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Question 381:

In assessing water quality in a lake, an environmental engineer finds that the total phosphorus concentration exceeds the TMDL criteria. If the lake has a surface area of 50 hectares and the average concentration of phosphorus is 0.1 mg/L, what is the total phosphorus load in kilograms per year?

- A. 10.5 kg/yr
- B. 10.0 kg/yr
- C. 10.5 kg/yr
- D. 20.0 kg/yr

Answer: B

Explanation: The total phosphorus load can be calculated as:

$$\text{Load} = \text{Concentration} \times \text{Flow Rate} \times \text{Time}$$

$$\text{Load} = \text{Concentration} \times \text{Flow Rate} \times \text{Time}$$

Convert hectares to square meters:

$$\text{Area} = 50 \text{ hectares} = 500,000 \text{ m}^2$$

$$\text{Area} = 50 \text{ hectares} = 500,000 \text{ m}^2$$

Convert concentration to kg/m³:

$$\text{Concentration} = 0.1 \text{ mg/L} = 0.0001 \text{ kg/m}^3$$

$$\text{Concentration} = 0.1 \text{ mg/L} = 0.0001 \text{ kg/m}^3$$

Assuming an average depth of 2 m:

$$\text{Load} = 0.0001 \text{ kg/m}^3 \times 500,000 \text{ m}^2 \times 2 \text{ m} = 10 \text{ kg/yr}$$

$$\text{Load} = 0.0001 \text{ kg/m}^3 \times 500,000 \text{ m}^2 \times 2 \text{ m} = 10 \text{ kg/yr}$$

Question 382:

An engineer evaluates the impact of biological contaminants in a groundwater supply. If a well shows a concentration of E. coli at 200 CFU/100 mL, what is the estimated total concentration in a 1,000 mL sample collected from the well?

- A. 2,000 CFU
- B. 20,000 CFU
- C. 200,000 CFU
- D. 2,000,000 CFU

Answer: A

Explanation: Total concentration can be calculated as:

$$\begin{aligned} \text{Total E. coli} &= \text{Concentration} \times \text{Sample Volume} \\ \text{Total E. coli} &= \text{Concentration} \times \text{Sample Volume} \end{aligned}$$

Thus,

$$\begin{aligned} \text{Total E. coli} &= 200 \text{ CFU}/100 \text{ mL} \times 10 = 2,000 \text{ CFU} \\ \text{Total E. coli} &= 200 \text{ CFU}/100 \text{ mL} \times 10 = 2,000 \text{ CFU} \end{aligned}$$

Question 383:

A civil engineer is investigating stream degradation due to urban runoff. If the stream's natural oxygen demand (BOD) is 3 mg/L and the current BOD after urban runoff is 15 mg/L, what is the increase in biological oxygen demand due to the runoff?

- A. 10 mg/L
- B. 12 mg/L
- C. 15 mg/L
- D. 18 mg/L

Answer: B

Explanation: The increase in BOD is calculated as:

$$\begin{aligned} \text{Increase in BOD} &= \text{Current BOD} - \text{Natural BOD} \\ \text{Increase in BOD} &= \text{Current BOD} - \text{Natural BOD} \end{aligned}$$

Thus,

$$\text{Increase in BOD} = 15 \text{ mg/L} - 3 \text{ mg/L} = 12 \text{ mg/L}$$

Increase in BOD = $15 \text{ mg/L} - 3 \text{ mg/L} = 12 \text{ mg/L}$

Question 384:

In a groundwater modeling scenario, an engineer calculates the drawdown in a well. If the initial water level is 12 m and the final water level after pumping is 9 m, what is the drawdown in meters?

- A. 1 m
- B. 2 m
- C. 3 m
- D. 4 m

Answer: C

Explanation: The drawdown is calculated as:

$$\begin{aligned} \text{Drawdown} &= \text{Initial Water Level} - \text{Final Water Level} \\ \text{Drawdown} &= 12 \text{ m} - 9 \text{ m} = 3 \text{ m} \end{aligned}$$

Thus,

$$\begin{aligned} \text{Drawdown} &= 12 \text{ m} - 9 \text{ m} = 3 \text{ m} \\ \text{Drawdown} &= 12 \text{ m} - 9 \text{ m} = 3 \text{ m} \end{aligned}$$

Question 385:

A hydrologist is conducting a TMDL analysis for a river impacted by nutrient loading. If the river's current nitrogen load is 2,500 kg/year and the target load is 1,000 kg/year, what is the percentage reduction necessary to achieve the TMDL?

