GATE Environmental Science and Engineering

Sample Paper – 4

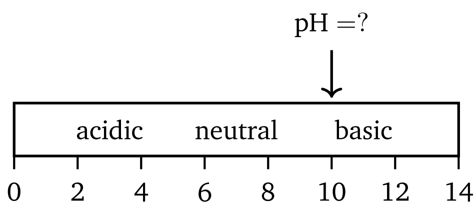
Duration: 128 Minutes **Maximum Marks: 72**

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. A groundwater sample has a hydroxyl-ion concentration $[\text{OH}^-] = 1 \times 10^{-4}$ mol/L at $25°$C. On the pH scale shown, its pH (where pH $= 14 -$ pOH) is: **[1 mark]**



(A) 10

(B) 4

(C) 14

(D) 7

Q2. Minamata disease, a severe neurological disorder first identified among fishing communities in Japan, is caused by the chronic ingestion of a heavy metal accumulated in fish. That metal is: **[1 mark]**

(A) lead (Pb)

(B) mercury (Hg)

(C) arsenic (As)

(D) cadmium (Cd)

Q3. A water sample contains magnesium ions Mg^{2+} 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) 12 mg/L as $CaCO_3$

(B) 24 mg/L as $CaCO_3$

(C) 25 mg/L as $CaCO_3$

(D) 50 mg/L as $CaCO_3$

Q4. At 25°C a water sample has a pH of 5. The hydrogen-ion concentration $[H^+]$ of the water is: **[1 mark]**

(A) 1×10^{-9} mol/L

(B) 1×10^{-7} mol/L

(C) 1×10^{-14} mol/L

(D) 1×10^{-5} mol/L

Q5. Long-term consumption of groundwater contaminated by a particular metalloid is linked to blackfoot disease and skin cancers reported in parts of West Bengal and Bangladesh. The contaminant chiefly responsible is: **[1 mark]**

(A) fluoride

(B) iron

(C) arsenic

(D) chloride

Q6. Among the following water-borne diseases, the one caused by a **virus** (rather than a bacterium or protozoan) is: **[1 mark]**

(A) cholera

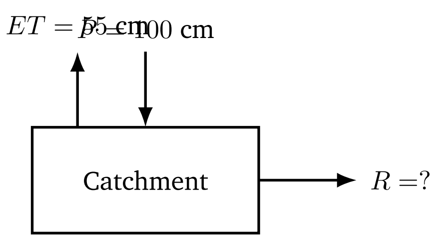
(B) typhoid

(C) amoebiasis

(D) infectious hepatitis (Hepatitis A)

Water Resources and Environmental Hydraulics

Q7. For the catchment water balance shown, the annual rainfall is $P = 100$ cm and the evapotranspiration loss is $ET = 55$ cm. If the change in storage over the year is negligible, the annual runoff $R = P - ET$ is: **[1 mark]**



(A) 155 cm

(B) 45 cm

(C) 55 cm

(D) 100 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 $C = 0.4$, rainfall intensity $i = 45$ mm/hr and area $A = 200$ ha. The peak runoff Q is: **[1 mark]**

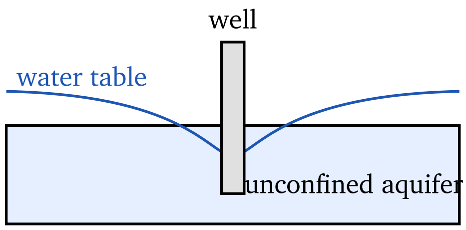
(A) 10 m^3/s

(B) 3600 m^3/s

(C) 100 m^3/s

(D) 36 m^3/s

Q9. An unconfined aquifer, tapped by the pumping well shown, has a total porosity $n = 0.35$ and a specific retention $S_r = 0.10$. The specific yield of the aquifer, $S_y = n - S_r$, is: **[1 mark]**



$n = 0.35,\ S_r = 0.10$

(A) 0.45

(B) 0.35

(C) 0.10

(D) 0.25

Q10. A confined aquifer has a hydraulic conductivity $K = 30$ m/day and a saturated thickness $b = 15$ m. The transmissivity of the aquifer, $T = K\,b$, is: **[1 mark]**

(A) 45 m^2/day

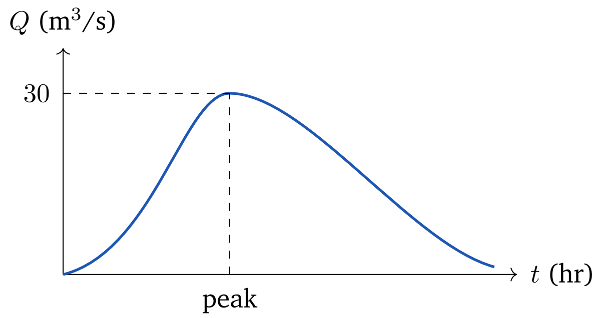
(B) 450 m^2/day

(C) 2 m^2/day

(D) 4500 m^2/day

Q11. A 3-hour unit hydrograph of a catchment has a peak ordinate of 30 m^3/s, as shown. For a rainfall excess of 5 cm occurring uniformly over the same

3-hour duration, the peak of the resulting direct-runoff hydrograph is: **[1 mark]**



(A) 30 m^3/s

(B) 6 m^3/s

(C) 300 m^3/s

(D) 150 m^3/s

Q12. A tube well delivers a steady discharge of 1200 litres per minute when the drawdown at the well is 4 m. The specific capacity of the well, defined as discharge per unit drawdown Q/s, is: **[1 mark]**

(A) 300 L/min per m

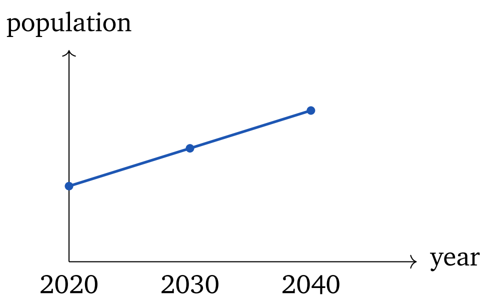
(B) 4800 L/min per m

(C) 0.0033 L/min per m

(D) 1200 L/min per m

Water Supply and Water Treatment

Q13. A town's population in the year 2020 is 80,000 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) 88,000

(B) 16,000

(C) 96,000

(D) 80,000

Q14. A city with a population of 250,000 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]**

