SAAT Mathematics

Sample Paper – 1

Duration: 40 Minutes **Maximum Marks: 40**

Instructions

- This paper contains **40** Multiple Choice Questions (Single Correct Answer), modelled on the Mathematics section of the **SAAT** (Siksha 'O' Anusandhan Admission Test).
- Each correct answer carries **+1 mark**. There is **no negative marking** for incorrect or unattempted answers.
- Only **one** option is correct. Attempt every question, since wrong answers are not penalised.
- Use of mobile phones, calculators, or other electronic gadgets is strictly prohibited.

Q1. If $A = \{1, 2, 3\}$ and $B = \{2, 3, 4, 5\}$, then the number of elements in $A \cap B$ is

(A) 1

(B) 2

(C) 3

(D) 4

Q2. If $f(x) = 2x + 3$, then the inverse function $f^{-1}(x)$ is

(A) $\frac{x+3}{2}$

(B) $2x - 3$

(C) $\frac{x-3}{2}$

(D) $\frac{3-x}{2}$

Q3. The modulus of the complex number $z = 3 + 4i$ is

(A) 5

(B) 7

(C) 25

(D) 1

Q4. If ω is a non-real cube root of unity, then $1 + \omega + \omega^2$ equals

(A) 1

(B) 3

(C) ω

(D) 0

Q5. The sum of the roots of the quadratic equation $2x^2 - 6x + 4 = 0$ is

(A) 6

(B) 3

(C) 2

(D) -3

Q6. If A is a 2×3 matrix and B is a 3×2 matrix, then the order of the product matrix AB is

(A) 2×2

(B) 3×3

(C) 2×3

(D) 3×2

Q7. The value of the determinant $\begin{vmatrix} 2 & 3 \\ 1 & 4 \end{vmatrix}$ is

(A) 11

(B) -5

(C) 5

(D) 8

Q8. If A is a 3×3 matrix with $|A| = 2$, then $|\text{adj } A|$ is

(A) 2

(B) 8

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

(D) 4

Q9. The number of ways in which 4 distinct books can be arranged on a shelf is

(A) 12

(B) 24

(C) 4

(D) 16

Q10. The value of ${}^5C_2$ is

(A) 10

(B) 20

(C) 5

(D) 25

Q11. The number of terms in the binomial expansion of $(x + y)^7$ is

(A) 6

(B) 9

(C) 8

(D) 7

Q12. The 10th term of the arithmetic progression $2, 5, 8, \dots$ is

(A) 32

(B) 27

(C) 20

(D) 29

Q13. The sum to infinity of the geometric progression $1 + \frac{1}{2} + \frac{1}{4} + \cdots$ is

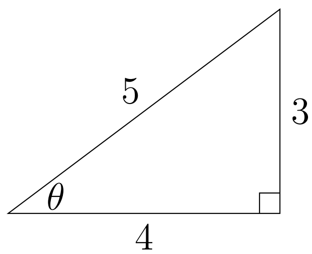
(A) 2

(B) 1

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

(D) ∞

Q14. In the right-angled triangle shown, $\sin\theta = \frac{3}{5}$. The value of $\cos\theta$ is



(A) $\frac{3}{5}$

(B) $\frac{4}{5}$

(C) $\frac{5}{3}$

(D) $\frac{3}{4}$

Q15. The general solution of the trigonometric equation $\sin\theta = 0$ is ($n \in \mathbb{Z}$)

(A) $2n\pi$

(B) $\frac{n\pi}{2}$

(C) $n\pi$

(D) $(2n+1)\frac{\pi}{2}$

Q16. The principal value of $\sin^{-1}\left(\frac{1}{2}\right)$ is

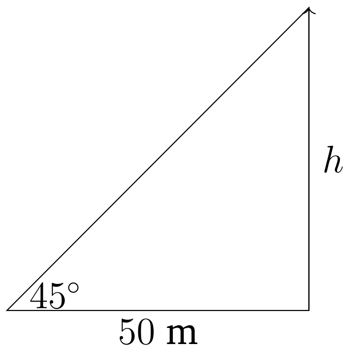
(A) $\frac{\pi}{3}$

(B) $\frac{\pi}{2}$

(C) $\frac{\pi}{4}$

(D) $\frac{\pi}{6}$

Q17. The angle of elevation of the top of a tower from a point 50 m from its base is $45°$, as shown. The height of the tower is



(A) 50 m

(B) $50\sqrt{3}$ m

(C) 25 m

(D) 100 m

Q18. The value of $\lim_{x \to 0} \dfrac{\sin x}{x}$ is

(A) 0

(B) 1

(C) ∞

(D) does not exist

Q19. At the point $x = 0$, the function $f(x) = |x|$ is

(A) discontinuous

(B) differentiable

(C) neither continuous nor differentiable

(D) continuous but not differentiable

Q20. If $y = x^3$, then the value of $\dfrac{dy}{dx}$ at $x = 2$ is

(A) 6

(B) 8

(C) 12

(D) 3

Q21. The derivative of e^{2x} with respect to x is

(A) $2e^{2x}$

(B) e^{2x}

(C) $\frac{1}{2}e^{2x}$

(D) $2x\,e^{2x-1}$

Q22. The slope of the tangent to the curve $y = x^2$ at the point where $x = 1$ is

