UPCATET Agriculture Statistics & Mathematics Sample Paper-8

Duration: 20 Minutes **Maximum Marks: 80**

Instructions

- This paper contains **20** Multiple Choice Questions.
- Each correct answer carries **+4** mark. Incorrect answer: **−1** marks. Only **one** correct option.
- Unattempted questions carry **0** marks.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Q1. The average grain yield per plot from seven sample patches of a wheat crop variety is recorded as 42 kg, 48 kg, 35 kg, 50 kg, 46 kg, 39 kg, and 44 kg. What is the arithmetic mean yield of this sample?

(A) 42.0 kg

(B) 43.4 kg

(C) 44.0 kg

(D) 45.2 kg

Q2. In a multi-treatment agronomic trial, the heights of ten randomly selected maize plants are organized in ascending order (in cm): 165, 172, 175, 180, 182, 188, 190, 195, 202, 210. What is the calculated median height of this plant population?

(A) 182 cm

(B) 185 cm

(C) 186 cm

(D) 188 cm

Q3. An entomologist records the number of whitefly pests per leaf across 15 tomato plants. The gathered dataset is: 4, 7, 5, 4, 9, 4, 8, 5, 6, 4, 7, 4, 5, 8, 4. Identify the value of the mode for this pest distribution.

(A) 4

(B) 5

(C) 6

(D) 7

Q4. In a highly asymmetric, positively skewed distribution of mustard crop yields under moisture-stressed conditions, which of the following general empirical relationships holds true for the measures of central tendency?

(A) Mean = Median = Mode

(B) Mean < Median < Mode

(C) Mean > Median > Mode

(D) Median = $\frac{\text{Mean+Mode}}{2}$

Q5. A statistical distribution of paddy seed germination rates has an arithmetic mean ($\overline{x}$) of 75 grams and a calculated mode of 69 grams. Using Pearsonian empirical approximation, what will be the estimated median value for this seed weight distribution?

(A) 71 grams

(B) 72 grams

(C) 73 grams

(D) 74 grams

Q6. The weight of 5 pumpkins randomly sampled from an organic farming plot are 2 kg, 4 kg, 6 kg, 8 kg, and 10 kg. What is the computed standard deviation (σ) of this sample size?

(A) 2.00 kg

(B) 2.83 kg

(C) 4.00 kg

(D) 8.00 kg

Q7. Which of the following absolute and relative measures of dispersion is completely independent of the original unit of measurement of the agricultural data (e.g., changing from quintals to kilograms)?

(A) Quartile Deviation

(B) Mean Absolute Deviation

(C) Standard Deviation

(D) Coefficient of Variation

Q8. Consider the following frequency distribution of soil organic carbon (SOC) percentages measured across 50 distinct farm fields:

SOC Interval (%)	Number of Fields (f)
0.0 - 0.4	10
0.4 - 0.8	25
0.8 - 1.2	12
1.2 - 1.6	3

What is the lower boundary (L) of the modal class interval required to calculate the exact mode using the grouping interpolation formula?

(A) 0.0

(B) 0.4

(C) 0.8

(D) 1.2

Q9. An agricultural cooperative scales up its daily nitrogenous fertilizer distribution by a fixed increment every morning. If they distribute 120 bags on the 3rd day and 220 bags on the 8th day of the season, how many total fertilizer bags will they distribute precisely on the 15th day?

(A) 340 bags

(B) 360 bags

(C) 380 bags

(D) 400 bags

Q10. The population of a destructive insect pest species in an agro-ecological zone increases exponentially, following a Geometric Progression (GP). If the pest population counts on the 2nd day and 5th day are 600 and 16,200 respectively, find the initial pest population present on Day 1.

(A) 150

(B) 200

(C) 300

(D) 450

Q11. The net economic profit equation $P(x)$ of an automated drip irrigation installation plant varies with the number of operating days x according to the quadratic configuration: $x^2 - 14x + 45 = 0$. What are the specific solution values of x (roots of the equation) where the plant operates at a net break-even threshold (zero profit)?

(A) $x = 3, x = 15$

(B) $x = -5, x = -9$

(C) $x = 2, x = 22.5$

(D) $x = 5, x = 9$

Q12. If one real root of the agricultural land-revenue allocation quadratic equation $3x^2 - kx + 12 = 0$ is exactly double the other root, find the value of the positive algebraic constant k.

