JEE Main Mathematics Sample Paper-4

Duration: 1 Hour **Maximum Marks: 100**

Instructions

- This paper contains TWO sections: **Section A** (MCQs) and **Section B** (Numerical).
- Section A contains 20 Multiple Choice Questions.
- Section B contains 5 Numerical Value Questions.
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries **-1 mark**.
- No negative marking for unattempted questions.

Section A — Multiple Choice Questions

Q1. Let $S = \{x \in \mathbb{R} : |x-2| > |x-3|\}$. Then S is given by: [JEE Main 2024]

(A) $(2.5, \infty)$

(B) $(-\infty, 2.5)$

(C) $(2, 3)$

(D) $(-\infty, 2) \cup (3, \infty)$

Q2. If $f(x) = \frac{x}{(1+x^n)^{1/n}}$ for $n \geq 2$ and $g(x) = (f \circ f \circ \cdots \circ f)(x)$ (f repeated n times), then $\int x^{n-2} g(x) dx$ is: [JEE Main 2023]

(A) $\frac{1}{n(n-1)}(1+nx^n)^{(n-1)/n} + C$

(B) $\frac{1}{n-1}(1+nx^n)^{(n-1)/n} + C$

(C) $\frac{1}{n(n+1)}(1+nx^n)^{(n+1)/n} + C$

(D) $\frac{1}{n^2}(1+nx^n)^{1/n} + C$

Q3. Value of c in Lagrange's MVT for $f(x) = \log_e x$ on $[1, e]$ is: [JEE Main 2022]

(A) $e - 1$

(B) $1/(e-1)$

(C) e

(D) 1

Q4. P on $x^2 + y^2 = 9$, Q on $7x + y + 50 = 0$. Minimum PQ: [JEE Main 2025]

(A) $5\sqrt{2} - 3$

(B) $10 - 3$

(C) $5\sqrt{2}$

(D) $3\sqrt{5}$

Q5. Number of solutions of $e^x = x^2$ is: [JEE Main 2021]

(A) 0

(B) 1

(C) 2

(D) 3

Q6. Vectors $\vec{a} = \hat{i} - \hat{j} + 2\hat{k}$, $\vec{b} = 2\hat{i} + 4\hat{j} + \hat{k}$, $\vec{c} = \lambda\hat{i} + \hat{j} + \mu\hat{k}$ mutually orthogonal. (λ, μ) is: [JEE Main 2024]

(A) $(-3, 2)$

(B) $(2, -3)$

(C) $(-2, 3)$

(D) $(3, -2)$

Q7. Probability leap year has 53 Sundays: [JEE Main 2023]

(A) $1/7$

(B) $2/7$

(C) $53/366$

(D) $7/366$

Q8. Plane containing line $\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}$ and point $(0, 0, 0)$: [JEE Main 2022]

(A) $x - 2y + z = 0$

(B) $x + 2y - 2z = 0$

(C) $2x + y - z = 0$

(D) $x - y + z = 0$

Q9. ω complex cube root of unity. Value of det $\begin{bmatrix} 1 & \omega & \omega^2 \\ \omega & \omega^2 & 1 \\ \omega^2 & 1 & \omega \end{bmatrix}$: [JEE Main 2025]

(A) 0

(B) 1

(C) 3

(D) ω

Q10. Eccentricity of ellipse $1/\sqrt{2}$, latus rectum $= 10$. Major axis: [JEE Main 2021]

(A) $20\sqrt{2}$

(B) $10\sqrt{2}$

(C) 20

(D) 15

Q11. $y = (x + \sqrt{x^2 + 1})^m$. Then $(x^2 + 1)y'' + xy' =$: [JEE Main 2024]

(A) $m^2 y$

(B) $-m^2 y$

(C) my

(D) 0

Q12. Sum of coefficients in $(1 - 3x + x^2)^{100}$: [JEE Main 2023]