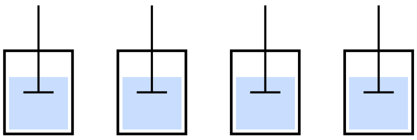
(A) 3.75 MLD

(B) 375 MLD

(C) 150 MLD

(D) 37.5 MLD

Q15. In the coagulation jar test shown, the optimum alum dose determined from the beakers is 30 mg/L. For a water-treatment plant handling 20 million litres per day (MLD), the mass of alum required per day is: **[1 mark]**



jars: increasing alum dose $\rightarrow$

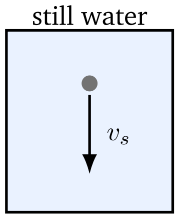
(A) 600 kg/day

(B) 60 kg/day

(C) 1.5 kg/day

(D) 6000 kg/day

Q16. A discrete spherical particle of diameter $d = 0.04$ mm $= 4 \times 10^{-5}$ m and submerged density $(\rho_s - \rho) = 1600$ kg/m^3 settles in still water, as shown. 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) 1.4×10^{-3} m/s

(B) 2.8×10^{-3} m/s

(C) 1.4×10^{-2} m/s

(D) 7×10^{-4} m/s

Q17. A flocculation basin of volume $V = 450$ m^3 receives a flow of $Q = 300$ m^3/hr. The theoretical hydraulic detention (retention) time $t_d = V/Q$ is: **[1 mark]**

(A) 0.67 hr

(B) 1.5 hr

(C) 3 hr

(D) 6 hr

Q18. In the disinfection of water, a chlorine dose of 8.0 mg/L is applied and a free chlorine residual of 1.5 mg/L is measured after the contact period. The chlorine demand of the water is: **[1 mark]**

(A) 9.5 mg/L

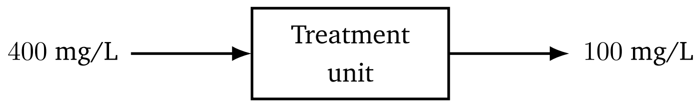
(B) 6.5 mg/L

(C) 1.5 mg/L

(D) 8.0 mg/L

Wastewater Treatment and Disposal

Q19. The influent to the treatment unit shown has a BOD of 400 mg/L and the effluent leaving it has a BOD of 100 mg/L. The BOD-removal efficiency of the unit is: **[1 mark]**



(A) 25%

(B) 100%

(C) 60%

(D) 75%

Q20. In the activated-sludge process, the concentrated biological solids that settle in the secondary clarifier and are pumped back to the head of the aeration tank to maintain the microbial population are collectively termed the: **[1 mark]**

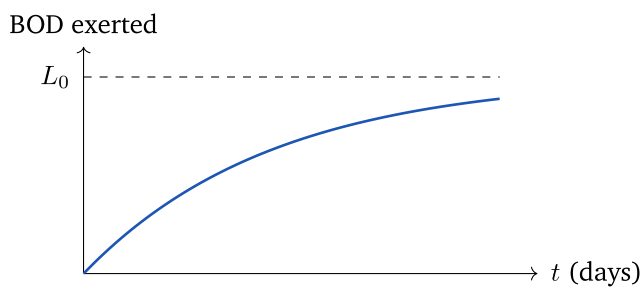
(A) waste activated sludge (WAS)

(B) primary sludge

(C) return activated sludge (RAS)

(D) digested sludge

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]**



first-order, $k = 0.20$/day

(A) 158 mg/L

(B) 250 mg/L

(C) 92 mg/L

(D) 200 mg/L

Q22. In an activated-sludge plant, the mixed-liquor suspended-solids concentration in the aeration tank is $X = 3000$ mg/L and the return (underflow) sludge concentration from the secondary clarifier is $X_r = 9000$ mg/L. Neglecting solids lost in the effluent, the sludge recycle ratio $R = \dfrac{X}{X_r - X}$ is: **[2 marks]**

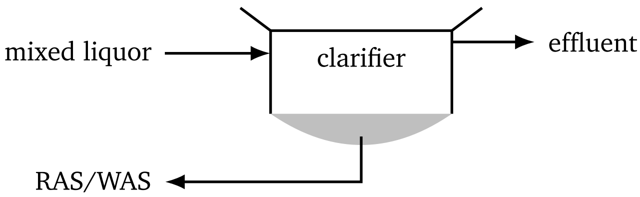
(A) 0.33

(B) 3.0

(C) 0.5

(D) 0.75

Q23. The secondary clarifier with sludge recycle shown handles a mixed liquor whose settled sludge volume after 30 minutes in a 1-litre cylinder is 300 mL/L, at a mixed-liquor suspended-solids concentration of 3000 mg/L. The Sludge Volume Index, $SVI = \dfrac{\text{settled volume (mL/L)} \times 1000}{\text{MLSS (mg/L)}}$, is: **[2 marks]**



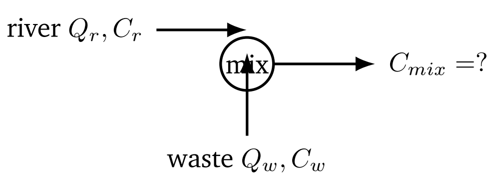
(A) 10 mL/g

(B) 1000 mL/g

(C) 100 mL/g

(D) 0.1 mL/g

Q24. Treated wastewater is discharged into a stream, as sketched. The waste stream carries $Q_w = 1$ m^3/s at a BOD of 180 mg/L and the receiving river carries $Q_r = 9$ m^3/s at a BOD of 3 mg/L. Assuming complete mixing, the BOD just downstream of the outfall is nearest to: **[2 marks]**



(A) 183 mg/L

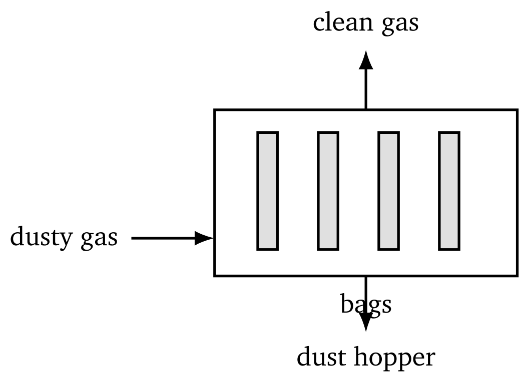
(B) 20.7 mg/L

(C) 90 mg/L

(D) 18 mg/L

Air Pollution and Control

Q25. A fabric-filter baghouse, shown schematically, treats a gas flow of 6000 m^3/min using a total filter-cloth area of 3000 m^2. The air-to-cloth ratio (filtration velocity) $= Q/A$ is: **[2 marks]**



(A) 2 m/min

(B) 0.5 m/min

(C) 20 m/min

(D) 5 m/min

Q26. A fabric filter receives a gas carrying a particulate loading of 12 g/m^3 and discharges it at 0.24 g/m^3. The overall collection (removal) efficiency of the baghouse is: **[2 marks]**

