

1. If  $P(x) = \frac{(x-b)(x-c)}{(a-b)(a-c)} + \frac{(x-c)(x-a)}{(b-c)(b-a)} + \frac{(x-a)(x-b)}{(c-a)(c-b)}$ , then for all real values of  $x$ ,  $P(x)$  equals

- (A) 1                      (B) 0  
 (C)  $x$                       (D)  $\frac{(x-a)(x-b)(x-c)}{(a-b)(b-c)(c-a)}$

2. Solution of  $0 < |3x + 1| < \frac{1}{3}$  is

- (A)  $(-4/9, -2/9)$                       (B)  $[-4/9, -2/9]$   
 (C)  $(-4/9, -2/9) - \{-1/3\}$                       (D)  $[-4/9, -2/9] - \{-1/3\}$

3. If  $x + \frac{1}{x} = a$ ,  $x^3 + \frac{1}{x^3} = b$ , then  $x^2 + \frac{1}{x^2}$  is

- (A)  $a^3 + a^2 - 3a - 2 - b$                       (B)  $a^3 - a^2 - 3a + 4 - b$   
 (C)  $a^3 - a^2 + 3a - 6 - b$                       (D)  $a^3 + a^2 - 3a + 4 + b$

4. Two distinct polynomial  $f(x)$  and  $g(x)$  are defined by  $f(x) = x^2 + ax + 2$  and  $g(x) = x^2 + 2x + a$ . If the equations  $f(x) = 0$  and  $g(x) = 0$  have a common root, then the sum of the roots of the equation  $f(x) + g(x) = 0$  is

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

5.  $4^{\sin^2 x} + 4^{\cos^2 x}$  is

- (A)  $\leq 4$                       (B)  $\geq 4$   
 (C)  $\leq 2$                       (D)  $\geq 2$

6. Let A(2,-1) and B(6,5) are two points. The ratio in which the foot of the perpendicular from (4,1) divides AB is

- (A) 8 : 15                      (B) 5 : 8  
 (C) -5 : 8                      (D) -8 : 5

7. Solution of  $|x - 1| + |x - 2| + |x - 3| \geq 6$  is
- (A)  $[0, 4]$                       (B)  $(-\infty, -2) \cup [4, \infty)$   
(C)  $(0, 4)$ .                      (D)  $(-\infty, 0) \cup [4, \infty)$
8. A man standing on a railway platform notices a train moving at uniform speed took 21 seconds to cross the platform which is 88 meters long and that it took 9 seconds to pass him. Then the length of the train in meters is
- (A) 55                                      (B) 160  
(C) 66                                      (D) 72
9. The largest non-negative integer  $k$  such that  $24^k$  divides  $13!$  is
- (A) 2                                      (B) 3  
(C) 4                                      (D) 5
10. If the three points  $A(1, 6)$ ,  $B(3, -4)$  and  $C(x, y)$  are collinear then the equation satisfying by  $x$  and  $y$  is
- (A)  $5x + y - 11 = 0$                       (B)  $5x + 13y + 5 = 0$   
(C)  $5x - 13y + 5 = 0$                       (D)  $13x - 5y + 5 = 0$
11. The number of solutions of  $2 \sin x + \cos x = 3$  is
- (A) 1                                      (B) 3  
(C) infinite                                      (D) 0
12. The period of the function  $f(x) = \cos 4x + \tan 3x$  is
- (A)  $\pi$                                       (B)  $\frac{\pi}{2}$   
(C)  $\frac{\pi}{3}$                                       (D)  $\infty$

13. From a circular disk of radius 13 cm a sector is cut with center angle  $\theta$ . If the height of the right circular cone formed using the above sector is 12 cm then  $\theta$  is

- (A)  $\frac{10\pi}{13}$                       (B)  $\frac{9\pi}{13}$   
(C)  $\frac{5\pi}{13}$                       (D)  $\frac{6\pi}{13}$

14. For the function  $f(x) = e^{\cos x}$ , Rolle's theorem is

- (A) applicable when  $0 \leq x \leq \frac{\pi}{2}$                       (B) applicable when  $\frac{\pi}{2} \leq x \leq \frac{3\pi}{2}$   
(C) applicable when  $\frac{\pi}{4} \leq x \leq \frac{\pi}{2}$                       (D) applicable when  $0 \leq x \leq \pi$

15. If  $p$  and  $q$  are coefficients of  $x^n$  in the expansions of  $(1+x)^{2n}$  and  $(1+x)^{2n-1}$  respectively, then  $\frac{p}{q}$  is equal to

- (A) 4                      (B) 1  
(C) 9                      (D) 2

16. If  $\alpha$  and  $\beta$  are the roots of the equation  $x^2 + x + 1 = 0$ , then the equation whose roots are  $\alpha^{19}$  and  $\beta^7$  is

- (A)  $x^2 - x + 1 = 0$                       (B)  $x^2 + x - 1 = 0$   
(C)  $x^2 + x + 1 = 0$                       (D)  $x^2 - x - 1 = 0$

17. The even function of the following is

- (A)  $f(x) = \frac{a^x + a^{-x}}{a^x - a^{-x}}$                       (B)  $f(x) = \frac{a^x + 1}{a^x - 1}$   
(C)  $f(x) = x \frac{a^x - 1}{a^x + 1}$                       (D)  $f(x) = \log_2(x + \sqrt{x^2 + 1})$



