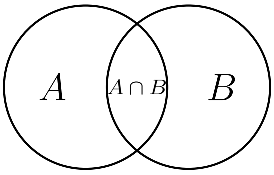
SRMJEEE Mathematics Sample Paper – 1

Duration: 47 Minutes **Maximum Marks: 40**

Instructions

- This paper contains **40** Multiple Choice Questions (Single Correct Answer), modelled on the Mathematics section of **SRMJEEE** (SRM Joint Engineering Entrance Examination).
- Each correct answer carries **+1 mark**. There is **no negative marking**; an unattempted or wrong answer scores 0.
- Only **one** option is correct. Choose carefully.
- The actual SRMJEEE is a **computer-based test** conducted in remote-proctored online mode, with all sections sharing a common time window and no per-section limit.
- Personal calculators, mobile phones, log tables and other electronic gadgets are strictly prohibited.

Q1. In a group, $n(A) = 20$, $n(B) = 15$ and $n(A \cap B) = 5$, as shown in the Venn diagram. The value of $n(A \cup B)$ is:



(A) 30

(B) 35

(C) 25

(D) 40

Q2. On the set of integers $\mathbb{Z}$, the relation R defined by "$a\,R\,b$ if and only if $a - b$ is divisible by 3" is:

(A) only reflexive

(B) an equivalence relation

(C) only symmetric

(D) not reflexive

Q3. The domain of the real function $f(x) = \dfrac{1}{\sqrt{x-2}}$ is:

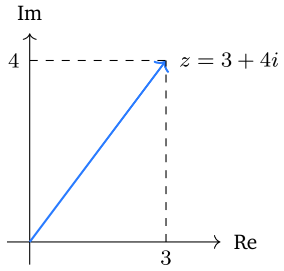
(A) $[2, \infty)$

(B) $\mathbb{R}$

(C) $(2, \infty)$

(D) $(-\infty, 2)$

Q4. The modulus of the complex number $z = 3 + 4i$, shown as a point on the Argand plane, is:



(A) 7

(B) 25

(C) $\sqrt{7}$

(D) 5

Q5. If ω is a non-real cube root of unity, then the value of $1 + \omega + \omega^2$ is:

(A) 0

(B) 1

(C) -1

(D) 3

Q6. The roots of the quadratic equation $x^2 - 4x + 5 = 0$ are:

(A) real and equal

(B) real and distinct

(C) complex (non-real)

(D) rational and distinct

Q7. If α and β are the roots of $x^2 - 5x + 6 = 0$, then the value of $\dfrac{1}{\alpha} + \dfrac{1}{\beta}$ is:

(A) $\dfrac{6}{5}$

(B) $\dfrac{5}{6}$

(C) 5

(D) 6

Q8. If A is a matrix of order 2×3 and B is a matrix of order 3×4, then the order of the product AB is:

(A) 3×3

(B) 2×3

(C) 3×4

(D) 2×4

Q9. A square matrix A possesses an inverse if and only if its determinant is:

(A) non-zero

(B) zero

(C) positive

(D) equal to 1

Q10. The value of the determinant $\begin{vmatrix} 2 & 3 \\ 1 & 4 \end{vmatrix}$ is:

(A) 11

(B) 5

(C) -5

(D) 8

Q11. The area of the triangle with vertices $(0,0)$, $(4,0)$ and $(0,3)$ is:

(A) 12 sq. units

(B) 24 sq. units

(C) 6 sq. units

(D) 3 sq. units

Q12. The number of distinct ways in which the letters of the word "DELHI" (all letters different) can be arranged is:

(A) 24

(B) 25

(C) 60

(D) 120

Q13. The number of ways of choosing a committee of 3 members from 6 persons is:

(A) 20

(B) 18

(C) 120

(D) 216

Q14. The number of ways in which 5 persons can be seated around a circular table is:

(A) 120

(B) 24

(C) 12

(D) 25

Q15. If α, β, γ are the roots of $x^3 - 6x^2 + 11x - 6 = 0$, then $\alpha + \beta + \gamma$ equals:

(A) 11

(B) -6

(C) 6

(D) -11

Q16. If α and β are the roots of $x^2 + px + q = 0$ (with $q \neq 0$), then the quadratic equation whose roots are $\frac{1}{\alpha}$ and $\frac{1}{\beta}$ is:

(A) $x^2 + px + q = 0$

(B) $x^2 - px + q = 0$

(C) $px^2 + qx + 1 = 0$

(D) $qx^2 + px + 1 = 0$

Q17. The value of $\lim_{x \to 0} \frac{\sin x}{x}$ is:

(A) 1

(B) 0

(C) ∞

(D) does not exist

Q18. If $y = x^2 \sin x$, then $\frac{dy}{dx}$ is:

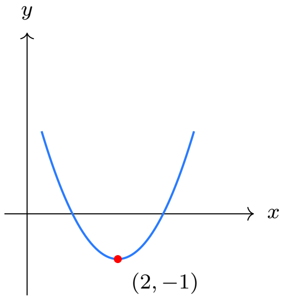
(A) $2x \cos x$

(B) $2x \sin x + x^2 \cos x$

(C) $x^2 \cos x$

(D) $2x \sin x - x^2 \cos x$

Q19. The function $f(x) = x^2 - 4x + 3$, whose graph is shown, attains its minimum value equal to:



(A) 3

(B) 1

(C) 2

(D) -1

Q20. The slope of the tangent to the curve $y = x^2$ at the point $(1, 1)$ is:

(A) 1

(B) 0

(C) 2

(D) 4

Q21. The order and degree of the differential equation $\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^3 + y = 0$ are, respectively:

(A) order 2, degree 1

(B) order 1, degree 3

(C) order 2, degree 3

(D) order 3, degree 1

Q22. $\int \sec^2 x \, dx$ equals:

(A) $\cot x + C$

(B) $\tan x + C$

(C) $\sec x + C$

(D) $-\tan x + C$

Q23. The value of $\int_{-1}^{1} x^3 \, dx$ is:

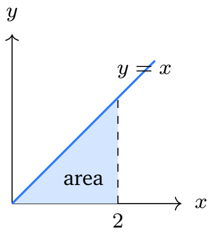
(A) $\frac{1}{2}$

(B) 2

(C) 1

(D) 0

Q24. The area of the region bounded by the line $y = x$, the x-axis and the line $x = 2$ (shaded) is:



(A) 4 sq. units

(B) 1 sq. unit

(C) 2 sq. units

(D) 8 sq. units

Q25. The value of $\int_{0}^{\pi/2} \cos x \, dx$ is:

(A) 1

(B) 0

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

(D) -1

Q26. The slope of the straight line $3x + 4y = 12$ is:

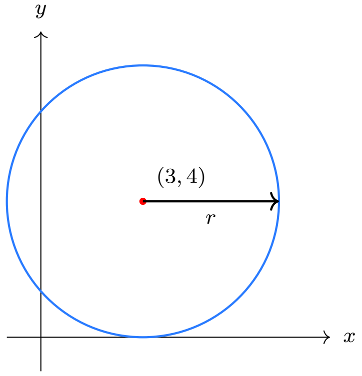
(A) $\frac{3}{4}$

(B) $-\frac{3}{4}$

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

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

Q27. The radius of the circle $x^2 + y^2 - 6x - 8y + 9 = 0$, whose centre is shown at $(3, 4)$, is:



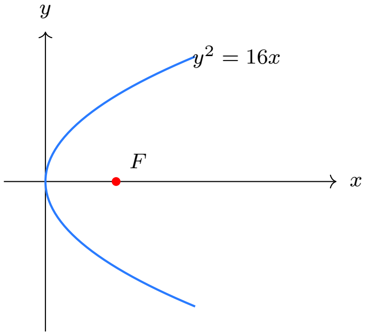
(A) 3

(B) 5

(C) 4

(D) 9

Q28. The coordinates of the focus of the parabola $y^2 = 16x$ (which opens to the right, as shown) are:



(A) $(0, 4)$

(B) $(2, 0)$

(C) $(16, 0)$

(D) $(4, 0)$

Q29. A line makes equal angles with all three coordinate axes. Its direction cosines are:

(A) $\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}$

(B) $\frac{1}{3}, \frac{1}{3}, \frac{1}{3}$

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

(D) $1, 1, 1$

Q30. The perpendicular distance of the plane $2x - y + 2z = 6$ from the origin is:

(A) 6

(B) 2

(C) 3

(D) 1

Q31. If $\vec{a} = \hat{i} + \hat{j} + \hat{k}$ and $\vec{b} = \hat{i} - \hat{j} + \hat{k}$, then $\vec{a} \cdot \vec{b}$ equals:

