B.K. BIRLA CENTRE FOR EDUCATION

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

FIRST TERM EXAMINATION (2026-27)

MATHEMATICS — CLASS XII — Subject Code: 041

SET A

Time allowed : 3 hours ***Maximum Marks : 80***

Date : 09-09-2026 ***Roll no :***

General Instructions :

Read the following instructions carefully and follow them :

(i) This question paper contains 38 questions. All questions are compulsory.

(ii) This question paper is divided into FIVE Sections — A, B, C, D and E.

(iii) In Section A, Questions no. 1 to 18 are multiple choice questions (MCQs) and questions no. 19 and 20 are Assertion-Reason based questions of 1 mark each.

(iv) In Section B, Questions no. 21 to 25 are very short answer (VSA) type questions, carrying 2 marks each.

(v) In Section C, Questions no. 26 to 31 are short answer (SA) type questions, carrying 3 marks each.

(vi) In Section D, Questions no. 32 to 35 are long answer (LA) type questions carrying 5 marks each.

(vii) In Section E, Questions no. 36 to 38 are case study based questions carrying 4 marks each. Internal choice is provided in 2 marks questions in each case study.

(viii) There is no overall choice. However, an internal choice has been provided in 2 questions in Section B, 2 questions in Section C, 2 questions in Section D and 3 questions in Section E.

(ix) Draw neat figures wherever required.

(x) Use of calculator is NOT allowed.

SECTION A

This section comprises multiple choice questions (MCQs) of 1 mark each.

Q.1 Let R be the relation on the set $A = \{1, 2, 3\}$ given by $R = \{(1, 1), (2, 2), (3, 3), (1, 2)\}$. Then R is : 1

(A) reflexive and symmetric but not transitive
(B) symmetric and transitive but not reflexive
(C) reflexive and transitive but not symmetric
(D) an equivalence relation

Q.2 The function $f : R \to R$ defined by $f(x) = 3x + 2$ is : 1

(A) one-one and onto
(B) one-one but not onto
(C) onto but not one-one

(D) neither one-one nor onto

Q.3 The principal value of $\sin^{-1}\left(-\frac{1}{2}\right)$ is : 1

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

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

(C) $\frac{5\pi}{6}$

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

Q.4 The domain of the function $\cos^{-1}x$ is : 1

(A) R

(B) $[-1, 1]$

(C) $[0, \pi]$

(D) $(-1, 1)$

Q.5 The value of $\tan^{-1}(\sqrt{3}) - \cot^{-1}(-\sqrt{3})$ is : 1

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

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

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

(D) 0

Q.6 If A is a matrix of order 3×4 and B is a matrix of order 4×2, then the order of AB is : 1

(A) 3×4

(B) 4×2

(C) 3×2

(D) 2×3

Q.7 If $A = [a_{ij}]$ is a 2×2 matrix such that $a_{ij} = i + j$, then a_{21} is equal to : 1

(A) 2

(B) 3

(C) 4

(D) 1

Q.8 For any square matrix A, the matrix $A + A'$ is always : 1

(A) a skew-symmetric matrix

(B) a symmetric matrix

(C) a zero matrix

(D) an identity matrix

Q.9 The function $f(x) = |x|$ is : 1

(A) continuous as well as differentiable at $x = 0$

(B) neither continuous nor differentiable at $x = 0$

(C) continuous at $x = 0$ but not differentiable at $x = 0$

(D) differentiable at $x = 0$ but not continuous at $x = 0$

Q.10 If $y = \log(\sin x)$, then $\frac{dy}{dx}$ is equal to : 1

(A) $\tan x$

(B) $\cot x$

(C) $-\cot x$

(D) $\frac{1}{\sin x}$

Q.11 If $y = e^{2x}$, then $\frac{d^2y}{dx^2}$ is equal to : 1

(A) $2e^{2x}$
(B) $4e^{2x}$
(C) e^{2x}
(D) $4e^{x}$

Q.12 The function $f(x) = x^2$ is strictly increasing on the interval : 1

(A) $(-\infty, 0)$
(B) $(0, \infty)$
(C) R
(D) $(-1, 1)$

Q.13 The function $f(x) = x^3 - 3x$ is strictly decreasing on the interval : 1

(A) $(-\infty, -1)$
(B) $(1, \infty)$
(C) $(-1, 1)$
(D) R

Q.14 The radius of a circle is increasing at the rate of 2 cm/s. The rate of increase of its area when the radius is 5 cm is : 1

(A) 10π cm²/s
(B) 20π cm²/s
(C) 25π cm²/s
(D) 4π cm²/s

Q.15 $\int \sec^2 x \, dx$ is equal to : 1

(A) $\tan x + C$
(B) $\sec x + C$
(C) $-\cot x + C$
(D) $\sec x \tan x + C$

Q.16 The value of $\int_0^{\pi/2} cos\, x \; dx$ is : 1

(A) 0
(B) 1
(C) -1
(D) $\frac{\pi}{2}$

Q.17 The area of the region bounded by the line $y = x$, the x-axis and the ordinates $x = 0$ and $x = 2$ is : 1