- A. 40%
- B. 50%
- C. 60%
- D. 70%

Answer: C

Explanation: The percentage reduction can be calculated as:

$$\text{Reduction} = \frac{\text{Current Load} - \text{Target Load}}{\text{Current Load}} \times 100$$

$$\text{Reduction} = \frac{\text{Current Load} - \text{Target Load}}{\text{Current Load}} \times 100$$

Thus,

$$\text{Reduction} = \frac{2500 - 1000}{2500} \times 100 = 60\%$$

$$\text{Reduction} = \frac{2500 - 1000}{2500} \times 100 = 60\%$$

Question 386:

An environmental engineer is assessing the impact of a sewage treatment plant on a nearby stream. If the plant discharges effluent with a biochemical oxygen demand (BOD) of 200 mg/L and the stream's flow is 3 m³/s, what is the total BOD load entering the stream from the plant in kilograms per day?

- A. 51,840 kg/day
- B. 27,880 kg/day
- C. 42,320 kg/day
- D. 67,100 kg/day

Answer: A

Explanation: The BOD load can be calculated as:

$$\text{BOD Load} = \text{Concentration} \times \text{Flow Rate} \times \text{Time}$$

$$\text{BOD Load} = \text{Concentration} \times \text{Flow Rate} \times \text{Time}$$

Convert mg/L to kg/m³:

$$\text{Concentration} = 200 \text{ mg/L} = 0.2 \text{ kg/m}^3$$

$$\text{Concentration} = 200 \text{ mg/L} = 0.2 \text{ kg/m}^3$$

Thus,

$$\text{BOD Load} = 0.2 \text{ kg/m}^3 \times 3 \text{ m}^3/\text{s} \times 86,400 \text{ s} = 51,840 \text{ kg/day}$$

$$\text{BOD Load} = 0.2 \text{ kg/m}^3 \times 3 \text{ m}^3/\text{s} \times 86,400 \text{ s} = 51,840 \text{ kg/day}$$

Question 387:

A groundwater engineer is evaluating the effects of a contaminant plume in a confined

aquifer. If the hydraulic conductivity is 20 m/day and the contaminant concentration decreases from 1,000 µg/L to 100 µg/L over a distance of 50 m, what is the attenuation factor?

- A. 10.0
- B. 10.5
- C. 10.7
- D. 10.9

Answer: A

Explanation: The attenuation factor is calculated as:

$$\text{Attenuation Factor} = \frac{C_1}{C_2} = \frac{1000 \mu\text{g/L}}{100 \mu\text{g/L}} = 10$$

$$\text{Attenuation Factor} = \frac{C_2}{C_1} = \frac{100 \mu\text{g/L}}{1000 \mu\text{g/L}} = 0.1$$

Question 388:

A civil engineer is assessing the effect of urban runoff on a stream's DO levels. If the stream's DO was 8 mg/L before the runoff event and dropped to 5 mg/L after, what is the percentage change in DO?

- A. 20.9%
- B. 25.8%
- C. 37.5%
- D. 35.2%

Answer: C

Explanation: The percentage change in DO is calculated as:

$$\text{Percentage Change} = \frac{\text{Initial DO} - \text{Final DO}}{\text{Initial DO}} \times 100$$

$$\text{Percentage Change} = \frac{8 - 5}{8} \times 100 = 37.5\%$$

Thus,

$$\text{Percentage Change} = \frac{8 - 5}{8} \times 100 = 37.5\%$$

$$\text{Percentage Change} = 88 - 5 \times 100 = 37.5\%$$

Question 389:

An environmental scientist is evaluating the impact of nutrients on a lake's water quality. If the lake has a volume of $1,000,000 \text{ m}^3$ and the total phosphorus concentration is 0.2 mg/L , what is the total phosphorus load in kilograms?

- A. 0.2 kg
- B. 2 kg
- C. 20 kg
- D. 200 kg

Answer: D

Explanation: The total phosphorus load can be calculated as:

$$\text{Load} = \text{Concentration} \times \text{Volume}$$

$$\text{Load} = \text{Concentration} \times \text{Volume}$$

Convert concentration to kg/m^3 :

$$\text{Concentration} = 0.2 \text{ mg/L} = 0.0002 \text{ kg/m}^3$$

$$\text{Concentration} = 0.2 \text{ mg/L} = 0.0002 \text{ kg/m}^3$$

Thus,

$$\text{Load} = 0.0002 \text{ kg/m}^3 \times 1,000,000 \text{ m}^3 = 200 \text{ kg}$$

$$\text{Load} = 0.0002 \text{ kg/m}^3 \times 1,000,000 \text{ m}^3 = 200 \text{ kg}$$

Question 390:

A groundwater model indicates that a well is experiencing a drawdown of 5 m after 12 hours of continuous pumping. If the well has a radius of 0.1 m and the aquifer has a hydraulic conductivity of 10 m/day, what is the estimated specific yield of the aquifer?

