NCEES
PE-Civil-WRE
1227 PE Civil Water Resources and Environmental

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Question: 1

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 m^3/s, what is the total BOD load entering the stream from the plant in kilograms per day?

A. 51,840 kg/day
B. 21,880 kg/day
C. 45,320 kg/day
D. 65,000 kg/day

Answer: A

Explanation:
The BOD load can be calculated as:

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

Convert mg/L to kg/m^3:

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

Thus,

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

Question: 2

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. 0.1
B. 0.5
C. 0.7
D. 10.0

Answer: D

Explanation:
The attenuation factor is calculated as:

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

Question: 3

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%
B. 25%
C. 37%
D. 35%

Answer: C

Explanation:
The percentage change in DO is calculated as:

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

Thus,

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

Question: 4

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 m³ 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:

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

Convert concentration to kg/m³:

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

Thus,

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

Question: 5

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:

$$\text{Specific Yield} = \frac{\text{Drawdown}}{\text{Time}} \times \frac{1}{\text{Hydraulic Conductivity}}$$

Thus,

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

Question: 6

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. 2000 m³/yr
B. 1500 m³/yr
C. 1600 m³/yr
D. 1700 m³/yr

Answer: A

Explanation:

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

Convert the recharge rate to meters:

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

Convert area to square meters:

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

Thus,

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

Question: 7

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:

$$v = K \cdot i$$

Where K is hydraulic conductivity and i is hydraulic gradient.
Thus,

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

Question: 8

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:

$$\text{Drawdown} = \text{Initial Water Level} - \text{Final Water Level}$$

Thus,

$$\text{Drawdown} = 15\,\text{m} - 10\,\text{m} = 5\,\text{m}$$

Question: 9

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 m^3/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. 1288 kg
B. 1576 kg
C. 1036 kg
D. 1296 kg

Answer: C

Explanation:

The mass of oxygen lost can be calculated as:

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

Where:

$$\text{Mass Loss} = (8\,\text{mg/L} - 5\,\text{mg/L}) \times 4\,\text{m}^3/s \times 86,400\,\text{s}$$

Convert mg/L to kg/m³:

$$\text{Mass Loss} = 3\,\text{mg/L} \times 4 \times 86,400 = 1036.8\,\text{kg}$$

Question: 10

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:

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

Thus,

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

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