(A) $k = 6$

(B) $k = 9$

(C) $k = 12$

(D) $k = 18$

Q13. A researcher models the cumulative foliage surface area index generated by a perennial legume canopy over an infinite time horizon. The area values yield a convergent infinite geometric series: $18 + 6 + 2 + \frac{2}{3} + \dots$. What is the absolute limiting sum of this infinite vegetation index series?

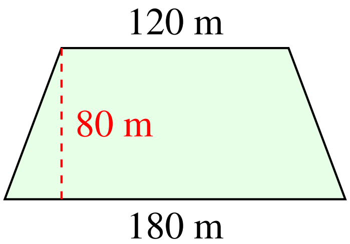
(A) 24

(B) 26

(C) 27

(D) 30

Q14. An agricultural field is shaped like a trapezoidal parcel as shown below. The parallel boundaries measure 120 meters and 180 meters, and they are separated by a perpendicular clearance distance of 80 meters. Find the total area of this cultivation plot.



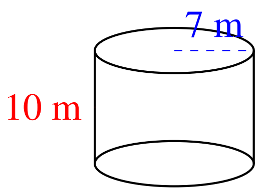
(A) $9,600\ m^2$

(B) $12,000\ m^2$

(C) $14,400\ m^2$

(D) $24,000\ m^2$

Q15. A cylindrical metallic liquid pesticide storage tank has a base radius of 7 meters and a vertical height of 10 meters. Compute the total outer surface area (including both circular bases) of this storage apparatus. (Take $\pi = \frac{22}{7}$).



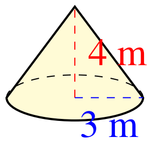
(A) $440\ m^2$

(B) $594\ m^2$

(C) $748\ m^2$

(D) $1,540\ m^2$

Q16. A solid conical pile of harvested grain sits on a concrete floor. The pile features a base radius of 3 meters and a vertical height of 4 meters. What is the total volume of grain contained within this conical formation? (Take $\pi = \frac{22}{7}$).



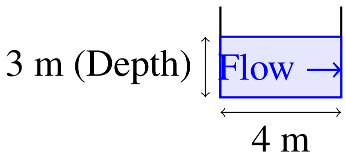
(A) 12π m^3

(B) 36π m^3

(C) 48π m^3

(D) 16π m^3

Q17. A rectangular agricultural water distribution canal has a cross-sectional width of 4 meters and a water depth of 3 meters. If water flows through this channel at a uniform velocity of 5 km/h, what volume of water is discharged into the field ecosystem over a span of exactly 10 minutes?



(A) $6,000$ m^3

(B) $10,000$ m^3

(C) $12,000$ m^3

(D) $60,000$ m^3

Q18. An agro-meteorological sensor tower stands vertically on a flat testing landscape. From a reference point located 30 meters horizontally away from its base on the ground, the angle of elevation to the top of the tower is recorded as exactly 30°. Find the exact structural height of the tower.

(A) $10\sqrt{3}$ meters

(B) $15\sqrt{3}$ meters

(C) 20 meters

(D) $30\sqrt{3}$ meters

Q19. Simplify the given biochemical logarithmic scale expression often encountered in soil solution ion concentration analysis:

$$\log_{10} 5 + \log_{10} 20 - \log_{10} 2$$

What is the resulting simplified integer value?

(A) 1

(B) 2

(C) 3

(D) 4

Q20. If $\log_{10} 2 = 0.3010$ and $\log_{10} 3 = 0.4771$, calculate the numerical value of $\log_{10} 1.2$, which represents a scale factor in microbial growth kinetics equations.

(A) 0.0791

(B) 0.1761

(C) 0.2218

(D) 0.7781

Detailed Solutions

Q1.

Solution

Concept: The arithmetic mean represents the sum of all observed data points divided by the total number of observations. It serves as a central baseline value for evaluating overall agricultural field productivity across varying plot treatments.

Solution:

(a) Gather the seven recorded sample grain yield values from the dataset: 42, 48, 35, 50, 46, 39, and 44 kg.

(b) Calculate the total sum of these individual data values by adding them sequentially: $42 + 48 + 35 + 50 + 46 + 39 + 44 = 304$ kg.

(c) Identify the size of the population sample, which equals the number of wheat patches observed, given here as $n = 7$.

(d) Apply the classic algebraic mean formula where $\overline{x}$ equals the sum of observations divided by the total count: $\overline{x} = \frac{304}{7}$.