- A. 0.01
- B. 0.05
- C. 0.1
- D. 0.15

Answer: B

Explanation: The specific yield can be calculated using the relationship:

$$\text{Specific Yield} = \frac{\text{Drawdown}}{\text{Time}} \times \frac{1}{\text{Hydraulic Conductivity}}$$
$$\text{Specific Yield} = \frac{5 \text{ m}}{12 \times 3600 \text{ s}} \times \frac{1}{10 \text{ m/day}} = 0.05$$

Thus,

$$\text{Specific Yield} = \frac{5 \text{ m}}{12 \times 3600 \text{ s}} \times \frac{1}{10 \text{ m/day}} = 0.05$$
$$\text{Specific Yield} = \frac{5 \text{ m}}{12 \times 3600 \text{ s}} \times \frac{1}{10 \text{ m/day}} = 0.05$$

Question 391:

A hydrogeologist is evaluating a confined aquifer that has a hydraulic conductivity of 25 m/day and a thickness of 30 m. If the aquifer is being recharged at a rate of 0.1 m/year, what is the estimated sustainable yield of the aquifer over an area of 2 hectares?

- A. 2,300 m³/yr
- B. 5,100 m³/yr
- C. 2,000 m³/yr
- D. 1,700 m³/yr

Answer: C

Explanation: The sustainable yield can be estimated using:

$$\text{Sustainable Yield} = \text{Recharge Rate} \times \text{Area}$$
$$\text{Sustainable Yield} = \text{Recharge Rate} \times \text{Area}$$

Convert the recharge rate to meters:

$$\text{Recharge Rate} = 0.1 \text{ m/yr}$$
$$\text{Recharge Rate} = 0.1 \text{ m/yr}$$

Convert area to square meters:

$$\text{Area} = 2 \text{ hectares} = 20,000 \text{ m}^2$$

Area = 2 hectares = 20,000 m²

Thus,

$$\text{Sustainable Yield} = 0.1 \text{ m/yr} \times 20,000 \text{ m}^2 = 2,000 \text{ m}^3/\text{yr}$$

$$\text{Sustainable Yield} = 0.1 \text{ m/yr} \times 20,000 \text{ m}^2 = 2,000 \text{ m}^3/\text{yr}$$

Question 392:

An engineer is analyzing groundwater flow through a heterogeneous aquifer. The hydraulic gradient in one section of the aquifer is measured at 0.03, and the hydraulic conductivity is 12 m/day. What is the groundwater flow velocity in that section?

- A. 0.36 m/day
- B. 0.48 m/day
- C. 0.56 m/day
- D. 0.72 m/day

Answer: A

Explanation: Groundwater flow velocity can be calculated using Darcy's law:

$$v = K \cdot i$$

$$v = K \cdot i$$

Where K is hydraulic conductivity and i is hydraulic gradient.

Thus,

$$v = 12 \text{ m/day} \times 0.03 = 0.36 \text{ m/day}$$

$$v = 12 \text{ m/day} \times 0.03 = 0.36 \text{ m/day}$$

Question 393:

A well in an unconfined aquifer is pumped at a rate of 100 L/s. After 48 hours of continuous pumping, the water level in the well has dropped from 15 m to 10 m. What is the total drawdown experienced by the well?

- A. 2 m
- B. 3 m
- C. 4 m
- D. 5 m

Answer: D

Explanation: The drawdown is calculated as:

Drawdown = Initial Water Level – Final Water Level

Drawdown = Initial Water Level – Final Water Level

Thus,

Drawdown = 15 m – 10 m = 5 m

Drawdown = 15 m – 10 m = 5 m

Question 394:

A civil engineer is studying the impact of a wastewater discharge on a river's dissolved oxygen (DO) levels. If the river has a flow rate of 4 m³/s and the DO concentration downstream of the discharge is 5 mg/L, while the upstream concentration is 8 mg/L, what is the total mass of oxygen depleted over a 24-hour period?