(A) 1

(B) -1

(C) 3^{100}

(D) 0

Q13. Area bounded by $y = \sin x$ and $y = \cos x$ between $x = 0$ and $x = \pi/2$: [JEE Main 2022]

(A) $2\sqrt{2}-2$

(B) $2\sqrt{2}$

(C) $\sqrt{2}-1$

(D) $2(\sqrt{2}-1)$

Q14. 5 boys, 3 girls in row, no two girls together. Number of ways: [JEE Main 2025]

(A) 14400

(B) 2400

(C) 720

(D) 120

Q15. Shortest distance between $y^2 = x - 1$ and $x^2 = y - 1$: [JEE Main 2021]

(A) $3\sqrt{2}/4$

(B) $3/(4\sqrt{2})$

(C) $1/\sqrt{2}$

(D) 0

Q16. If $\sin^{-1} x + \sin^{-1} y = \pi/2$, then dx/dy is: [JEE Main 2024]

(A) x/y

(B) $-y/x$

(C) $-x/y$

(D) $\sqrt{1-x^2}/\sqrt{1-y^2}$

Q17. $\lim_{x\to\infty} \left(\frac{x+6}{x+1}\right)^{x+4}$: [JEE Main 2023]

(A) e^5

(B) e^6

(C) e

(D) e^4

Q18. If $A^2 = I$, then $(A-I)^3 + (A+I)^3 - 7A$ is: [JEE Main 2022]

(A) A

(B) $I - A$

(C) $I + A$

(D) $3A$

Q19. Standard deviation of $6, 5, 9, 13, 12, 8, 10$: [JEE Main 2025]

(A) $\sqrt{52/7}$

(B) $52/7$

(C) 6

(D) 2

Q20. Image of point $(1, 2, 3)$ in plane $x + y + z = 12$: [JEE Main 2024]

(A) $(5, 6, 7)$

(B) $(3, 4, 5)$

(C) $(1, 2, 3)$

(D) $(2, 4, 6)$

Section B — Numerical Value Questions

Q21. System $x + y + z = 2$, $2x + 4y - z = 6$, $3x + 2y + \lambda z = \mu$ has infinitely many solutions. Find $\lambda + \mu$. [JEE Main 2024]

Q22. Number of points of non-differentiability of $f(x) = \max\{|x-1|, |x-2|, |x-3|\}$. [JEE Main 2023]

Q23. $A = \{1, 2, 3, 4\}$. Number of derangements $f : A \to A$ such that $f(i) \neq i$ for all i. [JEE Main 2025]

Q24. Line $y = mx + 1$ tangent to $y^2 = 4x$. Find m. [JEE Main 2022]

Q25. Sum of intercepts of plane through $(1, 2, 3)$ parallel to $x + 2y + 3z = 14$. [JEE Main 2021]

Detailed Solutions

Q1.

Solution

Concept: We are given the set $S = \{x \in \mathbb{R} : |x-2| > |x-3|\}$, which involves absolute value inequalities. To solve this, we need to determine the region where the absolute value expression holds.

Solution: - **Step 1:** Rewrite the inequality as two cases, based on the definition of absolute values: - Case 1: $x - 2 > 3 - x$ - Case 2: $2 - x > x - 3$ - **Step 2:** Solve both inequalities to find the interval where the inequality holds: - Solving Case 1 gives $x > 2.5$
- Solving Case 2 gives $x < 2.5$

Thus, the solution set is $(-\infty, 2.5) \cup (3, \infty)$.

Conclusion: The solution is $(-\infty, 2.5) \cup (3, \infty)$.

Final Answer: (D)

Answer: (D)

Q2.

Solution

Concept: We are asked to find the integral of the function $g(x)$, where $g(x)$ is a composition of the function $f(x) = x^{(1+x^n)^{1/n}}$ repeated n times.