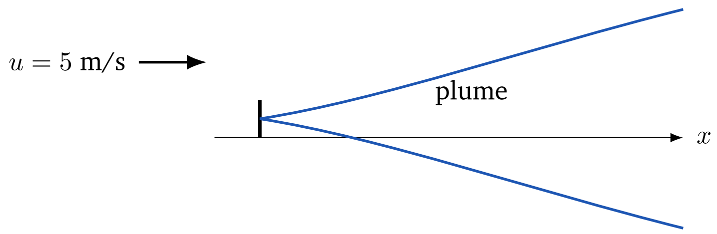
(A) 98%

(B) 2%

(C) 49%

(D) 90%

Q27. A continuous ground-level point source emits a pollutant at $Q = 100$ g/s into a wind of speed $u = 5$ 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 $\sigma_y = 25$ m and $\sigma_z = 10$ m, the concentration is nearest to: [2 marks]



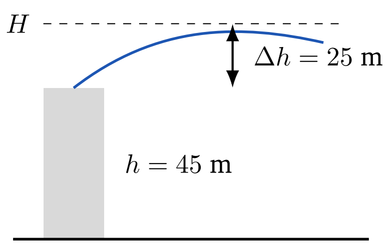
(A) 50.9 mg/m^3

(B) 25.5 mg/m^3

(C) 12.7 mg/m^3

(D) 5.09 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. When the environmental (ambient) lapse rate is markedly *greater* than the dry adiabatic lapse rate, the atmosphere is strongly unstable and vigorous vertical mixing occurs. The stability condition and the associated plume behaviour are best described as: [2 marks]

(A) stable atmosphere, fanning plume

(B) unstable atmosphere, looping plume

(C) neutral atmosphere, coning plume

(D) temperature inversion, fumigating plume

Q30. Ambient nitrogen dioxide 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 NO_2 is 46. Using $\mu g/m^3 = \text{ppm} \times \frac{M}{24.45} \times 1000$, the mass concentration is nearest to: **[2 marks]**

(A) 46 $\mu g/m^3$

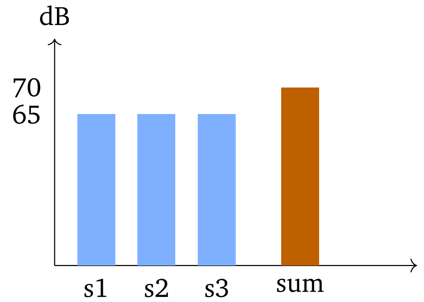
(B) 188 $\mu g/m^3$

(C) 94 $\mu g/m^3$

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

Noise Pollution and Environmental Monitoring

Q31. Three identical machines each produce a sound-pressure level of 65 dB at a point. When all three operate together, the combined level $L = 10\log_{10}\left(\sum 10^{L_i/10}\right)$ is (as suggested by the energy addition shown): **[2 marks]**



(A) 70 dB

(B) 195 dB

(C) 65 dB

(D) 68 dB

Q32. A point noise source produces 85 dB at a distance of 5 m. In a free field the sound level falls by 6 dB for every doubling of distance. The sound level at 20 m from the source is: **[2 marks]**

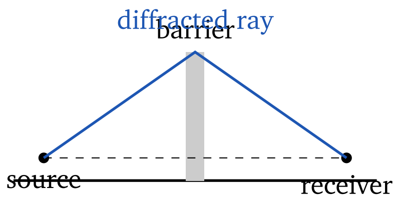
(A) 79 dB

(B) 73 dB

(C) 85 dB

(D) 67 dB

Q33. A solid noise barrier is placed between a road (source) and a house (receiver), as shown. For a barrier of given height, its acoustic performance (insertion loss) improves as the path-length difference δ between the diffracted ray over the top and the direct line of sight: **[2 marks]**



(A) decreases

(B) stays constant

(C) increases

(D) becomes negative

Q34. In environmental noise monitoring, the statistical noise index that denotes the sound level exceeded for only 10% of the total measurement period (a measure of the near-peak intrusive noise) is: **[2 marks]**

(A) L_{90}, the level exceeded 90% of the time

(B) L_{10}, the level exceeded 10% of the time

(C) L_{50}, the level exceeded 50% of the time

(D) L_{eq}, the level exceeded the entire time

Solid and Hazardous Waste Management

Q35. A city has a population of $400{,}000$ 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]**

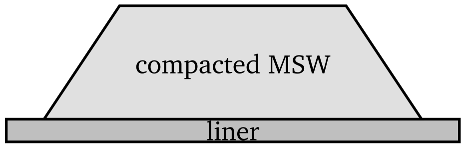
(A) 400 tonnes/day

(B) 120 tonnes/day

(C) 240 tonnes/day

(D) 480 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

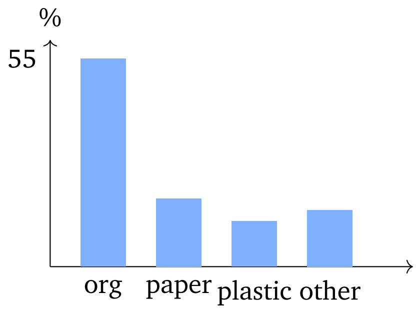
(A) 45,625 m^3

(B) 22,812 m^3

(C) 182,500 m^3

(D) 91,250 m^3

Q37. The bar chart shows the composition of a city's MSW: organic (compostable) 55%, paper 18%, plastic 12% and other 15%. If the total MSW is 200 tonnes/day, the mass of the compostable (organic) fraction available for composting is: **[2 marks]**



(A) 55 tonnes/day

(B) 90 tonnes/day

(C) 110 tonnes/day

(D) 200 tonnes/day

Q38. In the biological stabilisation of organic solid waste by vermicomposting, the organisms chiefly responsible for ingesting the waste and converting it into nutrient-rich castings are: **[2 marks]**

(A) filamentous fungi

(B) green algae

(C) earthworms (e.g. *Eisenia fetida*)

(D) blue-green bacteria

Q39. For efficient aerobic composting of organic solid waste, in addition to a suitable carbon-to-nitrogen ratio and adequate aeration, the moisture content of the composting mass should be maintained closest to: **[2 marks]**

(A) 10%

(B) 90%

(C) 30%

(D) 55%

Q40. A 100 kg batch of organic waste is composted. During the process the pile loses 20 kg of moisture as water vapour and a further 10 kg as carbon dioxide and other volatile gases. From the mass balance, the mass of finished compost remaining is: **[2 marks]**