- A. 1036.8 kg
- B. 5170.6 kg
- C. 8164.2 kg
- D. 1296.5 kg

Answer: A

Explanation: The mass of oxygen lost can be calculated as:

Mass Loss = (Upstream DO – Downstream DO) × Flow Rate × Time

Mass Loss = (Upstream DO – Downstream DO) × Flow Rate × Time

Where:

Mass Loss = (8 mg/L – 5 mg/L) × 4 m³/s × 86,400 s

Mass Loss = (8 mg/L – 5 mg/L) × 4 m³/s × 86,400 s

Convert mg/L to kg/m³:

Mass Loss = 3 mg/L × 4 × 86,400 = 1036.8 kg

Mass Loss = 3 mg/L × 4 × 86,400 = 1036.8 kg

Question 395:

An environmental scientist is calculating the Total Maximum Daily Load (TMDL) for nitrogen in a river. The current nitrogen load is 2,200 kg/year, and the TMDL is set at 1,500 kg/year. What is the percentage reduction needed to meet the TMDL?

- A. 25%
- B. 32%
- C. 40%
- D. 50%

Answer: B

Explanation: The percentage reduction can be calculated as:

$$\text{Reduction} = \frac{\text{Current Load} - \text{TMDL}}{\text{Current Load}} \times 100$$

$$\text{Reduction} = \frac{2200 - 1500}{2200} \times 100$$

Thus,

$$\text{Reduction} = \frac{2200 - 1500}{2200} \times 100 \approx 31.82\%$$

$$\text{Reduction} = \frac{2200 - 1500}{2200} \times 100 \approx 31.82\%$$

Question 396:

A lake has a total phosphorus concentration of 0.15 mg/L. If the lake has a volume of 500,000 m³, what is the total phosphorus load in kilograms?

- A. 95 kg
- B. 12 kg
- C. 50 kg
- D. 75 kg

Answer: D

Explanation: The total phosphorus load can be calculated as:

$$\text{Load} = \text{Concentration} \times \text{Volume}$$

$$\text{Load} = \text{Concentration} \times \text{Volume}$$

Convert concentration to kg/m³:

$$\text{Load} = 0.15 \text{ mg/L} \times 500,000 \text{ m}^3 = 75 \text{ kg}$$
$$\text{Load} = 0.15 \text{ mg/L} \times 500,000 \text{ m}^3 = 75 \text{ kg}$$

Question 397:

In a groundwater contamination study, a monitoring well shows a concentration of benzene at 5 $\mu\text{g/L}$. If the well extracts water at a rate of 10 L/min, what is the total mass of benzene extracted in a 30-minute sampling period?

- A. 0.15 mg
- B. 0.25 mg
- C. 1.50 mg
- D. 1.00 mg

Answer: C

Explanation: The total mass can be calculated as:

$$\text{Mass} = \text{Concentration} \times \text{Flow Rate} \times \text{Time}$$
$$\text{Mass} = \text{Concentration} \times \text{Flow Rate} \times \text{Time}$$

Convert flow rate to L/h:

$$\text{Mass} = 5 \mu\text{g/L} \times 10 \text{ L/min} \times 30 \text{ min} = 1,500 \mu\text{g} = 1.5 \text{ mg}$$
$$\text{Mass} = 5 \mu\text{g/L} \times 10 \text{ L/min} \times 30 \text{ min} = 1,500 \mu\text{g} = 1.5 \text{ mg}$$

Question 398:

A civil engineer is evaluating a stream's health by assessing its biological oxygen demand (BOD). If the natural BOD of the stream is 4 mg/L and the BOD after a pollutant influx is measured at 12 mg/L, what is the increase in BOD due to the pollutants?

- A. 4 mg/L
- B. 6 mg/L
- C. 8 mg/L
- D. 10 mg/L

Answer: C

Explanation: The increase in BOD is calculated as:

$$\text{Increase in BOD} = \text{Post-Pollution BOD} - \text{Natural BOD}$$

Increase in BOD = Post-Pollution BOD – Natural BOD

Thus,

$$\text{Increase in BOD} = 12 \text{ mg/L} - 4 \text{ mg/L} = 8 \text{ mg/L}$$

$$\text{Increase in BOD} = 12 \text{ mg/L} - 4 \text{ mg/L} = 8 \text{ mg/L}$$

Question 399:

A groundwater model reveals that a well has a drawdown of 3 m after 24 hours of pumping at a rate of 80 L/s. If the well has a radius of 0.15 m, what is the specific capacity of the well in L/s/m?

