

Secondary Education Examination
Model Question - 2078
Grade: 12

Time: 3 hrs **Mathematics (Mat. 008)** **F.M.:** 75

Candidates are required to give their answer in their own words as far as practicable. The figures in the margin indicate full marks.

Attempt **All** The Questions.

Group 'A'

[11 × 1 = 11]

Rewrite the correct option in your answer sheet.

1. If $1, \omega, \omega^2$ are the cube roots of unit then
A. $\omega = \omega^2$ B. $\omega^2 = \omega^3$ C. $1 + \omega + \omega^2 = 0$ D. $1 + \omega = \omega^2$
2. The number of ways that 7 beads of different colors can be strung together so as to form a necklace is
A. 5040 B. 2520 C. 720 D. 360
3. $\tan^{-1} \frac{5}{12}$ is equal to
A. $\sin^{-1} \frac{12}{13}$ B. $\cos^{-1} \frac{12}{13}$ C. $\sec^{-1} \frac{12}{13}$ D. $\operatorname{cosec}^{-1} \frac{12}{13}$
4. If $2 \cos \theta + 1 = 0$, is the trigonometric equation of the locus related to the string attached in the wall of a hall then the general value for θ is
A. $n\pi + (-1)^n \frac{2\pi}{3}$ for $n \in Z$
B. $n\pi + \frac{2\pi}{3}$ for $n \in Z$
C. $2n\pi \pm \frac{2\pi}{3}$ for $n \in Z$
D. $2n\pi + \frac{\pi}{3}$ for $n \in Z$

5. If $\vec{a} = 2\vec{i}$ and $\vec{b} = 3\vec{j}$ where, $\vec{i}, \vec{j}$ and $\vec{k}$ are unit vectors along X, Y, Z — axes respectively, then the value of $\vec{b} \times \vec{a}$ is equal to
A. $-6\vec{k}$ B. $6\vec{k}$ C. $6\vec{i}$ D. $6\vec{j}$
6. There is a large grassy area near the president house of Nepal. The area is the set of all points in a plane. The sum of whose distances from two fixed places (points) is constant. The conic section represented by the grassy area is...
A. Circle B. Parabola C. Hyperbola D. Ellipse
7. Four unbiased coins are tossed successively. The mean and variance of the distribution differed by
A. 1 B. 2 C. 3 D. 4
8. The degree of the differential equation $\frac{d^3y}{dx^3} + 5 \left(\frac{d^2y}{dx^2} \right)^2 + 4 \left(\frac{dy}{dx} \right)^4 + 6 = 0$ is
A. 1 B. 2 C. 3 D. 4
9. According to L Hospital's rule the value of $\lim_{x \rightarrow 0} \frac{x^3}{4 \sin x}$ is equal to
A. $\frac{3}{4}$ B. 0 C. $\frac{1}{4}$ D. ∞
10. When Gauss forward elimination method is used for solving the equations

$$3x + 4y = 18 \dots (i)$$

$$3y - x = 7 \dots (ii)$$

we apply the operation

- A. $eq^n(i) + 4eq^n(ii)$
- B. $eq^n(i) + 3eq^n(ii)$
- C. $eq^n(i) + eq^n(ii)$
- D. $eq^n(ii) + 3eq^n(i)$

11. The amount of gravity exerted by the earth on the mass 10 kg ($g = 9.8ms^{-2}$) is ...
 A. 9.8 Joule B. 9.8 Newton C. 98 Joule D. 98 Newton

OR

For the quadratic function $f(Q) = aQ^2 + bQ + C$ for real numbers a, b, c and $a \neq 0$, the maximum value attained at

- A. $\left(\frac{b}{2a}, \frac{4ac - b^2}{4a}\right)$
 B. $\left(-\frac{b}{2a}, \frac{4ac - b^2}{4a}\right)$
 C. $\left(-\frac{b}{2a}, \frac{b^2 - 4ac}{4a}\right)$
 D. $\left(\frac{b}{2a}, \frac{b^2 - 4ac}{4a}\right)$

Group 'B'

[8 × 5 = 40]

