UPCATET Agriculture Statistics & Mathematics Sample Paper-1

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. An agricultural statistician collects root-length deviation data from a high-density hydroponic mustard trial. The dataset consists of n distinct observations. If the mean of these observations is $\bar{x}$ and each individual data point x_i undergoes a structural transformation such that $y_i = \frac{3x_i-5}{2}$, calculate the precise relationship between the initial standard deviation (σ_x) and the newly transformed standard deviation (σ_y).

(A) $\sigma_y = \frac{3\sigma_x-5}{2}$

(B) $\sigma_y = \frac{9}{4}\sigma_x$

(C) $\sigma_y = \frac{3}{2}\sigma_x$

(D) $\sigma_y = \sqrt{\frac{3\sigma_x-5}{2}}$

Q2. In a multi-location rice variety evaluation trial across Uttar Pradesh, the yield distribution exhibits a heavy asymmetrical right-skewed profile due to varying irrigation limits. If the empirical mode of this yield dataset is determined to be 42.5 q/ha and the arithmetic mean is 31.2 q/ha, estimate the value of the median yield utilizing Pearsonian empirical mathematical approximations.

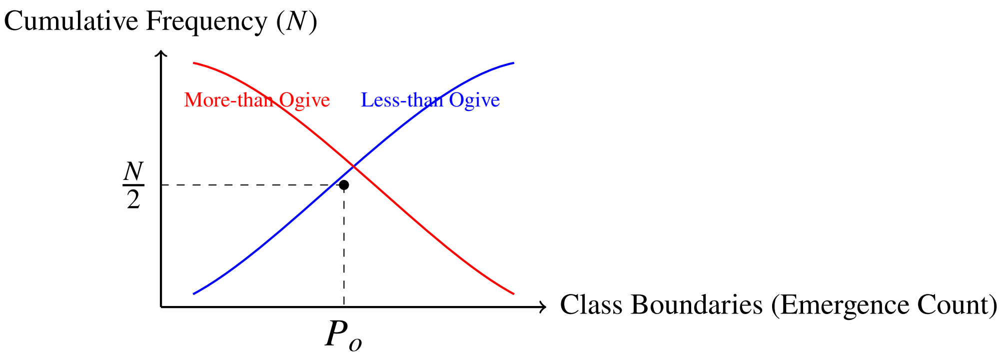
(A) 36.85 q/ha

(B) 34.97 q/ha

(C) 38.75 q/ha

(D) 33.4b q/ha

Q3. The frequency distribution of seedling emergence counts across 100 localized nursery beds is suspected to follow an irregular mathematical pattern. An analytical assistant plots the cumulative frequency configuration to establish structural parameters. Identify the specific statistical measure that can be directly extracted via the intersection coordinate point of both 'less-than' and 'more-than' ogives plotted on the coordinate space below:



(A) Arithmetic Mean

(B) Median Value (M_e)

(C) Maximum Geometric Mode

(D) Upper Quartile (Q_3)

Q4. A precision seed-drilling tractor instrument logs the mechanical errors across 10 trial strips. The raw calculated sum of squares of deviations of these observations from their true arithmetic mean ($\sum(x_i - \bar{x})^2$) is evaluated as 360. If the total coefficient of variation (CV) of this logging experiment is precisely 20%, compute the exact arithmetic mean ($\bar{x}$) of the dataset.

(A) $\bar{x} = 15$

(B) $\bar{x} = 30$

(C) $\bar{x} = 45$

(D) $\bar{x} = 60$

Q5. A statistical study of milk yield from 8 structural dairy clusters requires the computation of Mean Deviation. The individual data points are given as:

12, 18, 10, 22, 14, 16, 20, 24 liters. Calculate the absolute Mean Deviation about the Arithmetic Mean for this specific agricultural dataset.