(A) 70 kg

(B) 30 kg

(C) 90 kg

(D) 100 kg

Environmental Management, Sustainability and Climate

Q41. Within the Environmental Impact Assessment process, the specific document that sets out the mitigation measures, safeguards and the monitoring programme to be implemented during construction and operation of a cleared project is called the: **[2 marks]**

(A) Environmental Management Plan (EMP)

(B) Environmental Impact Assessment (EIA) report

(C) Detailed Project Report (DPR)

(D) Life Cycle Assessment (LCA)

Q42. The stratospheric ozone layer is important to life at the Earth's surface chiefly because it absorbs and screens out a harmful component of incoming solar radiation. That component is: **[2 marks]**

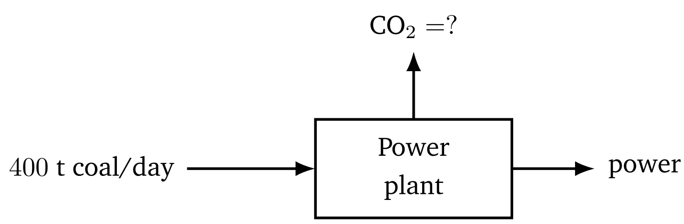
(A) infrared radiation

(B) visible light

(C) microwave radiation

(D) ultraviolet (UV-B) radiation

Q43. For the coal-fired power plant shown, the plant burns 400 tonnes of coal per day and each tonne of coal burned releases 2.5 tonnes of CO_2. From the mass balance, the daily CO_2 emission is: **[2 marks]**



(A) 1000 tonnes/day

(B) 160 tonnes/day

(C) 800 tonnes/day

(D) 2000 tonnes/day

Q44. In the widely used "3R" waste-management hierarchy for sustainable resource use, the option that should be given the **highest** priority is: **[2 marks]**

(A) recycle the waste materials

(B) recover energy by incineration

(C) reduce the quantity of waste generated at source

(D) dispose of the waste in a landfill

Q45. The Kigali Amendment (2016) to the Montreal Protocol extended international controls to phase down a group of synthetic gases that, although they do not deplete ozone, are potent greenhouse gases widely used as substitutes for CFCs in refrigeration and air-conditioning. These gases are the: **[2 marks]**

(A) carbon dioxide compounds

(B) hydrofluorocarbons (HFCs)

(C) methane and its derivatives

(D) sulphur dioxide compounds

Q46. Chlorofluorocarbons released at the surface drift up to the stratosphere, where ultraviolet light splits them and frees a reactive species that catalytically destroys ozone. The species chiefly responsible for this catalytic ozone destruction is the: **[2 marks]**

(A) carbon atom

(B) chlorine free radical ($Cl\cdot$)

(C) fluorine atom

(D) hydrogen atom

Detailed Solutions

Q1.

Solution

Concept – pH from the hydroxyl-ion concentration: At $25°C$, $pOH = -\log_{10}[OH^-]$ and the pH and pOH are linked by $pH + pOH = 14$.

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

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

Step 3 – apply the logarithm: $\log_{10}(10^{-4}) = -4$, so $pOH = 4$

Step 4 – convert to pH: $pH = 14 - pOH = 14 - 4$

$pH = 10$

Step 5 – interpret: A pH of 10 is greater than 7, so the water is basic, consistent with the high hydroxyl-ion content.

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

Answer: (A) Go Back to Q1

Q2.

Solution

Concept – heavy-metal toxicology, Minamata disease: Certain metals bioaccumulate up the aquatic food chain and cause characteristic named diseases in humans who eat the contaminated fish.

Step 1 – recall the Minamata episode: In Minamata Bay, Japan, an industrial plant discharged mercury, which micro-organisms converted to methylmercury.

Step 2 – trace the pathway: Methylmercury accumulated in fish and shellfish, and people eating them suffered severe damage to the central nervous system.

Step 3 – identify the metal: The disease is therefore the classic case of **mercury** poisoning.

Why the other options are wrong:

- A, lead: causes plumbism (neurological and blood effects), not Minamata disease.
- D, cadmium: causes Itai-itai disease (painful bone softening), a different named illness.
- C, arsenic: causes skin lesions and cancers, again a different syndrome.

Final Answer: mercury (Hg) $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q2

Q3.

Solution

Concept – expressing hardness as $CaCO_3$: The hardness contributed 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 $\frac{24}{2} = 12$

Step 2 – form the conversion factor: factor $= \frac{50}{12}$

Step 3 – multiply the magnesium concentration by the factor: Hardness $= 12 \times \frac{50}{12}$

Step 4 – the 12 cancels: Hardness $= 50$ mg/L as $CaCO_3$

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

Answer: (D) Go Back to Q3

Q4.

Solution

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

Step 1 – write the given pH: pH $= 5$

Step 2 – rearrange the definition: $[H^+] = 10^{-\text{pH}}$

Step 3 – substitute: $[H^+] = 10^{-5}$

Step 4 – state with units: $[H^+] = 1 \times 10^{-5}$ mol/L

Step 5 – sanity check: pH $5 < 7$ means an acidic sample, and indeed $[H^+] = 10^{-5}$ is larger than the neutral 10^{-7}.

Final Answer: $[H^+] = 1 \times 10^{-5}$ mol/L $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept – arsenic in groundwater: Some natural aquifers, especially in the Ganga–Brahmaputra plains, carry dissolved arsenic that produces chronic poisoning in people drinking the water for years.

Step 1 – recall the health effects: Chronic arsenic exposure causes skin pigmentation changes, keratosis, blackfoot disease and cancers of the skin, bladder and lung.

Step 2 – match to the region: These effects have been widely documented in West Bengal (India) and Bangladesh, pointing directly to arsenic.

Why the other options are wrong:

- A, fluoride: causes dental and skeletal fluorosis, not blackfoot disease.
- B, iron: mainly causes taste, colour and staining problems, not cancer.
- D, chloride: affects taste and corrosivity but is not the carcinogen described.

Final Answer: arsenic $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q5

Q6.

Solution

Concept – classifying water-borne diseases by causative agent: Water-borne diseases are grouped by whether the pathogen is a bacterium, a virus or a protozoan.

Step 1 – classify each option: Cholera is caused by the bacterium *Vibrio cholerae*; typhoid by the bacterium *Salmonella typhi*; amoebiasis by the protozoan *Entamoeba histolytica*.

Step 2 – identify the viral disease: Infectious hepatitis (Hepatitis A) is caused by the hepatitis A virus, so it is the viral disease in the list.

Final Answer: infectious hepatitis (Hepatitis A) $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q6

Q7.