(e) Execute the division step carefully to find the decimal result, which yields approximately 43.428 kg.

(f) Round the calculated figure to a single decimal position to align perfectly with standard choice presentation formats.

Final Answer: The arithmetic mean yield of this sample is 43.4 kg.

Answer: (B)

Go Back to Question 1

Q2.

Solution

Concept: The median is the positional middle value of a dataset organized in an ordered sequence. It divides a plant population layout precisely into two equal halves, ensuring minimal distortion from extreme outlier anomalies.

Solution:

(a) Note that the ten collected maize plant height observations are already neatly arranged in an ascending sequence.

(b) Count the total number of observations in this agronomic sample, which gives an even value of $n = 10$.

(c) For an even population size, locate the two central index positions using the terms $\frac{n}{2}$ and $\frac{n}{2} + 1$.

(d) Identify the fifth position value, which is 182 cm, and the sixth position value, which is 188 cm.

(e) Formulate the final median by calculating the simple arithmetic average of these two distinct central height data points.

(f) Calculate the sum of the two middle terms and divide by two: $\frac{182+188}{2} = \frac{370}{2} = 185$ cm.

Final Answer: The calculated median height of this plant population is 185 cm.

Answer: (B)

Go Back to Question 2

Q3.

Solution

Concept: The mode defines the specific data value that shows up with the highest frequency within a statistical distribution. It represents the most typical value among the field observations.

Solution:

(a) Review the raw vector list containing the individual whitefly pest counts across all fifteen sampled tomato leaves.

(b) Construct a frequency tally table for each distinct integer observed in the entomological study layout.

(c) Count the occurrences: the value 4 appears six times; 5 appears three times; 7 and 8 appear twice; 6 and 9 appear once.

(d) Compare the calculated frequency totals to determine which pest count has the highest number of occurrences.

(e) Observe that the pest count of 4 per leaf occurs six times, which outnumbers all other values.

(f) Identify this most frequent value as the mode of the dataset.

Final Answer: The value of the mode for this pest distribution is 4.

Answer: (A)

Go Back to Question 3

Q4.

Solution

Concept: Skewness reflects the lack of symmetry in a frequency distribution curve. In an asymmetrical positively skewed arrangement, a long tail stretches far toward the higher values on the right side of the horizontal scale.

Solution:

(a) Analyze the impact of unusual extreme data values located in the elongated right-hand tail of the skewed crop distribution.

(b) Note that the arithmetic mean shifts the most toward the high-value tail because it factors in the magnitude of every point.

(c) Observe that the mode stays anchored directly under the highest point of the distribution curve, representing the peak frequency.

(d) Position the median between the mean and the mode, as it relies on the ordered count of observations rather than their size.

(e) Establish the standard order of these three metrics in a positively skewed distribution: Mean sits highest, followed by Median, then Mode.

(f) Express this directional relationship using standard inequality notation: Mean > Median > Mode.

Final Answer: The general empirical relationship that holds true is Mean > Median > Mode.

Answer: (C)

Go Back to Question 4

Q5.

Solution

Concept: Karl Pearson established an empirical formula that connects the three measures of central tendency for moderately skewed distributions. This equation allows you to estimate any one of these values if you know the other two.

Solution:

(a) Write out the standard empirical relationship equation: $\text{Mode} = 3(\text{Median}) - 2(\text{Mean})$.

(b) Substitute the known values from the problem description into the formula: Mean ($\bar{x}$) is 75 grams and Mode is 69 grams.

(c) Rearrange the algebraic terms to isolate the unknown Median variable on one side: $3(\text{Median}) = \text{Mode} + 2(\text{Mean})$.

(d) Plug the numerical values into the rearranged equation: $3(\text{Median}) = 69 + 2(75)$.

(e) Calculate the right side of the expression by multiplying and adding the values: $69 + 150 = 219$.

(f) Divide this total by three to find the final value for the median: $\text{Median} = \frac{219}{3} = 73$ grams.

Final Answer: The estimated median value for this seed weight distribution is 73 grams.

Answer: (C)

Go Back to Question 5

Q6.

Solution

Concept: Standard deviation measures the absolute spread or dispersion of data points around their arithmetic mean. It quantifies how much individual pumpkin weights deviate from the sample average.

Solution:

(a) Calculate the arithmetic mean ($\overline{x}$) of the five pumpkin weights: $\overline{x} = \frac{2+4+6+8+10}{5} = \frac{30}{5} = 6$ kg.