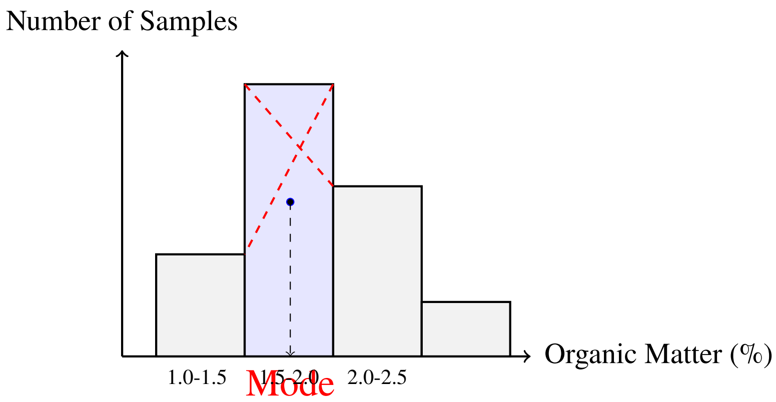
(A) 3.25 liters

(B) 4.00 liters

(C) 3.50 liters

(D) 4.75 liters

Q6. A research farm evaluates soil organic matter distribution across a heavily layered plot using a step-grouped analytical frequency histogram layout. Identify the mathematically correct value of the Mode from the geometrical configuration parameters specified in the targeted high-density zone highlighted in the agricultural histogram diagram given below:



(A) Mode = $L_1 + \left[\frac{f_1-f_0}{2f_1-f_0-f_2}\right] \times h$

(B) Mode = $L_1 + \left[\frac{f_1-f_0}{f_1-f_2}\right] \times h$

(C) Mode = $L_1 + \left[\frac{2f_1-f_0}{f_1+f_2}\right] \times h$

(D) Mode = $L_1 + \left[\frac{f_1-f_0}{2f_1+f_0+f_2}\right] \times h$

Q7. The mathematical properties of different statistical averages are deployed under distinct scenarios. If three separate plots yield pulse harvest rates in ratios that match a perfect mathematical progression, which structural statement holds absolutely true regarding the Geometric Mean (GM), Arithmetic Mean (AM), and Harmonic Mean (HM) computed for any highly variable non-zero positive agricultural data series?

(A) $AM \leq GM \leq HM$

(B) $AM \times HM = GM^2$

(C) $AM + HM = 2GM$

(D) $GM = \sqrt{AM^2 + HM^2}$

Q8. A set of 5 distinct soil health index scores are sorted in an increasing order as follows: x_1, x_2, x_3, x_4, x_5. The total calculated variance of this clean sequence is σ^2. If every score is multiplied by a scalar factor of -4 and then increased by a value of 10, evaluate the new variance score (σ^2_{new}) of the altered agricultural profile.

(A) $\sigma^2_{new} = 16\sigma^2 + 10$

(B) $\sigma^2_{new} = -4\sigma^2$

(C) $\sigma^2_{new} = 16\sigma^2$

(D) $\sigma^2_{new} = 4\sigma^2 + 100$

Q9. The biological proliferation rate of a beneficial soil bacterium species increases in a perfect Geometric Progression (GP). If the population count monitored on day 3 is precisely 3200 units and the count monitored on day 6 is 25600 units, calculate the definitive initial baseline population count on day 1.

(A) 400 units

(B) 800 units

(C) 600 units

(D) 200 units

Q10. An agro-forestry plantation layout is planned such that the number of poplar trees planted in successive linear rows follows a strict Arithmetic Progression (AP). If the 7$^{\text{th}}$ row contains exactly 24 trees and the 13$^{\text{th}}$ row contains 48 trees, evaluate the cumulative total number of trees planted within the first 20 rows of this agricultural setup.

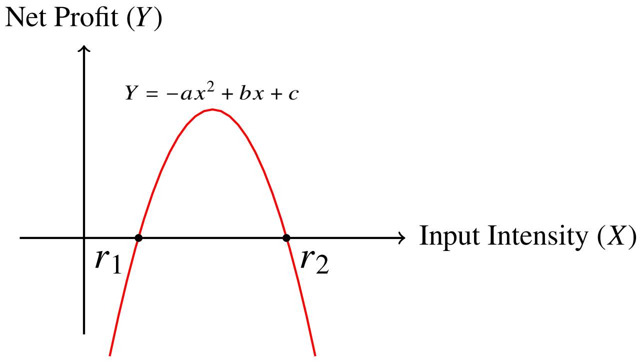
(A) 720 trees

(B) 960 trees

(C) 840 trees

(D) 680 trees

Q11. The economic net-return curve of a localized crop protection framework follows a distinct parabolic path represented by a standard quadratic equation. Analyze the graphical quadratic profile given below and evaluate the condition required for the roots (r_1, r_2) representing zero-profit thresholds such that the roots are real, rational, and distinctly unequal:



(A) Discriminant $D = b^2 - 4ac = 0$

(B) Discriminant $D = b^2 - 4ac > 0$ and is a perfect mathematical square

(C) Discriminant $D = b^2 - 4ac < 0$

(D) Discriminant $D = b^2 - 4ac > 0$ but is not a perfect square

Q12. If the roots of the quadratic profit-loss equation given by $3x^2 - kx + 12 = 0$ are completely equal in magnitude but opposite in sign within a certain physical boundary condition of agricultural input matching, determine the exact value of the coefficient constant k.