23. The interior angles of a polygon are in AP. The smallest angle is  $120^\circ$  and the common difference is  $5^\circ$ . The number of sides of the polygon is
- (A) 9 (B) 10  
(C) 16 (D) 5
24. For every real number  $x$ , let  $f(x) = \frac{x}{1!} + \frac{3}{2!}x^2 + \frac{7}{3!}x^3 + \frac{15}{4!}x^4 + \dots$ . Then the equation  $f(x) = 0$  has
- (A) no real solution (B) exactly one real solution  
(C) exactly two real solutions (D) infinite number of real solutions
25. Let  $p, q$  be real numbers. If  $\alpha$  is the root of  $x^2 + 3p^2x + 5q^2 = 0$ ,  $\beta$  is a root of  $x^2 + 9p^2x + 15q^2 = 0$  and  $0 < \alpha < \beta$ , then the equation  $x^2 + 6p^2x + 10q^2 = 0$  has a root  $\gamma$  that always satisfies
- (A)  $\gamma = \frac{\alpha}{4} + \beta$  (B)  $\beta < \gamma$   
(C)  $\alpha < \gamma < \beta$  (D)  $\gamma = \frac{\alpha}{2} + \beta$
26. Let  $I$  denote the  $3 \times 3$  identity matrix and  $P$  be a matrix obtained by rearranging the columns of  $I$ . Then
- (A) There are six distinct choices for  $P$  and  $\det(P) = 1$   
(B) There are six distinct choices for  $P$  and  $\det(P) = \pm 1$   
(C) There are more than one choices for  $P$  and some of them are not invertible  
(D) There are more than one choices for  $P$  and  $P^{-1} = I$  in each choice
27. If  $a^x = b^y = c^z = d^w$ , the value of  $x(\frac{1}{y} + \frac{1}{z} + \frac{1}{w})$  is
- (A)  $\log_a(abc)$  (B)  $\log_a(bcd)$   
(C)  $\log_b(cda)$  (D)  $\log_c(dab)$

28. The sum of the first  $n$  terms of the series  $1^2 + 2 \cdot 2^2 + 3^2 + 2 \cdot 4^2 + 5^2 + 2 \cdot 6^2 + \dots$  is  $\frac{n(n+1)^2}{2}$  when  $n$  is even. For an odd  $n$ , the sum is

- (A)  $\frac{3n(n+1)}{2}$                       (B)  $\frac{n^2(n+1)}{2}$   
(C)  $\frac{n(n+1)^2}{4}$                       (D)  $\frac{n^2(n+1)^2}{2}$

29. Let  $f(x)$  be a quadratic polynomial with  $f(2) = 10$  and  $f(-2) = -2$ . Then the coefficient of  $x$  in  $f(x)$  is

- (A) 1                                      (B) 2  
(C) 3                                      (D) 4

30. The three sides of a triangle are distinct positive integers in an A.P. If the smallest side is 10, the number of such triangles is

- (A) 8                                      (B) 9  
(C) 100                                      (D) infinite

31. The solution of the inequality  $1 + |x - 1| \geq 0$  is

- (A)  $(-\infty, 0)$                       (B)  $\mathbb{R}$   
(C)  $(-2, 0)$                       (D)  $(0, 2)$

32. The function  $f(x) = x^2 + bx + c$ , where  $b$  and  $c$  real constants, describes

- (A) one-to-one mapping  
(B) onto mapping  
(C) not one-to-one but onto mapping  
(D) neither one-to-one nor onto mapping

33. Let  $\mathbb{R}$  be the set of all real numbers and  $f : [-1, 1] \rightarrow \mathbb{R}$  be defined by

$$f(x) = \begin{cases} x \sin \frac{1}{x} & x \neq 0 \\ 0 & x = 0 \end{cases}$$

- (A)  $f$  satisfies the conditions of Roll's theorem on  $[1, 1]$
- (B)  $f$  satisfies the conditions of Lagrange's Mean Value Theorem on  $[1, 1]$
- (C)  $f$  satisfies the conditions of Rolle's theorem on  $[0, 1]$
- (D)  $f$  satisfies the conditions of Lagrange's Mean Value Theorem on  $[0, 1]$

34. A regular octagon was formed by cutting congruent isosceles right angled triangles from the corner of a unit square. The side length of the octagon is

- (A)  $\frac{\sqrt{2} - 1}{2}$
- (B)  $\sqrt{2} - 1$
- (C)  $\frac{\sqrt{5} - 1}{4}$
- (D)  $\frac{\sqrt{5} - 1}{2}$

35. The number of solutions of  $\sin x = \frac{6}{x}$  in  $0 \leq x \leq 12\pi$  is

- (A) 1
- (B) 6
- (C) 10
- (D) 12

36. If  $f(x) = x^4 + 9x^3 + 35x^2 - x + 4$ , then  $f(-5 + \sqrt{-4})$  is equal to

- (A) -160
- (B) 160
- (C) 0
- (D) 1

37. The solution of the equation  $(3 + 2\sqrt{2})^{x^2-8} + (3 + 2\sqrt{2})^{8-x^2} = 6$  are

- (A)  $3 \pm 2\sqrt{2}$
- (B)  $\pm 1$
- (C)  $\pm 3\sqrt{3}, \pm 2\sqrt{2}$
- (D)  $\pm 3, \pm \sqrt{7}$