Solution

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

Step 1 – list the data: $P = 100$ cm, $ET = 55$ cm, $\Delta S \approx 0$.

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

Step 3 – substitute the values: $R = 100 - 55$

Step 4 – evaluate: $R = 45$ cm

Final Answer: $R = 45$ cm $\Rightarrow \boxed{\text{B}}$

Answer: (B) 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: $C = 0.4$, $i = 45$ mm/hr, $A = 200$ ha.

Step 2 – form the numerator: $C\,i\,A = 0.4 \times 45 \times 200$

Step 3 – multiply step by step: $0.4 \times 45 = 18$

$18 \times 200 = 3600$

Step 4 – divide by 360**:** $Q = \dfrac{3600}{360}$

$Q = 10\ \text{m}^3/\text{s}$

Final Answer: $Q = 10\ \text{m}^3/\text{s} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q8

Q9.

Solution

Concept – specific yield of an aquifer: When an unconfined aquifer drains under gravity, only part of the pore water is released; the total porosity divides into specific yield (drainable) and specific retention (held by capillarity and adsorption), so $S_y = n - S_r$.

Step 1 – list the data: Total porosity $n = 0.35$, specific retention $S_r = 0.10$.

Step 2 – write the relation: $S_y = n - S_r$

Step 3 – substitute the values: $S_y = 0.35 - 0.10$

Step 4 – evaluate: $S_y = 0.25$

Step 5 – interpret: So 25% of the aquifer volume can be drained by gravity, while 10% is retained.

Final Answer: $S_y = 0.25 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q9

Q10.

Solution

Concept – transmissivity of a confined aquifer: Transmissivity is the rate at which water is transmitted through the full saturated thickness under a unit hydraulic gradient, $T = K\,b$.

Step 1 – list the data: $K = 30$ m/day, $b = 15$ m.

Step 2 – write the relation: $T = K\,b$

Step 3 – substitute the values: $T = 30 \times 15$

Step 4 – evaluate: $T = 450$ m^2/day

Final Answer: $T = 450$ m^2/day $\Rightarrow \boxed{\text{B}}$

Answer: (B) 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 $= 30$ m^3/s, rainfall excess $P = 5$ cm.

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

Step 3 – substitute: $Q_{peak} = 5 \times 30$

Step 4 – evaluate: $Q_{peak} = 150$ m^3/s

Final Answer: $Q_{peak} = 150$ m^3/s $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q11

Q12.

Solution

Concept – specific capacity of a well: The specific capacity measures how much discharge a well delivers for each metre of drawdown, $\frac{Q}{s}$.

Step 1 – list the data: Discharge $Q = 1200$ L/min, drawdown $s = 4$ m.

Step 2 – write the definition: Specific capacity $= \frac{Q}{s}$

Step 3 – substitute the values: $\frac{Q}{s} = \frac{1200}{4}$

Step 4 – evaluate: $\frac{Q}{s} = 300$ L/min per m

Final Answer: 300 L/min per m of drawdown $\Rightarrow \boxed{\text{A}}$

Answer: (A) **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**:** $n = \frac{2040 - 2020}{10} = 2$ decades

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

Step 3 – add to the base population: $P = 80000 + 16000$

$P = 96000$

Final Answer: $P = 96{,}000 \Rightarrow \boxed{\text{C}}$

Answer: (C) **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 $=$ 250000.

Step 2 – multiply: Demand $= 150 \times 250000$

Step 3 – evaluate in litres per day: Demand $= 37{,}500{,}000$ L/day

Step 4 – convert to million litres per day: Demand $= \dfrac{37{,}500{,}000}{10^6} = 37.5$ MLD

Final Answer: 37.5 MLD $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q14

Q15.

Solution

Concept – chemical dose to daily mass: The daily mass of a chemical equals its dose (mass per volume) multiplied by the daily flow treated. A handy shortcut is that mg/L $\times$ ML/day = kg/day.

Step 1 – list the data: Optimum alum dose = 30 mg/L (from the jar test), flow = 20 MLD.

Step 2 – write the relation: Mass = dose $\times$ flow

Step 3 – apply the unit shortcut: Mass = 30 mg/L $\times$ 20 ML/day

Step 4 – evaluate using mg/L $\times$ ML = kg: Mass $= 30 \times 20 = 600$ kg/day

Step 5 – verify from first principles: 30 mg/L $\times\ 20 \times 10^6$ L/day $= 600 \times 10^6$ mg/day = 600 kg/day.

Final Answer: 600 kg of alum per day $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q15

Q16.

Solution

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

Step 1 – list the data: $g = 9.81$ m/s^2, $(\rho_s - \rho) = 1600$ kg/m^3, $d = 4 \times 10^{-5}$ m, $\mu = 1.0 \times 10^{-3}$ Pa·s.

Step 2 – square the diameter: $d^2 = (4 \times 10^{-5})^2 = 16 \times 10^{-10} = 1.6 \times 10^{-9}$ m^2

Step 3 – form the numerator: $g(\rho_s - \rho)d^2 = 9.81 \times 1600 \times 1.6 \times 10^{-9}$

$9.81 \times 1600 = 15696$

$15696 \times 1.6 \times 10^{-9} = 2.511 \times 10^{-5}$

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

Step 5 – divide: $v_s = \dfrac{2.511 \times 10^{-5}}{0.018}$

$v_s = 1.395 \times 10^{-3}$ m/s

Step 6 – round: $v_s \approx 1.4 \times 10^{-3}$ m/s

Final Answer: $v_s \approx 1.4 \times 10^{-3}$ m/s $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q16

Q17.

Solution

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

Step 1 – list the data: $V = 450$ m^3, $Q = 300$ m^3/hr.

Step 2 – write the relation: $t_d = \frac{V}{Q}$

Step 3 – substitute the values: $t_d = \frac{450}{300}$

Step 4 – evaluate: $t_d = 1.5$ hr

Final Answer: $t_d = 1.5$ hr $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept – chlorine demand: The 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: Applied dose = 8.0 mg/L, free residual = 1.5 mg/L.

Step 2 – write the relation: Demand = dose − residual

Step 3 – substitute the values: Demand = 8.0 − 1.5

Step 4 – evaluate: Demand = 6.5 mg/L

Final Answer: chlorine demand = 6.5 mg/L $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept – removal efficiency: The efficiency of a unit is the fraction of the pollutant it removes, $\eta = \dfrac{C_{in} - C_{out}}{C_{in}} \times 100\%$.

Step 1 – list the data: Influent BOD $C_{in} = 400$ mg/L, effluent BOD $C_{out} = 100$ mg/L.