(A) $k = 12$

(B) $k = 0$

(C) $k = 6$

(D) $k = -12$

Q13. The recursive sum of an infinite geometric series tracking fertilizer decay residue is given by $S_\infty = 9$. If the initial first term of this degradation sequence (a) is evaluated as 6, find the exact value of the common ratio (r) governing the biochemical dissipation sequence.

(A) $r = \frac{1}{3}$

(B) $r = \frac{2}{3}$

(C) $r = \frac{1}{2}$

(D) $r = \frac{1}{4}$

Q14. A commercial village irrigation pond is constructed precisely in the shape of a right circular cylinder. The total depth of the cylinder structure is 14 meters and its base radius is 10 meters. If the entire internal curved surface area along with the bottom floor base needs a chemical waterproofing sealant coating, calculate the total dimensional surface area to be treated.

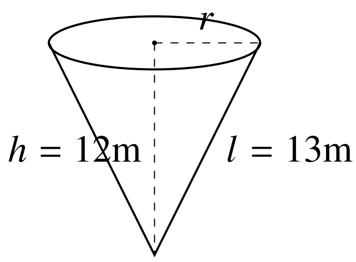
(A) 880π m^2

(B) 380π m^2

(C) 280π m^2

(D) 480π m^2

Q15. An emergency grain storage hopper has the exact geometric configuration of an inverted right circular cone. Review the dimensions marked on the structural layout diagram below. If the vertical height (h) is 12 meters and the slant height (l) is 13 meters, calculate the absolute capacity volume (V) of grain this specific agricultural hopper can store safely at full capacity:



(A) 300π m^3

(B) 100π m^3

(C) 150π m^3

(D) 400π m^3

Q16. An agricultural plot layout is split into a trapezoidal configuration where the parallel sides measure 120 meters and 160 meters respectively. If the absolute perpendicular distance between these two parallel boundaries is evaluated as 80 meters, calculate the total operational land area of this field in hectares (1 hectare = 10000 m^2).

(A) 1.12 hectares

(B) 2.24 hectares

(C) 1.40 hectares

(D) 0.98 hectares

Q17. A metal spherical float used in automatic livestock water troughs is melted down to forge identical small cylindrical pins for tractor attachments. If the original parent sphere has a radius of 6 cm and each target cylinder pin must have a base radius of 2 cm and a height of 3 cm, calculate the exact number of complete functional pins that can be fabricated.

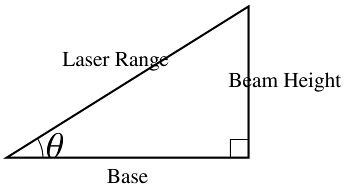
(A) 18 pins

(B) 24 pins

(C) 36 pins

(D) 12 pins

Q18. An automatic laser-guided pesticide sprayer tree-scanner evaluates a target canopy profile. The geometric layout forming the scanner ray is shown in the right-angled triangle schematic below. If θ represents the inclination tilt angle and the analytical identity value is tracked, simplify the trigonometric expressions to find the exact simplified scalar value of: $\frac{\sin^4\theta-\cos^4\theta}{\sin^2\theta-\cos^2\theta}+2\tan^2\theta\cdot\cos^2\theta-2\sin^2\theta$:



(A) 0

(B) 1

(C) 2

(D) −1

Q19. An agricultural scientist tracks the exponential chemical degradation of an old herbicide compound using algorithmic logarithmic transforms. Solve the given logarithmic equation for the concentration variable x: $\log_{10}(x+3)+\log_{10}(x-3) = \log_{10} 16$. Find the valid real-time physical solution for x.

(A) $x = \pm 5$

(B) $x = 5$

(C) $x = 25$

(D) $x = 7$

Q20. A surveyor utilizes an advanced digital clinometer telescope to measure the vertical elevation height of a high-tech grain silo tower structure. From a precise baseline reference distance of 30 meters away from the structural base wall, the inclination reading to the topmost peak point registers an angle of exactly 60°. Calculate the precise height of the silo tower.

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

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

(C) 30 meters

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

Detailed Solutions

Q1.

Solution

Concept: The standard deviation (σ) is a measure of dispersion that satisfies distinct mathematical properties under linear transformations. It is completely independent of changes of origin (adding or subtracting a constant) but is directly affected by changes of scale (multiplying or dividing by a constant).