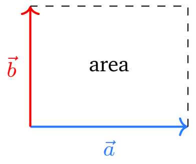
(A) 3

(B) 0

(C) 1

(D) 2

Q32. The area of the parallelogram whose adjacent sides are $\vec{a} = 2\hat{i}$ and $\vec{b} = 3\hat{j}$ is $|\vec{a} \times \vec{b}|$, equal to:



(A) 0

(B) 3

(C) 2

(D) 6

Q33. Three vectors $\vec{a}, \vec{b}, \vec{c}$ are coplanar if and only if their scalar triple product $[\vec{a}\ \vec{b}\ \vec{c}]$ is:

(A) 0

(B) 1

(C) positive

(D) negative

Q34. The arithmetic mean of the observations $2, 4, 6, 8, 10$ is:

(A) 5

(B) 6

(C) 30

(D) 8

Q35. A fair die is rolled once. The probability of obtaining an even number is:

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

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

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

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

Q36. A fair coin is tossed three times. The probability of getting exactly two heads is:

(A) $\frac{1}{8}$

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

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

(D) $\frac{3}{8}$

Q37. The value of $\sin 30^\circ + \cos 60^\circ$ is:

(A) 1

(B) 0

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

(D) 2

Q38. If $\sin\theta = \frac{3}{5}$ and θ is acute, then the value of $\sin 2\theta$ is:

(A) $\frac{12}{25}$

(B) $\frac{7}{25}$

(C) $\frac{24}{25}$

(D) $\frac{6}{5}$

Q39. The principal value of $\sin^{-1}\left(\frac{1}{2}\right)$ is:

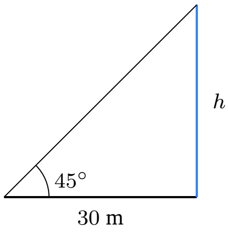
(A) $\frac{\pi}{3}$

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

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

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

Q40. The angle of elevation of the top of a vertical tower from a point on the ground, 30 m from its foot, is 45°, as shown. The height of the tower is:



(A) 15 m

(B) 60 m

(C) $30\sqrt{3}$ m

(D) 30 m

Detailed Solutions

Q1.

Solution

Concept — The inclusion–exclusion principle: When we add the sizes $n(A)$ and $n(B)$, every element that lies in *both* sets is counted twice — once as a member of A and once as a member of B. To recover the true number of distinct elements in the union we must therefore subtract the overlap exactly once. This gives the standard two-set identity

$$n(A \cup B) = n(A) + n(B) - n(A \cap B).$$

Step 1 — Read off the data: From the statement and the Venn diagram, the two circles have $n(A) = 20$ and $n(B) = 15$, and the lens-shaped common region carries $n(A \cap B) = 5$.

Step 2 — Substitute into the formula:

$$n(A \cup B) = 20 + 15 - 5.$$

Step 3 — Simplify: Adding first, $20 + 15 = 35$; then removing the double-counted overlap, $35 - 5 = 30$. Hence $n(A \cup B) = 30$.

Step 4 — Cross-check with the disjoint regions: Split the union into the three non-overlapping pieces of the diagram: "A only" $= 20 - 5 = 15$, "B only" $= 15 - 5 = 10$, and the shared part $= 5$. Their total

$$15 + 10 + 5 = 30$$

matches Step 3, confirming the count.

Why other options are wrong:

- (B) $35 = 20 + 15$ skips the subtraction, leaving the 5 shared elements double-counted.
- (C) $25 = 20 + 15 - 2(5)$ subtracts the overlap twice instead of once.
- (D) $40 = 20 + 15 + 5$ wrongly *adds* the intersection rather than removing it.

Final Answer: $n(A \cup B) = 30 \Rightarrow \boxed{\text{A}}$

Answer: (A)

Go Back to Q1

Q2.

Solution

Concept — Equivalence relations: A relation R on a set is called an *equivalence relation* when it simultaneously satisfies three properties — reflexivity (aRa for every a), symmetry ($aRb \Rightarrow bRa$) and transitivity (aRb and $bRc \Rightarrow aRc$). The relation here, "$3 \mid (a-b)$", is exactly the relation of *congruence modulo* 3, which is the prototype of an equivalence relation; verifying the three properties is just a matter of using basic divisibility facts.

Step 1 — Reflexivity: For any integer a we have $a - a = 0$, and $3 \mid 0$. So aRa always holds and R is reflexive.

Step 2 — Symmetry: Suppose aRb, i.e. $a - b = 3k$ for some integer k. Then

$$b - a = -(a-b) = -3k = 3(-k),$$

which is again a multiple of 3. Hence bRa, and R is symmetric.

Step 3 — Transitivity: Suppose aRb and bRc, i.e. $a - b = 3k$ and $b - c = 3m$. Adding,

$$a - c = (a-b) + (b-c) = 3k + 3m = 3(k+m),$$

a multiple of 3. Hence aRc, and R is transitive.

Step 4 — Conclude: All three properties hold, so R is an equivalence relation. (It partitions $\mathbb{Z}$ into the three residue classes $\{\ldots,-3,0,3,\ldots\}$, $\{\ldots,-2,1,4,\ldots\}$, $\{\ldots,-1,2,5,\ldots\}$.)

Why other options are wrong:

- (A) "only reflexive" is false because symmetry and transitivity were both verified above.
- (C) "only symmetric" ignores the reflexivity shown in Step 1.
- (D) "not reflexive" directly contradicts Step 1, where $a - a = 0$ is divisible by 3.

Final Answer: an equivalence relation $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Domain of a square root in a denominator: For a real-valued function, two conditions must be met at once. First, the quantity beneath a square root may not be negative, since the square root of a negative number is not real. Second, a denominator may never equal zero. Here the same expression $x - 2$ sits under the root *and* in the denominator, so it must be both non-negative and non-zero — that is, strictly positive.

Step 1 — Write the constraint: The denominator $\sqrt{x-2}$ is defined and non-zero precisely when

$$x - 2 > 0.$$

Step 2 — Solve the inequality: Adding 2 to both sides gives

$$x > 2.$$

Step 3 — Express as an interval: The set of all x with $x > 2$ is the open interval $(2, \infty)$. The endpoint $x = 2$ is excluded because it gives $\sqrt{0} = 0$ in the denominator, producing division by zero.

Step 4 — Spot-check: At $x = 3$, $f(3) = \dfrac{1}{\sqrt{1}} = 1$ is well defined; at $x = 2$, f is undefined; at $x = 1$, $\sqrt{-1}$ is not real. This matches the interval $(2, \infty)$.

Why other options are wrong:

- (A) $[2, \infty)$ wrongly includes $x = 2$, where the denominator is zero.
- (B) $\mathbb{R}$ ignores both restrictions and admits values that make the root imaginary.
- (D) $(-\infty, 2)$ takes the sign backwards; there $x - 2 < 0$ and the root is not real.

Final Answer: $(2, \infty) \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Modulus of a complex number: A complex number $z = a + bi$ is plotted on the Argand plane as the point (a, b), with the real part along the horizontal axis and the imaginary part along the vertical axis. Its modulus $|z|$ is the straight-line distance of this point from the origin, which by the Pythagorean theorem on the right triangle of legs a and b is

$$|z| = \sqrt{a^2 + b^2}.$$

Step 1 — Identify the parts: For $z = 3+4i$ the real part is $a = 3$ and the imaginary part is $b = 4$, matching the dashed projections 3 and 4 drawn in the figure.

Step 2 — Square the components:

$$a^2 = 3^2 = 9, \qquad b^2 = 4^2 = 16.$$

Step 3 — Add and take the root:

$$|z| = \sqrt{9 + 16} = \sqrt{25} = 5.$$

Step 4 — Recognise the 3–4–5 triangle: The horizontal leg 3, vertical leg 4 and hypotenuse 5 form the familiar Pythagorean triple, so the vector from the origin to z in the figure has length exactly 5.

Why other options are wrong:

- (A) 7 comes from adding $3 + 4$ instead of combining the squares.
- (B) 25 stops at $a^2 + b^2 = 9 + 16$ and forgets to take the square root.
- (C) $\sqrt{7}$ comes from $\sqrt{16 - 9}$, subtracting the squares instead of adding them.

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

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Cube roots of unity: The equation $x^3 = 1$ has exactly three roots: the real root 1 and two non-real complex roots, written ω and ω^2, which are complex conjugates of each other. Because they are the roots of $x^3 - 1 = 0$, Vieta's formula for the sum of the roots (the coefficient of x^2 here is 0) immediately forces their total to vanish, giving the key relations $\omega^3 = 1$ and $1 + \omega + \omega^2 = 0$.