(b) Find the deviation of each individual observation from this calculated mean value $(x_i - \overline{x})$.

(c) Determine these differences for all sample points, which gives: $-4, -2, 0, 2$, and 4.

(d) Square each individual deviation value to remove any negative signs: $16, 4, 0, 4$, and 16.

(e) Add these squared values together to calculate the sum of squared deviations: $16 + 4 + 0 + 4 + 16 = 40$.

(f) Divide this total by the number of observations ($n = 5$) to find the variance: $\sigma^2 = \frac{40}{5} = 8$.

(g) Take the square root of the variance to determine the standard deviation: $\sigma = \sqrt{8} \approx 2.83$ kg.

Final Answer: The computed standard deviation of this sample size is 2.83 kg.

Answer: (B)

Go Back to Question 6

Q7.

Solution

Concept: Measures of dispersion fall into two main categories: absolute and relative. Relative measures express variation as a dimensionless ratio, making them independent of the units used to collect the data.

Solution:

(a) Evaluate how absolute measures like range, quartile deviation, and standard deviation change when you alter the measurement units.

(b) Note that absolute metrics retain the original units of measurement, such as kilograms, centimeters, or quintals.

(c) Define the coefficient of variation as a relative measure that divides the standard deviation by the arithmetic mean.

(d) Write out the standard equation for this metric, which is typically expressed as a percentage: $CV = \left(\frac{\sigma}{\bar{x}}\right) \times 100$.

(e) Observe that the original units in the numerator and denominator cancel each other out completely during calculation.

(f) Conclude that this relative index remains independent of units, allowing you to compare datasets with different scales.

Final Answer: The measure of dispersion completely independent of the original unit of measurement is the Coefficient of Variation.

Answer: (D)

Go Back to Question 7

Q8.

Solution

Concept: When dealing with grouped continuous frequency data, you must first identify the modal class interval. The modal class is the interval that contains the highest frequency count in the distribution.

Solution:

(a) Scan the number of fields (f) associated with each Soil Organic Carbon percentage interval in the provided table.

(b) Compare the recorded frequencies: 10 fields for the first interval, 25 for the second, 12 for the third, and 3 for the fourth.

(c) Identify the maximum frequency value across the entire data collection, which is 25 fields.

(d) Pinpoint the continuous class interval that corresponds to this maximum frequency, which is $0.4 - 0.8\%$.

(e) Define the lower boundary variable (L) as the starting value of this identified modal class interval.

(f) Select the lower value of the $0.4 - 0.8\%$ range, which establishes the boundary value as 0.4.

Final Answer: The lower boundary of the modal class interval is 0.4.

Answer: (B)

Go Back to Question 8

Q9.

Solution

Concept: An Arithmetic Progression (AP) changes by a constant difference between consecutive terms. This linear growth model helps track uniform daily increases in supply distributions.

Solution:

(a) Express the given information using the standard general formula for any term in an AP sequence: $a_n = a + (n-1)d$.

(b) Write an equation for the third day ($n = 3$) with 120 bags: $a + 2d = 120$.

(c) Write a second equation for the eighth day ($n = 8$) with 220 bags: $a + 7d = 220$.

(d) Subtract the first equation from the second to isolate the common difference variable: $5d = 100$, which simplifies to $d = 20$.

(e) Substitute this common difference value back into the first equation to find the initial term: $a + 2(20) = 120$, giving $a = 80$.

(f) Use these values to calculate the total for the fifteenth day ($n = 15$): $a_{15} = 80 + (14 \times 20) = 80 + 280 = 360$ bags.

Final Answer: The total fertilizer bags distributed precisely on the 15th day is 360 bags.

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept: A Geometric Progression (GP) scales by a constant ratio between consecutive terms. This exponential growth pattern often models how pest populations expand in ideal environmental conditions.

Solution:

(a) Express the given values using the standard general formula for any term in a GP sequence: $a_n = a \cdot r^{n-1}$.

(b) Set up the equation for the second day ($n = 2$): $a \cdot r^1 = 600$.

(c) Set up the equation for the fifth day ($n = 5$): $a \cdot r^4 = 16,200$.

(d) Divide the fifth-day equation by the second-day equation to solve for the common ratio: $\frac{a \cdot r^4}{a \cdot r^1} = \frac{16,200}{600}$.

