NCEES

NCEES PE Civil: Water Resources and Environmental

NCEES - PE Civil Engineering - Water Resources and Environmental

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:

Load = Concentration × Flow Rate × Time
Load = Concentration × Flow Rate × Time

Convert hectares to square meters:

Area = 50 hectares = $500,\ 000\ m^2$
Area = 50 hectares = 500, 000 m2

Convert concentration to kg/m^3:

Concentration = 0.1 mg/L = $0.0001\ kg/m^3$
Concentration = 0.1 mg/L = 0.0001 kg/m3

Assuming an average depth of 2 m:

Load = $0.0001\ kg/m^3 \times 500,\ 000\ m^2 \times 2\ m = 10\ kg/yr$
Load = 0.0001 kg/m3 × 500, 000 m2 × 2 m = 10 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:

Total E. coli = Concentration × Sample Volume
Total E. coli = Concentration × Sample Volume

Thus,

Total E. coli = 200 CFU/100 mL × 10 = 2, 000 CFU
Total E. coli = 200 CFU/100 mL × 10 = 2, 000 CFU

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:

Increase in BOD = Current BOD − Natural BOD
Increase in BOD = Current BOD − Natural BOD

Thus,

Increase in BOD = 15 mg/L − 3 mg/L = 12 mg/L

Increase in BOD = 15 mg/L − 3 mg/L = 12 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:

Drawdown = Initial Water Level − Final Water Level
Drawdown = Initial Water Level − Final Water Level

Thus,

Drawdown = 12 m − 9 m = 3 m
Drawdown = 12 m − 9 m = 3 m

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:

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

Reduction = Current LoadCurrent Load − Target Load × 100

Thus,

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

Reduction = 25002500 − 1000 × 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 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. 27,880 kg/day
C. 42,320 kg/day
D. 67,100 kg/day

Answer: A

Explanation: The BOD load can be calculated as:

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

BOD Load = Concentration × Flow Rate × Time

Convert mg/L to kg/m^3:

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

Concentration = 200 mg/L = 0.2 kg/m3

Thus,

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

BOD Load = 0.2 kg/m3 × 3 m3/s × 86,400 s = 51,840 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:

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

Attenuation Factor = C2C1 = 100 µg/L1000 µg/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. 20.9%
B. 25.8%
C. 37.5%
D. 35.2%

Answer: C

Explanation: The percentage change in DO is calculated as:

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

Percentage Change = Initial DOInitial DO − Final DO × 100

Thus,

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

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 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:

Load = Concentration × Volume
Load = Concentration × Volume

Convert concentration to kg/m^3:

Concentration = 0.2 mg/L = 0.0002 kg/m^3
Concentration = 0.2 mg/L = 0.0002 kg/m3

Thus,

Load = $0.0002\ kg/m^3 \times 1,000,000\ m^3 = 200\ kg$
Load = 0.0002 kg/m3 × 1,000,000 m3 = 200 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:

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

Specific Yield = TimeDrawdown × Hydraulic Conductivity1

Thus,

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

Specific Yield = 12 × 3600 s5 m × 10 m/day1 = 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 m^3/yr
B. 5,100 m^3/yr
C. 2,000 m^3/yr
D. 1,700 m^3/yr

Answer: C

Explanation: The sustainable yield can be estimated using:

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

Sustainable Yield = Recharge Rate × Area

Convert the recharge rate to meters:

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

Recharge Rate = 0.1 m/yr

Convert area to square meters:

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

Area = 2 hectares = 20, 000 m2

Thus,

$$\text{Sustainable Yield} = 0.1\ \text{m/yr} \times 20,000\ \text{m}^2 = 2,000\ \text{m}^3\text{/yr}$$
Sustainable Yield = 0.1 m/yr × 20, 000 m2 = 2, 000 m³/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 · i

Where KK is hydraulic conductivity and ii is hydraulic gradient.
Thus,

$$v = 12\ \text{m/day} \times 0.03 = 0.36\ \text{m/day}$$
v = 12 m/day × 0.03 = 0.36 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 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. 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 m^3/s × 86, 400 s
Mass Loss = (8 mg/L − 5 mg/L) × 4 m3/s × 86, 400 s

Convert mg/L to kg/m^3:

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:

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

Reduction = Current LoadCurrent Load − TMDL × 100

Thus,

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

Reduction = 22002200 − 1500 × 100 ≈ 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. 95 kg
B. 12 kg
C. 50 kg
D. 75 kg

Answer: D

Explanation: The total phosphorus load can be calculated as:

Load = Concentration × Volume
Load = Concentration × Volume

Convert concentration to kg/m^3:

$\text{Load} = 0.15\ \text{mg/L} \times 500,000\ \text{m}^3 = 75\ \text{kg}$
Load = 0.15 mg/L × 500, 000 m3 = 75 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. 1.50 mg
D. 1.00 mg

Answer: C

Explanation: The total mass can be calculated as:

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

Convert flow rate to L/h:

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

Increase in BOD = Post-Pollution BOD − Natural BOD

Increase in BOD = Post-Pollution BOD − Natural BOD

Thus,

Increase in BOD = 12 mg/L − 4 mg/L = 8 mg/L
Increase in BOD = 12 mg/L − 4 mg/L = 8 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:

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

Thus,

$$\text{Specific Capacity} = \frac{80\ L/s}{3\ m} \approx 26.67\ L/s/m$$
Specific Capacity = 3 m80 L/s ≈ 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. 150 mg/L
B. 805 mg/L

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

Answer: D

Explanation: Convert area to square meters:

$$\text{Area} = 1 \text{ hectare} = 10,000 \text{ m}^2$$
Area = 1 hectare = 10, 000 m2

The volume of the pond is:

$$\text{Volume} = \text{Area} \times \text{Depth} = 10,000 \text{ m}^2 \times 2\, m = 20,000\, m^3$$
Volume = Area × Depth = 10, 000 m2 × 2 m = 20, 000 m3

Convert kg to mg:

$$\text{Concentration} = \frac{15\, kg \times 1,000,000\, mg/kg}{20,000\, m^3} = 750\, mg/L$$
Concentration = 20, 000 m3 15 kg × 1, 000, 000 mg/kg = 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. 188.3 kg
C. 864.5 kg
D. 172.8 kg

Answer: A

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

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

Thus,

Mass Loss = $(9\ \text{mg/L} - 5\ \text{mg/L}) \times 1.5\ \text{m}^3/s \times 86,\ 400\ \text{s}$
Mass Loss = (9 mg/L − 5 mg/L) × 1.5 m3/s × 86, 400 s

Convert mg/L to kg/m³:

Mass Loss = $4\ \text{mg/L} \times 1.5\ m^3/s \times 86,\ 400s = 518,\ 400\ mg = 518.4kg$
Mass Loss = 4 mg/L × 1.5 m3/s × 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. 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:

Load = Concentration × Flow Rate × Time
Load = Concentration × Flow Rate × Time

Thus,

Load = $12\ \text{mg/L} \times 2.5\ m^3/s \times 86,\ 400\ s = 1,\ 036,\ 800\ mg = 1,\ 036.8\ kg/day$
Load = 12 mg/L × 2.5 m3/s × 86, 400 s = 1, 036, 800 mg = 1, 036.8 kg/day