Step 1 — Factor the defining equation: Write

$$x^3 - 1 = (x-1)(x^2 + x + 1) = 0.$$

The factor $x - 1$ gives the root 1; the non-real roots come from $x^2 + x + 1 = 0$.

Step 2 — Use the sum of roots of the quadratic: For $x^2 + x + 1 = 0$ the two roots ω and ω^2 satisfy $\omega + \omega^2 = -1$ (sum of roots $= -\frac{b}{a} = -1$).

Step 3 — Add the real root: Therefore

$$1 + \omega + \omega^2 = 1 + (-1) = 0.$$

Step 4 — Verify numerically: With $\omega = -\frac{1}{2} + \frac{\sqrt{3}}{2}i$ and $\omega^2 = -\frac{1}{2} - \frac{\sqrt{3}}{2}i$, the imaginary parts cancel and the real parts give $1 - \frac{1}{2} - \frac{1}{2} = 0$, confirming the result.

Why other options are wrong:

- (B) 1 would result from ignoring ω and ω^2 entirely.
- (C) -1 is the value of just $\omega + \omega^2$, leaving out the real root 1.
- (D) 3 would arise from wrongly treating all three roots as equal to 1.

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

Answer: (A) **Go Back to Q5**

Q6.

Solution

Concept — The discriminant: For a quadratic $ax^2 + bx + c = 0$, the quantity $D = b^2 - 4ac$ is the part that sits under the square root in the quadratic formula $x = \dfrac{-b \pm \sqrt{D}}{2a}$. Its sign therefore decides the nature of the roots: $D > 0$ gives two distinct real roots, $D = 0$ gives one repeated real root, and $D < 0$ makes the square root imaginary, giving a conjugate pair of non-real complex roots.

Step 1 — Identify the coefficients: For $x^2 - 4x + 5 = 0$ we read $a = 1$, $b = -4$ and $c = 5$.

Step 2 — Substitute into $D = b^2 - 4ac$:

$$D = (-4)^2 - 4(1)(5).$$

Step 3 — Simplify:

$$D = 16 - 20 = -4.$$

Step 4 — Interpret and cross-check: Since $D = -4 < 0$, the roots are non-real. Indeed the formula gives $x = \dfrac{4 \pm \sqrt{-4}}{2} = 2 \pm i$, a genuine conjugate pair, confirming the conclusion.

Why other options are wrong:

- (A) "real and equal" would require $D = 0$, but $D = -4$.
- (B) "real and distinct" would require $D > 0$, again contradicted by $D = -4$.
- (D) "rational and distinct" also needs $D > 0$ (and a perfect-square D); neither holds.

Final Answer: complex (non-real) roots $\Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q6**

Q7.

Solution

Concept — Vieta's relations: For a quadratic $x^2 + bx + c = 0$ with roots α, β, the sum of the roots is $\alpha + \beta = -b$ and the product is $\alpha\beta = c$. This lets us evaluate symmetric expressions in the roots without actually solving the equation, by rewriting the target in terms of the sum and the product.

Step 1 — Extract sum and product: Comparing $x^2 - 5x + 6 = 0$ with $x^2 + bx + c = 0$ gives $b = -5$, $c = 6$, so

$$\alpha + \beta = -(-5) = 5, \qquad \alpha\beta = 6.$$

Step 2 — Combine the target over a common denominator:

$$\frac{1}{\alpha} + \frac{1}{\beta} = \frac{\beta + \alpha}{\alpha\beta} = \frac{\alpha + \beta}{\alpha\beta}.$$

Step 3 — Substitute the known values:

$$\frac{\alpha+\beta}{\alpha\beta}=\frac{5}{6}.$$

Step 4 — Verify with the actual roots: The equation factors as $(x-2)(x-3)=0$, so $\alpha=2, \beta=3$. Then $\frac{1}{2}+\frac{1}{3}=\frac{3+2}{6}=\frac{5}{6}$, matching Step 3.

Why other options are wrong:

- (A) $\frac{6}{5}$ inverts the ratio, using $\frac{\alpha\beta}{\alpha+\beta}$ by mistake.
- (C) 5 reports only the sum $\alpha+\beta$.
- (D) 6 reports only the product $\alpha\beta$.

Final Answer: $\frac{1}{\alpha}+\frac{1}{\beta}=\frac{5}{6}\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept — Conformability and order of a matrix product: Two matrices can be multiplied only when the number of columns of the first equals the number of rows of the second — the “inner” dimensions must agree. When A is $m\times n$ and B is $n\times p$, each entry of AB is formed by pairing a row of A (length n) with a column of B (length n), and the resulting matrix inherits the “outer” dimensions, so AB is $m\times p$.

Step 1 — Write down the two orders: Here A is 2×3 (so $m=2$, $n=3$) and B is 3×4 (so $n=3$, $p=4$).

Step 2 — Check conformability: Place the orders side by side as $(2\times\mathbf{3})(\mathbf{3}\times4)$. The two inner numbers are both 3, so the product AB is defined.

Step 3 — Read off the outer dimensions: The surviving outer numbers are 2 and 4, so

$$\text{order of } AB = 2\times4.$$

Step 4 — Note on the reverse product: The product BA would pair $(3\times4)(2\times3)$, whose inner numbers 4 and 2 disagree, so BA is not even defined — a reminder that matrix multiplication is order-sensitive.

Why other options are wrong:

- (A) 3×3 uses the two inner dimensions instead of the outer ones.
- (B) 2×3 simply repeats the order of A.
- (C) 3×4 simply repeats the order of B.

Final Answer: order of AB is $2 \times 4 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Invertibility and the determinant: The inverse of a square matrix is given by the adjugate formula

$$A^{-1} = \frac{1}{\det A}\,\text{adj}\,A.$$

Because $\det A$ appears in the denominator, the formula breaks down precisely when $\det A = 0$. A matrix with zero determinant is called *singular* and has no inverse; one with non-zero determinant is *non-singular* and is invertible. Thus "$\det A \neq 0$" is both necessary and sufficient for A^{-1} to exist.

Step 1 — State the requirement: For A^{-1} to be defined, the scalar $\dfrac{1}{\det A}$ must exist, which requires $\det A \neq 0$.

Step 2 — Why zero fails: If $\det A = 0$ the rows (or columns) of A are linearly dependent, so A collapses space and cannot be undone; division by $\det A = 0$ in the formula is undefined.

Step 3 — Why any non-zero value works: For any $\det A = k \neq 0$, the scalar $\frac{1}{k}$ is a well-defined real number, so A^{-1} exists. The sign or exact size of k does not matter.

Why other options are wrong:

- (B) "zero" is exactly the singular case, where no inverse exists.
- (C) "positive" is too restrictive: a matrix with $\det A = -2$ is still invertible.
- (D) "equal to 1" is far too restrictive: e.g. $\det A = 5$ also yields an inverse.

Final Answer: determinant non-zero $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — The 2×2 determinant: For a 2×2 matrix the determinant is the difference of the two diagonal products: the product down the main diagonal (top-left times bottom-right) minus the product down the anti-diagonal (top-right times bottom-left),

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc.$$

Geometrically this number is the signed area of the parallelogram spanned by the two rows.

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

Step 2 — Main-diagonal product:

$$ad = (2)(4) = 8.$$

Step 3 — Anti-diagonal product:

$$bc = (3)(1) = 3.$$

Step 4 — Subtract:

$$ad - bc = 8 - 3 = 5.$$

Why other options are wrong:

- (A) $11 = 8 + 3$ adds the two products instead of subtracting.
- (C) $-5 = bc - ad$ reverses the order of subtraction.
- (D) 8 keeps only the main-diagonal product ad and drops bc.

Final Answer: determinant $= 5 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Area of a triangle: The general coordinate formula for the area of a triangle with vertices $(x_1, y_1), (x_2, y_2), (x_3, y_3)$ is $\frac{1}{2}\,|x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)|$. When two sides lie along the coordinate axes (a right angle at the origin), this reduces to the familiar $\frac{1}{2} \times$ base $\times$ height, because the two legs serve directly as base and height.

Step 1 — Recognise the right angle: The vertices are $(0, 0)$, $(4, 0)$ and $(0, 3)$. The side from $(0, 0)$ to $(4, 0)$ lies on the x-axis and the side from $(0, 0)$ to $(0, 3)$ lies on the y-axis, so they meet at a right angle at the origin.

