



B.K. BIRLA CENTRE FOR EDUCATION

SARALA BIRLA GROUP OF SCHOOLS
A CBSE DAY-CUM-BOYS' RESIDENTIAL SCHOOL

PRE BOARD-2 EXAMINATION- 2025-26

MATHEMATICS (041)

Class: XII A

Marking Scheme

Time: 3 hr

Date:

Max Marks: 80

Admission no:

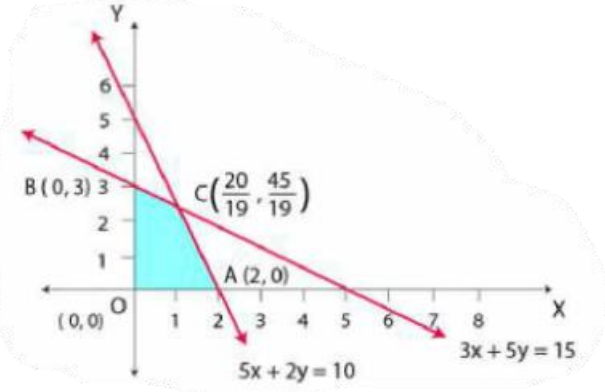
Roll no:

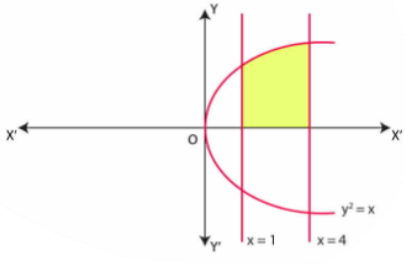
Q.no	SECTION A	Marks
1	(a) $x \frac{dy}{dx} + y = 0$	1
2	(b) $\tan^{-1} x^3 + c$	1
3	(b) 3A	1
4	(d) $i \neq j$	1
5	(c) 0	1
6	(b) Unbounded	1
7	(c) $\left(\pm \frac{1}{\sqrt{3}}, \pm \frac{1}{\sqrt{3}}, \pm \frac{1}{\sqrt{3}}\right)$	1
8	(a) $\sqrt{3}$	1
9	(d) 2 and 4	1
10	(a) 512	1
11	(c) -2	1
12	(b) x^2	1
13	(c) parabola	1
14	(c) ± 6	1
15	(d) $\frac{1}{36}$	1
16	(b) $\pm \frac{1}{\sqrt{3}}(-\hat{i} + \hat{j} + \hat{k})$	1
17	(b) -24	1
18	(b) $\frac{\pi}{4}$	1
19	(c) Assertion is correct, reason is incorrect	1
20	(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.	1
	SECTION B	
21	$\cos^{-1}(\cos \frac{\pi}{3}) + 2\sin^{-1}(\sin \frac{\pi}{6})$	1
	$\frac{\pi}{3} + 2 \times \frac{\pi}{6} = \frac{2\pi}{3}$	1

	OR $\tan^{-1}\left(\tan \pi + \frac{\pi}{6}\right)$ $\frac{\pi}{6} \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$	1 1
22	$\frac{x^2+x+1}{(x+2)(x^2+1)} = \frac{A}{x+2} + \frac{Bx+C}{x^2+1}$ A=3/5, B= 2/5 and C = 1/5 $\frac{x^2+x+1}{(x+2)(x^2+1)} = \frac{3}{5(x+2)} + \frac{\frac{2}{5}x + \frac{1}{5}}{x^2+1}$ $\int \frac{x^2+x+1}{(x+2)(x^2+1)} dx$ $= \frac{3}{5} \log x+2 + \frac{1}{5} \log x^2+1 + \frac{1}{5} \tan^{-1} x + C$	½ 1/2 1
23	$\lim_{x \rightarrow 3^+} f(x) = \lim_{x \rightarrow 3^-} f(x) = f(3)$ $f(3) = 4$ $\lim_{x \rightarrow 3^+} f(x) = \lim_{x \rightarrow 3^+} 3x - 5 = 4$ $\lim_{x \rightarrow 0^-} f(x) = \lim_{x \rightarrow 3^-} x + k = 3 + k$ $3+k = 4, k = 1$	½ ½ ½ 1/2
24	the volume of a cube with radius “x” is given by $V = x^3$ and surface area = $6x^2$ Hence, the rate of change of volume “V” with respect to the time “t” is given by: $\frac{dV}{dt} = 9 \text{ cm}^3/\text{s}$ $9 = \frac{dV}{dt} = \frac{d}{dt} x^3 = 3x^2 \cdot \frac{dx}{dt}, \text{ By using the chain rule } \frac{dx}{dt} = \frac{3}{x^2}$ $\frac{ds}{dt} = \frac{d(6x^2)}{dt} = 12 \frac{dx}{dt} = 12 \times \frac{3}{x^2} = \frac{36}{x}$ At $x = 10, \frac{ds}{dt} = 3.6 \text{ cm}^2/\text{s}$ OR $p(x) = 41 - 72x - 18x^2$ $P'(x) = -72 - 36$ $P'' = -36$ For maximum or minima or critical points $p'(x) = 0$	½ 1/2 1/2 ½ ½