(A) 1 sq unit
(B) 2 sq units
(C) 4 sq units
(D) 8 sq units

Q.18 The area of the region bounded by the curve $y = x^2$, the x-axis and the lines $x = 0$ and $x = 3$ is : 1

(A) 3 sq units

(B) 6 sq units
(C) 9 sq units
(D) 27 sq units

Q.19 Directions : In the question below, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option. 1

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

Reason (R) : The order of a differential equation is the order of the highest order derivative occurring in it.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

Q.20 Directions : In the question below, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option. 1

Assertion (A) : The differential equation $\frac{dy}{dx} + y = e^x$ is a linear differential equation of order 1.

Reason (R) : A differential equation is linear if the dependent variable and all its derivatives occur in the first degree and are not multiplied together.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

SECTION B

This section comprises very short answer (VSA) type questions of 2 marks each.

Q.21 Find the value of $\tan^{-1}(1) + \cos^{-1}\left(-\frac{1}{2}\right) + \sin^{-1}\left(-\frac{1}{2}\right)$. 2

OR

Find the principal value of $\cos^{-1}\left(-\frac{1}{2}\right) + 2\sin^{-1}\left(\frac{1}{2}\right)$.

Q.22 If $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$, find $A + A'$ and show that it is a symmetric matrix. 2

Q.23 Evaluate : $\int \frac{x}{x^2+1}\, dx$ 2

Q.24 Find the order and the degree of the differential equation $\left(\frac{d^2y}{dx^2}\right)^3 + \left(\frac{dy}{dx}\right)^2 + y = 0$. 2

Q.25 Find the general solution of the differential equation $\frac{dy}{dx} = \frac{1+y^2}{1+x^2}$. 2

OR

Find the general solution of the differential equation $\frac{dy}{dx} = e^{x+y}$.

SECTION C

This section comprises short answer (SA) type questions of 3 marks each.

Q.26 Show that the relation R defined on the set Z of all integers by $\mathrm{R} = \{(\mathrm{a}, \mathrm{b}) : 3 \text{ divides } (\mathrm{a} - \mathrm{b})\}$ is an equivalence relation. Also write its equivalence classes. 3

Q.27 (a) Find the principal value of $sin^{-1}\left(-\frac{1}{\sqrt{2}}\right)$. 3

(b) Find the principal value of $cos^{-1}\left(-\frac{\sqrt{3}}{2}\right)$.

(c) Write the domain and the principal value branch of $tan^{-1}x$.

OR

(a) Find the principal value of $cot^{-1}(-1)$.

(b) Write the range (principal value branch) of $cos^{-1}x$.

(c) Find the value of $cos^{-1}\left(cos\ \frac{2\pi}{3}\right)$.

Q.28 Evaluate : $\int \frac{\mathrm{x}}{(\mathrm{x}+1)(\mathrm{x}+2)}\,\mathrm{dx}$ 3

Q.29 Evaluate : $\int x \sin x\ dx$ 3

Q.30 Using integration, find the area of the region bounded by the parabola $\mathrm{y}^2 = 4\mathrm{x}$ and the line $\mathrm{x} = 4$. 3

Q.31 Using integration, find the area of the region in the first quadrant enclosed by the circle $\mathrm{x}^2 + \mathrm{y}^2 = 16$. 3

OR

Using integration, find the area of the region enclosed by the ellipse $\frac{\mathrm{x}^2}{9} + \frac{\mathrm{y}^2}{4} = 1$.

SECTION D

This section comprises long answer (LA) type questions of 5 marks each.

Q.32 (a) Let $\mathrm{A} = \{1, 2, 3, 4, 5\}$ and let $\mathrm{R} = \{(\mathrm{a}, \mathrm{b}) : |\mathrm{a} - \mathrm{b}| \text{ is divisible by } 2\}$ be a relation on A. Show that R is an equivalence relation and write all its equivalence classes. 5

(b) Show that the function $\mathrm{f} : \mathrm{N} \to \mathrm{N}$ defined by $\mathrm{f}(\mathrm{x}) = \mathrm{x}^2$ is one-one but not onto.

Q.33 (a) Express the matrix $A = \begin{bmatrix} 3 & 5 \\ 1 & -1 \end{bmatrix}$ as the sum of a symmetric and a skew-symmetric matrix. 5

(b) If $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 0 \\ 1 & 3 \end{bmatrix}$, verify that $(AB)' = B'A'$.