Step 2 — Identify base and height: base $= 4$ (length along the x-axis), height $= 3$ (length along the y-axis).

Step 3 — Apply the formula:

$$\text{area} = \tfrac{1}{2} \times 4 \times 3 = \tfrac{1}{2} \times 12 = 6 \text{ sq. units.}$$

Step 4 — Cross-check by determinant:

$$\text{area} = \tfrac{1}{2}\left|0(0-3) + 4(3-0) + 0(0-0)\right| = \tfrac{1}{2}|12| = 6,$$

in agreement with Step 3.

Why other options are wrong:

- (A) 12 is the product base $\times$ height without the factor $\frac{1}{2}$.
- (B) 24 doubles the base–height product (forgets $\frac{1}{2}$ and doubles).
- (D) 3 uses only the height and omits the base entirely.

Final Answer: area $= 6$ sq. units $\Rightarrow \boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q11**

Q12.

Solution

Concept — Permutations of distinct objects: Arranging n distinct objects in a row is a step-by-step choice: there are n ways to fill the first position, $n-1$ ways left for the second, and so on down to 1 for the last. By the multiplication principle the total number of arrangements is the product $n \times (n-1) \times \cdots \times 1 = n!$. The factorial counts each ordering exactly once because every object is different.

Step 1 — Count and check distinctness: The word "DELHI" has the letters D, E, L, H, I — that is 5 letters, and all five are different, so no division for repeats is needed.

Step 2 — Set up the count: The number of arrangements is $5!$.

Step 3 — Expand the factorial:

$$5! = 5 \times 4 \times 3 \times 2 \times 1.$$

Step 4 — Multiply out:

$$5 \times 4 = 20, \quad 20 \times 3 = 60, \quad 60 \times 2 = 120, \quad 120 \times 1 = 120.$$

Why other options are wrong:

- (A) $24 = 4!$ permutes only four of the five letters.
- (B) $25 = 5^2$ uses the wrong operation (squaring rather than factorial).
- (C) $60 = \frac{5!}{2}$ wrongly divides by 2 as if a letter repeated, but none does.

Final Answer: $5! = 120 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Combinations: Choosing a committee is a selection where the *order* of the members does not matter — picking persons $\{X, Y, Z\}$ is the same committee as $\{Z, Y, X\}$. The number of such unordered selections of r objects from n is the binomial coefficient

$$\binom{n}{r} = \frac{n!}{r!\,(n-r)!},$$

where the $r!$ in the denominator removes the orderings that a permutation would have counted separately.

Step 1 — Identify n and r: We choose $r = 3$ members from $n = 6$ persons, so we need $\binom{6}{3}$.

Step 2 — Write the formula:

$$\binom{6}{3} = \frac{6!}{3!\,(6-3)!} = \frac{6!}{3!\,3!}.$$

Step 3 — Cancel and simplify: Writing the top as $6 \cdot 5 \cdot 4 \cdot 3!$ and cancelling one $3!$,

$$\binom{6}{3} = \frac{6 \cdot 5 \cdot 4}{3 \cdot 2 \cdot 1} = \frac{120}{6} = 20.$$

Step 4 — Sanity check by symmetry: Since $\binom{6}{3} = \binom{6}{3}$ is self-complementary and lies at the centre of row 6 of Pascal's triangle $(1, 6, 15, 20, 15, 6, 1)$, the value 20 is exactly the central, largest entry, as expected.

Why other options are wrong:

- (C) $120 = {}^6P_3$ counts ordered selections, treating $\{X, Y, Z\}$ and its reorderings as different.
- (B) 18 comes from a faulty cancellation of the factorials.
- (D) $216 = 6^3$ wrongly allows repetition and order (choosing with replacement).

Final Answer: $\binom{6}{3} = 20 \Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q13**

Q14.

Solution

Concept — Circular permutations: On a circle there is no fixed "first" seat: a seating and any rotation of it look identical because only the relative order around the table matters. The $n!$ linear arrangements therefore over-count by a factor of n (the n rotations of each pattern). Dividing gives $\frac{n!}{n} = (n-1)!$ distinct circular arrangements, which is equivalent to fixing one person's seat and permuting the rest.

Step 1 — Choose the model: For $n = 5$ persons around a circular table the count is $(n-1)! = (5-1)!$.

Step 2 — Reduce the factorial:

$$(5-1)! = 4!.$$

Step 3 — Evaluate:

$$4! = 4 \times 3 \times 2 \times 1 = 24.$$

Step 4 — Cross-check by the division argument: The $5! = 120$ linear orders, grouped into sets of 5 rotations that are the same around the table, give $\frac{120}{5} = 24$, agreeing with Step 3.

Why other options are wrong:

- (A) $120 = 5!$ counts arrangements in a straight line, not around a circle.
- (C) $12 = \frac{4!}{2}$ over-divides, as if reflections were also identified (a necklace count).
- (D) $25 = 5^2$ has no combinatorial meaning here.

Final Answer: $4! = 24 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Vieta's formulas for a cubic: For a monic cubic $x^3 + bx^2 + cx + d = 0$ with roots α, β, γ, the coefficients are the elementary symmetric functions of the roots, up to sign:

$$\alpha + \beta + \gamma = -b, \qquad \alpha\beta + \beta\gamma + \gamma\alpha = c, \qquad \alpha\beta\gamma = -d.$$

The sum of the roots is therefore minus the coefficient of x^2.

Step 1 — Read the coefficients: Comparing $x^3 - 6x^2 + 11x - 6 = 0$ with $x^3 + bx^2 + cx + d = 0$ gives $b = -6$, $c = 11$, $d = -6$.

Step 2 — Apply the sum-of-roots formula:

$$\alpha + \beta + \gamma = -b = -(-6) = 6.$$

Step 3 — Verify by finding the actual roots: Factoring, $x^3 - 6x^2 + 11x - 6 =$

$(x-1)(x-2)(x-3)$, so the roots are $1, 2, 3$. Their sum

$$1+2+3=6$$

matches Step 2.

Why other options are wrong:

- (A) 11 is the value of $\alpha\beta+\beta\gamma+\gamma\alpha$ (sum of products two at a time), not the sum.
- (B) -6 keeps the raw coefficient b without the sign change.
- (D) -11 negates the pairwise-product sum, which is the wrong quantity and the wrong sign.

Final Answer: $\alpha+\beta+\gamma=6 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Building an equation with reciprocal roots: If α is a root of an equation in x, then $\frac{1}{\alpha}$ is a root of the equation obtained by replacing x with $\frac{1}{x}$ and clearing denominators. The neat consequence for a quadratic is that the coefficients get reversed: $ax^2+bx+c=0$ becomes $cx^2+bx+a=0$ for the reciprocal roots.

Step 1 — Replace x by $\frac{1}{x}$: Starting from $x^2+px+q=0$, substitute $x \mapsto \frac{1}{x}$:

$$\left(\frac{1}{x}\right)^2+p\left(\frac{1}{x}\right)+q=0 \quad\Longrightarrow\quad \frac{1}{x^2}+\frac{p}{x}+q=0.$$

Step 2 — Clear denominators by multiplying by x^2:

$$1+px+qx^2=0.$$

Step 3 — Write in standard form: Reordering by descending powers,

$$qx^2+px+1=0.$$

Note this is just the original with its first and last coefficients 1 and q swapped, as the concept predicted.

Step 4 — Verify via sum and product: The reciprocal roots $\frac{1}{\alpha}, \frac{1}{\beta}$ have sum $\dfrac{\alpha+\beta}{\alpha\beta} = \dfrac{-p}{q}$ and product $\dfrac{1}{\alpha\beta} = \dfrac{1}{q}$. The equation $qx^2 + px + 1 = 0$ has sum of roots $-\frac{p}{q}$ and product $\frac{1}{q}$, matching exactly.

Why other options are wrong:

- (A) $x^2 + px + q = 0$ is the original equation, with the same roots, not their reciprocals.
- (B) $x^2 - px + q = 0$ only flips the sign of the middle term (roots $-\alpha, -\beta$), not the reciprocals.
- (C) $px^2 + qx + 1 = 0$ swaps the roles of p and q incorrectly.

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

Answer: (D) **Go Back to Q16**

Q17.

Solution

Concept — A fundamental trigonometric limit: The expression $\dfrac{\sin x}{x}$ is of the indeterminate form $\frac{0}{0}$ at $x = 0$, so it cannot be evaluated by direct substitution. Its value is the standard result

$$\lim_{x\to 0} \frac{\sin x}{x} = 1,$$

valid when x is measured in radians. Intuitively, for small angles the arc and its sine are nearly equal, so their ratio tends to 1.