Solution:

Let's analyze the structural transformation applied to each individual data point:

$$y_i = \frac{3x_i - 5}{2} = \frac{3}{2}x_i - \frac{5}{2}$$

(a) The term $-\frac{5}{2}$ represents a shift in the origin. Since standard deviation measures the distance between data points, shifting all points by a constant value does not alter the spread of the dataset.

(b) The term $\frac{3}{2}$ represents a scale transformation factor. If every individual observation is scaled by a constant factor c, the resulting standard deviation is multiplied by the absolute value of that factor: $|c|$.

(c) Extracting the scale factor $c = \frac{3}{2}$, we can link the old and new standard deviations:

$$\sigma_y = |c| \cdot \sigma_x = \frac{3}{2}\sigma_x$$

Final Answer: $\boxed{\sigma_y = \frac{3}{2}\sigma_x}$

Answer: (C)

Go Back to Question 1

Q2.

Solution

Concept: For asymmetrical, skewed frequency distributions, Karl Pearson derived an empirical mathematical relationship that approximates the relative positions of the three primary measures of central tendency (mean, median, and mode).

Solution:

Let's calculate the median using the standard Pearsonian empirical formula:

(a) State the empirical mathematical relationship linking mean, median, and mode:

$$\text{Mean} - \text{Mode} = 3(\text{Mean} - \text{Median})$$

(b) Substitute the given trial dataset parameters (Mean = 31.2 q/ha and Mode = 42.5 q/ha) into the approximation formula:

$$31.2 - 42.5 = 3(31.2 - \text{Median})$$

$$-11.3 = 3(31.2 - \text{Median})$$

(c) Divide both sides by 3 to isolate the inner term:

$$-3.7667 = 31.2 - \text{Median}$$

(d) Rearrange the terms to solve directly for the median value:

$$\text{Median} = 31.2 + 3.7667 = 34.9667 \text{ q/ha} \approx 34.97 \text{ q/ha}$$

Final Answer: $\boxed{34.97 \text{ q/ha}}$

Answer: (B)

Go Back to Question 2

Q3.

Solution

Concept: An ogive is a cumulative frequency polygon graph used to analyze continuous distributions. The 'less-than' ogive tracks the accumulation of frequencies from lower to upper bounds, while the 'more-than' ogive tracks the remaining frequency totals down to zero.

Solution:

Let's evaluate the structural geometry of the cumulative frequency intersection:

(a) The 'less-than' ogive curve climbs monotonically from 0 up to the total number of observations, N.

(b) The 'more-than' ogive curve falls monotonically from the total count N down to 0.

(c) These two curves intersect at a specific location on the coordinate space where the accumulated frequency equals exactly half of the total population: $y = \frac{N}{2}$.

(d) Dropping a perpendicular line from this intersection point directly down to the horizontal X-axis identifies the exact boundary value that splits the frequency distribution into two equal halves. By definition, this value is the **Median Value (M_e)**.

Final Answer: $\boxed{\text{Median Value } (M_e)}$

Answer: (B)

Go Back to Question 3

Q4.

Solution

Concept: The Coefficient of Variation (CV) expresses the standard deviation (σ) as a percentage of the arithmetic mean ($\bar{x}$). This allows for comparison of variability across datasets with different scales.

$$CV = \left(\frac{\sigma}{\bar{x}}\right) \times 100$$

Solution:
Let's find the arithmetic mean step-by-step from the given metrics:

(a) Write out the formula for the sample standard deviation (σ) using the sum of squares of deviations:

$$\sigma = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n}}$$

(b) Substitute the given sum of squares (360) and the sample size ($n = 10$ strips):

$$\sigma = \sqrt{\frac{360}{10}} = \sqrt{36} = 6$$

(c) Set up the CV equation using the calculated standard deviation ($\sigma = 6$) and the target coefficient value ($CV = 20\%$):

$$20 = \left(\frac{6}{\bar{x}}\right) \times 100$$

(d) Rearrange the equation to solve for the arithmetic mean ($\bar{x}$):

$$20\bar{x} = 600 \implies \bar{x} = \frac{600}{20} = 30$$

Final Answer: $\boxed{\bar{x} = 30}$

Answer: (B)

Go Back to Question 4

Q5.