Q.34 (a) If $\mathrm{y} = \mathrm{x}^{\sin \mathrm{x}}$, $\mathrm{x} > 0$, find $\frac{\mathrm{dy}}{\mathrm{dx}}$. 5

(b) If $\mathrm{x} = \mathrm{a}(\theta - \sin\theta)$ and $\mathrm{y} = \mathrm{a}(1 - \cos\theta)$, find $\frac{\mathrm{dy}}{\mathrm{dx}}$ at $\theta = \frac{\pi}{2}$.

OR

Examine the continuity and the differentiability of the function
$\mathrm{f}(\mathrm{x}) = 3\mathrm{x} - 2$ for $\mathrm{x} \leq 1$ and $\mathrm{f}(\mathrm{x}) = 2\mathrm{x}^2 - \mathrm{x}$ for $\mathrm{x} > 1$, at $\mathrm{x} = 1$.

Q.35 (a) Find the intervals in which the function $f(x) = 2x^3 - 9x^2 + 12x - 5$ is (i) strictly increasing and (ii) strictly decreasing. 5

(b) The radius of a circle is increasing uniformly at the rate of 3 cm/s. Find the rate at which the area of the circle is increasing when the radius is 10 cm.

OR

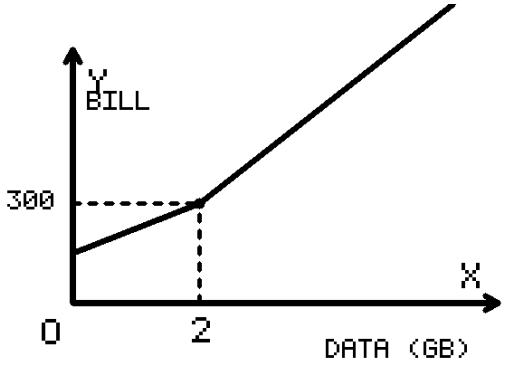
(a) Show that the function $f(x) = x^3 - 3x^2 + 4x$ is strictly increasing on R.

(b) The volume of a cube is increasing at the rate of 9 cm³/s. Find the rate at which its surface area is increasing when the length of an edge is 10 cm.

SECTION E

This section comprises 3 case study based questions of 4 marks each.

Q.36 Case Study – 1 : A mobile network company charges its customers according to the monthly data usage x (in GB). The monthly bill (in ₹) is modelled by the function $f(x) = 200 + 50x$ for $0 \leq x \leq 2$ and $f(x) = kx + 100$ for $x > 2$, where k is a constant. The company claims that there is no sudden jump in the bill as the usage crosses 2 GB. 4



On the basis of the above information, answer the following questions :

(i) Write the value of $f(2)$ using the first expression.

(ii) Write the condition on f at $x = 2$ that expresses the company's claim.

(iii) Find the value of k for which f is continuous at $x = 2$, and hence find the bill for 5 GB of data.

OR

(iii) If instead $k = 120$, examine whether f is continuous at $x = 2$, and find the jump in the bill at $x = 2$.

Q.37 Case Study – 2 : A spherical balloon is being inflated for a school science exhibition. Air is pumped into the balloon at a constant rate of 900 cm³/s. Let r be the radius of the balloon (in cm) at time t seconds. 4

On the basis of the above information, answer the following questions :

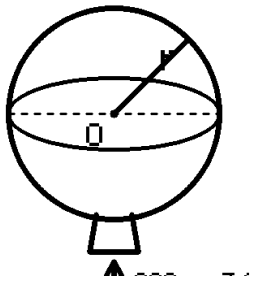
(i) Write the volume V of the balloon in terms of its radius r.

(ii) Write the relation between $\frac{dV}{dt}$ and $\frac{dr}{dt}$.

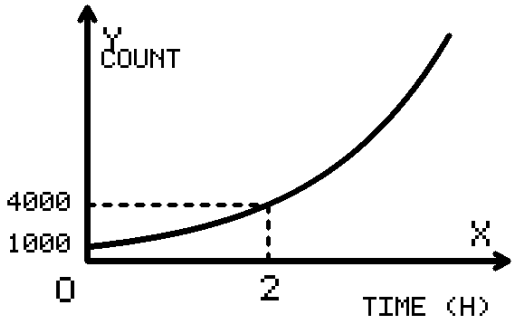
(iii) Find the rate at which the radius of the balloon is increasing when the radius is 15 cm.

OR

(iii) Find the rate at which the surface area of the balloon is increasing when the radius is 15 cm.



Q.38 Case Study – 3 : In a laboratory, the number of bacteria in a culture increases at a rate proportional to the number present at that instant. Initially the culture contains 1000 bacteria and after 2 hours the count is found to be 4000. Let y be the number of bacteria present after t hours. 4



On the basis of the above information, answer the following questions :

(i) Form the differential equation representing the above situation.

(ii) Write the order and the degree of this differential equation.

(iii) Solve the differential equation and find the number of bacteria present after 4 hours.

OR

(iii) Solve the differential equation and find the time in which the number of bacteria becomes 16000.

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