38. The number of real roots of the equation  $\left(x + \frac{1}{x}\right)^3 + x + \frac{1}{x} = 0$  is
- (A) 0 (B) 2  
(C) 4 (D) 6
39. The order of the differential equation of all parabolas whose axis of symmetry along  $x$ -axis is
- (A) 2 (B) 1  
(C) 3 (D) 4
40. If  $ax^2 + bx + c = 0$  and  $2x^2 + 3x + 4 = 0$  have a common root where  $a, b, c \in \mathbb{N}$  (set of natural numbers), the least value of  $a + b + c$  is
- (A) 13 (B) 11  
(C) 7 (D) 9
41. If  $m = {}^nC_2$ , then  ${}^mC_2$  is equal to
- (A)  $3 {}^nC_4$  (B)  ${}^{n+1}C_4$   
(C)  $3 {}^{n+1}C_4$  (D)  $3 {}^{n+1}C_3$
42. How many odd numbers of six significant digits can be formed with the digits 0,1,2,5,6,7 when no digit is repeated?
- (A) 120 (B) 96  
(C) 360 (D) 288
43. The coefficient of  $x^n$ , where  $n$  is any positive integer, in the expansion of  $(1 + 2x + 3x^2 + \dots \infty)^{\frac{1}{2}}$  is
- (A) 1 (B)  $\frac{n+1}{2}$   
(C)  $2n+1$  (D)  $n+1$

44. If  $x$ ,  $y$  and  $z$  are greater than 1, then the value of

$$\begin{vmatrix} 1 & \log_x y & \log_x z \\ \log_y x & 1 & \log_y z \\ \log_z x & \log_z y & 1 \end{vmatrix} \text{ is}$$

- (A)  $\log x \log y \log z$                       (B)  $\log x + \log y + \log z$   
 (C) 0    (D)  $1 - (\log x \log y \log z)$

45. Consider an ellipse with foci at  $(5, 15)$  and  $(21, 15)$ . If the x-axis touches the ellipse, then the length of the major axis is

- (A) 17    (B) 34  
 (C) 13    (D)  $\sqrt{416}$

46. Consider the function defined by  $f(x) = \begin{cases} \frac{\sin x^2}{x}, & \text{when } x < 0; \\ x^2 + ax + b & \text{when } x \geq 0. \end{cases}$

Suppose  $f(x)$  is differentiable on  $R$ , then

- (A)  $a = 0, b = 0$                               (B)  $a = 1, b = 0$   
 (C)  $a = 0, b = 1$                               (D)  $a = 1, b = 1$

47. If  $f(x) = \begin{cases} x^3 & x \geq 1 \\ ax^2 + bx + c & x < 1 \end{cases}$

where  $a$ ,  $b$  and  $c$  are constants such that has second derivative at  $x = 1$ . Then  $a$  equals

- (A) -6    (B) -3  
 (C) 6    (D) 3

48. A coin is tossed five times. If the outcomes are 2 heads and 3 tails (in same order), then what is the possibility that the fourth toss is a head?

- (A)  $\frac{1}{4}$  (B)  $\frac{2}{5}$   
 (C)  $\frac{1}{2}$  (D)  $\frac{3}{5}$

49. If the function  $f : \mathbb{R} \rightarrow \mathbb{R}$  is defined by  $f(x) = (x^2 + 1)^{35} \forall x \in \mathbb{R}$ , then  $f$  is

- (A) one-one but not onto (B) onto but not one-one  
 (C) neither one-one nor onto (D) both one-one and onto

50. If  $C$  is the reflection of  $A(2, 4)$  in  $x$ -axis and  $B$  is the reflection of  $C$  in  $y$ -axis, then  $|AB|$  is

- (A) 20 (B)  $2\sqrt{5}$   
 (C)  $4\sqrt{5}$  (D) 4

51. Let  $\omega$  be the complex number  $\cos\frac{2\pi}{3} + i \sin\frac{2\pi}{3}$ . Then the number of distinct

complex numbers  $z$  satisfying 
$$\begin{vmatrix} z+1 & \omega & \omega^2 \\ \omega & z+\omega^2 & 1 \\ \omega^2 & 1 & z+\omega \end{vmatrix} = 0$$
 is equal to

- (A) 1 (B) 2  
 (C) 3 (D) 4

52. If  $A$  and  $B$  are square matrices of the same order such that  $(A+B)(A-B) = A^2 - B^2$ , then  $(ABA^{-1})^2$  is equal to

- (A)  $B^2$  (B)  $I$   
 (C)  $A^2B^2$  (D)  $A^2$

53.  $ABCD$  is a square with  $A = (1, 2)$  and  $B = (3, -4)$ . If line  $CD$  passes through  $(3, 8)$ , then the mid point of  $CD$  is
- (A)  $(2, 6)$  (B)  $(6, 2)$   
(C)  $(2, 5)$  (D)  $(\frac{28}{5}, \frac{1}{5})$
54. Using binomial theorem, the value of  $(0.999)^3$  correct to 3 decimal places is
- (A) 0.998 (B) 0.999  
(C) 0.996 (D) 0.997
55. The simplified form of  $\frac{2}{\sqrt{2+\sqrt{2+\sqrt{2+2\cos 4x}}}}$  is
- (A)  $\sec \frac{x}{2}$  (B)  $\sec x$   
(C)  $\cos x$  (D) 1
56. The lines  $x + 2y + 3 = 0$ ,  $x + 2y - 7 = 0$  and  $2x - y - 4 = 0$  are three sides of a square. Equation of the remaining side of the square can be
- (A)  $2x - y - 14 = 0$  (B)  $2x - y + 8 = 0$   
(C)  $2x - y - 10 = 0$  (D)  $2x - y - 6 = 0$
57. The equation  $\sqrt{3}\sin x + \cos x = 4$  has
- (A) only one solution (B) two solutions  
(C) infinitely many solutions (D) no solution
58. If the angle between tangents drawn to  $x^2 + y^2 + 2gx + 2fy + c = 0$  from  $(0, 0)$  is  $\frac{\pi}{2}$ , then
- (A)  $g^2 + f^2 = 3c$  (B)  $g^2 + f^2 = 2c$   
(C)  $g^2 + f^2 = 5c$  (D)  $g^2 + f^2 = 4c$