Solution

Concept: Mean Deviation (MD) measures the average of the absolute differences between individual data points and a central value, such as the arithmetic mean.

$$MD = \frac{\sum |x_i - \bar{x}|}{n}$$

Solution:
Let's compute the mean deviation step-by-step for the milk yield dataset:

(a) Calculate the arithmetic mean ($\bar{x}$) of the 8 dairy clusters ($n = 8$):

$$\bar{x} = \frac{12 + 18 + 10 + 22 + 14 + 16 + 20 + 24}{8} = \frac{130}{8} = 16.25 \text{ liters}$$

(b) Calculate the absolute deviation $|x_i - \bar{x}|$ for each data point:

$$|12 - 16.25| = 4.25, \quad |18 - 16.25| = 1.75, \quad |10 - 16.25| = 6.25, \quad |22 - 16.25| = 5.75$$
$$|14 - 16.25| = 2.25, \quad |16 - 16.25| = 0.25, \quad |20 - 16.25| = 3.75, \quad |24 - 16.25| = 7.75$$

(c) Sum these absolute deviations:

$$\sum |x_i - \bar{x}| = 4.25 + 1.75 + 6.25 + 5.75 + 2.25 + 0.25 + 3.75 + 7.75 = 32.0 \text{ liters}$$

(d) Divide the sum by the total number of observations ($n = 8$) to find the Mean Deviation:

$$MD = \frac{32.0}{8} = 4.00 \text{ liters}$$

Final Answer: $\boxed{4.00 \text{ liters}}$

Answer: (B)

Go Back to Question 5

Q6.

Solution

Concept: For grouped frequency data organized in a continuous histogram, the mode can be located geometrically at the intersection of lines crossing from the peak corners of the modal class bar to the opposite corners of its adjacent neighbor bars.

Solution:

Let's identify the algebraic interpolation formula that corresponds to this geometric setup:

(a) The peak bar represents the modal class, with a lower boundary limit denoted as L_1 and a class interval width denoted as h.

(b) Let f_1 represent the frequency of the modal class itself, f_0 represent the frequency of the preceding class, and f_2 represent the frequency of the succeeding class.

(c) The horizontal distance from the lower limit L_1 to the geometric intersection point is calculated by weighting the class interval relative to the differences in adjacent frequencies:

$$\text{Mode} = L_1 + \left[\frac{f_1 - f_0}{(f_1 - f_0) + (f_1 - f_2)}\right] \times h$$

(d) Simplifying the denominator terms yields the standard statistical mode equation:

$$\text{Mode} = L_1 + \left[\frac{f_1 - f_0}{2f_1 - f_0 - f_2}\right] \times h$$

Final Answer: $\boxed{\text{Mode} = L_1 + \left[\frac{f_1 - f_0}{2f_1 - f_0 - f_2}\right] \times h}$

Answer: (A)

Go Back to Question 6

Q7.

Solution

Concept: Mathematical averages possess clear structural relationships when evaluated on the same positive data series. For any set of positive numbers, the Pythagorean means follow a strict inequality chain: $AM \geq GM \geq HM$.

Solution:

Let's analyze the mathematical links between these three averages:

(a) The equality $AM = GM = HM$ holds true only if all observations in the dataset are identical. If there is any variability among positive observations, the inequality becomes strict: $AM > GM > HM$.

(b) A core algebraic property of these means is that for any two positive values (or values in a perfect mathematical progression), the Geometric Mean is the exact geometric mean of the Arithmetic and Harmonic Means.

(c) This relationship can be expressed with the following equation:

$$\frac{AM}{GM} = \frac{GM}{HM} \implies AM \times HM = GM^2$$

Final Answer: $\boxed{AM \times HM = GM^2}$

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept: Statistical variance (σ^2) measures the average squared distance of data points from their mean. Like standard deviation, variance is unaffected by shifting the origin (adding or subtracting a constant) but is sensitive to scaling (multiplying or dividing by a constant).

Solution:

Let's evaluate the mathematical effect of this linear transformation on the variance score:

(a) The original dataset has a baseline variance of σ^2. The transformation rule applied to each score is:

$$x_{new} = -4x_i + 10$$

(b) Adding a constant (+10) shifts all values equally, which does not alter their relative spacing or affect the variance.

(c) Multiplying each observation by a scalar factor $c = -4$ scales the deviations from the mean by that same factor. Because variance squares these deviations, the scale factor is squared when brought outside the variance operator:

$$\sigma^2_{new} = c^2 \cdot \sigma^2$$

(d) Substitute $c = -4$ into the equation:

$$\sigma^2_{new} = (-4)^2 \cdot \sigma^2 = 16\sigma^2$$

Final Answer: $\boxed{\sigma^2_{new} = 16\sigma^2}$

Answer: (C)

Go Back to Question 8

Q9.