Solution: - **Step 1:** We begin by recalling the formula for $g(x)$, the composition of $f(x)$ repeated n times. We are tasked with evaluating the integral:

$$\int x^{n-2} g(x)\, dx$$

- **Step 2:** Use standard integral properties and perform algebraic simplifications to evaluate the integral. The formula is derived through successive applications of integration techniques.
- **Step 3:** After solving, we arrive at the solution:

$$\frac{1}{n(n-1)} (1 + nx^n)^{(n-1)/n} + C$$

Conclusion: The integral evaluates to $\frac{1}{n(n-1)} (1 + nx^n)^{(n-1)/n} + C$.

Final Answer: (A)

Answer: (A)

Q3.

Solution

Concept: We are given the function $f(x) = \ln x$ and need to find the value of c in the Lagrange's Mean Value Theorem (MVT) for $f(x)$ on the interval $[1, e]$.

Solution: - **Step 1:** Apply the MVT, which states that there exists some c in the interval $(1, e)$ such that:

$$f'(c) = \frac{f(e) - f(1)}{e - 1}$$

- **Step 2:** Compute $f'(x)$:

$$f'(x) = \frac{1}{x}$$

Therefore, we need to solve for c such that:

$$\frac{1}{c} = \frac{1}{e - 1}$$

- **Step 3:** Solving gives:

$$c = e$$

Conclusion: The value of c is e.

Final Answer: (C)

Answer: (C)

Q4.

Solution

Concept: We are given two geometric figures: a point P on the circle $x^2 + y^2 = 9$ and a line $7x + y + 50 = 0$. We are to find the minimum distance between P and the line.

Solution: - **Step 1:** Use the formula for the distance between a point and a line:

$$d = \frac{|Ax_1 + By_1 + C|}{\sqrt{A^2 + B^2}}$$

where the equation of the line is $7x + y + 50 = 0$ and the point P is on the circle $x^2 + y^2 = 9$.

- **Step 2:** Calculate the distance using the coordinates of the point on the circle that minimizes the distance. After geometric computations, the minimum distance is found to be:

$$5\sqrt{2}$$

Conclusion: The minimum distance between P and the line is $5\sqrt{2}$.

Final Answer: (C)

Answer: (C)

Q5.

Solution

Concept: We are asked to find the number of solutions to the equation $e^x = x^2$.

Solution: - **Step 1:** Analyze the two functions $f(x) = e^x$ and $g(x) = x^2$. These two functions intersect at points where $e^x = x^2$.

- **Step 2:** Solve the equation graphically or numerically to find the number of intersection points.

- **Step 3:** After analyzing, we find that there are two solutions.

Conclusion: The number of solutions is 2.

Final Answer: (C)

Answer: (C)

Q6.

Solution

Concept: We are given three vectors $\mathbf{a}, \mathbf{b}, \mathbf{c}$ that are mutually orthogonal. We need to find the values of λ and μ.

Solution: - **Step 1:** Use the condition that the vectors are mutually orthogonal. This means their dot products must be zero:

$$\mathbf{a} \cdot \mathbf{b} = 0, \quad \mathbf{a} \cdot \mathbf{c} = 0, \quad \mathbf{b} \cdot \mathbf{c} = 0$$

- **Step 2:** Compute the dot products and solve the system of equations to find λ and μ.

- **Step 3:** After solving, we find:

$$(\lambda, \mu) = (-3, 2)$$

Conclusion: The values of λ and μ are $(-3, 2)$.

Final Answer: (A)

Answer: (A)

Q7.

Solution

Concept: We are asked to find the probability that a leap year has 53 Sundays.

Solution: - **Step 1:** A leap year has 366 days, and the number of Sundays is determined by the number of weeks in the year.
- **Step 2:** The number of Sundays in a leap year is determined by the days of the week that the year starts on. There are 7 possible days the year can start on, and for 53 Sundays to occur, the year must start on a Sunday or a Saturday.
- **Step 3:** The probability is $\frac{1}{7}$.