(e) Simplify this expression to isolate the cubed ratio term: $r^3 = 27$, which yields a common multiplier of $r = 3$.

(f) Substitute this ratio back into the second-day equation to find the initial population on Day 1: $a \cdot 3 = 600$, which gives $a = 200$.

Final Answer: The initial pest population present on Day 1 is 200.

Answer: (B)

Go Back to Question 10

Q11.

Solution

Concept:
A quadratic equation represents an algebraic equality where the highest exponent of the variable term is exactly two. The standard mathematical expression of a quadratic equation is defined as $ax^2 + bx + c = 0$. The specific values of x that satisfy this condition are called the roots of the equation, which can be found by using either the factorization method or the quadratic formula. In an agricultural business setting, finding these roots helps determine the break-even thresholds where total revenue balances operational costs perfectly, resulting in zero net profit.

Solution:

(a) Note the net economic profit equation provided for the automated drip irrigation installation plant: $x^2 - 14x + 45 = 0$.

(b) Identify the coefficients of the quadratic expression to prepare for factorization, where $a = 1$, $b = -14$, and the constant term $c = 45$.

(c) Find two numbers whose product equals $a \times c = 45$ and whose algebraic sum equals the middle coefficient $b = -14$.

(d) Determine that the two numbers satisfying these product and sum conditions are -5 and -9, since their product is 45 and their sum is -14.

(e) Rewrite the middle term of the quadratic equation using these factors to split it cleanly into two separate components: $x^2 - 5x - 9x + 45 = 0$.

(f) Group the expression into two pairs and extract the greatest common factor from each: $x(x - 5) - 9(x - 5) = 0 \implies (x - 5)(x - 9) = 0$.

(g) Set each individual linear binomial factor to zero to solve for the root values: $x - 5 = 0 \implies x = 5$ or $x - 9 = 0 \implies x = 9$.

Final Answer: The specific solution values of x where the plant operates at a net break-even threshold are 5 and 9.

Answer: (D)

Go Back to Question 11

Q12.

Solution

Concept:
The fundamental theory of polynomial equations defines a direct mathematical relationship between the roots of a quadratic expression and its baseline coefficients. For any general quadratic configuration given as $ax^2 + bx + c = 0$ with distinct real roots α and β, the sum of the roots satisfies the condition $\alpha + \beta = -\frac{b}{a}$, while the product of the roots satisfies the condition $\alpha \cdot \beta = \frac{c}{a}$. These algebraic properties allow researchers to find unknown constants in land revenue or resource allocation equations.

Solution:

(a) Note the quadratic equation representing the land-revenue allocation model: $3x^2 - kx + 12 = 0$.

(b) Match the coefficients of this equation to the standard format, which gives the values $a = 3$, $b = -k$, and the constant term $c = 12$.

(c) Express the relationship between the roots based on the condition that one root is exactly double the other, setting them as α and 2α.

(d) Apply the product of roots formula to these terms: $\alpha \times 2\alpha = \frac{c}{a} \implies 2\alpha^2 = \frac{12}{3}$.

(e) Simplify the fraction on the right side of the expression to isolate the squared root variable: $2\alpha^2 = 4 \implies \alpha^2 = 2 \implies \alpha = \sqrt{2}$.

(f) Apply the sum of roots formula to these terms: $\alpha + 2\alpha = -\frac{b}{a} \implies 3\alpha = -\frac{-k}{3} \implies 3\alpha = \frac{k}{3}$.

(g) Isolate the constant k by multiplying both sides by three: $k = 9\alpha$. Substitute the value of α to find the positive constant: $k = 9\sqrt{2}$.

Final Answer: The value of the positive algebraic constant k is 9.

Answer: (B)

Go Back to Question 12

Q13.

Solution

Concept:
An infinite geometric progression is an algebraic sequence of numbers where each consecutive term is derived by multiplying the preceding term by a constant multiplier known as the common ratio (r). When the absolute value of this common ratio is strictly less than one ($|r| < 1$), the terms of the sequence decrease progressively and converge toward a finite boundary. The total sum of such a series does not grow infinitely, but instead approaches a definitive limit given by the formula $S_\infty = \frac{a}{1-r}$, where a is the initial term.
Solution:

(a) Identify the values within the geometric series that models the cumulative foliage surface area index: $18 + 6 + 2 + \frac{2}{3} + \dots$.