59. Let  $P$  be the point  $(1, 0)$  and  $Q$  a point on the locus  $y^2 = 8x$ . The locus of the mid point of  $PQ$  is
- (A)  $x^2 - 4y + 2 = 0$  (B)  $x^2 + 4y + 2 = 0$   
(C)  $y^2 + 4x + 2 = 0$  (D)  $y^2 - 4x + 2 = 0$
60. The number of values of  $c$  such that the line  $y = 4x + c$  touches the curve  $\frac{x^2}{4} + y^4 = 1$ , is
- (A) 1 (B) 2  
(C)  $\infty$  (D) 0
61. If the sum of distances from a point  $P$  on two mutually perpendicular straight lines is 1 unit, then the locus of  $P$  is
- (A) a parabola (B) a circle  
(C) an ellipse (D) a straight line
62. The function  $f(x) = \sec(\log(x + \sqrt{1 + x^2}))$  is
- (A) odd (B) even  
(C) neither odd nor even (D) constant
63. The second order derivative  $\frac{d^2y}{dx^2}$  at  $t = \frac{\pi}{4}$  where  $x = a \sin^3 t$  and  $y = a \cos^3 t$  is
- (A) 2 (B)  $\frac{1}{12a}$   
(C)  $\frac{4\sqrt{2}}{3a}$  (D)  $\frac{3a}{4\sqrt{2}}$
64. If  $y = \cos^{-1}(\cos x)$ , then  $y'(x) =$
- (A) 1 for all  $x$  (B) -1 for all  $x$   
(C) 1 in second and third quadrant (D) -1 in third and fourth quadrant

65. If  $x^2 + y^2 = t - \frac{1}{t}$  and  $x^4 + y^4 = t^2 + \frac{1}{t^2}$ , then  $\frac{dy}{dx} =$
- (A)  $\frac{1}{x^2y^3}$  (B)  $\frac{1}{xy^3}$   
 (C)  $\frac{1}{x^2y^2}$  (D)  $\frac{1}{x^3y}$
66. If  $y = \lim_{n \rightarrow \infty} (1+x)(1+x^2)(1+x^4)\dots(1+x^{2^n})$ , and  $x^2 < 1$ , then  $y'$  is equal to
- (A) 1 (B)  $\frac{1}{1-x}$   
 (C)  $\frac{1}{(1-x)^2}$  (D)  $\frac{-1}{(1-x)^2}$
67. The points  $(k-1, k+2)$ ,  $(k, k+1)$ ,  $(k+1, k)$  are collinear for
- (A) any value of  $k$  (B)  $k = -1/2$  only  
 (C) no value of  $k$  (D) integral values of  $k$  only
68. One ticket is selected at random from 50 tickets numbered 00, 01, 02, ... 49. Then the probability that the sum of the digits on the selected ticket is 8, given that the product of these digits is zero, equals
- (A)  $\frac{5}{14}$  (B)  $\frac{1}{50}$   
 (C)  $\frac{1}{7}$  (D)  $\frac{1}{14}$
69. A focus of an ellipse is at the origin. The directrix is the line  $x = 4$  and the eccentricity is  $\frac{1}{2}$ . Then the length of the semi-major axis is
- (A)  $\frac{8}{3}$  (B)  $\frac{2}{3}$   
 (C)  $\frac{4}{3}$  (D)  $\frac{5}{3}$
70. If  $y = |\cos x| + |\sin x|$ , then  $\frac{dy}{dx}$  at  $x = \frac{2\pi}{3}$  is
- (A) 0 (B) 1  
 (C)  $\frac{1-\sqrt{3}}{2}$  (D)  $\frac{\sqrt{3}-1}{2}$

71. Let  $f : \mathbb{R} \rightarrow \mathbb{R}$  be a positive increasing function with  $\lim_{x \rightarrow \infty} \frac{f(3x)}{f(x)} = 1$ . Then  $\lim_{x \rightarrow \infty} \frac{f(2x)}{f(x)} =$
- (A)  $\frac{3}{2}$  (B) 3  
(C) 1 (D)  $\frac{2}{3}$
72. Let  $\mathbb{R}$  be the real line. Consider the following subsets of the plane  $\mathbb{R} \times \mathbb{R}$  :  
 $S = \{(x, y) : y = x + 1 \text{ and } 0 < x < 2\}$  and  $T = \{(x, y) : x - 1 \text{ is an integer}\}$ .  
 Which one of the following is true?
- (A) Neither  $S$  nor  $T$  is an equivalence relation on  $\mathbb{R}$   
 (B) Both  $S$  and  $T$  are equivalence relations on  $\mathbb{R}$   
 (C)  $S$  is an equivalence relation on  $\mathbb{R}$  but  $T$  is not  
 (D)  $T$  is an equivalence relation on  $\mathbb{R}$  but  $S$  is not
73. If  $\sin y = x \sin(a + y)$ , then  $\frac{dy}{dx}$  is
- (A)  $\frac{\sin a}{\sin^2(a+y)}$  (B)  $\frac{\sin^2(a+y)}{\sin a}$   
 (C)  $\sin a \sin^2(a + y)$  (D)  $\frac{\sin^2(a-y)}{\sin a}$
74. The non-zero vectors  $a$ ,  $b$  and  $c$  are related by  $a = 8b$  and  $c = -7b$ . Then the angle between  $a$  and  $c$  is
- (A) 0 (B)  $\frac{\pi}{2}$   
 (C)  $\pi$  (D)  $\frac{\pi}{4}$
75. The domain of the function  $f(x) = \cot^{-1}\left(\frac{x}{\sqrt{x^2 - [x^2]}}\right)$ , for real  $x \in \mathbb{R}$  (here  $[x]$  is the largest integer less than  $x$ ) is
- (A)  $\mathbb{R} - \{\pm\sqrt{n}, n \in \mathbb{N}\}$  (B)  $\mathbb{R} - \{\sqrt{n} : n \geq 0, n \in I\}$   
 (C)  $\mathbb{R}$  (D)  $\mathbb{R} - \{0\}$

