solution

Concept – adding two unequal sound levels: $L = 10\log_{10}\left(10^{L_1/10} + 10^{L_2/10}\right)$.

Step 1 – list the data: $L_1 = 85$ dB, $L_2 = 79$ dB.

Step 2 – convert each to relative energy: $10^{85/10} = 10^{8.5} = 3.162 \times 10^8$

$10^{79/10} = 10^{7.9} = 0.794 \times 10^8$

Step 3 – add the energies: $3.162 \times 10^8 + 0.794 \times 10^8 = 3.956 \times 10^8$

Step 4 – take the logarithm: $\log_{10}(3.956 \times 10^8) = 8.597$

Step 5 – multiply by 10: $L = 10 \times 8.597 = 85.97 \approx 86$ dB

Final Answer: ≈ 86 dB $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept – distance attenuation of a point source: In a free field the level drops by 6 dB for every doubling of the distance from the source.

Step 1 – list the data: $L = 95$ dB at $r_1 = 5$ m; find the level at $r_2 = 20$ m.

Step 2 – count the doublings: $\dfrac{20}{5} = 4 = 2^2$, so the distance doubles twice.

Step 3 – compute the total drop: $2 \times 6 = 12$ dB

Step 4 – subtract from the reference level: $L_2 = 95 - 12$

$L_2 = 83$ dB

Final Answer: 83 dB $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q33

Q34.

Solution

Concept – day-night average sound level L_{dn}: L_{dn} is an energy-average level over 24 hours that penalises night-time noise because it is more disturbing.

Step 1 – recall the night window: Night is taken as 2200 to 0700 hours.

Step 2 – recall the penalty: Before averaging, a fixed 10 dB is added to every night-time hourly level.

Why the other options are wrong:

- B and C, 5 dB / 3 dB: are not the standard L_{dn} night penalty (5 dB is the evening penalty used in L_{den}).
- D, no penalty: would make L_{dn} identical to a plain 24-hour L_{eq}, defeating its purpose.

Final Answer: 10 dB added to night-time levels $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q34

Q35.

Solution

Concept – total MSW generation: Total daily MSW = population × per-capita generation rate; then convert kg to tonnes (1 tonne = 1000 kg).

Step 1 – list the data: Population = 300000, rate = 0.6 kg/person/day.

Step 2 – multiply: $300000 \times 0.6 = 180000$ kg/day

Step 3 – convert to tonnes: $\dfrac{180000}{1000} = 180$ tonnes/day

Final Answer: 180 tonnes/day $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q35

Q36.

Solution

Concept – landfill airspace from mass and density: Volume $=$ mass $\div$ compacted density; multiply the daily volume by the number of days.

Step 1 – convert the daily mass to kg: 150 tonnes/day $= 150 \times 1000 = 150000$ kg/day

Step 2 – compute the daily volume: $\dfrac{150000}{600} = 250$ m^3/day

Step 3 – multiply by the number of days: $250 \times 365 = 91250$ m^3

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

Answer: (D) Go Back to Q36

Q37.

Solution

Concept – component mass from a percentage composition: Mass of a fraction $=$ (percentage $\div$ 100) $\times$ total mass.

Step 1 – read the plastic share from the chart: Plastic $= 12\%$ of the MSW.

Step 2 – list the total mass: Total MSW $= 150$ tonnes/day.

Step 3 – convert the percentage to a fraction: $\dfrac{12}{100} = 0.12$

Step 4 – multiply: $0.12 \times 150 = 18$ tonnes/day

Final Answer: 18 tonnes/day $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q37

Q38.

Solution

Concept – characteristics of hazardous waste: A waste is characteristically hazardous if it shows any of four properties: ignitability, corrosivity, reactivity or toxicity.

Step 1 – test each option against the four: Reactivity (unstable, explosive or reacts violently with water) is one of the four defining characteristics.

Why the other options are wrong:

- B, biodegradability: is a property that generally makes a waste *less* hazardous, not a defining hazardous characteristic.

- C, high moisture content: affects handling and calorific value, not hazard classification.
- D, low calorific value: relates to combustibility for energy recovery, not hazard.

Final Answer: reactivity $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q38

Q39.

Solution

Concept – ash residue from incineration: Ash mass $=$ ash fraction $\times$ input mass.

Step 1 – list the data: Input $= 150$ tonnes/day, ash fraction $= 25\% = 0.25$.