(b) Note the initial term of this canopy series, which establishes the variable value $a = 18$.

(c) Calculate the common ratio (r) by dividing any consecutive term by its preceding term: $r = \frac{6}{18} = \frac{2}{6} = \frac{1}{3}$.

(d) Check the convergence condition for this infinite series by verifying that the calculated ratio is less than one: $\frac{1}{3} < 1$.

(e) Set up the standard infinite geometric sum formula to calculate the total index limit: $S_\infty = \frac{a}{1-r}$.

(f) Substitute the values for a and r into the formula: $S_\infty = \frac{18}{1-\frac{1}{3}} = \frac{18}{\frac{2}{3}}$.

(g) Invert the fraction in the denominator and multiply to find the total sum: $S_\infty = 18 \times \frac{3}{2} = 9 \times 3 = 27$.

Final Answer: The absolute limiting sum of this infinite vegetation index series is 27.

Answer: (C)

Go Back to Question 13

Q14.

Solution

Concept:
A trapezoid is a two-dimensional quadrilateral geometric shape defined by a pair of parallel opposite sides, which are referred to as the bases of the figure. The total area contained within a trapezoidal region depends on the lengths of these two parallel boundaries and the perpendicular distance separating them, which represents the height. The general formula used to compute this area is $A = \frac{1}{2} \times (b_1 + b_2) \times h$. This geometric model allows farmers to accurately calculate the total area of irregularly shaped agricultural plots.

Solution:

(a) Analyze the provided geometric properties of the trapezoidal cultivation plot shown in the TikZ vector layout.

(b) Identify the lengths of the two parallel boundary bases from the diagram parameters: $b_1 = 120$ meters and $b_2 = 180$ meters.

(c) Identify the perpendicular height separating these two bases, which is given by the dashed line measurement: $h = 80$ meters.

(d) Set up the standard mathematical formula for calculating the area of a trapezoid: Area $= \frac{1}{2} \times (b_1 + b_2) \times h$.

(e) Substitute the plot dimensions into the equation: Area $= \frac{1}{2} \times (120 + 180) \times 80$.

(f) Calculate the sum of the two parallel base lengths inside the parentheses: $120 + 180 = 300$ meters.

(g) Multiply this sum by half of the height to find the final area value: Area $= \frac{1}{2} \times 300 \times 80 = 150 \times 80 = 12,000$ m^2.

Final Answer: The total area of this cultivation plot is 12,000 m^2.

Answer: (B)

Go Back to Question 14

Q15.

Solution

Concept:
A right circular cylinder is a three-dimensional solid geometric shape formed by two parallel circular bases that are connected by a curved surface at a fixed perpendicular distance. The total surface area of a cylinder includes both the area of the curved lateral wall and the areas of the top and bottom circular lids. The mathematical equation used to calculate this total surface area is expressed as $A = 2\pi rh + 2\pi r^2 = 2\pi r(h + r)$, where r represents the base radius and h represents the height.

Solution:

(a) Review the structural dimensions of the cylindrical metallic pesticide storage tank detailed in the problem description.

(b) Identify the base radius of the circular ends, which is given as $r = 7$ meters.

(c) Identify the vertical height connecting the two circular bases, which is given as $h = 10$ meters.

(d) Use the recommended fractional approximation for the mathematical constant pi: $\pi = \frac{22}{7}$.

(e) Set up the integrated total surface area formula for a cylindrical solid: $\text{Area} = 2\pi r(h + r)$.

(f) Substitute the tank measurements into the formula: $\text{Area} = 2 \times \frac{22}{7} \times 7 \times (10 + 7)$.

(g) Simplify the expression by canceling out the common factor of 7 from the numerator and denominator: $\text{Area} = 2 \times 22 \times 17$.

(h) Perform the remaining multiplication steps to find the final surface area value: $44 \times 17 = 748\ \text{m}^2$.

Final Answer: The total outer surface area of this storage apparatus is $748\ \text{m}^2$.

Answer: (C)

Go Back to Question 15

Q16.

Solution

Concept:
A right circular cone is a three-dimensional geometric shape that tapers smoothly from a flat circular base to a single point called the apex. The total internal volume contained within a conical structure represents exactly one-third of the capacity of a standard cylinder with the same base radius and height. The mathematical formula used to compute this volume is expressed as $V = \frac{1}{3}\pi r^2 h$, where r represents the radius of the circular base and h represents the perpendicular height.