76. Number of real solutions of the equation  $x^7 + 14x^5 + 16x^3 + 30x - 560 = 0$  is

- (A) 7 (B) 1  
(C) 3 (D) 5

77. The value of  $n \in I$  for which the function  $f(x) = \frac{\sin nx}{\sin \frac{x}{n}}$  has  $4\pi$  as its period, is

- (A) 2 (B) 3  
(C) 4 (D) 5

78. The differential equation of the family of circles with fixed radius 5 units and center on the line  $y = 2$  is

- (A)  $(y - 2)^2 y'^2 = 25 - (y - 2)^2$  (B)  $(x - 2)^2 y'^2 = 25 - (y - 2)^2$   
(C)  $(y - 2)y'^2 = 25 - (y - 2)^2$  (D)  $(x - 2)y'^2 = 25 - (y - 2)^2$

79. The domain of the function  $\sin^{-1}(\log_2 \frac{x^2}{2})$  is

- (A)  $[-1, 2] - \{0\}$  (B)  $[-2, 2] - (-1, 1)$   
(C)  $[-2, 2] - \{0\}$  (D)  $[1, 2]$

80. The quadratic equations  $x^2 - 6x + a = 0$  and  $x^2 - cx + 6 = 0$  have one root in common. The other roots of the first and second equations are integers in the ratio 4 : 3. Then the common root is

- (A) 1 (B) 4  
(C) 3 (D) 2



87. The number of sides of a polygon with 44 diagonals is

- (A) 10 (B) 11  
(C) 12 (D) 13

88. If  $f(2) = 2$  and  $f'(2) = 1$ , then  $\lim_{x \rightarrow 2} \frac{2x^2 - 4f(x)}{x-2} =$

- (A) 4 (B) -4  
(C) 2 (D) -2

89. For the function  $f(x) = \begin{cases} x - 1 & x < 0; \\ \frac{1}{4} & x = 0; \\ x^2 & x > 0. \end{cases}$

$\lim_{x \rightarrow 0^+} f(x)$  and  $\lim_{x \rightarrow 0^-} f(x)$  are

- (A) 0, 1 (B) 0, -1  
(C) 1, -1 (D) -2, -1

90. The value of  $x$  for which  $1 + x \log (x + \sqrt{x^2 + 1}) \geq \sqrt{1 + x^2}$  are

- (A)  $x \leq 0$  (B)  $0 \leq x \leq 1$   
(C)  $x \geq 0$  (D)  $x \leq 1$

91. The maximum value of  $\sin x + \frac{1}{2} \sin 2x + \frac{1}{3} \sin 3x$ ,  $0 \leq x \leq \frac{\pi}{2}$ , is

- (A)  $1 + 2\sqrt{2}$  (B)  $2\sqrt{2} - 1$   
(C)  $1 - 2\sqrt{2}$  (D)  $\frac{1}{2} + \frac{4}{3\sqrt{2}}$

92. Let  $f(x) = \begin{cases} x + 2 & -1 \leq x \leq 0; \\ 1 & x = 0; \\ \frac{x}{2} & 0 < x \leq 1. \end{cases}$

Then on  $[-1, 1]$  this function has

- (A) a minimum (B) a maximum  
 (C) neither a minimum nor a maximum (D)  $f'(x)$  does not exist

93.  $\int \frac{1}{1 + \cos x + \sin x} dx =$

- (A)  $\log |1 + \tan \frac{x}{2}| + c$  (B)  $\frac{1}{2} \log |1 + \tan \frac{x}{2}| + c$   
 (C)  $2 \log |1 + \tan \frac{x}{2}| + c$  (D)  $\frac{1}{2} \log |1 - \tan \frac{x}{2}| + c$

94.  $\int \frac{\sin x \cos x}{\sqrt{1 - \sin^4 x}} dx =$

- (A)  $\frac{1}{2} \sin^{-1}(\sin^2 x) + c$  (B)  $\frac{1}{2} \cos^{-1}(\sin^2 x) + c$   
 (C)  $\tan^{-1}(\sin^2 x) + c$  (D)  $\tan^{-1}(2 \sin^2 x) + c$

95.  $\int \frac{dx}{x(x^n+1)}$  is equal to

- (A)  $\frac{1}{n} \log \left( \frac{x^n}{x^n+1} \right) + c$  (B)  $\frac{1}{n} \log \left( \frac{x^n+1}{x^n} \right) + c$   
 (C)  $\log \left( \frac{x^n}{x^n+1} \right) + c$  (D)  $\frac{1}{n} \log \left( \frac{x^n}{x^n-1} \right) + c$

96.  $\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \sin |x| dx$  is equal to

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

97. The value of  $\int_1^4 e^{\sqrt{x}} dx$  is

- (A)  $e^2$  (B)  $2e^2$   
 (C)  $4e^2$  (D)  $3e^2$

98. The area bounded by the curves  $\sqrt{x} + \sqrt{y} = 1$  and  $x + y = 1$ , is

- (A)  $\frac{1}{3}$  sq unit (B)  $\frac{1}{6}$  sq unit  
(C)  $\frac{1}{2}$  sq unit (D)  $\frac{1}{5}$  sq unit