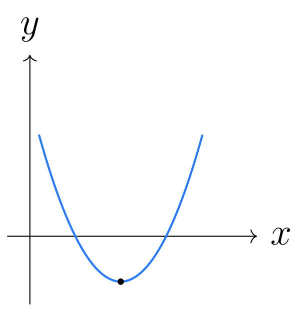
(A) 1

(B) 2

(C) 4

(D) $\frac{1}{2}$

Q23. The function $f(x) = x^2 - 4x + 3$, whose graph is shown, attains its minimum value at $x =$



(A) 0

(B) 1

(C) 2

(D) 4

Q24. The value of $\int x^2\,dx$ is

(A) $2x + C$

(B) $x^3 + C$

(C) $3x^3 + C$

(D) $\frac{x^3}{3} + C$

Q25. The value of $\int \frac{1}{x}\,dx$ (for $x > 0$) is

(A) $-\frac{1}{x^2} + C$

(B) $\ln|x| + C$

(C) $x + C$

(D) $\frac{1}{x^2} + C$

Q26. The value of $\int_0^1 2x\,dx$ is

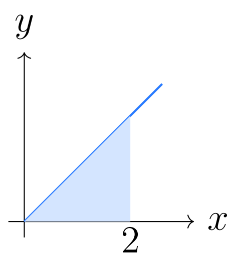
(A) 1

(B) 2

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

(D) 0

Q27. The area of the shaded region bounded by the line $y = x$, the x-axis and $x = 2$, shown below, is



(A) 4

(B) 1

(C) 8

(D) 2

Q28. The order of the differential equation $\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^3 + y = 0$ is

(A) 0

(B) 1

(C) 2

(D) 3

Q29. The general solution of the differential equation $\frac{dy}{dx} = y$ is

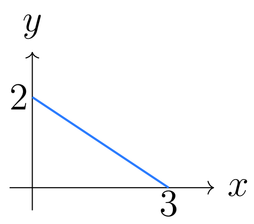
(A) $y = Ce^x$

(B) $y = Cx$

(C) $y = x + C$

(D) $y = Ce^{-x}$

Q30. The slope of the straight line $2x + 3y = 6$, shown below, is



(A) $\frac{2}{3}$

(B) $-\frac{2}{3}$

(C) $\frac{3}{2}$

(D) $-\frac{3}{2}$

Q31. The perpendicular distance of the origin from the line $3x + 4y - 10 = 0$ is

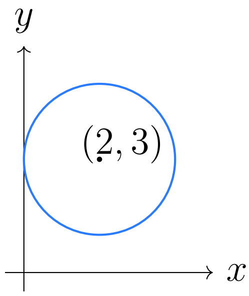
(A) 10

(B) 5

(C) 2

(D) 1

Q32. The radius of the circle $x^2 + y^2 - 4x - 6y + 9 = 0$, shown below, is



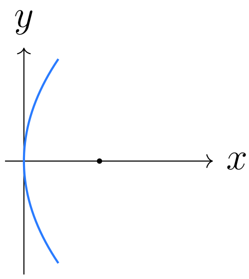
(A) 9

(B) 3

(C) $\sqrt{13}$

(D) 2

Q33. The focus of the parabola $y^2 = 8x$, shown below, is



(A) $(2, 0)$

(B) $(0, 2)$

(C) $(4, 0)$

(D) $(-2, 0)$

Q34. The eccentricity of the hyperbola $\dfrac{x^2}{16} - \dfrac{y^2}{9} = 1$ is

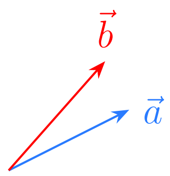
(A) $\frac{3}{4}$

(B) $\frac{5}{4}$

(C) $\frac{4}{5}$

(D) $\frac{5}{3}$

Q35. For the vectors $\vec{a} = \hat{i} + 2\hat{j} + 2\hat{k}$ and $\vec{b} = 2\hat{i} + 2\hat{j} + \hat{k}$, the scalar (dot) product $\vec{a} \cdot \vec{b}$ is



(A) 4

(B) 6

(C) 8

(D) 10

Q36. If $|\vec{a}| = 2$, $|\vec{b}| = 3$ and the angle between $\vec{a}$ and $\vec{b}$ is $90°$, then $|\vec{a} \times \vec{b}|$ is

(A) 0

(B) 2

(C) 3

(D) 6

Q37. The distance between the points $(1, 2, 3)$ and $(4, 6, 3)$ in space is

(A) 5

(B) 7

(C) 25

(D) $\sqrt{34}$

Q38. The arithmetic mean of the observations $2, 4, 6, 8, 10$ is

(A) 5

(B) 6

(C) 4

(D) 8

Q39. A card is drawn at random from a well-shuffled pack of 52 playing cards. The probability that it is an ace is

(A) $\frac{1}{52}$

(B) $\frac{1}{4}$

(C) $\frac{1}{13}$

(D) $\frac{4}{13}$

Q40. A fair die is rolled once. The probability of getting a number greater than 4 is

(A) $\frac{1}{6}$

(B) $\frac{1}{2}$

(C) $\frac{2}{3}$

(D) $\frac{1}{3}$

Detailed Solutions

Q1.

Solution

Concept — Intersection of sets: $A \cap B$ contains the elements common to both sets.