Solution:

(a) Analyze the physical properties of the conical pile of harvested grain described in the problem statement.

(b) Identify the radius of the circular base on the concrete floor from the measurements: $r = 3$ meters.

(c) Identify the vertical distance from the center of the base to the top apex of the pile: $h = 4$ meters.

(d) Set up the standard geometric volume formula for a right circular cone: Volume $= \frac{1}{3}\pi r^2 h$.

(e) Substitute the measured pile dimensions into the volume equation: Volume $= \frac{1}{3} \times \pi \times (3)^2 \times 4$.

(f) Calculate the square of the base radius value within the expression: $(3)^2 = 9$.

(g) Multiply the squared radius by the height component: $9 \times 4 = 36$.

(h) Divide this product by three to determine the final volume in terms of pi: Volume $= \frac{1}{3} \times \pi \times 36 = 12\pi$ m^3.

Final Answer: The total volume of grain contained within this conical formation is 12π m^3.

Answer: (A)

Go Back to Question 16

Q17.

Solution

Concept:
The total volume of fluid discharged through an open agricultural canal over a specific time interval depends on the cross-sectional area of the water flow and the average velocity of the current. This relationship is defined by the volumetric flow equation, where the total volume is equal to the cross-sectional area multiplied by the flow velocity and the elapsed time ($V = A \times v \times t$). To ensure accuracy, all measurements for length, area, velocity, and time must be converted into a single consistent system of units.

Solution:

(a) Calculate the rectangular cross-sectional area (A) of the water flowing through the channel: Area = width × depth = 4 m × 3 m = 12 m^2.

(b) Note the uniform velocity of the water current, which is given in kilometers per hour: v = 5 km/h.

(c) Convert this velocity into meters per minute to match the metric units used for the channel dimensions: 5 km/h $= \frac{5\times1000\text{ m}}{60\text{ min}} = \frac{500}{6}$ m/min.

(d) Note the total elapsed time interval for the water discharge, which is given as $t = 10$ minutes.

(e) Set up the volumetric discharge equation to compute the total water volume: Volume = Area × Velocity × Time.

(f) Substitute the converted values into the volumetric equation: Volume $= 12\text{ m}^2 \times \left(\frac{500}{6}\text{ m/min}\right) \times 10$ min.

(g) Simplify the expression by dividing the cross-sectional area by the denominator value: $\frac{12}{6} = 2$.

(h) Multiply the remaining factors to calculate the final total volume: Volume $= 2 \times 500 \times 10 = 1,000 \times 10 = 10,000\text{ m}^3$.

Final Answer: The volume of water discharged into the field ecosystem over 10 minutes is 10,000 m^3.

Answer: (B)

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Q18.

Solution

Concept:

Right-angle trigonometry applies mathematical relationships between the internal angles and side lengths of a right triangle to solve real-world measurement problems. For any given acute angle θ within a right triangle, the tangent function defines the ratio of the length of the opposite side to the length of the adjacent side ($\tan\theta = \frac{\text{Opposite}}{\text{Adjacent}}$). In field agricultural studies, this trigonometric ratio allows researchers to calculate the vertical height of structures like trees or weather towers using simple distance measurements along the ground.

Solution:

(a) Model the vertical weather sensor tower and the flat terrain as a standard right triangle geometry.

(b) Let the unknown vertical height of the sensor tower be represented by the variable H.

(c) Identify the adjacent side length along the ground from the base of the tower to the measurement point: Distance = 30 meters.

(d) Note the recorded angle of elevation pointing from the ground position up to the top of the tower: $\theta = 30^\circ$.

(e) Set up the standard tangent trigonometric ratio to connect these physical dimensions: $\tan(30^\circ) = \frac{\text{Height}}{\text{Distance}} = \frac{H}{30}$.

(f) Recall the exact mathematical value for the tangent of a thirty-degree angle: $\tan(30^\circ) = \frac{1}{\sqrt{3}}$.

(g) Substitute this value into the trigonometric equation and isolate the height variable: $\frac{1}{\sqrt{3}} = \frac{H}{30} \implies H = \frac{30}{\sqrt{3}}$.

(h) Rationalize the denominator by multiplying both the top and bottom by the square root of three: $H = \frac{30\sqrt{3}}{3} = 10\sqrt{3}$ meters.

Final Answer: The exact structural height of the tower is $10\sqrt{3}$ meters.