99. A particular solution of  $\log\left(\frac{dy}{dx}\right) = 3x + 4y$ ,  $y(0) = 0$  is

- (A)  $e^{3x} + 3e^{-2y} = 4$  (B)  $4e^{3x} - 3x^{-4y} = 3$   
(C)  $3e^{3x} + 4e^{-4y} = 7$  (D)  $4e^{3x} + 3e^{-4y} = 7$

100. The vectors  $\vec{a} = \hat{i} + \hat{j} + m\hat{k}$ ,  $\vec{b} = \hat{i} + \hat{j} + (m+1)\hat{k}$  and  $\vec{c} = \hat{i} - \hat{j} + m\hat{k}$  are coplanar

- (A) if  $m = 1$  (B) if  $m = 4$   
(C) if  $m = 3$  (D) for no value of  $m$

101. The value of  $\frac{(\vec{a} \times \vec{b})^2 + (\vec{a} \cdot \vec{b})^2}{2\vec{a}^2 \cdot \vec{b}^2}$  is

- (A)  $\vec{a} \cdot \vec{b}$  (B) 1  
(C) 0 (D)  $\frac{1}{2}$

102. For,  $\frac{2^2 + 4^2 + \dots + (2n)^2}{1^2 + 2^2 + \dots + (2n-1)^2}$  to exceed 1.01, the maximum value of  $n$  is

- (A) 99 (B) 100  
(C) 101 (D) 150

103. Tangents to a circle at points  $P$  and  $Q$  on the circle meet at a point  $R$ . If  $PQ = 6$  and  $PR = 5$ , then radius of the circle is

- (A)  $\frac{13}{3}$  (B) 4  
(C)  $\frac{15}{4}$  (D)  $\frac{15}{5}$

104. Number of distinct primes dividing  $12! + 13! + 14!$  is
- (A) 5 (B) 6  
(C) 7 (D) 8
105. If the quadratic polynomial  $f(x) = ax^2 + bx + c$  has positive coefficients  $a, b, c$  in AP in that order. If  $f(x) = 0$  has integer roots  $\alpha, \beta$ , then  $\alpha + \beta + \alpha\beta$  is
- (A) 3 (B) 5  
(C) 7 (D) 14
106. If  $y = \frac{x+c}{1+x^2}$  where  $c$  is a constant and  $y$  is stationary, then  $xy$  is equal to
- (A)  $\frac{1}{2}$  (B)  $\frac{3}{4}$   
(C)  $\frac{1}{3}$  (D)  $\frac{1}{4}$
107. The probability that event  $A$  occur is  $\frac{3}{4}$  and the probability the  $B$  occur is  $\frac{2}{3}$ . Minimum and maximum possible values of  $P(A \cap B)$  is
- (A)  $\frac{5}{12}, \frac{2}{3}$  (B)  $\frac{5}{12}, \frac{3}{4}$   
(C)  $\frac{2}{3}, \frac{3}{4}$  (D)  $\frac{5}{12}, \frac{1}{2}$
108. A straight line through  $(-3,4)$  be such that the portion intercepted by the axes is divided at  $(-3,4)$  in the ratio 4:1 externally, then which of the following is not a point on the line
- (A)  $(9,0)$  (B)  $(-\frac{1}{2}, \frac{19}{6})$   
(C)  $(3,1)$  (D)  $(-3,4)$
109. The system of equations  $x + \frac{2}{3}y + \frac{1}{3}z = 0$ ,  $y + 2z = 0$ ,  $x + \frac{4}{3} + \frac{5}{3}z = 0$  posses
- (A) no solution (B) only trivial solution  
(C) infinite non-trial solutions (D) one non-trivial solution

110. A bird is sitting on the top at a vertical pole of height 20 m and elevation from a point 0 on the ground is  $45^\circ$ . The bird from the top of the pole flies off horizontally away from the pole. After one second, the elevation of the bird from 0 is reduced to  $30^\circ$ , then the speed of the bird is

- (A)  $40(\sqrt{3} - \sqrt{2})$                       (B)  $20\sqrt{2}$   
(C)  $20(\sqrt{3} - 1)$                       (D)  $40(\sqrt{2} - 1)$

111. All the thirteen spade cards are drawn from a pack and formed a new pack. From these 13 spade cards, cards are drawn one by one without replacement till the ace of spade comes. The probability the ace comes in the fourth draw is

- (A)  $\frac{1}{13}$                                       (B)  $\frac{12}{13}$   
(C)  $\frac{9}{13}$                                       (D)  $\frac{4}{13}$

112. The point of intersection of the tangents drawn to the curve  $x^2y = 1 - y$  at the point where it is met by the curve  $xy = 1 - y$  is given by

- (A) (0,-1)                                  (B) (1,1)  
(C) (0,1)                                    (D) (-1, -1)

113. Three positive numbers form an increasing G.P. If the middle term in the G.P. is doubled the three numbers are in an A.P. Then the common ratio of the G.P. is

- (A)  $3 + \sqrt{2}$                               (B)  $2 - \sqrt{3}$   
(C)  $2 + \sqrt{3}$                               (D)  $\sqrt{2} - \sqrt{3}$

114. A problem in mathematics is given to three students  $A, B, C$  and their respective probability of solving the problem is  $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}$ . Probability that the problem is solved is

- (A)  $\frac{3}{4}$                                       (B)  $\frac{1}{2}$   
(C)  $\frac{2}{3}$                                       (D)  $\frac{1}{3}$