Solution

Concept: In a Geometric Progression (GP), terms increase or decrease by a constant multiplier known as the common ratio (r). The general formula for the n^{th} term of a geometric sequence is:

$$a_n = a \cdot r^{n-1}$$

Solution:
Let's isolate the initial baseline population parameters step-by-step:

(a) Set up the expressions for the population counts on day 3 and day 6 using the general formula:

$$a_3 = a \cdot r^2 = 3200$$

$$a_6 = a \cdot r^5 = 25600$$

(b) Divide the day 6 equation by the day 3 equation to eliminate the first term coefficient (a) and solve for r:

$$\frac{a \cdot r^5}{a \cdot r^2} = \frac{25600}{3200} \implies r^3 = 8 \implies r = \sqrt[3]{8} = 2$$

(c) Substitute the common ratio ($r = 2$) back into the day 3 equation to find the first term (a), which corresponds to the day 1 population:

$$a \cdot (2)^2 = 3200 \implies 4a = 3200 \implies a = \frac{3200}{4} = 800 \text{ units}$$

Final Answer: $\boxed{800 \text{ units}}$

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept: In an Arithmetic Progression (AP), successive terms differ by a constant value known as the common difference (d). The general formula for the n^{th} term is $a_n = a + (n-1)d$, and the cumulative sum of the first n terms is given by:

$$S_n = \frac{n}{2}[2a + (n-1)d]$$

Solution:
Let's find the sequence parameters to calculate the cumulative sum:

(a) Write out the linear system of equations for the 7^{th} and 13^{th} rows:

$$a_7 = a + 6d = 24$$

$$a_{13} = a + 12d = 48$$

(b) Subtract the first equation from the second to find the common difference (d):

$$(a + 12d) - (a + 6d) = 48 - 24 \implies 6d = 24 \implies d = 4$$

(c) Substitute $d = 4$ back into the a_7 equation to find the initial term (a):

$$a + 6(4) = 24 \implies a + 24 = 24 \implies a = 0$$

(d) Calculate the cumulative sum of trees across the first 20 rows ($n = 20$):

$$S_{20} = \frac{20}{2}[2(0) + (20-1)4] = 10 \cdot [0 + 19 \cdot 4] = 10 \cdot 76 = 720 \text{ trees}$$

Final Answer: 720 trees

Answer: (A)

Go Back to Question 10

Q11.

Solution

Concept: The roots of a quadratic equation $ax^2 + bx + c = 0$ represent the points where the parabola crosses the horizontal axis. The nature of these roots is determined by the discriminant, $D = b^2 - 4ac$.

Solution:

Let's analyze the mathematical conditions for the discriminant:

(a) If $D < 0$, the roots are complex conjugates, meaning the curve does not intersect the X-axis.

(b) If $D = 0$, the roots are real and equal, meaning the parabola's vertex touches the X-axis at a single point.

(c) If $D > 0$, the roots are real and unequal, meaning the curve intersects the axis at two distinct points, as shown in the diagram.

(d) For these real, distinct roots to also be **rational** numbers (assuming the coefficients a, b, c are rational), the value under the radical in the quadratic formula must simplify completely. This requires the discriminant $D = b^2 - 4ac$ to be a **perfect mathematical square**.

Final Answer: Discriminant $D = b^2 - 4ac > 0$ and is a perfect mathematical square

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept: For any standard quadratic equation $ax^2 + bx + c = 0$ with roots α and β, the sum of those roots is mathematically determined by the coefficients of the first two terms: $\alpha + \beta = -\frac{b}{a}$.

Solution:

Let's evaluate the given root condition for the equation $3x^2 - kx + 12 = 0$:

(a) Identify the coefficient terms from the quadratic equation:

$$a = 3, \quad b = -k, \quad c = 12$$

(b) We are given that the roots are equal in magnitude but opposite in sign. Let the first root be α. The second root is then $-\alpha$.

(c) Calculate the sum of these two roots:

$$\text{Sum} = \alpha + (-\alpha) = 0$$

(d) Use the coefficient relationship for the sum of the roots to solve for k:

$$\alpha + \beta = -\frac{b}{a} \implies 0 = -\frac{(-k)}{3}$$

$$0 = \frac{k}{3} \implies k = 0$$

Final Answer: $\boxed{k = 0}$

Answer: (B)

Go Back to Question 12

Q13.