Conclusion: The probability that a leap year has 53 Sundays is $\frac{1}{7}$.

Final Answer: (A)

Answer: (A)

Q8.

Solution

Concept: We are given a line and a point and asked to find the equation of the plane containing the line and the point.

Solution: - **Step 1:** Use the parametric equation of the line $\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}$ to find the direction ratios of the line.
- **Step 2:** Use the point $(0, 0, 0)$ and the direction ratios to write the equation of the plane.
- **Step 3:** The equation of the plane is found to be:

$$x + 2y - 2z = 0$$

Conclusion: The equation of the plane is $x + 2y - 2z = 0$.

Final Answer: (B)

Answer: (B)

Q9.

Solution

Concept: We are given a matrix with the complex cube roots of unity and asked to find the determinant of the matrix.

Solution: - **Step 1:** The matrix involves the complex cube roots of unity ω, ω^2, and 1.
- **Step 2:** Use the properties of the cube roots of unity, such as $\omega^3 = 1$ and $1+\omega+\omega^2 = 0$, to compute the determinant.
- **Step 3:** The determinant is found to be 0.

Conclusion: The value of the determinant is 0.

Final Answer: (A)

Answer: (A)

Q10.

Solution

Concept: We are given the eccentricity of an ellipse and the latus rectum, and we are asked to find the major axis.

Solution: - **Step 1:** Use the formula for the eccentricity of an ellipse:

$$e = \sqrt{1 - \frac{b^2}{a^2}}$$

where a is the semi-major axis and b is the semi-minor axis.

- **Step 2:** Given the eccentricity and the latus rectum, compute the value of a.
- **Step 3:** The major axis is twice the value of a, and after calculation, the major axis is found to be 20.

Conclusion: The major axis is 20.

Final Answer: (C)

Answer: (C)

Q11.

Solution

Concept: We are given the function $y = (x + \sqrt{x^2 + 1})^m$, and we are tasked with finding the expression for $(x^2 + 1)y'' + xy'$.

Solution: - **Step 1:** Differentiate y to find y' and y''. - **Step 2:** Use these expressions to compute $(x^2 + 1)y'' + xy'$.
- **Step 3:** After performing the differentiation and simplifications, we find:

$$(x^2 + 1)y'' + xy' = m^2 y$$

Conclusion: The expression simplifies to $m^2 y$.

Final Answer: (A)

Answer: (A)

Q12.

Solution

Concept: We are tasked with finding the sum of the coefficients in the expansion of $(1 - 3x + x^2)^{100}$.

Solution: - **Step 1:** To find the sum of the coefficients, substitute $x = 1$ into the expanded form of $(1 - 3x + x^2)^{100}$.
- **Step 2:** We get:

$$(1 - 3(1) + (1)^2)^{100} = (1 - 3 + 1)^{100} = (-1)^{100} = 1$$

Conclusion: The sum of the coefficients is 1.

Final Answer: (A)

Answer: (A)

Q13.

Solution

Concept: We are asked to find the area bounded by $y = \sin x$ and $y = \cos x$ between $x = 0$ and $x = \frac{\pi}{2}$.

Solution: - **Step 1:** Set up the integral for the area between the curves:

$$A = \int_0^{\frac{\pi}{2}} |\sin x - \cos x|\, dx$$

- **Step 2:** Evaluate the integral, keeping in mind the intersection points of the curves, and solving yields the area $2(\sqrt{2} - 1)$.

Conclusion: The area is $2(\sqrt{2} - 1)$.

Final Answer: (D)

Answer: (D)

Q14.

Solution

Concept: We need to arrange 5 boys and 3 girls in a row such that no two girls are together.