Step 1 — Write the two sets: $A = \{1, 2, 3\}$.

Step 2 — Write the second set: $B = \{2, 3, 4, 5\}$.

Step 3 — Check each element of A: Is $1 \in B$? No.

Step 4 — Continue checking: Is $2 \in B$? Yes, keep 2.

Step 5 — Continue checking: Is $3 \in B$? Yes, keep 3.

Step 6 — Collect the common elements: $A \cap B = \{2, 3\}$.

Step 7 — Count them: The set $\{2, 3\}$ has 2 elements, so $n(A \cap B) = 2$.

Why other options are wrong: 1 misses an element; 3 and 4 count non-common elements.

Final Answer: $n(A \cap B) = 2 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — Inverse function: Put $y = f(x)$, solve for x in terms of y, then swap.

Step 1 — Write the function as an equation: $y = 2x + 3$.

Step 2 — Move the constant to the left: Subtract 3 from both sides: $y - 3 = 2x$.

Step 3 — Isolate x: Divide both sides by 2: $x = \dfrac{y-3}{2}$.

Step 4 — Swap the variables: Replace y by x to write the inverse: $f^{-1}(x) = \dfrac{x-3}{2}$.

Why other options are wrong: $\frac{x+3}{2}$ has the wrong sign; $2x - 3$ is not an inverse; $\frac{3-x}{2}$ negates wrongly.

Final Answer: $f^{-1}(x) = \dfrac{x-3}{2} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q2

Q3.

Solution

Concept — Modulus of a complex number: $|a+bi| = \sqrt{a^2+b^2}$.

Step 1 — Identify the parts: Here $a = 3$ (real part) and $b = 4$ (imaginary part).

Step 2 — Substitute into the formula: $|3+4i| = \sqrt{3^2+4^2}$.

Step 3 — Square each part: $3^2 = 9$ and $4^2 = 16$, so $|z| = \sqrt{9+16}$.

Step 4 — Add inside the root: $9 + 16 = 25$, so $|z| = \sqrt{25}$.

Step 5 — Take the square root: $\sqrt{25} = 5$.

Why other options are wrong: 7 adds the parts; 25 forgets the square root; 1 subtracts.

Final Answer: $|z| = 5 \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — Cube roots of unity: The three cube roots of unity are $1, \omega, \omega^2$ and their sum is zero.

Step 1 — Recall the defining equation: The cube roots of unity satisfy $x^3 = 1$, i.e. $x^3 - 1 = 0$.

Step 2 — Factorise: $x^3 - 1 = (x-1)(x^2+x+1) = 0$.

Step 3 — Identify ω: The non-real roots ω and ω^2 satisfy $x^2+x+1 = 0$, i.e. $\omega^2 + \omega + 1 = 0$.

Step 4 — Rearrange: Therefore $1 + \omega + \omega^2 = 0$.

Why other options are wrong: 1, 3 and ω contradict the standard sum-of-roots property.

Final Answer: $1 + \omega + \omega^2 = 0 \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Sum of roots: For $ax^2 + bx + c = 0$, the sum of roots is $-\frac{b}{a}$.

Step 1 — Compare with the standard form: The equation is $2x^2 - 6x + 4 = 0$.

Step 2 — Read off the coefficients: $a = 2$, $b = -6$, $c = 4$.

Step 3 — Write the sum-of-roots formula: Sum $= -\frac{b}{a}$.

Step 4 — Substitute the values: Sum $= -\frac{-6}{2}$.

Step 5 — Simplify the sign: $-\frac{-6}{2} = \frac{6}{2}$.

Step 6 — Divide: $\frac{6}{2} = 3$.

Why other options are wrong: 6 forgets to divide by a; 2 is the product; -3 has the wrong sign.

Final Answer: Sum of roots $= 3 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q5

Q6.

Solution

Concept — Order of a matrix product: $(m \times n)(n \times p)$ gives an $m \times p$ matrix, provided the inner dimensions match.

Step 1 — Write the orders: A is 2×3 and B is 3×2.

Step 2 — Check the inner dimensions: The inner numbers are 3 and 3; they are equal, so AB exists.

Step 3 — Take the outer dimensions: The product takes the first number of A and the last number of B: 2 and 2.

Step 4 — Write the order of AB: The order is 2×2.

Why other options are wrong: 3×3, 2×3 and 3×2 misread the outer dimensions.

Final Answer: Order of AB is $2 \times 2 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q6

Q7.

Solution

Concept — 2×2 determinant: $\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$.

Step 1 — Read off the entries: $a = 2$, $b = 3$, $c = 1$, $d = 4$.

Step 2 — Write the formula: Determinant $= ad - bc$.

Step 3 — Substitute: $= (2)(4) - (3)(1)$.

Step 4 — Multiply each product: $(2)(4) = 8$ and $(3)(1) = 3$, so $= 8 - 3$.

Step 5 — Subtract: $8 - 3 = 5$.

Why other options are wrong: 11 adds the products; -5 reverses the subtraction; 8 keeps only ad.

Final Answer: Determinant $= 5 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Determinant of adjoint: For an $n \times n$ matrix, $|\text{adj } A| = |A|^{n-1}$.

Step 1 — Note the size: A is a 3×3 matrix, so $n = 3$.