Step 1 — Recognise the indeterminate form: Substituting $x = 0$ gives $\dfrac{\sin 0}{0} = \dfrac{0}{0}$, which is undefined, so a limiting argument is required.

Step 2 — Squeeze-theorem justification: For $0 < x < \frac{\pi}{2}$ a geometric area comparison gives $\cos x \le \dfrac{\sin x}{x} \le 1$. As $x \to 0$, $\cos x \to 1$, so the middle term is trapped between two quantities both tending to 1:

$$\lim_{x\to 0} \frac{\sin x}{x} = 1.$$

Step 3 — Numerical confirmation: Taking $x = 0.01$ rad, $\sin(0.01) \approx 0.00999983$, so $\dfrac{\sin x}{x} \approx 0.99998$, already extremely close to 1, supporting the result.

Why other options are wrong:

- (B) 0 would require the numerator to vanish faster than x, but here both shrink at the same rate.

- (C) ∞ would require the denominator to dominate, which it does not.
- (D) “does not exist” is false; the two-sided limit is the finite value 1 (the function is even).

Final Answer: the limit is $1 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — The product rule: When a function is a product of two factors $y = u(x)\,v(x)$, its derivative is not the product of the derivatives. Instead each factor is differentiated in turn while the other is held fixed, and the two contributions are added:

$$\frac{d}{dx}(uv) = u'v + uv'.$$

Step 1 — Split into factors: Take $u = x^2$ and $v = \sin x$, so that $y = uv$.

Step 2 — Differentiate each factor: Using the power rule and the derivative of sine,

$$u' = \frac{d}{dx}(x^2) = 2x, \qquad v' = \frac{d}{dx}(\sin x) = \cos x.$$

Step 3 — Assemble with the product rule:

$$\frac{dy}{dx} = u'v + uv' = (2x)(\sin x) + (x^2)(\cos x) = 2x\sin x + x^2\cos x.$$

Step 4 — Quick check at $x = 0$: At $x = 0$, $\dfrac{dy}{dx} = 2(0)\sin 0 + 0^2\cos 0 = 0$, which is consistent with $y = x^2 \sin x$ being flat at the origin (it behaves like x^3 near 0).

Why other options are wrong:

- (A) $2x\cos x$ mixes u' with v' and keeps only one term.
- (C) $x^2\cos x$ keeps only the uv' term and drops $u'v$.
- (D) $2x\sin x - x^2\cos x$ has the wrong sign on the second term.

Final Answer: $2x\sin x + x^2\cos x \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Minimum of an upward parabola: The graph of $f(x) = x^2 - 4x + 3$ is a parabola opening upward (positive leading coefficient), so it has a single lowest point, its vertex. At that vertex the tangent is horizontal, meaning the derivative is zero. Solving $f'(x) = 0$ locates the x of the vertex, and substituting back into f gives the minimum *value* (the y-coordinate).

Step 1 — Differentiate:

$$f'(x) = \frac{d}{dx}(x^2 - 4x + 3) = 2x - 4.$$

Step 2 — Find the critical point: Set the derivative to zero,

$$2x - 4 = 0 \quad \Longrightarrow \quad x = 2.$$

Step 3 — Confirm it is a minimum: The second derivative is $f''(x) = 2 > 0$, so the curve is concave up and $x = 2$ gives a minimum.

Step 4 — Evaluate the minimum value:

$$f(2) = 2^2 - 4(2) + 3 = 4 - 8 + 3 = -1.$$

This matches the marked vertex $(2, -1)$ on the graph.

Why other options are wrong:

- (A) 3 is $f(0)$, the y-intercept, not the lowest point.
- (B) 1 is a root of $f(x) = 0$ (where the curve meets the x-axis), not the minimum.
- (C) 2 is the x-coordinate of the vertex, not the minimum y-value.

Final Answer: minimum value $= -1 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept — Slope of a tangent via the derivative: The tangent line to a curve at a point is the straight line that just touches the curve there, and its slope equals the instantaneous rate of change of y with respect to x at that point. This rate of change is exactly the derivative $\frac{dy}{dx}$, evaluated at the x-coordinate of the point of contact.

Step 1 — Differentiate the curve: For $y = x^2$, the power rule gives

$$\frac{dy}{dx} = 2x.$$

Step 2 — Substitute the point: The point of contact is $(1, 1)$, so set $x = 1$:

$$\left.\frac{dy}{dx}\right|_{x=1} = 2(1) = 2.$$

Step 3 — Interpret: The tangent at $(1, 1)$ has slope 2; its equation is $y - 1 = 2(x - 1)$, i.e. $y = 2x - 1$, which indeed passes through $(1, 1)$.

Why other options are wrong:

- (A) 1 uses the y-value of the point rather than the derivative.
- (B) 0 would be the slope only at the vertex $x = 0$, not at $x = 1$.
- (D) 4 evaluates the derivative at $x = 2$ instead of $x = 1$.

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

Answer: (C) Go Back to Q20

Q21.

Solution

Concept — Order and degree of a differential equation: The *order* is the order of the highest derivative that appears. The *degree* is the exponent (power) of that highest-order derivative, but only after the equation has been written as a polynomial in all its derivatives (free of radicals and fractional powers on the derivatives). Crucially, the degree is read off the *highest-order* term — powers attached to lower-order derivatives are irrelevant to it.

Step 1 — List the derivatives present: The equation $\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^3 + y = 0$

contains the second derivative $\dfrac{d^2y}{dx^2}$ and the first derivative $\dfrac{dy}{dx}$.

Step 2 — Determine the order: The highest derivative is $\dfrac{d^2y}{dx^2}$ (a second derivative), so the order is 2.

Step 3 — Determine the degree: The equation is already polynomial in the derivatives. The highest-order derivative $\dfrac{d^2y}{dx^2}$ appears to the first power, so the degree is 1.

Step 4 — Address the cube (common trap): The exponent 3 sits on $\dfrac{dy}{dx}$, which is a *lower*-order derivative; it does not affect the degree, which is decided solely by the power of $\dfrac{d^2y}{dx^2}$.

Why other options are wrong:

- (B) order 1, degree 3 wrongly treats $\left(\frac{dy}{dx}\right)^3$ as the leading term.
- (C) order 2, degree 3 correctly finds the order but mistakenly takes the degree from the cubed first derivative.
- (D) order 3, degree 1 over-counts the order; no third derivative is present.

Final Answer: order 2, degree $1 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — Integration as the reverse of differentiation: An indefinite integral asks for a function whose derivative is the integrand. Since differentiation of the standard trigonometric functions gives $\dfrac{d}{dx}(\tan x) = \sec^2 x$, reversing this tells us that $\sec^2 x$ integrates to $\tan x$, plus an arbitrary constant of integration C because constants vanish under differentiation.

Step 1 — Recall the matching derivative:

$$\frac{d}{dx}(\tan x) = \sec^2 x.$$

Step 2 — Reverse it to integrate: Therefore

$$\int \sec^2 x \, dx = \tan x + C.$$

Step 3 — Verify by differentiating the answer: Differentiating $\tan x + C$ returns $\sec^2 x + 0 = \sec^2 x$, exactly the original integrand, confirming the result.

Why other options are wrong:

- (A) $\cot x + C$ is the antiderivative of $-\csc^2 x$, a different integrand.
- (C) $\sec x + C$ is the antiderivative of $\sec x \tan x$, not $\sec^2 x$.
- (D) $-\tan x + C$ differentiates to $-\sec^2 x$, the wrong sign.

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

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Odd functions over symmetric limits: A function is *odd* if $f(-x) = -f(x)$, meaning its graph has rotational symmetry about the origin. Over an interval $[-a, a]$ symmetric about 0, the signed area to the left of the origin exactly cancels the signed area to the right, so

$$\int_{-a}^{a} f(x)\,dx = 0 \quad \text{whenever } f \text{ is odd.}$$

Step 1 — Test the parity of the integrand: For $f(x) = x^3$,

$$f(-x) = (-x)^3 = -x^3 = -f(x),$$

so f is an odd function.

Step 2 — Note the symmetric limits: The limits -1 and 1 are symmetric about the origin, so the odd-function property applies directly and the integral is 0.

Step 3 — Confirm by direct integration: Using the antiderivative $\frac{x^4}{4}$,

$$\int_{-1}^{1} x^3\,dx = \left[\frac{x^4}{4}\right]_{-1}^{1} = \frac{1^4}{4} - \frac{(-1)^4}{4} = \frac{1}{4} - \frac{1}{4} = 0,$$

agreeing with Step 2.