	$-72 - 36x = 0, x = -2$ $x = -2, p''(-2) = -36 < 0$ hence $x = -2$ is a point of local maxima, maximum profit = 113	$\frac{1}{2}$ $\frac{1}{2}$
25	$f(x) = 4x^3 - 6x^2 - 72x + 30$ $f'(x) = 12x^2 - 12x - 72$ For critical points $f'(x) = 0$, $12x^2 - 12x - 72 = 0$ $12(x-3)(x+2) = 0$ $x = 2, x = -3$ $(-\infty, -2)$ and $(3, \infty)$ the function is increasing $(-2, 3)$ the function is decreasing	$\frac{1}{2}$ $1/2$ $\frac{1}{2}$ $1/2$
	SECTION C	
26	$y^x + x^y + x^x = a^b$ $\frac{d}{dx}(y^x + x^y + x^x) = \frac{d}{dx}a^b$ $\frac{d}{dx}(y^x + x^y + x^x) = 0$ $\frac{du}{dx} + \frac{dv}{dx} + \frac{dw}{dx} = 0$ Taking log one by one for $u = y^x, v = x^y, w = x^x$ $\frac{du}{dx} = y^x \left(\frac{x}{y} \frac{dy}{dx} + \log y \right),$ $\frac{dv}{dx} = x^y \left(\frac{y}{x} + \log x \frac{dy}{dx} \right),$ $\frac{dw}{dx} = x^x (1 + \log x)$ $\frac{du}{dx} + \frac{dv}{dx} + \frac{dw}{dx}$ $= y^x \left(\frac{x}{y} \frac{dy}{dx} + \log y \right) + x^y \left(\frac{y}{x} + \log x \frac{dy}{dx} \right) + x^x (1 + \log x)$ $= 0$ OR If $x = a(\cos t + t \sin t)$ and $y = a(\sin t - t \cos t)$, find $\frac{d^2y}{dx^2}$ $\frac{dx}{dt} = a t \cos t$ and $\frac{dy}{dt} = a t \cos t$	 $1/2$ $\frac{1}{2}$ $\frac{1}{2}$ $1/2$ $\frac{1}{2}$ $1+1$ $1/2$