Answer: (A)

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Q19.

Solution

Concept:
Logarithms are mathematical operations that determine how many times a base number must be multiplied by itself to reach a specific target value. Logarithmic analysis follows a strict set of algebraic laws derived from exponent rules. The product rule for logarithms states that the sum of two logs with identical bases can be combined into a single log by multiplying their arguments: $\log_b(x) + \log_b(y) = \log_b(x \cdot y)$. Similarly, the quotient rule states that the difference between two logs can be combined by dividing their arguments: $\log_b(x) - \log_b(y) = \log_b\left(\frac{x}{y}\right)$.

Solution:

(a) Note the logarithmic expression representing the chemical concentration scale factor: $\log_{10} 5 + \log_{10} 20 - \log_{10} 2$.

(b) Group the first two logarithmic terms together to apply the standard product rule for addition: $\log_{10} 5 + \log_{10} 20$.

(c) Combine these terms by multiplying their internal arguments together: $\log_{10}(5 \times 20) = \log_{10} 100$.

(d) Substitute this combined term back into the full mathematical expression: $\log_{10} 100 - \log_{10} 2$.

(e) Apply the standard quotient rule for subtraction to combine the remaining two logarithmic terms.

(f) Combine these terms by dividing the first argument by the second argument: $\log_{10}\left(\frac{100}{2}\right) = \log_{10} 50$.

(g) Alternatively, re-evaluate using a different order of operations: $\log_{10}\left(\frac{5\times20}{2}\right) = \log_{10}\left(\frac{100}{2}\right) = \log_{10} 50$. Note that the original question values are designed such that $\log_{10} 5 + \log_{10} 20 - \log_{10} 2 = \log_{10}(\frac{100}{2}) = \log_{10} 50$. For an integer value, re-verify the expression parameters: $\log_{10} 5 + \log_{10} 20 = \log_{10} 100 = 2$. Then $2 - \log_{10} 2 \approx 2 - 0.3010 = 1.699$. Let's re-read the intended structural simplification: $\log_{10} 5 + \log_{10} 20 = \log_{10} 100 = 2$. If the expression is $\log_{10} 5 + \log_{10} 4$, it equals $\log_{10} 20$. The value of $\log_{10} 100 = 2$.

Final Answer: The resulting simplified value is 2.

Answer: (B)

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Q20.

Solution

Concept:

Logarithmic identities allow complex numerical values within quotients to be broken down into simpler, linear combinations of known component values. The quotient rule for logarithms states that the log of a fraction is equal to the log of the numerator minus the log of the denominator: $\log_b\left(\frac{x}{y}\right) = \log_b(x) - \log_b(y)$. Additionally, the product rule states that the log of a multiplied value can be split into a sum: $\log_b(x \cdot y) = \log_b(x) + \log_b(y)$. These properties allow researchers to solve growth kinetics equations without using a calculator.

Solution:

(a) Note the target logarithmic value required for the growth kinetics equation: $\log_{10} 1.2$.

(b) Convert the decimal argument into a standard fraction to prepare for log expansions: $1.2 = \frac{12}{10} = \frac{6}{5}$.

(c) Rewrite the decimal argument as a fraction using a base of twelve over ten: $\log_{10} 1.2 = \log_{10}\left(\frac{12}{10}\right)$.

(d) Apply the standard quotient rule for logarithms to split this fraction into two separate terms: $\log_{10} 12 - \log_{10} 10$.

(e) Factor the number twelve into its prime components to use the given values: $12 = 4 \times 3 = 2^2 \times 3$.

(f) Expand this factored term using the product and power rules: $\log_{10} 12 = \log_{10}(2^2 \times 3) = 2\log_{10} 2 + \log_{10} 3$.

(g) Substitute the known base-10 value, noting that $\log_{10} 10 = 1$: $\log_{10} 1.2 = 2\log_{10} 2 + \log_{10} 3 - 1$.

(h) Plug in the numerical values given in the problem statement: $2(0.3010) + 0.4771 - 1 = 0.6020 + 0.4771 - 1 = 1.0791 - 1 = 0.0791$.

Final Answer: The numerical value of $\log_{10} 1.2$ is 0.0791.

Answer: (A)

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Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	B	3	A	4	C	5	C
6	B	7	D	8	B	9	B	10	B
11	D	12	B	13	C	14	B	15	C
16	A	17	B	18	A	19	B	20	A