Step 2 – find the amount removed: $C_{in} - C_{out} = 400 - 100 = 300$ mg/L

Step 3 – divide by the influent value: $\dfrac{300}{400} = 0.75$

Step 4 – express as a percentage: $\eta = 0.75 \times 100 = 75\%$

Final Answer: $\eta = 75\% \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept – sludge streams in the activated-sludge process: The mixed liquor flows from the aeration tank to the secondary clarifier, where the biological solids settle. Part of this settled sludge is recycled and part is wasted.

Step 1 – identify the recycled stream: The concentrated sludge pumped from the clarifier underflow back to the aeration tank keeps the microbial population high; this is the return activated sludge (RAS).

Step 2 – distinguish it from the wasted stream: The excess sludge removed from the system to control the solids inventory is the waste activated sludge (WAS).

Why the other options are wrong:

- A, WAS: is the portion wasted, not the portion returned.
- B, primary sludge: settles in the primary clarifier ahead of aeration, a different stream.
- D, digested sludge: is the stabilised product from the sludge digester, not the clarifier return.

Final Answer: return activated sludge (RAS) $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q20

Q21.

Solution

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

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: $e^{-kt} = e^{-1.0} = 0.3679$

Step 4 – find the fraction exerted: $1 - e^{-kt} = 1 - 0.3679 = 0.6321$

Step 5 – multiply by the ultimate BOD: $y_5 = 250 \times 0.6321$

$y_5 = 158.0$ mg/L

Step 6 – round: $y_5 \approx 158$ mg/L

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

Answer: (A) Go Back to Q21

Q22.

Solution

Concept – sludge recycle ratio: Writing a solids mass balance around the aeration tank and clarifier, and neglecting the solids leaving in the effluent, the recycle (return) ratio is $R = \dfrac{X}{X_r - X}$, where X is the aeration-tank MLSS and X_r the return-sludge concentration.

Step 1 – list the data: $X = 3000$ mg/L, $X_r = 9000$ mg/L.

Step 2 – compute the denominator: $X_r - X = 9000 - 3000 = 6000$ mg/L

Step 3 – form the ratio: $R = \dfrac{X}{X_r - X} = \dfrac{3000}{6000}$

Step 4 – evaluate: $R = 0.5$

Step 5 – interpret: The plant must return sludge at half the incoming wastewater flow to hold the aeration tank at 3000 mg/L MLSS.

Final Answer: $R = 0.5 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q22

Q23.

Solution

Concept – Sludge Volume Index (SVI): SVI is the volume in millilitres occupied by 1 gram of settled sludge after 30 minutes of settling, $SVI = \dfrac{\text{settled volume (mL/L)} \times 1000}{\text{MLSS (mg/L)}}$.

Step 1 – list the data: Settled sludge volume $= 300$ mL/L, MLSS $= 3000$ mg/L.

Step 2 – form the numerator: $300 \times 1000 = 300000$

Step 3 – divide by the MLSS: $SVI = \dfrac{300000}{3000}$

Step 4 – evaluate: $SVI = 100$ mL/g

Step 5 – interpret: An SVI near 100 mL/g indicates a well-settling sludge with good clarifier performance.

Final Answer: $SVI = 100 \text{ mL/g} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q23

Q24.

Solution

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

Step 1 – list the data: $Q_w = 1$ m^3/s, $C_w = 180$ mg/L, $Q_r = 9$ m^3/s, $C_r = 3$ mg/L.

Step 2 – compute the waste load: $Q_w C_w = 1 \times 180 = 180$

Step 3 – compute the river load: $Q_r C_r = 9 \times 3 = 27$

Step 4 – add the loads: $Q_w C_w + Q_r C_r = 180 + 27 = 207$

Step 5 – add the flows: $Q_w + Q_r = 1 + 9 = 10$ m^3/s

Step 6 – divide: $C_{mix} = \dfrac{207}{10} = 20.7$ mg/L

Final Answer: $C_{mix} = 20.7 \text{ mg/L} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q24

Q25.

Solution

Concept – air-to-cloth ratio of a baghouse: The air-to-cloth ratio (also called filtration velocity or face velocity) is the volumetric gas flow divided by the total fabric filtering area, $V_f = Q/A$.

Step 1 – list the data: $Q = 6000$ m^3/min, $A = 3000$ m^2.

Step 2 – write the relation: $V_f = \frac{Q}{A}$

Step 3 – substitute the values: $V_f = \frac{6000}{3000}$

Step 4 – evaluate: $V_f = 2$ m^3/min per m^2 $= 2$ m/min

Step 5 – interpret: A face velocity of about 2 m/min is typical of a shaker/reverse-air fabric filter; too high a value would drive particles through the cloth and raise the pressure drop.

Final Answer: $V_f = 2$ m/min $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept – collection efficiency: The efficiency of a particulate control device is the fraction of the incoming dust it captures, $\eta = \frac{C_{in} - C_{out}}{C_{in}} \times 100\%$.

Step 1 – list the data: Inlet loading $C_{in} = 12$ g/m^3, outlet loading $C_{out} = 0.24$ g/m^3.

Step 2 – find the amount captured: $C_{in} - C_{out} = 12 - 0.24 = 11.76$ g/m^3

Step 3 – divide by the inlet loading: $\frac{11.76}{12} = 0.98$

Step 4 – express as a percentage: $\eta = 0.98 \times 100 = 98\%$

Final Answer: $\eta = 98\% \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q26

Q27.

Solution

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

Step 1 – list the data: $Q = 100$ g/s, $u = 5$ m/s, $\sigma_y = 25$ m, $\sigma_z = 10$ m.

Step 2 – form the denominator factors: $\sigma_y\,\sigma_z = 25 \times 10 = 250$

$\sigma_y\,\sigma_z\,u = 250 \times 5 = 1250$

Step 3 – include π: $\pi \times 1250 = 3926.99$

Step 4 – divide: $C = \dfrac{100}{3926.99}$

$C = 0.02546\ \text{g/m}^3$

Step 5 – convert to mg/m^3: $C = 0.02546 \times 1000 = 25.46\ \text{mg/m}^3$

Step 6 – round: $C \approx 25.5\ \text{mg/m}^3$

Final Answer: $C \approx 25.5\ \text{mg/m}^3 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q27

Q28.

Solution

Concept – effective stack height: The effective stack height is the physical stack height plus the plume rise, $H = h + \Delta h$.

Step 1 – list the data: Physical stack height $h = 45$ m, plume rise $\Delta h = 25$ m.