Why other options are wrong:

- (A) $\frac{1}{2}$ would arise from integrating only over $[0, 1]$ as $\frac{x^4}{4}\Big|_0^1 = \frac{1}{4}$ and then mis-scaling.
- (B) 2 ignores the cancellation and adds the two halves.

- (C) 1 comes from treating $\left[\frac{x^4}{4}\right]$ as if both endpoints contributed $+\frac{1}{4}$.

Final Answer: the integral is $0 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q23

Q24.

Solution

Concept — Area under a curve by integration: The area of the region bounded by a curve $y = f(x)$, the x-axis, and two vertical lines $x = a$ and $x = b$ (with $f \geq 0$) is the definite integral $\displaystyle\int_a^b y\,dx$. The integral sums up infinitely many thin vertical strips of height y and width dx.

Step 1 — Identify the boundaries: The region is bounded above by $y = x$, below by the x-axis, and on the right by $x = 2$; on the left it closes at the origin where $y = x$ meets the axis ($x = 0$). So $a = 0$, $b = 2$.

Step 2 — Set up the integral:

$$\text{area} = \int_0^2 x\,dx.$$

Step 3 — Integrate and apply the limits:

$$\int_0^2 x\,dx = \left[\frac{x^2}{2}\right]_0^2 = \frac{2^2}{2} - \frac{0^2}{2} = \frac{4}{2} - 0 = 2 \text{ sq. units.}$$

Step 4 — Cross-check with the triangle: The shaded region is a right triangle with base 2 (along the x-axis) and height 2 (the value of $y = x$ at $x = 2$). Its area is $\frac{1}{2} \cdot 2 \cdot 2 = 2$, matching the integral.

Why other options are wrong:

- (A) 4 uses base$\times$height without the factor $\frac{1}{2}$.
- (B) 1 halves the correct area, perhaps from integrating to $x = 1$ by mistake.
- (D) 8 squares the upper limit ($2^3/?$ slip) and loses the $\frac{1}{2}$.

Final Answer: area $= 2$ sq. units $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q24

Q25.

Solution

Concept — The fundamental theorem of calculus: A definite integral $\int_a^b f(x)\,dx$ is evaluated by finding an antiderivative F (so that $F' = f$) and computing $F(b) - F(a)$. The integrand here, $\cos x$, has the well-known antiderivative $\sin x$.

Step 1 — Find the antiderivative:

$$\int \cos x\,dx = \sin x.$$

Step 2 — Evaluate at the two limits:

$$\big[\sin x\big]_0^{\pi/2} = \sin\frac{\pi}{2} - \sin 0.$$

Step 3 — Substitute the known values: Since $\sin\frac{\pi}{2} = 1$ and $\sin 0 = 0$,

$$1 - 0 = 1.$$

Step 4 — Sense-check geometrically: The graph of $\cos x$ on $[0, \frac{\pi}{2}]$ falls from 1 to 0, enclosing a positive area of order 1; the exact value being 1 is consistent with this.

Why other options are wrong:

- (B) 0 would require the two endpoint values of $\sin$ to be equal, but $\sin\frac{\pi}{2} \neq \sin 0$.
- (C) $\frac{\pi}{2}$ confuses the area with the width of the interval.
- (D) -1 reverses the sign, as if computing $\sin 0 - \sin\frac{\pi}{2}$.

Final Answer: the integral is $1 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept — Slope of a line in general form: A line written as $ax + by + c = 0$ has slope $-\frac{a}{b}$. This follows from solving for y to reach the slope–intercept form $y = mx + k$, where the coefficient of x is the slope. The minus sign arises from moving the x-term to the other side and dividing by b.

Step 1 — Identify the coefficients: Rewrite $3x + 4y = 12$ as $3x + 4y - 12 = 0$, so $a = 3$, $b = 4$.

Step 2 — Apply the slope formula:

$$m = -\frac{a}{b} = -\frac{3}{4}.$$

Step 3 — Verify by converting to $y = mx + k$: Solving for y,

$$4y = 12 - 3x \quad \Longrightarrow \quad y = -\frac{3}{4}x + 3,$$

so the coefficient of x is indeed $-\frac{3}{4}$, and the y-intercept is 3.

Why other options are wrong:

- (A) $\frac{3}{4}$ drops the negative sign required when moving the x-term across.
- (C) $\frac{4}{3}$ inverts the ratio (uses $-\frac{b}{a}$, the slope of the perpendicular without sign).
- (D) $-\frac{4}{3}$ inverts the ratio as well, keeping the sign.

Final Answer: slope $= -\frac{3}{4} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — General equation of a circle: The equation $x^2+y^2+2gx+2fy+c = 0$ represents a circle with centre $(-g, -f)$ and radius $\sqrt{g^2 + f^2 - c}$. These come from completing the square in x and in y, which converts the equation to the centre–radius form $(x + g)^2 + (y + f)^2 = g^2 + f^2 - c$.

Step 1 — Match coefficients: Compare $x^2 + y^2 - 6x - 8y + 9 = 0$ with the general form:

$$2g = -6 \Rightarrow g = -3, \qquad 2f = -8 \Rightarrow f = -4, \qquad c = 9.$$

Step 2 — Locate the centre: Centre $= (-g, -f) = (3, 4)$, matching the marked point in the figure.

Step 3 — Compute the radius:

$$r = \sqrt{g^2 + f^2 - c} = \sqrt{(-3)^2 + (-4)^2 - 9} = \sqrt{9 + 16 - 9} = \sqrt{16} = 4.$$

Step 4 — Verify by completing the square:

$$(x-3)^2 + (y-4)^2 = 9 + 16 - 9 = 16 = 4^2,$$

which is a circle of centre $(3, 4)$ and radius 4, confirming Step 3.

Why other options are wrong:

- (A) 3 is the x-coordinate of the centre, not the radius.
- (B) 5 comes from $\sqrt{g^2 + f^2} = \sqrt{9 + 16}$, forgetting to subtract c.
- (D) 9 takes the constant term $c = 9$ directly, ignoring the radius formula and its square root.

Final Answer: radius $= 4 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q27

Q28.

Solution

Concept — Standard right-opening parabola: A parabola of the form $y^2 = 4ax$ (with $a > 0$) opens to the right, has its vertex at the origin, axis along the positive x-axis, and focus at the point $(a, 0)$. The constant a is the distance from the vertex to the focus, so identifying a from the equation immediately locates the focus.

Step 1 — Compare with the standard form: Write the given equation beside the template:

$$y^2 = 16x \quad \text{versus} \quad y^2 = 4ax.$$

Step 2 — Solve for a: Matching the coefficients of x,

$$4a = 16 \quad \Longrightarrow \quad a = 4.$$

Step 3 — Write the focus: For $y^2 = 4ax$ the focus is $(a, 0)$, so here it is

$$(a, 0) = (4, 0).$$

Step 4 — Consistency with the figure: The parabola in the diagram opens rightward with its vertex at the origin, so the focus must lie on the positive x-axis, in agreement with $(4, 0)$.

Why other options are wrong:

- (A) $(0, 4)$ places the focus on the y-axis, which would suit an upward parabola $x^2 = 4ay$.
- (B) $(2, 0)$ uses $\frac{a}{2}$ instead of a.
- (C) $(16, 0)$ uses the coefficient $4a = 16$ directly instead of $a = 4$.

Final Answer: focus $= (4, 0) \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q28

Q29.

Solution

Concept — Direction cosines: If a line makes angles α, β, γ with the x-, y- and z-axes, its direction cosines are $l = \cos\alpha$, $m = \cos\beta$, $n = \cos\gamma$, and they always satisfy the normalisation identity $l^2 + m^2 + n^2 = 1$. “Equal angles with all three axes” means $\alpha = \beta = \gamma$, hence $l = m = n$.

Step 1 — Use the equal-angle condition: Since $l = m = n$, write each as l. The normalisation becomes

$$l^2 + l^2 + l^2 = 1 \quad \Longrightarrow \quad 3l^2 = 1.$$

Step 2 — Solve for l:

$$l^2 = \frac{1}{3} \quad \Longrightarrow \quad l = \frac{1}{\sqrt{3}}.$$

Step 3 — Write the direction cosines: Therefore

$$(l, m, n) = \left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right).$$

Step 4 — Check the normalisation: $\left(\frac{1}{\sqrt{3}}\right)^2 \times 3 = \frac{1}{3} \times 3 = 1$, so the identity $l^2 + m^2 + n^2 = 1$ holds, confirming the answer. (The common angle is $\cos^{-1}\frac{1}{\sqrt{3}} \approx 54.7^\circ$.)