Step 2 — Compute the exponent: $n - 1 = 3 - 1 = 2$.

Step 3 — Write the formula with this exponent: $|\text{adj } A| = |A|^2$.

Step 4 — Substitute $|A| = 2$: $|\text{adj } A| = 2^2$.

Step 5 — Evaluate the power: $2^2 = 4$.

Why other options are wrong: 2 uses power 1; 8 uses power 3; $\frac{1}{2}$ is $|A^{-1}|$.

Final Answer: $|\text{adj } A| = 4 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Arrangement of distinct objects: n distinct objects can be arranged in $n!$ ways.

Step 1 — Identify n: There are 4 distinct books, so $n = 4$.

Step 2 — Write the number of arrangements: Number of ways $= 4!$.

Step 3 — Expand the factorial: $4! = 4 \times 3 \times 2 \times 1$.

Step 4 — Multiply step by step: $4 \times 3 = 12$, then $12 \times 2 = 24$, then $24 \times 1 = 24$.

Why other options are wrong: 12 is $\frac{4!}{2}$; 4 and 16 are not factorials of 4.

Final Answer: Number of arrangements $= 24 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q9

Q10.

Solution

Concept — Combinations: ${}^nC_r = \dfrac{n!}{r!(n-r)!}$.

Step 1 — Identify n and r: $n = 5$ and $r = 2$.

Step 2 — Substitute into the formula: ${}^5C_2 = \dfrac{5!}{2!\,(5-2)!} = \dfrac{5!}{2!\,3!}$.

Step 3 — Cancel $3!$: Write $5! = 5 \times 4 \times 3!$, so ${}^5C_2 = \dfrac{5 \times 4 \times 3!}{2!\,3!} = \dfrac{5 \times 4}{2!}$.

Step 4 — Expand $2!$: $2! = 2 \times 1 = 2$, so ${}^5C_2 = \dfrac{5 \times 4}{2}$.

Step 5 — Multiply the numerator: $5 \times 4 = 20$, so ${}^5C_2 = \dfrac{20}{2}$.

Step 6 — Divide: $\dfrac{20}{2} = 10$.

Why other options are wrong: 20 forgets to divide by $2!$; 5 and 25 are unrelated.

Final Answer: ${}^5C_2 = 10 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q10

Q11.

Solution

Concept — Number of terms: The expansion of $(x + y)^n$ has $n + 1$ terms.

Step 1 — Identify the power: The expression is $(x + y)^7$, so $n = 7$.

Step 2 — Write the count formula: Number of terms $= n + 1$.

Step 3 — Substitute: Number of terms $= 7 + 1$.

Step 4 — Add: $7 + 1 = 8$.

Why other options are wrong: 7 forgets the $+1$; 6 and 9 miscount.

Final Answer: 8 terms $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — nth term of an AP: $a_n = a + (n - 1)d$.

Step 1 — Find the first term: The AP is $2, 5, 8, \ldots$, so $a = 2$.

Step 2 — Find the common difference: $d = 5 - 2 = 3$.

Step 3 — State the required term: We want the 10th term, so $n = 10$.

Step 4 — Substitute into the formula: $a_{10} = 2 + (10 - 1) \times 3$.

Step 5 — Simplify the bracket: $10 - 1 = 9$, so $a_{10} = 2 + 9 \times 3$.

Step 6 — Multiply: $9 \times 3 = 27$, so $a_{10} = 2 + 27$.

Step 7 — Add: $2 + 27 = 29$.

Why other options are wrong: 32 uses $n = 11$; 27 forgets a; 20 uses a wrong d.

Final Answer: $a_{10} = 29 \Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Sum to infinity of a GP: $S_\infty = \dfrac{a}{1-r}$ for $|r| < 1$.

Step 1 — Find the first term: The GP is $1 + \frac{1}{2} + \frac{1}{4} + \cdots$, so $a = 1$.

Step 2 — Find the common ratio: $r = \dfrac{1/2}{1} = \frac{1}{2}$.

Step 3 — Check convergence: Since $|r| = \frac{1}{2} < 1$, the formula applies.

Step 4 — Substitute: $S_\infty = \dfrac{1}{1 - \frac{1}{2}}$.

Step 5 — Simplify the denominator: $1 - \frac{1}{2} = \frac{1}{2}$, so $S_\infty = \dfrac{1}{\frac{1}{2}}$.

Step 6 — Divide: Dividing by $\frac{1}{2}$ means multiplying by 2, so $S_\infty = 2$.

Why other options are wrong: 1 is only the first term; $\frac{1}{2}$ is the ratio; the series converges, so not ∞.

Final Answer: $S_\infty = 2 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Pythagorean identity: $\sin^2\theta + \cos^2\theta = 1$, or use the 3-4-5 triangle.

Step 1 — Read the given ratio: $\sin\theta = \frac{3}{5}$, so the opposite side is 3 and the hypotenuse is 5.

Step 2 — Find the adjacent side by Pythagoras: $\text{adjacent}^2 = \text{hyp}^2 - \text{opp}^2 = 5^2 - 3^2$.

Step 3 — Compute the squares: $5^2 = 25$ and $3^2 = 9$, so $\text{adjacent}^2 = 25 - 9$.

Step 4 — Subtract: $25 - 9 = 16$, so $\text{adjacent}^2 = 16$.