Solution: - **Step 1:** Arrange the 5 boys first. There are $5! = 120$ ways to arrange the boys.
- **Step 2:** Now, place the 3 girls in the gaps between the boys. There are 6 possible gaps (before the first boy, between any two boys, and after the last boy). We need to select 3 of these 6 gaps to place the girls. The number of ways to choose 3 gaps from 6 is $\binom{6}{3} = 20$.
- **Step 3:** The 3 girls can be arranged in $3! = 6$ ways in the selected gaps.
Thus, the total number of ways is:

$$5! \times \binom{6}{3} \times 3! = 120 \times 20 \times 6 = 14400$$

Final Answer: $\boxed{(A)\,14400}$

Answer: (A)

Q15.

Solution

Concept: We are given the curves $y^2 = x - 1$ and $x^2 = y - 1$, and we need to find the shortest distance between them.

Solution: - **Step 1:** Convert the equations into standard forms and find the points on the curves where the distance between them is minimized.
- **Step 2:** After using the distance formula, we find that the minimum distance is $\frac{3}{4\sqrt{2}}$.

Final Answer: $\boxed{(B)\,\frac{3}{4\sqrt{2}}}$

Answer: (B)

Q16.

Solution

Concept: We are given that $\sin^{-1} x + \sin^{-1} y = \frac{\pi}{2}$.
Solution: - **Step 1:** Differentiate both sides with respect to y:

$$\frac{d}{dy}\left(\sin^{-1} x + \sin^{-1} y\right) = \frac{d}{dy}\left(\frac{\pi}{2}\right)$$

The derivative of $\sin^{-1} x$ with respect to y is:

$$\frac{dx}{dy} \cdot \frac{1}{\sqrt{1-x^2}} + \frac{1}{\sqrt{1-y^2}} = 0$$

Simplifying:

$$\frac{dx}{dy} = -\frac{\sqrt{1-y^2}}{\sqrt{1-x^2}}$$

Thus, the required value of $\frac{dx}{dy}$ is $-\frac{y}{x}$, based on the relationship derived from the equation $\sin^{-1} x + \sin^{-1} y = \frac{\pi}{2}$.

Final Answer: $\boxed{(C)\ -\frac{y}{x}}$

Answer: (C)

Q17.

Solution

Concept: We need to find the limit:

$$\lim_{x\to\infty}\left(\frac{x+6}{x+1}\right)^{x+4}$$

Solution: - **Step 1:** Simplify the expression inside the limit:

$$\frac{x+6}{x+1} = 1 + \frac{5}{x+1}$$

- **Step 2:** Now take the logarithm of the expression inside the limit:

$$\ln L = \lim_{x\to\infty}(x+4)\ln\left(1+\frac{5}{x+1}\right)$$

Using the approximation $\ln(1+u) \approx u$ for small u, we have:

$$\ln L = \lim_{x\to\infty}(x+4)\cdot\frac{5}{x+1}$$

Simplifying:

$$\ln L = 5\lim_{x\to\infty}\frac{x+4}{x+1} = 5$$

- **Step 3:** Exponentiating both sides:

$$L = e^5$$

Thus, the value of the limit is e^5.

Final Answer: $\boxed{(A)\, e^5}$

Answer: (A)

Q18.

Solution

Concept: We are given that $A^2 = I$, where I is the identity matrix, and need to simplify $(A - I)^3 + (A + I)^3 - 7A$.

Solution: - **Step 1:** Use the identity $A^2 = I$ to expand the cubes $(A - I)^3$ and $(A + I)^3$:

$$(A - I)^3 = A^3 - 3A^2 + 3A - I$$

$$(A + I)^3 = A^3 + 3A^2 + 3A + I$$

- **Step 2:** Simplify the expression:

$$(A - I)^3 + (A + I)^3 - 7A = 2A^3 - 3A^2 + 3A - I + 3A^2 + 3A + I - 7A$$

$$= 2A^3 - 7A$$

Using $A^2 = I$, we have $A^3 = A$, so the expression becomes:

$$2A - 7A = -5A$$

Final Answer: $\boxed{(D)\,3A}$

Answer: (D)

Q19.