12. The binomial expression for two algebraic terms a and x is given as $(a + x)^n$.
 (a) Write the binomial theorem for any positive integer n in expansion form. [1]
 (b) Write the general term of the expansion. [1]
 (c) Write any one property of binomial coefficients. [1]
 (d) Write the single term for $C(n, r) + C(n, r-1)$. [1]
 (e) How many terms are there in the expression? [1]
13. Given $n^4 < 10^n$ for a fixed positive integer $n \geq 2$, prove that $(n + 1)^4 < 10^{n+1}$ using principle of mathematical induction. [5]
14. (a) Evaluate $\cos\left(\sin^{-1}\frac{3}{5} + \sin^{-1}\frac{5}{13}\right)$. [3]
 (b) Using vector method, find the area of the triangle with vertices $A(1, 4, 6)$, $B(-2, 5, 1)$ and $C(1, -1, 1)$. [2]

15. The information given below relates to the advertisement and sales of a departmental store in lakhs of Nepalese rupees

	Advertisement Exp (X)	Salary (Y)
A.M. ($\bar{x}$)	20	100
S.D. (σ)	3	12
	Correlation coeff between (X) and (Y) = 0.8	

- (a) Find the two regression equations related to above data. [4]
 (b) What should be the advertisement expenditure if the department store wants to attain sales target of Rs. 200 lakhs. [1]
16. Suman and Nikita are studying about application of derivative and integration in a class. They ask each other the quiz questions as given below. On the basis of these questions answer the following.
- (a) $f'(x)$ and $g'(x)$ are derivatives of the functions $f(x)$ and $g(x)$. What is the expression equal to $\lim_{x \rightarrow a} \frac{f(x)}{g(x)}$ according to L'Hospital's rule for form ∞/∞ [1]
 (b) State Rolle's Theorem. [1]
 (c) What is the expression equal to $\int \frac{1}{x^2 + a^2} dx$? [1]
 (d) What does ' C ' represent in the expression $\int \frac{dx}{3 \sin x + 4 \cos x} = \frac{1}{5} \ln \left| \tan \left(\frac{x}{2} + \frac{1}{2} \tan^{-1} \frac{4}{3} \right) \right| + C$?
 (e) Write a difference between derivative and antiderivative ?
17. Integrate $\int \frac{1}{x^4 - 1} dx$ using the concept of partial fraction. Also give an example of proper rational fraction and improper rational fraction. [3+2]
18. Use simplex method and maximize: $Z(x, y) = x + y$ subject to constraints $2x + 3y \geq 22$, $2x + y \geq 14$, $x \geq 0$, $y \geq 0$. [5]
19. Write any one difference between like parallel forces and unlike parallel forces. A heavy uniform beam whose mass is 60 kg is

suspended in a horizontal position by two vertical strings each of which can sustain a tension of 52.5 kg wt. How far from the centre of the beam must a body of mass 30 kg placed so that one of the strings may just break? [1 + 4]

OR

If the demand function $P = 85 - 4Q - Q^2$, find the consumer's surplus at demand 4 units and price 64 units. Also make a revenue function for demand equation $P = 20 + 5Q - Q^2$. Obtain the standard quadratic equation for marginal revenue. Q represents the number of units demands and P represent the price. [2 + 1 + 1 + 1]

Group 'C' [3 × 8 = 24]

20. A mixture is to be made of three foods, A, B and C which contain nutrients P, Q, R as shown in the table below. The quantity of P, Q, R is 45 units, 54 units and 45 units respectively.

Food	Units of nutrients per kg of the foods		
	P	Q	R
A	2	2	4
B	3	5	0
C	4	3	5

- (a) Express the information in equation form. [1]
 (b) Solve the equations using matrix. [5]
 (c) If the cost per kg of the foods A, B, C are Rs. 300, Rs. 240 and Rs. 180 respectively, find the total cost of the mixture by matrix method. [2]
21. A line makes an angle $\alpha, \beta, \gamma, \delta$ with the four diagonals of a cube kept in a dining room.
 (a) Find the direction ratios of any two diagonals of the cube and express the diagonals in vector form. [3]

- (b) Find the angle between the any two diagonals of the cube. [2]

- (c) Prove that $\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma + \cos^2 \delta = \frac{4}{3}$. [3]

22. A college hostel accommodating 1000 students; one of them came from abroad with infection of corona virus, then the hostel was isolated. If the rate at which the virus spreads is assumed to be proportional to the product of the number 'N' of infected students and number of non-infected students and the number of infected students is 50 after 4 days.

- (a) Express the above information in the form of differential equation [2]
 (b) Solve the differential equation. [2]
 (c) Show that more than 95% students will be infected after 10 days. [4]

Ambik