Step 2 – write the relation: $H = h + \Delta h$

Step 3 – substitute the values: $H = 45 + 25$

Step 4 – evaluate: $H = 70$ m

Step 5 – interpret: Dispersion calculations use $H = 70$ m as the release height, giving lower ground-level concentrations than the physical 45 m alone.

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

Answer: (D) Go Back to Q28

Q29.

Solution

Concept – atmospheric stability and plume shape: Comparing the environmental lapse rate with the dry adiabatic lapse rate classifies the atmosphere and fixes the plume behaviour.

Step 1 – interpret the given condition: When the environmental lapse rate is much greater than the dry adiabatic rate (superadiabatic), a displaced parcel keeps accelerating, so the atmosphere is strongly unstable.

Step 2 – match to the plume shape: Strong vertical eddies whip the plume up and down, producing the wavy "looping" plume.

Why the other options are wrong:

- A, stable/fanning: occurs under an inversion where vertical motion is suppressed.
- C, neutral/coning: occurs when the two lapse rates are about equal.
- D, inversion/fumigation: is a special transient case, not the strongly unstable condition described.

Final Answer: unstable atmosphere, looping plume $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q29

Q30.

Solution

Concept – converting ppm by volume to mass concentration: At 25°C and 1 atm, $\mu g/m^3 = \text{ppm} \times \dfrac{M}{24.45} \times 1000$, where M is the molecular mass and 24.45 L the molar volume.

Step 1 – list the data: Concentration $= 0.05$ ppm, $M = 46$ (for NO_2), molar volume $= 24.45$ L.

Step 2 – form the mass ratio: $\dfrac{M}{24.45} = \dfrac{46}{24.45} = 1.8814$

Step 3 – multiply by the ppm value: $0.05 \times 1.8814 = 0.09407$

Step 4 – multiply by 1000: $0.09407 \times 1000 = 94.07\ \mu g/m^3$

Step 5 – round: $\approx 94\ \mu g/m^3$

Final Answer: $\approx 94\ \mu g/m^3 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q30

Q31.

Solution

Concept – addition of equal sound sources: Sound levels add on an energy basis, $L = 10\log_{10}(\sum 10^{L_i/10})$. For n equal sources of level L_1, this simplifies to $L = L_1 + 10\log_{10} n$.

Step 1 – list the data: Three sources, each $L_1 = 65$ dB, so $n = 3$.

Step 2 – write the simplified relation: $L = L_1 + 10\log_{10} n$

Step 3 – evaluate the logarithm: $\log_{10} 3 = 0.477$, so $10\log_{10} 3 = 4.77$

Step 4 – add to the single-source level: $L = 65 + 4.77$

$L = 69.77$ dB

Step 5 – round: $L \approx 70$ dB

Why option B is wrong: Levels in decibels are logarithmic and must never be added arithmetically; $65 + 65 + 65 = 195$ dB is physically meaningless.

Final Answer: $L \approx 70$ dB $\Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q31**

Q32.

Solution

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

Step 1 – list the data: 90... correction: level $= 85$ dB at $r_1 = 5$ m; required at $r_2 = 20$ m.

Step 2 – count the doublings: From 5 m to 10 m is one doubling, and 10 m to 20 m is a second doubling, so there are 2 doublings.

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

Step 4 – subtract from the near level: $L_2 = 85 - 12$

$L_2 = 73$ dB

Step 5 – cross-check with the formula: $L_2 = L_1 - 20\log_{10}\left(\frac{r_2}{r_1}\right) = 85 - 20\log_{10}(4) = 85 - 20(0.602) = 85 - 12.04 \approx 73$ dB.

Final Answer: $L_2 = 73$ dB $\Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q32**

Q33.

Solution

Concept – how a noise barrier works: A solid barrier interrupts the direct line of sight so the sound must diffract over its top. The extra distance the diffracted ray travels compared with the straight path is the path-length difference δ.

Step 1 – relate δ to the Fresnel number: The Fresnel number is $N = \frac{2\delta}{\lambda}$; the barrier's insertion loss grows with N.

Step 2 – see the effect of increasing δ: A larger δ (achieved by a taller barrier, or by placing the barrier closer to the source or receiver) raises N and therefore raises the insertion loss.

Step 3 – state the trend: Hence the barrier performs better as the path-length difference δ increases.

Why the other options are wrong:

- A and B: a smaller or unchanged δ would not improve attenuation.
- D: δ is a geometric extra length and cannot be negative when the barrier truly blocks the line of sight.

Final Answer: performance improves as δ increases $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q33

Q34.

Solution

Concept – statistical noise descriptors: For a fluctuating noise, the index L_n is the level exceeded for $n\%$ of the measurement period.

Step 1 – interpret the required index: The level exceeded for only 10% of the time is L_{10}; because it is exceeded only briefly, it represents the higher, intrusive noise peaks.

Step 2 – contrast with the others: L_{90} (exceeded 90% of the time) is taken as the background level, L_{50} is the median, and L_{eq} is the equivalent continuous energy-average level.

Final Answer: L_{10}, exceeded 10% of the time $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q34

Q35.

Solution

Concept – total MSW generation: Total daily waste equals per-capita generation rate times population.

Step 1 – list the data: Population $= 400000$, rate $= 0.6$ kg/person/day.

Step 2 – multiply: Waste $= 0.6 \times 400000$

Step 3 – evaluate in kilograms: Waste $= 240000$ kg/day

Step 4 – convert to tonnes (1 tonne $=$ 1000 kg): Waste $= \dfrac{240000}{1000} = 240$ tonnes/day

Final Answer: 240 tonnes/day $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q35

Q36.

Solution

Concept – landfill airspace from mass and density: Volume equals mass divided by in-place (compacted) density; over a year multiply the daily volume by 365.

Step 1 – list the data: Mass $= 150$ tonnes/day $= 150000$ kg/day, density $= 600$ kg/m^3, period $= 365$ days.

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

Step 3 – multiply by the number of days: $V_{year} = 250 \times 365$

Step 4 – evaluate: $V_{year} = 91250$ m^3

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

Answer: (D) Go Back to Q36

Q37.

Solution

Concept – fraction of a waste stream: The mass of any component equals its percentage share multiplied by the total mass.

Step 1 – list the data: Organic (compostable) fraction $= 55\%$, total MSW $= 200$ tonnes/day.

Step 2 – convert the percentage to a fraction: $55\% = 0.55$

Step 3 – multiply by the total: Organic mass $= 0.55 \times 200$

Step 4 – evaluate: Organic mass $= 110$ tonnes/day

Step 5 – interpret: This 110 tonnes/day of organic matter is the feedstock available for composting or biomethanation.

Final Answer: 110 tonnes/day $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q37

Q38.