Step 5 — Take the root: $\text{adjacent} = \sqrt{16} = 4$.

Step 6 — Write the cosine ratio: $\cos\theta = \dfrac{\text{adjacent}}{\text{hypotenuse}} = \dfrac{4}{5}$.

Why other options are wrong: $\frac{3}{5}$ is $\sin\theta$; $\frac{5}{3}$ and $\frac{3}{4}$ invert or mix ratios.

Final Answer: $\cos\theta = \dfrac{4}{5} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — General solution: $\sin\theta = 0$ when θ is an integer multiple of π.

Step 1 — List where sine is zero: $\sin\theta = 0$ at $\theta = 0, \pi, 2\pi, 3\pi, \ldots$ and also $-\pi, -2\pi, \ldots$

Step 2 — Spot the pattern: These are exactly the integer multiples of π.

Step 3 — Write the general solution: $\sin\theta = 0 \Rightarrow \theta = n\pi$, where $n \in \mathbb{Z}$.

Why other options are wrong: $2n\pi$ misses the odd multiples; $\frac{n\pi}{2}$ and $(2n+1)\frac{\pi}{2}$ include points where $\sin\theta \neq 0$.

Final Answer: $\theta = n\pi \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Principal value of $\sin^{-1}$: It lies in $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$.

Step 1 — Restate the problem: We need the angle θ in $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ with $\sin\theta = \frac{1}{2}$.

Step 2 — Recall the standard value: $\sin\frac{\pi}{6} = \frac{1}{2}$.

Step 3 — Check the range: $\frac{\pi}{6}$ lies in $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$, so it is the principal value.

Step 4 — Conclude: $\sin^{-1}\left(\frac{1}{2}\right) = \frac{\pi}{6}$.

Why other options are wrong: $\frac{\pi}{3}$ gives $\frac{\sqrt{3}}{2}$; $\frac{\pi}{2}$ gives 1; $\frac{\pi}{4}$ gives $\frac{1}{\sqrt{2}}$.

Final Answer: $\sin^{-1}\left(\frac{1}{2}\right) = \frac{\pi}{6} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Angle of elevation: $\tan(\text{angle}) = \dfrac{\text{height}}{\text{base distance}}$.

Step 1 — Label the quantities: Height of tower $= h$, base distance $= 50$ m, angle $= 45°$.

Step 2 — Set up the equation: $\tan 45° = \dfrac{h}{50}$.

Step 3 — Insert the known tangent: $\tan 45° = 1$, so $1 = \dfrac{h}{50}$.

Step 4 — Solve for h: Multiply both sides by 50: $h = 50$ m.

Why other options are wrong: $50\sqrt{3}$ uses $60°$; 25 halves wrongly; 100 doubles.

Final Answer: Height $= 50$ m $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Standard limit: $\lim_{x \to 0} \dfrac{\sin x}{x} = 1$.

Step 1 — Note the form: Substituting $x = 0$ gives $\dfrac{\sin 0}{0} = \dfrac{0}{0}$, an indeterminate form.

Step 2 — Recall the standard result: For x measured in radians, $\dfrac{\sin x}{x} \to 1$ as $x \to 0$.

Step 3 — State the value: Hence $\lim_{x \to 0} \dfrac{\sin x}{x} = 1$.

Why other options are wrong: The limit exists and equals 1, so 0, ∞ and "does not exist" are incorrect.

Final Answer: The limit is $1 \Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Continuity vs differentiability: $|x|$ has no break at 0 but its graph has a sharp corner there.

Step 1 — Evaluate the function at 0**:** $f(0) = |0| = 0$.

Step 2 — Find the limit at 0**:** $\lim_{x \to 0} |x| = 0$.

Step 3 — Conclude continuity: Limit $= f(0) = 0$, so f is continuous at 0.

Step 4 — Left-hand derivative: For $x < 0$, $f(x) = -x$, so the slope is -1.

Step 5 — Right-hand derivative: For $x > 0$, $f(x) = x$, so the slope is $+1$.

Step 6 — Compare the one-sided derivatives: $-1 \neq +1$, so f is not differentiable at 0.

Why other options are wrong: It is neither discontinuous nor differentiable at 0.

Final Answer: Continuous but not differentiable $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept — Power rule: $\frac{d}{dx}x^n = nx^{n-1}$.

Step 1 — Identify the power: $y = x^3$, so $n = 3$.

Step 2 — Apply the power rule: $\frac{dy}{dx} = 3x^{3-1} = 3x^2$.

Step 3 — Substitute $x = 2$**:** $\frac{dy}{dx} = 3(2)^2$.

Step 4 — Square: $(2)^2 = 4$, so $\frac{dy}{dx} = 3 \times 4$.

Step 5 — Multiply: $3 \times 4 = 12$.

Why other options are wrong: 6 uses $3x$; 8 is x^3; 3 drops the x^2.

Final Answer: $\left.\frac{dy}{dx}\right|_{x=2} = 12 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q20

Q21.

Solution

Concept — Chain rule for exponentials: $\frac{d}{dx}e^{kx} = k\,e^{kx}$.

Step 1 — Identify the inner function: The exponent is $2x$, so $k = 2$.

Step 2 — Differentiate the exponent: $\frac{d}{dx}(2x) = 2$.