115. The equations of tangent and normal to the curve  $y = x^4 - 6x^3 + 13x^2 - 10x + 5$  at the point (1,3) are
- (A)  $2x - y + 1 = 0, 2x + y + 1 = 0$                       (B)  $x + 2y - 7 = 0, x + 2y + 7 = 0$   
(C)  $2x - y + 1 = 0, x + 2y - 7 = 0$                       (D)  $2x + y + 1 = 0, x + 2y + 7 = 0$
116. Coordinates of the points on the line  $\frac{x+2}{3} + \frac{y+1}{2} + \frac{z-3}{2}$  at a distance 5 units from the point (1,3,3) are
- (A) (3,7,4), (-2,-1,3)                      (B) (7,4,3), (2,-1,3)  
(C) (4,3,7), (-2,-1,3)                      (D) (1,0,1), (-2,1,3)
117. Geetha and Somu appear for an interview for two vacancies in a company. The probability of Geetha's selection is  $\frac{1}{5}$  and Somu is  $\frac{1}{6}$ . Then the probability that (i) both of them are selected (ii) both of them are not selected are respectively
- (A)  $\frac{1}{30}, \frac{2}{5}$                       (B)  $\frac{1}{30}, \frac{2}{3}$   
(C)  $\frac{7}{30}, \frac{2}{3}$                       (D)  $\frac{7}{30}, \frac{2}{3}$
118. The set of homogenous equations  $tx + (t+1)y + (t-1)z = 0, (t+1)x + ty + (t+2)z = 0, (t-1)x + (t+2)y + tz = 0$  has non-trivial solutions for
- (A) three values of t                      (B) two values of t  
(C) one value of t                      (D) no value of t
119. The points  $(0, \frac{8}{3}), (1, 3), (82, 30)$
- (A) from an obtuse angled triangle                      (B) from an acute angled triangle  
(C) from a right angled triangle                      (D) lie on a straight line

120. A straight line is normal to both the parabolas  $y^2 = x$  and  $x^2 = y$ . The distance of the origin from it is

- (A)  $\frac{3}{4\sqrt{2}}$  (B)  $\frac{1}{2\sqrt{2}}$   
(C)  $\frac{1}{\sqrt{2}}$  (D)  $\frac{1}{3\sqrt{2}}$

121.  $\int_0^{\pi} e^{\sin^2 x} \cos^2 x dx =$

- (A) 0 (B)  $-1$   
(C) 1 (D)  $\pi$

122. The solution of the differential equation  $e^{\frac{dy}{dx}} = x + 1$  when  $y(0) = 3$

- (A)  $y = x \log x - x + 2$  (B)  $y = (x + 1) \log(|x + 1|) - x + 3$   
(C)  $y = (x + 1) \log(|x + 1|) + x + 3$  (D)  $y = x \log x + x + 3$

123. Let the line  $\frac{x-2}{3} = \frac{y-1}{-5} = \frac{z+2}{2}$  lie in the plane  $x + 3y - \alpha z + \beta = 0$ , then  $(\alpha, \beta)$  lie on

- (A)  $x + y = 1$  (B)  $x - y = 1$   
(C)  $x + y = 13$  (D)  $x - y = 2$

124. The equation  $\begin{vmatrix} 1 & x & x^2 \\ x^2 & 1 & x \\ x & x^2 & 1 \end{vmatrix} = 0$  has

- (A) exactly two distinct roots (B) one pair of real equal roots  
(C) three pairs of equal roots (D) modulus of each root is 2



## PHYSICS

126. A heater coil is cut into two equal parts and only one part is used for heating. The heat generated will now be
- (A) doubled (B) four times  
(C) one fourth (D) halved
127. The material suitable for making electromagnets should have
- (A) high retentivity and high coercivity  
(B) low retentivity and low coercivity  
(C) high retentivity and low coercivity  
(D) low retentivity and high coercivity
128. A particle moves in a straight line with retardation proportional to its displacement. Its loss of kinetic energy for any displacement  $x$  is proportional to
- (A)  $x^2$  (B)  $e^x$   
(C)  $x$  (D)  $\log_e x$
129. The electric charge of the neutrino is given by
- (A) 1 (B)  $-1$   
(C) 0 (D) 2
130. The sun releases energy by
- (A) nuclear fission (B) nuclear fusion  
(C) spontaneous combustion (D) hydro-thermal process
131. A semiconductor with equal concentration of acceptor and donor type impurities is termed as
- (A) compensated (B) intrinsic  
(C) amphoteric (D) None of the above
132. X-rays consists of
- (A) negatively charged particles (B) electromagnetic radiation  
(C) a stream of neutrons (D) positively charged particles
133. Copper crystallizes in fcc lattice with a unit cell edge of 361 pm. The radius of copper atom is
- (A) 108 pm (B) 128 pm  
(C) 157 pm (D) 181 pm

134. A container with insulating walls is divided into equal parts by a partition fitted with a valve. One part is filled with an ideal gas at a pressure  $P$  and temperature  $T$ , whereas the other part is completely evacuated. If the valve is suddenly opened, the pressure and temperature of the gas will be
- (A)  $P/2, T/2$  (B)  $P, T$   
 (C)  $P, T/2$  (D)  $P/2, T$
135. The commutator bracket  $[XY, Z]$  is expanded as
- (A)  $[X, Z] + [X, Y]$  (B)  $[X, Z]Y + Z[Y, Z]$   
 (C)  $Z[X, Z] + [Y, X]Z$  (D)  $[Z, Y] + [X, Z]$
136. The force carrier in the case of EM waves is
- (A) a photon (B) a proton  
 (C) a pion (D) an electron
137. Any f-orbit can accommodate upto
- (A) fourteen electrons (B) nine electrons  
 (C) ten electrons (D) eighteen electrons
138. The unit of magnetic flux would be
- (A)  $Wb$  (B)  $Wb - m^2$   
 (C) Ampere-Coulomb (D)  $Wb / m^2$
139. A calcite crystal is placed over a dot on a piece of paper and rotated. On seeing through the calcite, one will see
- (A) two rotating dots  
 (B) two stationary dots  
 (C) one dot only  
 (D) one dot rotating about the other
140. Assume that a neutron breaks into a proton and an electron. The energy released during this process is  
 (mass of neutron =  $1.6725 \times 10^{-27}$  kg, mass of proton =  $1.6725 \times 10^{-27}$  kg, mass of electron  $9.6725 \times 10^{-31}$  kg)
- (A)  $0.73 MeV$  (B)  $7.10 MeV$   
 (C)  $6.30 MeV$  (D)  $5.4 MeV$
141. The angle between electric and magnetic field in an electromagnetic wave travelling in vacuum is
- (A)  $2\pi$  (B)  $2\pi/3$