Why other options are wrong:

- (B) $\frac{1}{3}$ each gives $l^2 + m^2 + n^2 = 3 \cdot \frac{1}{9} = \frac{1}{3} \neq 1$.
- (C) $\frac{1}{\sqrt{2}}$ each gives $3 \cdot \frac{1}{2} = \frac{3}{2} \neq 1$.
- (D) $1, 1, 1$ gives $1 + 1 + 1 = 3 \neq 1$ (these are direction *ratios*, not cosines).

Final Answer: $\left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right) \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q29

Q30.

Solution

Concept — Perpendicular distance of a plane from the origin: For a plane written as $ax + by + cz = d$, the vector (a, b, c) is normal (perpendicular) to the plane. The perpendicular distance from the origin is obtained by normalising this equation, i.e. dividing the constant d by the length of the normal vector:

$$\text{distance} = \frac{|d|}{\sqrt{a^2 + b^2 + c^2}}.$$

Step 1 — Identify the coefficients: For $2x - y + 2z = 6$ we have $a = 2$, $b = -1$, $c = 2$ and $d = 6$.

Step 2 — Compute the magnitude of the normal:

$$\sqrt{a^2 + b^2 + c^2} = \sqrt{2^2 + (-1)^2 + 2^2} = \sqrt{4 + 1 + 4} = \sqrt{9} = 3.$$

Step 3 — Divide to get the distance:

$$\text{distance} = \frac{|6|}{3} = \frac{6}{3} = 2.$$

Step 4 — Reasonableness check: The plane crosses the axes at $(3, 0, 0)$, $(0, -6, 0)$, $(0, 0, 3)$, all at least 3 units away, so a perpendicular distance of 2 (shorter than any intercept) is geometrically sensible.

Why other options are wrong:

- (A) 6 reports d alone, forgetting to divide by the normal's length.
- (C) 3 is the magnitude of the normal $\sqrt{a^2 + b^2 + c^2}$, not the distance.
- (D) 1 comes from miscomputing $\sqrt{a^2 + b^2 + c^2}$ as 6 and then $6/6$.

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

Answer: (B) Go Back to Q30

Q31.

Solution

Concept — The scalar (dot) product: The dot product of two vectors multiplies corresponding components and adds the results to give a single scalar:

$$\vec{a} \cdot \vec{b} = a_1b_1 + a_2b_2 + a_3b_3.$$

It is positive when the vectors point in broadly the same direction, zero when they are perpendicular, and negative when they point oppositely.

Step 1 — List the components: For $\vec{a} = \hat{\imath} + \hat{\jmath} + \hat{k}$ and $\vec{b} = \hat{\imath} - \hat{\jmath} + \hat{k}$,

$$\vec{a} = (1, 1, 1), \qquad \vec{b} = (1, -1, 1).$$

Step 2 — Multiply componentwise:

$$a_1b_1 = (1)(1) = 1, \quad a_2b_2 = (1)(-1) = -1, \quad a_3b_3 = (1)(1) = 1.$$

Step 3 — Add the three products:

$$\vec{a} \cdot \vec{b} = 1 + (-1) + 1 = 1.$$

Step 4 — Interpret: Since the result 1 is positive (not zero), the vectors are neither perpendicular nor opposite; they make an acute angle.

Why other options are wrong:

- (A) 3 ignores the negative sign on the middle term, adding $1 + 1 + 1$.
- (B) 0 over-subtracts, as if the middle term were -2 or two terms cancelled wrongly.
- (D) 2 drops one of the $+1$ contributions.

Final Answer: $\vec{a} \cdot \vec{b} = 1 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q31

Q32.

Solution

Concept — Parallelogram area via the cross product: The magnitude of the cross product of two vectors equals the area of the parallelogram they span: $|\vec{a} \times \vec{b}| = |\vec{a}||\vec{b}|\sin\theta$, where θ is the angle between them. The cross product itself is a vector perpendicular to both, governed by the right-hand rule and the basis relation $\hat{\imath} \times \hat{\jmath} = \hat{k}$.

Step 1 — Form the cross product: With $\vec{a} = 2\hat{\imath}$ and $\vec{b} = 3\hat{\jmath}$,

$$\vec{a} \times \vec{b} = (2\hat{\imath}) \times (3\hat{\jmath}) = 6\,(\hat{\imath} \times \hat{\jmath}) = 6\hat{k}.$$

Step 2 — Take the magnitude:

$$|\vec{a} \times \vec{b}| = |6\hat{k}| = 6 \text{ sq. units}.$$

Step 3 — Cross-check with $|\vec{a}||\vec{b}|\sin\theta$: The vectors $2\hat{\imath}$ and $3\hat{\jmath}$ are perpendicular, so $\theta = 90^\circ$ and $\sin\theta = 1$:

$$|\vec{a}||\vec{b}|\sin 90^\circ = 2 \cdot 3 \cdot 1 = 6,$$

matching Step 2. Geometrically this is just a 2×3 rectangle of area 6, as in the figure.

Why other options are wrong:

- (A) 0 would require the vectors to be parallel ($\sin\theta = 0$), but they are perpendicular.
- (B) 3 keeps only the length of $\vec{b}$.
- (C) 2 keeps only the length of $\vec{a}$.

Final Answer: area $= 6 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Scalar triple product and coplanarity: The scalar triple product $[\vec{a}\,\vec{b}\,\vec{c}] = \vec{a}\cdot(\vec{b}\times\vec{c})$ gives the *signed volume* of the parallelepiped having $\vec{a},\vec{b},\vec{c}$ as adjacent edges. If the three vectors lie in a common plane, the parallelepiped is squashed flat and has zero volume. Conversely, a non-zero volume means the vectors stick out of any single plane. Hence coplanarity is equivalent to the triple product vanishing.

Step 1 — State the geometric meaning: $[\vec{a}\,\vec{b}\,\vec{c}]$ equals the volume (up to sign) of the box spanned by the three vectors.

Step 2 — Apply the flat-box condition: For the vectors to be coplanar the box must collapse to zero thickness, so its volume is 0:

$$[\vec{a}\,\vec{b}\,\vec{c}] = 0.$$

Step 3 — Equivalent determinant form: Writing the vectors as rows, coplanarity is the same as the determinant condition

$$\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix} = 0,$$

i.e. the rows are linearly dependent.

Why other options are wrong:

- (B) 1 is a specific non-zero volume, so the vectors would span space, not a plane.
- (C) “positive” means a strictly non-zero (positive) volume, hence non-coplanar.
- (D) “negative” likewise denotes a non-zero (oppositely oriented) volume, again non-coplanar.

Final Answer: $[\vec{a}\,\vec{b}\,\vec{c}] = 0 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q33

Q34.

Solution

Concept — The arithmetic mean: The arithmetic mean (average) of a data set is the total of all the observations divided by how many there are,

$$\bar{x} = \frac{\sum x_i}{n}.$$

It represents the single value that, if every observation equalled it, would give the same total.

Step 1 — Count the observations: The data are $2, 4, 6, 8, 10$, so $n = 5$.

Step 2 — Add them up:

$$\sum x_i = 2 + 4 + 6 + 8 + 10 = 30.$$

Step 3 — Divide by the count:

$$\bar{x} = \frac{30}{5} = 6.$$

Step 4 — Symmetry check: The values form an evenly spaced (arithmetic) sequence, so their mean equals the middle term. The middle value is 6, confirming the answer.

Why other options are wrong:

- (A) 5 is n, the number of observations, not their average.
- (C) 30 is the total $\sum x_i$, before dividing by n.
- (D) 8 is one of the data values, not the central average.

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

Answer: (B) **Go Back to Q34**

Q35.

Solution

Concept — Classical (equally likely) probability: When every outcome of an experiment is equally likely, the probability of an event is the ratio of the number of outcomes favourable to that event to the total number of possible outcomes:

$$P = \frac{\text{number of favourable outcomes}}{\text{total number of outcomes}}.$$

A fair die has six equally likely faces, so this model applies directly.

Step 1 — List the sample space: Rolling one die gives outcomes $\{1, 2, 3, 4, 5, 6\}$, so the total number of outcomes is 6.

Step 2 — Identify the favourable outcomes: The even numbers are $\{2, 4, 6\}$, which is 3 outcomes.

Step 3 — Form and simplify the ratio:

$$P = \frac{3}{6} = \frac{1}{2}.$$

Step 4 — Sanity check via complement: The odd numbers $\{1, 3, 5\}$ also number 3, giving probability $\frac{1}{2}$; since even and odd are complementary and equally sized, each must have probability $\frac{1}{2}$, confirming the result.