Step 3 — Apply the chain rule: $\frac{d}{dx}e^{2x} = e^{2x} \times 2$.

Step 4 — Write neatly: $= 2e^{2x}$.

Why other options are wrong: e^{2x} drops the factor 2; $\frac{1}{2}e^{2x}$ divides instead; the last option misapplies the power rule.

Final Answer: $\frac{d}{dx}e^{2x} = 2e^{2x} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — Slope of tangent: The slope equals $\frac{dy}{dx}$ at the point.

Step 1 — Identify the power: $y = x^2$, so $n = 2$.

Step 2 — Differentiate by the power rule: $\frac{dy}{dx} = 2x^{2-1} = 2x$.

Step 3 — Substitute $x = 1$: $\frac{dy}{dx} = 2(1)$.

Step 4 — Compute: $2(1) = 2$.

Why other options are wrong: 1 drops the factor 2; 4 uses $x = 2$; $\frac{1}{2}$ inverts.

Final Answer: Slope $= 2 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Minimum of a quadratic: The minimum of $f(x) = x^2 - 4x + 3$ occurs where $f'(x) = 0$.

Step 1 — Differentiate term by term: $\frac{d}{dx}(x^2) = 2x$, $\frac{d}{dx}(-4x) = -4$, $\frac{d}{dx}(3) = 0$.

Step 2 — Write the derivative: $f'(x) = 2x - 4$.

Step 3 — Set the derivative to zero: $2x - 4 = 0$.

Step 4 — Isolate the x term: $2x = 4$.

Step 5 — Solve for x: $x = \frac{4}{2} = 2$.

Step 6 — Confirm it is a minimum: $f''(x) = 2 > 0$, so $x = 2$ gives a minimum.

Why other options are wrong: 0, 1 and 4 do not satisfy $f'(x) = 0$.

Final Answer: Minimum at $x = 2 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Power rule for integration: $\int x^n \, dx = \frac{x^{n+1}}{n+1} + C$.

Step 1 — Identify the power: The integrand is x^2, so $n = 2$.

Step 2 — Raise the power by one: $n + 1 = 2 + 1 = 3$.

Step 3 — Apply the formula: $\int x^2 \, dx = \frac{x^3}{3} + C$.

Why other options are wrong: $2x$ is a derivative; x^3 and $3x^3$ omit or invert the $\frac{1}{3}$.

Final Answer: $\frac{x^3}{3} + C \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Standard integral: $\int \frac{1}{x}\,dx = \ln|x| + C$.

Step 1 — Note why the power rule fails: Writing $\frac{1}{x} = x^{-1}$ and using the power rule would give $\frac{x^0}{0}$, which is undefined.

Step 2 — Use the special case: The antiderivative of x^{-1} is the natural logarithm.

Step 3 — Write the result: $\int \frac{1}{x}\,dx = \ln|x| + C$.

Why other options are wrong: $-\frac{1}{x^2}$ and $\frac{1}{x^2}$ are derivatives; $x + C$ is wrong.

Final Answer: $\ln|x| + C \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q25

Q26.

Solution

Concept — Definite integral: Integrate, then apply the limits.

Step 1 — Find the antiderivative: $\int 2x\,dx = 2 \cdot \frac{x^2}{2} = x^2$.

Step 2 — Write with the limits: $\int_0^1 2x\,dx = \left[x^2\right]_0^1$.

Step 3 — Substitute the upper limit: At $x = 1$: $1^2 = 1$.

Step 4 — Substitute the lower limit: At $x = 0$: $0^2 = 0$.

Step 5 — Subtract: $1 - 0 = 1$.

Why other options are wrong: 2 forgets to apply limits; $\frac{1}{2}$ integrates x; 0 is wrong.

Final Answer: The integral $= 1 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q26

Q27.

Solution

Concept — Area under a curve: Area $= \int_0^2 x\,dx$ (a triangle of base 2, height 2).

Step 1 — Set up the integral: Area $= \int_0^2 x\,dx$.

Step 2 — Find the antiderivative: $\int x\,dx = \frac{x^2}{2}$, so Area $= \left[\frac{x^2}{2}\right]_0^2$.

Step 3 — Substitute the upper limit: At $x = 2$: $\frac{2^2}{2} = \frac{4}{2} = 2$.

Step 4 — Substitute the lower limit: At $x = 0$: $\frac{0^2}{2} = 0$.

Step 5 — Subtract: $2 - 0 = 2$.

Step 6 — Cross-check with the triangle area: $\frac{1}{2} \times \text{base} \times \text{height} = \frac{1}{2} \times 2 \times 2 = 2$, which agrees.

Why other options are wrong: 4 forgets the $\frac{1}{2}$; 1 and 8 use wrong limits.

Final Answer: Area $= 2 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q27

Q28.

Solution

Concept — Order of a differential equation: It is the order of the highest derivative present.

Step 1 — List the derivatives present: The equation contains $\frac{d^2y}{dx^2}$ and $\frac{dy}{dx}$.

Step 2 — Compare their orders: $\frac{d^2y}{dx^2}$ is a second derivative; $\frac{dy}{dx}$ is a first derivative.

Step 3 — Pick the highest: The highest-order derivative is $\frac{d^2y}{dx^2}$.

Step 4 — Read off the order: Its order is 2. The cube on $\frac{dy}{dx}$ affects the degree, not the order.