	$\frac{dy}{dx} = \tan t$ $\frac{d^2y}{dx^2} = \sec^2 t \frac{dt}{dx}$ $\frac{d^2y}{dx^2} = \frac{\sec^2 t}{at}$	1/2																								
27	<table border="1"><tr><td>x_i</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr><tr><td>$P_i(x)$</td><td>$\frac{1}{36}$</td><td>$\frac{2}{36}$</td><td>$\frac{3}{36}$</td><td>$\frac{4}{36}$</td><td>$\frac{5}{36}$</td><td>$\frac{6}{36}$</td><td>$\frac{5}{36}$</td><td>$\frac{4}{36}$</td><td>$\frac{3}{36}$</td><td>$\frac{2}{36}$</td><td>$\frac{1}{36}$</td></tr></table> $E(X) = \mu = \sum_{i=1}^n x_i P_i = 7$ OR Let E be the event that ‘number 4 appears at least once’ and F be the event that ‘the sum of the numbers appearing is 6’. Then, $E = \{(4,1), (4,2), (4,3), (4,4), (4,5), (4,6), (1,4), (2,4), (3,4), (5,4), (6,4)\}$ $F = \{(1,5), (2,4), (3,3), (4,2), (5,1)\}$ $P(E) = 11/36$ and $P(F) = 5/36$, $E \cap F = \{(2,4), (4,2)\}$, $P(E \cap F) = 2/36$ $P(E/F) = \frac{P(E \cap F)}{P(F)} = \frac{2}{5}$	x_i	2	3	4	5	6	7	8	9	10	11	12	$P_i(x)$	$\frac{1}{36}$	$\frac{2}{36}$	$\frac{3}{36}$	$\frac{4}{36}$	$\frac{5}{36}$	$\frac{6}{36}$	$\frac{5}{36}$	$\frac{4}{36}$	$\frac{3}{36}$	$\frac{2}{36}$	$\frac{1}{36}$	2 1 ½ ½ 1/2 ½ 1/2 1/2
x_i	2	3	4	5	6	7	8	9	10	11	12															
$P_i(x)$	$\frac{1}{36}$	$\frac{2}{36}$	$\frac{3}{36}$	$\frac{4}{36}$	$\frac{5}{36}$	$\frac{6}{36}$	$\frac{5}{36}$	$\frac{4}{36}$	$\frac{3}{36}$	$\frac{2}{36}$	$\frac{1}{36}$															
28	$\frac{dy}{dx} + y \cot x = 4x \operatorname{cosec} x$ $P = \cot x$, $Q = 4x \operatorname{cosec} x$ $I.F = e^{\int \cot x dx} = \sin x$ $y I.F. = \int Q.IF dx$ $y \sin x = \int 4x \operatorname{cosec} x \sin x dx = \int 4x dx$ $y \sin x = 2x^2 + C$, $C = -\frac{\pi^2}{2}$ $y \sin x = 2x^2 - \frac{\pi^2}{2}$ OR $e^x \tan y dx + (1-e^x) \sec^2 y dy = 0$ $(1-e^x) \sec^2 y dy = -e^x \tan y dx$ $\frac{\sec^2 y}{\tan y} dy = \frac{-e^x}{1-e^x} dx$ $\log \tan y = \log 1-e^x + \log c$	½ ½ 1/2 ½ ½ ½ ½ ½ 1																								

	$\log \tan y - \log 1 - e^x = \log c $ Taking exponential both side $\tan y = c (1 - e^x)$	$\frac{1}{2}$ $\frac{1}{2}$
29	$\int_1^4 [x - 1 + x - 2 + x - 3] dx$ $\int_1^4 x - 1 dx + \int_1^4 x - 2 dx + \int_1^4 x - 3 dx$ $= \int_1^4 (x - 1) dx + \int_1^2 -(x - 2) dx + \int_2^4 (x - 2) dx + \int_1^3 -(x - 3) dx + \int_3^4 (x + 3) dx$ For calculation $\int_1^4 [x - 1 + x - 2 + x - 3] dx = \frac{19}{2}$	$\frac{1}{2}$ $\frac{1}{2}$
30	$\int \frac{x + 3}{\sqrt{5 - 4x + x^2}} dx$ $x + 3 = A \frac{d}{dx} (5 - 4x + x^2) + B$ $A = -\frac{1}{2} \text{ and } B = 1$ $\int \frac{x + 3}{\sqrt{5 - 4x + x^2}} dx$ $= -\frac{1}{2} \int \frac{(-4 - 2x)}{\sqrt{5 - 4x + x^2}} dx + \int \frac{dx}{\sqrt{5 - 4x + x^2}}$ For calculation $\int \frac{x + 3}{\sqrt{5 - 4x + x^2}} dx = -\sqrt{5 - 4x + x^2} + \sin^{-1} \frac{x + 2}{3} + C$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$
31	 Corner points (0,0), (0,3), (2,0), (20/19, 45/19) Max. of Z = 235/19, at (20/19, 45/19)	2 $\frac{1}{2}$ $\frac{1}{2}$
SECTION D		