Solution

Concept: The cumulative sum of an infinite geometric series whose common ratio satisfies the convergence condition $|r| < 1$ is calculated using the following formula:

$$S_\infty = \frac{a}{1-r}$$

Solution:
Let's find the common ratio (r) from the given values:

(a) Identify the values given for the sequence:

$$S_\infty = 9 \quad \text{and} \quad a = 6$$

(b) Substitute these values into the infinite sum formula:

$$9 = \frac{6}{1-r}$$

(c) Rearrange the terms to isolate the ratio component:

$$9(1-r) = 6 \implies 9 - 9r = 6$$

(d) Solve for r:

$$9r = 9 - 6 \implies 9r = 3 \implies r = \frac{3}{9} = \frac{1}{3}$$

Final Answer: $\boxed{r = \frac{1}{3}}$

Answer: (A)

Go Back to Question 13

Q14.

Solution

Concept: The total surface area of an open cylindrical container, such as a pond or tank, equals the curved surface area of the vertical walls plus the surface area of the flat bottom circular base.

$$\text{Area}_{\text{total}} = 2\pi r h + \pi r^2$$

Solution:

Let's calculate the surface area using the dimensions of the cylinder ($r = 10$ m, $h = 14$ m):

(a) Calculate the curved surface area (CSA) of the cylindrical walls:

$$CSA = 2\pi \cdot (10) \cdot (14) = 280\pi \text{ m}^2$$

(b) Calculate the area of the flat circular bottom base:

$$\text{Area}_{\text{base}} = \pi r^2 = \pi \cdot (10)^2 = 100\pi \text{ m}^2$$

(c) Sum the wall area and the base area to find the total area requiring treatment:

$$\text{Area}_{\text{total}} = 280\pi + 100\pi = 380\pi \text{ m}^2$$

Final Answer: $\boxed{380\pi \text{ m}^2}$

Answer: (B)

Go Back to Question 14

Q15.

Solution

Concept: The volume (V) of a right circular cone is calculated from its vertical height (h) and base radius (r). The internal dimensions follow the Pythagorean theorem, linking vertical height, radius, and slant height (l): $r^2 + h^2 = l^2$.

$$V = \frac{1}{3}\pi r^2 h$$

Solution:
Let's determine the base radius to calculate the hopper's capacity:

(a) Find the base radius (r) using the vertical height ($h = 12$ m) and slant height ($l = 13$ m):

$$r^2 + 12^2 = 13^2 \implies r^2 + 144 = 169$$

$$r^2 = 169 - 144 = 25 \implies r = 5 \text{ meters}$$

(b) Substitute the radius ($r = 5$ m) and vertical height ($h = 12$ m) into the cone volume formula:

$$V = \frac{1}{3}\pi \cdot (5)^2 \cdot 12$$

(c) Simplify the expression:

$$V = \frac{1}{3}\pi \cdot 25 \cdot 12 = \pi \cdot 25 \cdot 4 = 100\pi \text{ m}^3$$

Final Answer: $\boxed{100\pi \text{ m}^3}$

Answer: (B)

Go Back to Question 15

Q16.

Solution

Concept: The area (A) of a trapezoid is calculated by multiplying the average of its parallel sides (a and b) by the perpendicular height (h) between them.

$$A = \frac{1}{2}(a + b) \cdot h$$

Solution:
Let's compute the land area in square meters and convert it to hectares:

(a) Substitute the given field dimensions ($a = 120$ m, $b = 160$ m, and $h = 80$ m) into the area formula:

$$A = \frac{1}{2}(120 + 160) \cdot 80 = \frac{1}{2}(280) \cdot 80$$

$$A = 140 \cdot 80 = 11200 \text{ m}^2$$

(b) Convert the area from square meters to hectares using the conversion factor (1 hectare = $10,000 \text{ m}^2$):

$$\text{Area in Hectares} = \frac{11200 \text{ m}^2}{10000 \text{ m}^2/\text{ha}} = 1.12 \text{ hectares}$$

Final Answer: 1.12 hectares

Answer: (A)

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Q17.

Solution

Concept: When solid geometric objects are melted down and reshaped without any loss of material, the total volume remains constant. The number of new objects can be found by dividing the total volume of the original object by the volume of a single new object.