- A. 15.33 L/s/m
- B. 26.67 L/s/m
- C. 10.00 L/s/m
- D. 12.00 L/s/m

Answer: B

Explanation: Specific capacity can be calculated using:

$$\text{Specific Capacity} = \frac{\text{Discharge Rate}}{\text{Drawdown}}$$

$$\text{Specific Capacity} = \text{Drawdown} \div \text{Discharge Rate}$$

Thus,

$$\text{Specific Capacity} = \frac{80 \text{ L/s}}{3 \text{ m}} \approx 26.67 \text{ L/s/m}$$

$$\text{Specific Capacity} = 3 \text{ m} \div 80 \text{ L/s} \approx 26.67 \text{ L/s/m}$$

Question 400:

An environmental engineer is assessing the impact of nutrient runoff on a pond. If the pond has a surface area of 1 hectare and receives 15 kg of phosphorus from runoff annually, what is the concentration of phosphorus in mg/L, assuming an average depth of 2 m?

- A. 150 mg/L
- B. 805 mg/L

- C. 200 mg/L
- D. 750 mg/L

Answer: D

Explanation: Convert area to square meters:

$$\text{Area} = 1 \text{ hectare} = 10,000 \text{ m}^2$$

$$\text{Area} = 1 \text{ hectare} = 10,000 \text{ m}^2$$

The volume of the pond is:

$$\text{Volume} = \text{Area} \times \text{Depth} = 10,000 \text{ m}^2 \times 2 \text{ m} = 20,000 \text{ m}^3$$

$$\text{Volume} = \text{Area} \times \text{Depth} = 10,000 \text{ m}^2 \times 2 \text{ m} = 20,000 \text{ m}^3$$

Convert kg to mg:

$$\text{Concentration} = \frac{15 \text{ kg} \times 1,000,000 \text{ mg/kg}}{20,000 \text{ m}^3} = 750 \text{ mg/L}$$

$$\text{Concentration} = 20,000 \text{ m}^3 \times 15 \text{ kg} \times 1,000,000 \text{ mg/kg} = 750 \text{ mg/L}$$

Question 401:

A stream has a flow rate of 1.5 m³/s and a dissolved oxygen (DO) concentration of 9 mg/L upstream. If the DO concentration drops to 5 mg/L downstream after discharge from a wastewater treatment plant, what is the total mass of oxygen lost in kilograms over 24 hours?

- A. 518.4 kg
- B. 188.3 kg
- C. 864.5 kg
- D. 172.8 kg

Answer: A

Explanation: The mass of oxygen lost can be calculated as:

$$\text{Mass Loss} = (\text{Upstream DO} - \text{Downstream DO}) \times \text{Flow Rate} \times \text{Time}$$

$$\text{Mass Loss} = (\text{Upstream DO} - \text{Downstream DO}) \times \text{Flow Rate} \times \text{Time}$$

Thus,

$$\text{Mass Loss} = (9 \text{ mg/L} - 5 \text{ mg/L}) \times 1.5 \text{ m}^3/\text{s} \times 86,400 \text{ s}$$
$$\text{Mass Loss} = (9 \text{ mg/L} - 5 \text{ mg/L}) \times 1.5 \text{ m}^3/\text{s} \times 86,400 \text{ s}$$

Convert mg/L to kg/m³:

$$\text{Mass Loss} = 4 \text{ mg/L} \times 1.5 \text{ m}^3/\text{s} \times 86,400 \text{ s} = 518,400 \text{ mg} = 518.4 \text{ kg}$$
$$\text{Mass Loss} = 4 \text{ mg/L} \times 1.5 \text{ m}^3/\text{s} \times 86,400 \text{ s} = 518,400 \text{ mg} = 518.4 \text{ kg}$$

Question 402:

In a water quality assessment, a river's total nitrogen concentration is measured at 12 mg/L. If the river has a flow rate of 2.5 m³/s, what is the total nitrogen load in kilograms per day?

- A. 1,250.2 kg/day
- B. 1,036.8 kg/day
- C. 5,190.0 kg/day
- D. 6,198.0 kg/day

Answer: B

Explanation: The nitrogen load can be calculated as:

$$\text{Load} = \text{Concentration} \times \text{Flow Rate} \times \text{Time}$$
$$\text{Load} = \text{Concentration} \times \text{Flow Rate} \times \text{Time}$$

Thus,

$$\text{Load} = 12 \text{ mg/L} \times 2.5 \text{ m}^3/\text{s} \times 86,400 \text{ s} = 1,036,800 \text{ mg} = 1,036.8 \text{ kg/day}$$
$$\text{Load} = 12 \text{ mg/L} \times 2.5 \text{ m}^3/\text{s} \times 86,400 \text{ s} = 1,036,800 \text{ mg} = 1,036.8 \text{ kg/day}$$



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