Why other options are wrong:

- (A) $\frac{1}{3}$ would mean only 2 favourable outcomes out of 6.
- (B) $\frac{1}{6}$ counts a single face, as if asking for one specific number.
- (D) $\frac{2}{3}$ counts 4 favourable outcomes, more even numbers than a die has.

Final Answer: $P = \dfrac{1}{2} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q35

Q36.

Solution

Concept — The binomial distribution: When an experiment with two outcomes (success/failure) is repeated n independent times with success probability p, the chance of exactly r successes is

$$P(X = r) = \binom{n}{r} p^r (1-p)^{n-r}.$$

The binomial coefficient $\binom{n}{r}$ counts the different orders in which the r successes can occur. For a fair coin, success (heads) has $p = \frac{1}{2}$.

Step 1 — Set the parameters: Here $n = 3$ tosses, we want $r = 2$ heads, and $p = \frac{1}{2}$, so $1 - p = \frac{1}{2}$.

Step 2 — Substitute into the formula:

$$P(X = 2) = \binom{3}{2} \left(\frac{1}{2}\right)^2 \left(\frac{1}{2}\right)^1.$$

Step 3 — Evaluate the pieces: $\binom{3}{2} = 3$, and $\left(\frac{1}{2}\right)^2 \left(\frac{1}{2}\right)^1 = \left(\frac{1}{2}\right)^3 = \frac{1}{8}$, so

$$P = 3 \cdot \frac{1}{8} = \frac{3}{8}.$$

Step 4 — Cross-check by listing: The eight equally likely outcomes are HHH, HHT, HTH, THH, HTT, THT, TTH, TTT. Exactly two heads occur in HHT, HTH, THH — 3 of the 8 outcomes, giving $\frac{3}{8}$, in agreement.

Why other options are wrong:

- (A) $\frac{1}{8}$ counts only one specific arrangement (e.g. HHT), missing the $\binom{3}{2} = 3$ orders.
- (B) $\frac{1}{2}$ ignores the count of tosses and the binomial coefficient entirely.
- (C) $\frac{1}{4}$ drops the factor $\binom{3}{2} = 3$ in a different way, undercounting the arrangements.

Final Answer: $P = \dfrac{3}{8} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q36

Q37.

Solution

Concept — Standard trigonometric values and complementary angles: The values at the special angles come from a 30–60–90 triangle: $\sin 30^\circ = \frac{1}{2}$ and $\cos 60^\circ = \frac{1}{2}$. These are in fact equal because 30° and 60° are complementary, and the co-function identity $\cos 60^\circ = \sin(90^\circ - 60^\circ) = \sin 30^\circ$ guarantees it.

Step 1 — Write each value:

$$\sin 30^\circ = \frac{1}{2}, \qquad \cos 60^\circ = \frac{1}{2}.$$

Step 2 — Add them:

$$\sin 30^\circ + \cos 60^\circ = \frac{1}{2} + \frac{1}{2}.$$

Step 3 — Simplify:

$$\frac{1}{2} + \frac{1}{2} = \frac{2}{2} = 1.$$

Step 4 — Confirm via the co-function link: Because $\cos 60^\circ = \sin 30^\circ$, the sum is just $2\sin 30^\circ = 2 \cdot \frac{1}{2} = 1$, the same result.

Why other options are wrong:

- (B) 0 would require the two terms to cancel, but both are $+\frac{1}{2}$.
- (C) $\frac{1}{2}$ keeps only one of the two terms.
- (D) 2 wrongly takes each value as 1 instead of $\frac{1}{2}$.

Final Answer: $\sin 30^\circ + \cos 60^\circ = 1 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q37

Q38.

Solution

Concept — The double-angle identity for sine: The sine of twice an angle is given by $\sin 2\theta = 2\sin\theta\cos\theta$. To use it we need both $\sin\theta$ and $\cos\theta$; the missing one is recovered from the Pythagorean identity $\sin^2\theta + \cos^2\theta = 1$, taking the positive root because θ is acute (first quadrant, where cosine is positive).

Step 1 — Find $\cos\theta$: With $\sin\theta = \frac{3}{5}$,

$$\cos\theta = \sqrt{1 - \sin^2\theta} = \sqrt{1 - \frac{9}{25}} = \sqrt{\frac{16}{25}} = \frac{4}{5}.$$

(This is the familiar 3–4–5 right triangle.)

Step 2 — Apply the identity:

$$\sin 2\theta = 2\sin\theta\cos\theta = 2 \cdot \frac{3}{5} \cdot \frac{4}{5}.$$

Step 3 — Simplify:

$$2 \cdot \frac{3}{5} \cdot \frac{4}{5} = \frac{2 \cdot 3 \cdot 4}{25} = \frac{24}{25}.$$

Step 4 — Reasonableness check: Since $0 < \sin 2\theta \leq 1$ for the resulting angle, the value $\frac{24}{25} = 0.96$ is a valid sine, close to 1 as expected when 2θ is near 90°.

Why other options are wrong:

- (A) $\frac{12}{25}$ drops the factor 2, computing $\sin\theta\cos\theta$ only.
- (B) $\frac{7}{25}$ is $\cos 2\theta = 1 - 2\sin^2\theta$, a different identity.
- (D) $\frac{6}{5}$ exceeds 1 and so cannot be a sine value at all.

Final Answer: $\sin 2\theta = \dfrac{24}{25} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q38

Q39.

Solution

Concept — Principal value of the inverse sine: Because $\sin$ repeats and takes each value infinitely often, $\sin^{-1}$ is made a genuine function by restricting its output to the principal range $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$. The principal value of $\sin^{-1}(x)$ is the unique angle in that range whose sine is x.

Step 1 — Set up the equation: We need θ with

$$\sin\theta = \frac{1}{2}, \qquad \theta \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right].$$

Step 2 — Recall the special angle: From the 30–60–90 triangle, $\sin 30^\circ = \frac{1}{2}$, and $30^\circ = \frac{\pi}{6}$ radians.

Step 3 — Check it lies in the principal range: $\frac{\pi}{6} \approx 0.52$ lies inside $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$, so

$$\sin^{-1}\left(\tfrac{1}{2}\right) = \frac{\pi}{6}.$$

Step 4 — Note the rejected solution: Although $\sin\frac{5\pi}{6} = \frac{1}{2}$ as well, $\frac{5\pi}{6}$ is outside the principal range, so it is not the principal value.

Why other options are wrong:

- (A) $\frac{\pi}{3}$ has $\sin = \frac{\sqrt{3}}{2}$, not $\frac{1}{2}$.
- (C) $\frac{\pi}{4}$ has $\sin = \frac{1}{\sqrt{2}}$, not $\frac{1}{2}$.
- (D) $\frac{\pi}{2}$ has $\sin = 1$, not $\frac{1}{2}$.

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

Answer: (B) Go Back to Q39

Q40.

Solution

Concept — Heights and distances via the tangent ratio: The tower, the ground, and the line of sight form a right triangle with the right angle at the foot of the tower. The angle of elevation is the angle the line of sight makes with the horizontal. In this triangle the tower height is the side opposite the elevation angle and the ground distance is the adjacent side, so

$$\tan(\text{angle of elevation}) = \frac{\text{opposite}}{\text{adjacent}} = \frac{\text{height}}{\text{horizontal distance}}.$$

Step 1 — Set up the equation: With elevation 45°, height h, and ground distance 30 m,

$$\tan 45^\circ = \frac{h}{30}.$$

Step 2 — Substitute the known tangent: Since $\tan 45^\circ = 1$,

$$1 = \frac{h}{30}.$$

Step 3 — Solve for h:

$$h = 30 \times 1 = 30 \text{ m}.$$

Step 4 — Interpret the geometry: An elevation of exactly 45° makes the right triangle isosceles, so the height equals the base distance — $h = 30$ m matches the 30 m ground distance, confirming the figure.

Why other options are wrong:

- (A) 15 m halves the distance, as if using $\tan$ of a smaller angle incorrectly.
- (B) 60 m doubles the distance, using a ratio of 2 that no standard angle gives here.
- (C) $30\sqrt{3}$ m uses $\tan 60^\circ = \sqrt{3}$ instead of $\tan 45^\circ = 1$.

Final Answer: height $= 30$ m $\Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q40**

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	B	3	C	4	D	5	A
6	C	7	B	8	D	9	A	10	B
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	D	24	C	25	A
26	B	27	C	28	D	29	A	30	B
31	C	32	D	33	A	34	B	35	C
36	D	37	A	38	C	39	B	40	D