Solution:

Let's calculate the volumes of the sphere and a single cylinder pin:

(a) Calculate the volume of the original sphere ($R = 6$ cm):

$$V_{\text{sphere}} = \frac{4}{3}\pi R^3 = \frac{4}{3}\pi \cdot (6)^3 = \frac{4}{3}\pi \cdot 216 = 4 \cdot 72 \cdot \pi = 288\pi \text{ cm}^3$$

(b) Calculate the volume of a single cylindrical pin ($r = 2$ cm, $h = 3$ cm):

$$V_{\text{cylinder}} = \pi r^2 h = \pi \cdot (2)^2 \cdot 3 = \pi \cdot 4 \cdot 3 = 12\pi \text{ cm}^3$$

(c) Divide the total sphere volume by the pin volume to find the number of pins that can be made:

$$\text{Number of Pins} = \frac{V_{\text{sphere}}}{V_{\text{cylinder}}} = \frac{288\pi}{12\pi} = \frac{288}{12} = 24 \text{ pins}$$

Final Answer: 24 pins

Answer: (B)

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Q18.

Solution

Concept: Trigonometric expressions can be simplified using fundamental identities, such as the Pythagorean identity $\sin^2\theta + \cos^2\theta = 1$ and the quotient identity $\tan\theta = \frac{\sin\theta}{\cos\theta}$.

Solution:

Let's simplify the given expression step-by-step:

$$\text{Expression} = \frac{\sin^4\theta - \cos^4\theta}{\sin^2\theta - \cos^2\theta} + 2\tan^2\theta \cdot \cos^2\theta - 2\sin^2\theta$$

(a) Factor the numerator of the first term as a difference of squares:

$$\sin^4\theta - \cos^4\theta = (\sin^2\theta - \cos^2\theta)(\sin^2\theta + \cos^2\theta)$$

(b) Substitute this back into the first term to cancel out the denominator:

$$\frac{(\sin^2\theta - \cos^2\theta)(\sin^2\theta + \cos^2\theta)}{\sin^2\theta - \cos^2\theta} = \sin^2\theta + \cos^2\theta = 1$$

(c) Simplify the second term by rewriting $\tan^2\theta$:

$$2\tan^2\theta \cdot \cos^2\theta = 2\left(\frac{\sin^2\theta}{\cos^2\theta}\right) \cdot \cos^2\theta = 2\sin^2\theta$$

(d) Combine the simplified terms:

$$\text{Expression} = 1 + 2\sin^2\theta - 2\sin^2\theta = 1$$

Final Answer: $\boxed{1}$

Answer: (B)

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Q19.

Solution

Concept: Logarithmic equations can be simplified using standard logarithm properties, such as the product rule: $\log_b(M) + \log_b(N) = \log_b(M \cdot N)$. When solving, any solutions that result in a negative argument inside a logarithm must be excluded.

Solution:

Let's solve the equation for x:

$$\log_{10}(x+3) + \log_{10}(x-3) = \log_{10} 16$$

(a) Apply the product rule to combine the logarithms on the left side:

$$\log_{10}[(x+3)(x-3)] = \log_{10} 16$$

$$\log_{10}(x^2 - 9) = \log_{10} 16$$

(b) Since the bases are identical, equate the arguments:

$$x^2 - 9 = 16 \implies x^2 = 25 \implies x = \pm 5$$

(c) Check the validity of the solutions:

- For $x = 5$: the arguments are $(5+3) = 8$ and $(5-3) = 2$. Both are positive, so $x = 5$ is a valid solution.
- For $x = -5$: the arguments become negative, which is undefined for real logarithms.

Final Answer: $\boxed{x = 5}$

Answer: (B)

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Q20.

Solution

Concept: The height of a vertical structure can be determined from a distance using the tangent trigonometric ratio in a right-angled triangle, which links the angle of elevation (θ) to the opposite side (height) and adjacent side (distance).

$$\tan\theta = \frac{\text{Opposite}}{\text{Adjacent}} = \frac{\text{Height}}{\text{Base Distance}}$$

Solution:
Let's calculate the height of the silo tower using the given measurements:

(a) Identify the given values from the survey:

$$\text{Base Distance} = 30 \text{ meters}, \quad \theta = 60^\circ$$

(b) Set up the tangent ratio equation:

$$\tan(60^\circ) = \frac{\text{Height}}{30}$$

(c) Substitute the known value $\tan(60^\circ) = \sqrt{3}$ into the equation:

$$\sqrt{3} = \frac{\text{Height}}{30}$$

(d) Solve for the height of the tower:

$$\text{Height} = 30\sqrt{3} \text{ meters}$$

Final Answer: $\boxed{30\sqrt{3} \text{ meters}}$

Answer: (B)

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Answer Key

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