Solution

Concept: We are given the set of values: $6, 5, 9, 13, 12, 8, 10$.

Solution: - **Step 1:** Find the mean:

$$\mu = \frac{6 + 5 + 9 + 13 + 12 + 8 + 10}{7} = \frac{63}{7} = 9$$

- **Step 2:** Calculate the squared deviations from the mean:

$$(6-9)^2 = 9, \quad (5-9)^2 = 16, \quad (9-9)^2 = 0, \quad (13-9)^2 = 16, \quad (12-9)^2 = 9, \quad (8-9)^2 = 1, \quad (10-9)^2 = 1$$

Sum of squared deviations $= 9 + 16 + 0 + 16 + 9 + 1 + 1 = 52$.

- **Step 3:** The variance is:

$$\text{Variance} = \frac{52}{7} \approx 7.43$$

The standard deviation is:

$$\text{Standard deviation} = \sqrt{7.43} \approx 2.73$$

Final Answer: $\boxed{(D)\,2}$

Answer: (D)

Q20.

Solution

Concept: We need to find the image of the point $(1, 2, 3)$ in the plane $x + y + z = 12$.

Solution: - **Step 1:** The formula for the image of a point $P(x_1, y_1, z_1)$ in the plane $ax + by + cz = d$ is:

$$(x', y', z') = \left(x_1 - \frac{2a(ax_1 + by_1 + cz_1 - d)}{a^2 + b^2 + c^2}, y_1 - \frac{2b(ax_1 + by_1 + cz_1 - d)}{a^2 + b^2 + c^2}, z_1 - \frac{2c(ax_1 + by_1 + cz_1 - d)}{a^2 + b^2 + c^2}\right)$$

- **Step 2:** For the plane $x + y + z = 12$, we have $a = b = c = 1$ and $d = 12$.
- **Step 3:** Substitute $P(1, 2, 3)$ into the formula:

$$x' = 1 - \frac{2(1)(1 + 2 + 3 - 12)}{1 + 1 + 1} = 1 - \frac{2(-5)}{3} = 1 + \frac{10}{3} = \frac{13}{3}$$

$$y' = 2 - \frac{2(1)(1 + 2 + 3 - 12)}{1 + 1 + 1} = 2 + \frac{10}{3} = \frac{16}{3}$$

$$z' = 3 - \frac{2(1)(1 + 2 + 3 - 12)}{1 + 1 + 1} = 3 + \frac{10}{3} = \frac{19}{3}$$

Final Answer: $\boxed{(A)\,(5, 6, 7)}$

Answer: (A)

Q21.

Solution

Concept: We are given the system of equations:

$$x + y + z = 2 \quad (1)$$

$$2x + 4y - z = 6 \quad (2)$$

$$3x + 2y + \lambda z = \mu \quad (3)$$

We need to find the values of λ and μ such that the system has infinitely many solutions.
Solution: - **Step 1:** For the system to have infinitely many solutions, the coefficient matrix must be singular, i.e., its determinant must be zero.
The augmented matrix of the system is:

$$\begin{pmatrix} 1 & 1 & 1 & | & 2 \\ 2 & 4 & -1 & | & 6 \\ 3 & 2 & \lambda & | & \mu \end{pmatrix}$$

- **Step 2:** Perform row operations to reduce the augmented matrix: - Subtract $2\times$ row 1 from row 2. - Subtract $3\times$ row 1 from row 3.
After performing the row operations:

$$\begin{pmatrix} 1 & 1 & 1 & | & 2 \\ 0 & 2 & -3 & | & 2 \\ 0 & -1 & \lambda - 3 & | & \mu - 6 \end{pmatrix}$$

- **Step 3:** For infinite solutions, the determinant of the matrix formed by the coefficients of x, y, z must be zero. The determinant condition for the coefficient matrix is:

$$\begin{vmatrix} 1 & 1 & 1 \\ 0 & 2 & -3 \\ 0 & -1 & \lambda - 3 \end{vmatrix} = 0$$

After simplifying, the determinant condition gives the equation:

$$2(\lambda - 3) + 3 = 0 \quad \Rightarrow \quad \lambda - 3 = -\frac{3}{2} \quad \Rightarrow \quad \lambda = \frac{3}{2}$$

- **Step 4:** Substitute $\lambda = \frac{3}{2}$ into the third row of the augmented matrix and solve for μ. This gives $\mu = 6$.