32	For labelled and correct diagram  Required area = $\int_1^4 \sqrt{x} dx$ For calculation $= \frac{14}{3}$	2 1/2 2 1/2
33	To prove reflexive To prove symmetric To prove transitive Proving T_1 related with T_3 $\frac{3}{6} = \frac{4}{8} = \frac{5}{10}$ OR Showing one one Taking cases, x_1, x_2 both are even , x_1, x_2 both are odd and x_1, x_2 one is odd another is even Showing onto by any method	1 1 2 1 3 2
34	(i) $2x + 4y + 3z = 29000$ $5x + 2y + 3z = 30500$ $x + y + z = 9500$ (ii) matrix method $AX=B$ $X=A^{-1}B$ $A = -1$ $\text{adj } A = \begin{bmatrix} -1 & -1 & 6 \\ -2 & -1 & 9 \\ 3 & 2 & -16 \end{bmatrix}$ calculation $X= 2500, y= 3000$ and $z =4000$	1 1/2 1/2 2 1/2 1/2
35	$\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}$ and $\frac{x-2}{3} = \frac{y-4}{4} = \frac{z-5}{5}$ $\vec{a}_1 = \hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{a}_2 = 2\hat{i} + 4\hat{j} + 5\hat{k}$ $\vec{b}_1 = 2\hat{i} + 3\hat{j} + 4\hat{k}$, $\vec{b}_2 = 3\hat{i} + 4\hat{j} + 5\hat{k}$ $\vec{a}_2 - \vec{a}_1 = \hat{i} + 2\hat{j} + 2\hat{k}$	1 1/2 1

	$\vec{b}_1 \times \vec{b}_2 = -\hat{i} + 2\hat{j} - \hat{k}$ $ \vec{b}_1 \times \vec{b}_2 = \sqrt{6}$ $(\vec{b}_1 \times \vec{b}_2) \cdot (\vec{a}_2 - \vec{a}_1) = 1$ $\text{S.D.} = d = \left \frac{(\vec{b}_1 \times \vec{b}_2) \cdot (\vec{a}_2 - \vec{a}_1)}{ \vec{b}_1 \times \vec{b}_2 } \right $ $\text{Shortest distance } d = \frac{1}{\sqrt{6}}$ The lines do not intersect OR Eq. of line $\vec{r} = \vec{a} + \lambda \vec{b}$ Line passes through (1,2,-4) and let (a,b,c) be the D, Ratio of line then Eq of line is $\vec{r} = \hat{i} + 2\hat{j} - 4\hat{k} + \lambda(a\hat{i} + b\hat{j} + c\hat{k})$ Line is perpendicular to the lines $\frac{x-8}{3} = \frac{y+19}{-16} = \frac{z-10}{7} \quad \text{and} \quad \frac{x-15}{3} = \frac{y-29}{8} = \frac{z-5}{-5}$ $\vec{a} \times \vec{b}$ is perpendicular to $\vec{a}$ and $\vec{b}$ both $\vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & -16 & 7 \\ 3 & 8 & -5 \end{vmatrix}$ $= 24\hat{i} + 36\hat{j} + 72\hat{k}$ Hence D' Ratio of line is (24,36,72) Eq. of line $\frac{x-1}{24} = \frac{y-2}{36} = \frac{z+4}{72}$ $\vec{r} = \hat{i} + 2\hat{j} - 4\hat{k} + \lambda(24\hat{i} + 36\hat{j} + 72\hat{k})$ $\vec{r} = \hat{i} + 2\hat{j} - 4\hat{k} + \lambda(2\hat{i} + 3\hat{j} + 6\hat{k})$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ 1/2 $\frac{1}{2}$ 1/2 $2\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$
	SECTION E	
36	Let A be the event that the doctor visit the patient late and let E₁, E₂, E₃, E₄ be the events that the doctor comes by cab, metro, bike and other means of transport respectively. P(E₁)=0.3, P(E₂)=0.2, P(E₃)=0.1, P(E₄)=0.4 P(A E₁) = Probability that the doctor arriving late when he comes by cab = 0.25 Similarly, P (A E₂) = 0.3, P (A E₃) = 0.35 and	

