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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 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 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. 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 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%
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 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 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:

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

Convert concentration to kg/m^3:

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

Thus,

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

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:

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

Thus,

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

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. 2000 m^3/yr
B. 1500 m^3/yr
C. 1600 m^3/yr
D. 1700 m^3/yr

Answer: A

Explanation: The sustainable yield can be estimated using:

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

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 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:

$$v = K \cdot i$$

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 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:

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

Thus,

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

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 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 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:

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

Thus,

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

Question 396:
A lake has a total phosphorus concentration of 0.15 mg/L. If the lake has a

volume of 500,000 m^3, what is the total phosphorus load in kilograms?

A. 10.75 kg
B. 11.25 kg
C. 15.00 kg
D. 75.0 kg

Answer: D

Explanation: The total phosphorus load can be calculated as:

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

Convert concentration to kg/m^3:

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

Question 397:
In a groundwater contamination study, a monitoring well shows a concentration of benzene at 5 µg/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. 0.50 mg
D. 1.50 mg

Answer: D

Explanation: The total mass can be calculated as:

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

Convert flow rate to L/h:

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

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:

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

Thus,

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

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:

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

Thus,

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

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. 0.15 mg/L
B. 0.75 mg/L
C. 91.00 mg/L
D. 750 mg/L

Answer: D

Explanation: Convert area to square meters:

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

The volume of the pond is:

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

Convert kg to mg:

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

Question 401:
A stream has a flow rate of 1.5 m^3/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. 288 kg
C. 864 kg
D. 1,728 kg

Answer: A

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

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

Thus,

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

Convert mg/L to kg/m^3:

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

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 m^3/s, what is the total nitrogen load in kilograms per day?

A. 1250 kg/day
B. 1300 kg/day
C. 1036 kg/day
D. 1600 kg/day

Answer: C

Explanation: The nitrogen load can be calculated as:

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

Thus,

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

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