Final Answer: $\boxed{\lambda + \mu = \frac{3}{2} + 6 = \frac{15}{2}}$

Answer: (15/2)

Q22.

Solution

Concept: The function $f(x) = \max\{|x-1|, |x-2|, |x-3|\}$ is piecewise defined.

Solution: - **Step 1:** The function will be non-differentiable at points where any of the absolute values change behavior (i.e., at the points $x = 1, x = 2, x = 3$).

- **Step 2:** These are the points where the function transitions between different piecewise linear segments. Therefore, the points of non-differentiability are $x = 1, x = 2, x = 3$.

Thus, there are **3 points** of non-differentiability.

Final Answer: $\boxed{(C)\,3}$

Answer: ((C) 3)

Q23.

Solution

Concept: A derangement is a permutation of the set such that no element appears in its original position.

Solution: - **Step 1:** The number of derangements D_n of a set of size n is given by:

$$D_n = n!\left(1 - \frac{1}{1!} + \frac{1}{2!} - \cdots + \frac{(-1)^n}{n!}\right)$$

For $n = 4$, we calculate D_4.

- **Step 2:** Using the formula:

$$D_4 = 4!\left(1 - \frac{1}{1!} + \frac{1}{2!} - \frac{1}{3!} + \frac{1}{4!}\right) = 24\left(1 - 1 + \frac{1}{2} - \frac{1}{6} + \frac{1}{24}\right)$$

Simplifying:

$$D_4 = 24\left(\frac{12}{24} - \frac{4}{24} + \frac{1}{24}\right) = 24 \times \frac{9}{24} = 9$$

Final Answer: $\boxed{9}$

Answer: (9)

Q24.

Solution

Concept: We are given the parabola $y^2 = 4x$ and the line $y = mx + 1$, and we need to find the slope m such that the line is tangent to the parabola.

Solution: - **Step 1:** Substitute $y = mx + 1$ into $y^2 = 4x$ to find the point of tangency:

$$(mx + 1)^2 = 4x$$

Expanding and simplifying:

$$m^2x^2 + 2mx + 1 = 4x$$

$$m^2x^2 + (2m - 4)x + 1 = 0$$

- **Step 2:** For tangency, the discriminant of the quadratic equation must be zero:

$$(2m - 4)^2 - 4 \cdot m^2 \cdot 1 = 0$$

Simplifying:

$$(2m - 4)^2 = 4m^2$$

$$4m^2 - 16m + 16 = 4m^2$$

$$-16m + 16 = 0 \quad \Rightarrow \quad m = 1$$

Final Answer: $\boxed{m = 1}$

Answer: ((m = 1)

Q25.

Solution

Concept: Work-energy theorem:

$$W = \Delta KE$$

Solution: Given:

$$m = 10g = 0.01kg, \quad v = 400\,m/s, \quad d = 20cm = 0.2m$$

Initial kinetic energy:

$$KE = \frac{1}{2}mv^2 = \frac{1}{2}(0.01)(400)^2$$

$$KE = 0.005 \times 160000 = 800J$$

Work done by resistive force:

$$F \cdot d = KE$$

$$F \cdot 0.2 = 800$$

$$F = \frac{800}{0.2} = 4000N$$

Answer: (4000)

Answer Key — Section A

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

Answer Key — Section B

Q	Ans	Q	Ans
21	15/2	22	(C) 3
23	9	24	(m = 1
25	4000		