	$P(A E_4) = 0.1$ $P(A) = P(E_1)P\left(\frac{A}{E_1}\right) + P(E_2)P\left(\frac{A}{E_2}\right) + P(E_3)P\left(\frac{A}{E_3}\right) + P(E_4)P\left(\frac{A}{E_4}\right)$ $P(A) = 0.25 \times 0.3 + 0.3 \times 0.2 + 0.1 \times 0.35 + 0.4 \times 0.1 = 0.21$ $(i) P(E_4/A) = \frac{P(E_4)P(A/E_4)}{P(E_1)P\left(\frac{A}{E_1}\right) + P(E_2)P\left(\frac{A}{E_2}\right) + P(E_3)P\left(\frac{A}{E_3}\right) + P(E_4)P\left(\frac{A}{E_4}\right)} = \frac{4}{21}$ $(ii) P(E_2/A) = \frac{P(E_2)P(A/E_2)}{P(E_1)P\left(\frac{A}{E_1}\right) + P(E_2)P\left(\frac{A}{E_2}\right) + P(E_3)P\left(\frac{A}{E_3}\right) + P(E_4)P\left(\frac{A}{E_4}\right)} = \frac{2}{7}$ $(iii) P(E_3/A) + P(E_4/A) = \frac{P(E_3)P\left(\frac{A}{E_3}\right) + P(E_4)P(A/E_4)}{P(E_1)P\left(\frac{A}{E_1}\right) + P(E_2)P\left(\frac{A}{E_2}\right) + P(E_3)P\left(\frac{A}{E_3}\right) + P(E_4)P\left(\frac{A}{E_4}\right)} = \frac{5}{14}$ OR $P(E_1/A) + P(E_2/A) = \frac{P(E_1)P\left(\frac{A}{E_1}\right) + P(E_2)P(A/E_2)}{P(E_1)P\left(\frac{A}{E_1}\right) + P(E_2)P\left(\frac{A}{E_2}\right) + P(E_3)P\left(\frac{A}{E_3}\right) + P(E_4)P\left(\frac{A}{E_4}\right)} = \frac{9}{14}$	1 1 2 2
37	(i) we have $\vec{OA} = 8\hat{i}$ km $\vec{AB} = 6\hat{j}$ vector distance from Gitika's house to school $= 8\hat{i} + 6\hat{j}$ (ii) vector distance from school to Alope's house $= 6\cos 30^\circ \hat{i} + 6\sin 30^\circ \hat{j}$ $= 3\sqrt{3}\hat{i} + 3\hat{j}$ (iii) vector distance from Gitika's house to Alope's house = $8\hat{i} + 6\hat{j} + 3\sqrt{3}\hat{i} + 3\hat{j}$ $= (8 + 3\sqrt{3}) + 9\hat{j}$ OR The total distance travel by Gitika from her house to Alope's house $= 8 + 6 + 6 = 20$ km	1 1 2 2
38	Let the increase of ₹ x in annual subscription of ₹ 300 maximize the profit of the company. Due to this increase of ₹ x, x subscriber will discontinue. Therefore Number of subscriber $= 500 - x$ Annual subscription $= ₹ (300 + x)$ R be the total revenue $= (500 - x)(300 + x)$ $\frac{dR}{dx} = 200 - 2x \text{ and } \frac{d^2R}{dx^2} = -2$ For critical point $\frac{dR}{dx} = 200 - 2x = 0$, $x = 100$	2

	$\frac{d^2R}{dx^2} < 0 \text{ at } x=100$ So R is maximum at x=100 and maximum R = 400x400=160000	2
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