Solution

Concept – vermicomposting: Vermicomposting is the aerobic conversion of biodegradable organic waste into a stable, humus-like product through the combined action of earthworms and micro-organisms.

Step 1 – identify the key organism: Earthworms, most commonly *Eisenia fetida* (the red wiggler), ingest the organic matter and excrete nutrient-rich vermicasts.

Step 2 – note the product: The castings are rich in plant-available nitrogen, phosphorus and potassium, making a valuable soil conditioner.

Why the other options are wrong:

- A, fungi and D, bacteria: assist decomposition but are not what defines vermicomposting.
- B, algae: are photosynthetic organisms not used to digest solid waste.

Final Answer: earthworms (*Eisenia fetida*) $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q38

Q39.

Solution

Concept – moisture control in composting: Aerobic composting micro-organisms need enough water to stay active but not so much that the pile becomes waterlogged and turns anaerobic.

Step 1 – recall the optimum range: The recommended moisture content of the composting mass is about 50–60%.

Step 2 – match to the option: Of the choices given, 55% lies squarely in this optimum band.

Why the other options are wrong:

- A, 10% and C, 30%: are too dry, slowing microbial activity.
- B, 90%: is far too wet, filling the pore spaces, excluding oxygen and creating anaerobic, odorous conditions.

Final Answer: about 55% moisture $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q39

Q40.

Solution

Concept – mass balance across composting: By conservation of mass, the finished compost equals the initial feed minus everything that leaves the pile as water vapour and gases.

Step 1 – list the data: Initial feed $= 100$ kg, water lost $= 20$ kg, CO_2 and volatiles lost $= 10$ kg.

Step 2 – add the losses: Total loss $= 20 + 10 = 30$ kg

Step 3 – subtract from the feed: Compost $= 100 - 30$

Step 4 – evaluate: Compost $= 70$ kg

Final Answer: 70 kg of finished compost $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q40

Q41.

Solution

Concept – components of the EIA process: An EIA study predicts the environmental effects of a project; the plan that turns its recommendations into concrete actions is a distinct document.

Step 1 – identify the required document: The Environmental Management Plan (EMP) lists the mitigation measures, safeguards, responsibilities and the monitoring schedule to be followed during construction and operation.

Step 2 – distinguish it from the study itself: The EIA report predicts and evaluates impacts, whereas the EMP is the implementation-and-monitoring blueprint drawn from those findings.

Why the other options are wrong:

- B, EIA report: assesses impacts but does not itself lay out the operational monitoring plan.

- C, DPR: is an engineering and financial project document, not an environmental safeguard plan.
- D, LCA: evaluates cradle-to-grave environmental loads of a product, a different tool.

Final Answer: Environmental Management Plan (EMP) $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q41

Q42.

Solution

Concept – protective role of the ozone layer: Stratospheric ozone absorbs the biologically damaging short-wavelength part of sunlight before it reaches the surface.

Step 1 – identify the radiation absorbed: Ozone strongly absorbs ultraviolet radiation, particularly the UV-B band (280–315 nm).

Step 2 – note why it matters: Screening out UV-B protects living tissue from sunburn, skin cancer, cataracts and damage to crops and phytoplankton.

Why the other options are wrong:

- A, infrared: is chiefly absorbed by greenhouse gases such as CO_2 and water vapour, not ozone.
- B, visible light: passes largely unabsorbed to the surface.
- C, microwaves: are unrelated to the ozone layer's screening function.

Final Answer: ultraviolet (UV-B) radiation $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q42

Q43.

Solution

Concept – CO_2 emission from an emission factor: The daily emission equals the emission factor (mass of CO_2 per unit fuel) times the amount of fuel burned per day.

Step 1 – list the data: Coal burned $= 400$ tonnes/day, emission factor $= 2.5$ tonnes CO_2 per tonne of coal.

Step 2 – multiply: $CO_2 = 2.5 \times 400$

Step 3 – evaluate: $CO_2 = 1000$ tonnes/day

Step 4 – interpret: The plant releases about 1000 tonnes of carbon dioxide each day, a figure used in its carbon-footprint accounting.

Final Answer: 1000 tonnes/day $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q43

Q44.

Solution

Concept – the "3R" waste hierarchy: Sustainable waste management ranks options as Reduce, then Reuse/Recycle, then Recover, then Dispose, in decreasing order of preference.

Step 1 – recall the top of the hierarchy: Preventing waste from being generated at all, that is, reducing at source, saves the most material and energy and is placed first.

Step 2 – rank the remaining options: Recycling and energy recovery come lower because they still process waste that already exists, and landfill disposal is the least preferred.

Why the other options are wrong:

- A, recycle and B, recover: are useful but rank below source reduction.
- D, landfill disposal: is the last resort, not the priority.

Final Answer: reduce waste at source $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q44

Q45.

Solution

Concept – the Kigali Amendment to the Montreal Protocol: The Montreal Protocol first phased out ozone-depleting CFCs and HCFCs. Their common replacements, though harmless to ozone, turned out to be strong greenhouse gases, so a further amendment was needed.

Step 1 – identify the replacement gases: Hydrofluorocarbons (HFCs) replaced CFCs/HCFCs in refrigeration and air-conditioning; they have zero ozone-depletion potential but very high global-warming potential.

Step 2 – link to the Kigali Amendment: The 2016 Kigali Amendment brought

HFCs under the Protocol's control, mandating a global phase-down to protect the climate.

Why the other options are wrong:

- A, CO_2 and C, methane: are addressed by the Paris Agreement and Kyoto Protocol, not the Montreal Protocol.
- D, SO_2: is an acid-rain pollutant unrelated to this treaty.

Final Answer: hydrofluorocarbons (HFCs) $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q45

Q46.

Solution

Concept – catalytic ozone destruction by CFCs: CFCs are stable at the surface but, on reaching the stratosphere, are broken apart by ultraviolet light, releasing reactive halogen atoms.

Step 1 – identify the released species: Ultraviolet photolysis of a CFC frees a chlorine atom (a chlorine free radical, $Cl\cdot$).

Step 2 – describe the catalytic cycle: Chlorine reacts with ozone, $Cl + O_3 \rightarrow ClO + O_2$, and is then regenerated, $ClO + O \rightarrow Cl + O_2$, so a single chlorine atom can destroy many thousands of ozone molecules.

Why the other options are wrong:

- A, carbon and C, fluorine: from the CFC are not the active ozone-destroying catalyst.
- D, hydrogen: is not the species released from a chlorofluorocarbon.

Final Answer: chlorine free radical ($Cl\cdot$) $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q46

Answer Key

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