Why other options are wrong: 0 and 1 ignore the second derivative; 3 confuses the power with the order.

Final Answer: Order $= 2 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q28

Q29.

Solution

Concept — Variable-separable equation: $\frac{dy}{dx} = y \Rightarrow \frac{dy}{y} = dx$.

Step 1 — Separate the variables: From $\frac{dy}{dx} = y$, divide by y and multiply by dx: $\frac{dy}{y} = dx$.

Step 2 — Integrate both sides: $\int \frac{dy}{y} = \int dx$.

Step 3 — Carry out the integration: $\ln|y| = x + c$.

Step 4 — Exponentiate both sides: $|y| = e^{x+c} = e^c\, e^x$.

Step 5 — Write the constant as C: Let $C = \pm e^c$, so $y = Ce^x$.

Why other options are wrong: Cx and $x + C$ do not satisfy $y' = y$; Ce^{-x} satisfies $y' = -y$.

Final Answer: $y = Ce^x \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q29

Q30.

Solution

Concept — Slope from general form: For $ax + by + c = 0$, slope $= -\frac{a}{b}$.

Step 1 — Compare with the general form: The line is $2x + 3y - 6 = 0$.

Step 2 — Read off the coefficients: $a = 2$, $b = 3$.

Step 3 — Write the slope formula: Slope $= -\frac{a}{b}$.

Step 4 — Substitute: Slope $= -\frac{2}{3}$.

Why other options are wrong: $\frac{2}{3}$ misses the sign; $\frac{3}{2}$ and $-\frac{3}{2}$ invert the ratio.

Final Answer: Slope $= -\frac{2}{3} \Rightarrow \boxed{B}$

Answer: (B) Go Back to Q30

Q31.

Solution

Concept — Distance of a point from a line: $d = \dfrac{|ax_0 + by_0 + c|}{\sqrt{a^2 + b^2}}$.

Step 1 — Read off the line and point: $a = 3$, $b = 4$, $c = -10$, and the point is the origin $(x_0, y_0) = (0, 0)$.

Step 2 — Substitute into the numerator: $|3(0) + 4(0) - 10| = |-10| = 10$.

Step 3 — Substitute into the denominator: $\sqrt{3^2 + 4^2} = \sqrt{9 + 16} = \sqrt{25} = 5$.

Step 4 — Form the fraction: $d = \dfrac{10}{5}$.

Step 5 — Divide: $\dfrac{10}{5} = 2$.

Why other options are wrong: 10 forgets the denominator; 5 is the denominator; 1 is wrong.

Final Answer: Distance $= 2 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q31

Q32.

Solution

Concept — Radius of a circle: For $x^2 + y^2 + 2gx + 2fy + c = 0$, radius $= \sqrt{g^2 + f^2 - c}$.

Step 1 — Match the coefficients: Comparing $x^2 + y^2 - 4x - 6y + 9 = 0$ gives $2g = -4$, $2f = -6$, $c = 9$.

Step 2 — Solve for g: $g = \dfrac{-4}{2} = -2$.

Step 3 — Solve for f: $f = \dfrac{-6}{2} = -3$.

Step 4 — Write the radius formula: $r = \sqrt{g^2 + f^2 - c}$.

Step 5 — Substitute: $r = \sqrt{(-2)^2 + (-3)^2 - 9}$.

Step 6 — Square the terms: $(-2)^2 = 4$ and $(-3)^2 = 9$, so $r = \sqrt{4 + 9 - 9}$.

Step 7 — Simplify under the root: $4 + 9 - 9 = 4$, so $r = \sqrt{4}$.

Step 8 — Take the root: $\sqrt{4} = 2$.

Why other options are wrong: 9 is c; 3 uses only f; $\sqrt{13}$ forgets to subtract c.

Final Answer: Radius $= 2 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Focus of $y^2 = 4ax$: The focus is at $(a, 0)$.

Step 1 — Compare with the standard form: $y^2 = 8x$ against $y^2 = 4ax$ gives $4a = 8$.

Step 2 — Solve for a: $a = \frac{8}{4} = 2$.

Step 3 — Write the focus: The focus is $(a, 0) = (2, 0)$.

Why other options are wrong: $(0, 2)$ swaps axes; $(4, 0)$ uses $4a$; $(-2, 0)$ has the wrong sign.

Final Answer: Focus $= (2, 0) \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q33

Q34.

Solution

Concept — Eccentricity of a hyperbola: $e = \sqrt{1 + \frac{b^2}{a^2}}$.

Step 1 — Read off a^2 and b^2: From $\frac{x^2}{16} - \frac{y^2}{9} = 1$, $a^2 = 16$ and $b^2 = 9$.

Step 2 — Substitute into the formula: $e = \sqrt{1 + \frac{9}{16}}$.

Step 3 — Add the fractions: $1 + \frac{9}{16} = \frac{16}{16} + \frac{9}{16} = \frac{25}{16}$.

Step 4 — Write the root: $e = \sqrt{\frac{25}{16}}$.

Step 5 — Take the root of numerator and denominator: $e = \frac{\sqrt{25}}{\sqrt{16}} = \frac{5}{4}$.

Why other options are wrong: $\frac{3}{4}$ and $\frac{4}{5}$ are < 1 (impossible for a hyperbola); $\frac{5}{3}$ uses wrong values.