Step 2 – multiply: $0.25 \times 150 = 37.5$ tonnes/day

Step 3 – interpret: Incineration reduces the mass to about a quarter, but the 37.5 tonnes/day of ash (some of it fly ash) still needs safe landfilling.

Final Answer: 37.5 tonnes/day $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q39

Q40.

Solution

Concept – optimum C/N ratio for composting: Microbes need carbon for energy and nitrogen for protein; the feedstock works best when this balance is right.

Step 1 – recall the optimum band: An initial C/N ratio of about $25 : 1$ to $30 : 1$ gives efficient aerobic composting.

Step 2 – pick the closest option: $25 : 1$ lies in this band.

Why the other options are wrong:

- A, $1 : 1$ and D, $3 : 1$: far too much nitrogen, leading to ammonia loss and odour.
- C, $150 : 1$: far too little nitrogen, so decomposition is very slow.

Final Answer: $25 : 1 \Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q40

Q41.

Solution

Concept – Life Cycle Assessment (LCA): LCA is a "cradle-to-grave" method that quantifies environmental burdens across every stage of a product's life.

Step 1 – match the description: The stages named – raw-material extraction, manufacture, use and disposal – are exactly the boundaries of an LCA.

Why the other options are wrong:

- B, EIA: assesses one proposed *project* or development, not a product across its life.
- C, Environmental Audit: checks an operating facility's compliance with standards.
- D, Risk Assessment: estimates the probability and consequence of a hazard.

Final Answer: Life Cycle Assessment $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q41

Q42.

Solution

Concept – global-warming potential of methane: GWP compares the heat trapped by a mass of a gas with the same mass of CO_2 over a chosen horizon.

Step 1 – recall the 100-year value: Methane's 100-year GWP is about 28 (roughly 25–30 depending on the assessment).

Step 2 – pick the closest option: 28 matches this value.

Why the other options are wrong:

- A, 1: is the reference value of CO_2 itself.
- C, 265: is the GWP of nitrous oxide.
- D, 23,900: is the GWP of sulphur hexafluoride.

Final Answer: about 28 $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q42

Q43.

Solution

Concept – emission from an emission factor (mass balance): Daily emission = emission factor (kg CO_2 per kg product) $\times$ daily production.

Step 1 – list the data: Factor $= 1.5$ kg CO_2/kg product, production $= 800$ kg/day.

Step 2 – multiply: $1.5 \times 800 = 1200$ kg/day

Step 3 – convert to tonnes: $\frac{1200}{1000} = 1.2$ tonnes/day

Final Answer: 1.2 tonnes/day $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q43

Q44.

Solution

Concept – units of a carbon footprint: A carbon footprint totals the greenhouse gases from an activity, each converted to the equivalent mass of CO_2 by its GWP.

Step 1 – recall the aggregation rule: Every gas (CH_4, N_2O, etc.) is multiplied by its GWP to give a CO_2-equivalent mass, then summed.

Step 2 – state the resulting unit: The sum is expressed in tonnes (or kg) of CO_2-equivalent.

Why the other options are wrong:

- A, kWh: measures energy, an input, not the emission itself.
- C, litres of fuel: is an activity measure, not the aggregated emission.
- D, hectares: is the unit of an ecological (land) footprint, a different indicator.

Final Answer: tonnes of CO_2-equivalent $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q44

Q45.

Solution

Concept – the 2015 climate treaty: The Paris Agreement, adopted at COP21 in 2015, is built on voluntary national pledges.

Step 1 – match the defining features: Countries submit Nationally Determined Contributions (NDCs) and aim to hold warming well below 2°C, pursuing 1.5°C.

Why the other options are wrong:

- A, Montreal Protocol (1987): phases out ozone-depleting substances, not a temperature target.
- C, Kyoto Protocol (1997): set binding targets for developed countries only, without NDCs.
- D, Basel Convention: controls transboundary movement of hazardous wastes.

Final Answer: Paris Agreement $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q45

Q46.

Solution

Concept – highest-GWP synthetic gas: Among common greenhouse gases, fully fluorinated compounds have the largest GWP and longest lifetimes.

Step 1 – compare the 100-year GWPs: $CO_2 = 1$, $CH_4 \approx 28$, $N_2O \approx 265$, $SF_6 \approx 23{,}900$.

Step 2 – pick the maximum: Sulphur hexafluoride (SF_6) has by far the highest value and an atmospheric lifetime of thousands of years.

Final Answer: sulphur hexafluoride (SF_6) $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q46

Answer Key

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