Final Answer: $e = \frac{5}{4} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q34

Q35.

Solution

Concept — Dot product: $\vec{a} \cdot \vec{b} = a_1b_1 + a_2b_2 + a_3b_3$.

Step 1 — List the components: $\vec{a} = (1, 2, 2)$ and $\vec{b} = (2, 2, 1)$.

Step 2 — Multiply the first components: $a_1b_1 = (1)(2) = 2$.

Step 3 — Multiply the second components: $a_2b_2 = (2)(2) = 4$.

Step 4 — Multiply the third components: $a_3b_3 = (2)(1) = 2$.

Step 5 — Add the products: $2 + 4 + 2 = 8$.

Why other options are wrong: 4, 6 and 10 drop or mis-add a term.

Final Answer: $\vec{a} \cdot \vec{b} = 8 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q35

Q36.

Solution

Concept — Magnitude of cross product: $|\vec{a} \times \vec{b}| = |\vec{a}||\vec{b}| \sin\theta$.

Step 1 — List the given values: $|\vec{a}| = 2$, $|\vec{b}| = 3$, $\theta = 90^\circ$.

Step 2 — Substitute into the formula: $|\vec{a} \times \vec{b}| = 2 \times 3 \times \sin 90^\circ$.

Step 3 — Insert the sine value: $\sin 90^\circ = 1$, so $|\vec{a} \times \vec{b}| = 2 \times 3 \times 1$.

Step 4 — Multiply: $2 \times 3 = 6$, then $6 \times 1 = 6$.

Why other options are wrong: 0 is the dot product at 90°; 2 and 3 are just the magnitudes.

Final Answer: $|\vec{a} \times \vec{b}| = 6 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q36

Q37.

Solution

Concept — Distance in 3D: $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$.

Step 1 — Label the points: $(x_1, y_1, z_1) = (1, 2, 3)$ and $(x_2, y_2, z_2) = (4, 6, 3)$.

Step 2 — Find the differences: $x_2 - x_1 = 3$, $y_2 - y_1 = 4$, $z_2 - z_1 = 0$.

Step 3 — Substitute: $d = \sqrt{3^2 + 4^2 + 0^2}$.

Step 4 — Square each difference: $3^2 = 9$, $4^2 = 16$, $0^2 = 0$, so $d = \sqrt{9 + 16 + 0}$.

Step 5 — Add under the root: $9 + 16 + 0 = 25$, so $d = \sqrt{25}$.

Step 6 — Take the root: $\sqrt{25} = 5$.

Why other options are wrong: 7 adds the differences; 25 forgets the root; $\sqrt{34}$ mis-sums.

Final Answer: Distance $= 5 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q37

Q38.

Solution

Concept — Arithmetic mean: Mean $= \dfrac{\text{sum of observations}}{\text{number of observations}}$.

Step 1 — Count the observations: The values are $2, 4, 6, 8, 10$, which is 5 observations.

Step 2 — Add them step by step: $2 + 4 = 6$, $6 + 6 = 12$, $12 + 8 = 20$, $20 + 10 = 30$.

Step 3 — Form the mean: Mean $= \dfrac{30}{5}$.

Step 4 — Divide: $\dfrac{30}{5} = 6$.

Why other options are wrong: 5 uses the wrong count; 4 and 8 are individual values.

Final Answer: Mean $= 6 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q38

Q39.

Solution

Concept — Classical probability: $P = \dfrac{\text{favourable outcomes}}{\text{total outcomes}}$.

Step 1 — Count the total outcomes: A full pack has 52 cards.

Step 2 — Count the favourable outcomes: There are 4 aces.

Step 3 — Form the probability: $P = \dfrac{4}{52}$.

Step 4 — Reduce the fraction: Divide numerator and denominator by 4: $\dfrac{4}{52} = \dfrac{1}{13}$.

Why other options are wrong: $\frac{1}{52}$ is one card; $\frac{1}{4}$ inverts; $\frac{4}{13}$ does not reduce correctly.

Final Answer: $P(\text{ace}) = \dfrac{1}{13} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q39

Q40.

Solution

Concept — Probability with a die: $P = \dfrac{\text{favourable}}{6}$.

Step 1 — Count the total outcomes: A die has 6 faces, so there are 6 outcomes.

Step 2 — List the favourable outcomes: Numbers greater than 4 are 5 and 6.

Step 3 — Count them: That is 2 favourable outcomes.

Step 4 — Form the probability: $P = \dfrac{2}{6}$.

Step 5 — Reduce the fraction: Divide top and bottom by 2: $\dfrac{2}{6} = \dfrac{1}{3}$.

Why other options are wrong: $\frac{1}{6}$ counts one outcome; $\frac{1}{2}$ and $\frac{2}{3}$ miscount.

Final Answer: $P = \dfrac{1}{3} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q40

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	C	3	A	4	D	5	B
6	A	7	C	8	D	9	B	10	A
11	C	12	D	13	A	14	B	15	C
16	D	17	A	18	B	19	D	20	C
21	A	22	B	23	C	24	D	25	B
26	A	27	D	28	C	29	A	30	B
31	C	32	D	33	A	34	B	35	C
36	D	37	A	38	B	39	C	40	D