- (C)  $\pi/2$  (D)  $4\pi$

142. According to Bohr's principle the relation between main quantum number  $n$  and radius  $r$  of the orbit is

- (A)  $r\alpha\frac{1}{n}$  (B)  $r\alpha\frac{1}{n^2}$   
 (C)  $r\alpha n$  (D)  $r\alpha n^2$

143. Two wires are made of the same material and have the same volume. However, wire 1 has cross-sectional area  $A$  and wire 2 has cross-sectional area  $3A$ . If the length of wire 1 increases by  $\Delta x$  on applying force  $F$ , the force needed to stretch wire 2 by the same amount is

- (A)  $F$  (B)  $4F$   
 (C)  $6F$  (D)  $9F$

144. The surface of metal is illuminated with the light of 400 nm. The kinetic energy of the ejected photoelectrons was found to be 1.68 eV. The work function of the metal is ( $hc = 1240 \text{ eV}\cdot\text{nm}$ )

- (A) 3.09 eV (B) 1.41 eV  
 (C) 1.51 eV (D) 1.68 eV

145. Which of the following Poisson brackets is non-vanishing?

- (A)  $(q_i, p_j)$  (B)  $(p_i, p_j)$   
 (C)  $(q_i, p_j)$  if  $i \neq j$  (D)  $(q_i, p_j)$  if  $i = j$

146. A particle is acted on by forces given in newtons by  $F_1 = 10\hat{i} - 4\hat{j}$  and  $F_2 = 17\hat{i} + 2\hat{j}$ . The force  $F_3$  which balances these forces is

- (A)  $F_1 = -10\hat{i} - 4\hat{j}N$  (B)  $F_1 = -27\hat{i} + 2\hat{j}N$   
 (C)  $F_1 = 27\hat{i} + 4\hat{j}N$  (D)  $F_1 = 12\hat{i} - 6\hat{j}N$

147. If pressure is increased on a piece of wax, the melting point of wax

- (A) decreases (B) does not change  
 (C) increases (D) decreases at first then increases

148. Which one of the following particle is a boson?

- (A) Photon (B) Proton  
 (C) Neutron (D) Electron

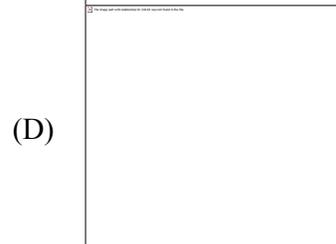
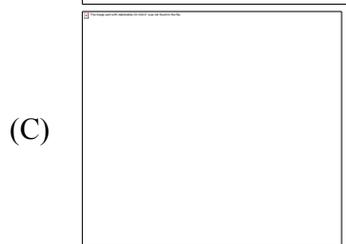
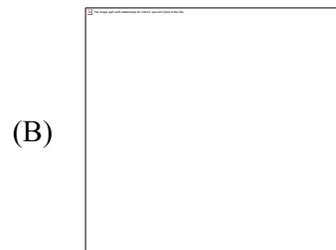
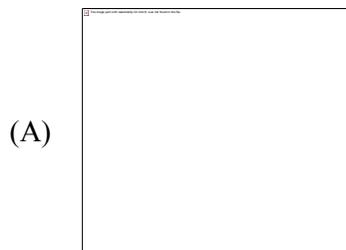
149. What is the dimensional formula of specific heat?
- (A)  $[M L^{-2} T^{-2}]$  (B)  $[M^0 L^2 T^{-2} K^{-1}]$   
 (C)  $[M^0 L T^{-2}]$  (D)  $[M L T^{-2}]$
150. Which of the following pairs of physical quantities have different dimensions?
- (A) Stress, pressure (B) Young's modulus, energy  
 (C) Density, relative density (D) Energy, torque
151. A bus starts from rest with an acceleration of  $1 \text{ m/sec}^2$ . A man who is 48 m behind the bus starts with a uniform velocity of  $10 \text{ ms}^{-1}$ . Then after how much time the man will catch the bus?
- (A) 12 sec (B) 8 sec  
 (C) 10 sec (D) 4 sec
152. Which of the following force is conservative?
- (A) Gravitational force (B) Frictional force  
 (C) Air resistance (D) Viscous force
153. A particle moves in a plane with uniform acceleration having direction different than that of instantaneous velocity. What is the nature of trajectory?
- (A) Straight line (B) Parabola  
 (C) Circle (D) Ellipse
154. In a uniform circular motion  $\vec{r}$ ,  $\vec{V}$  and  $\vec{\omega}$  stands for radius vector, linear velocity and angular velocity respectively. Then which of the following is true?
- (A)  $\vec{V} = \vec{r} \times \vec{\omega}$  (B)  $\vec{V} = \vec{\omega} \times \vec{r}$   
 (C)  $\vec{V} = \vec{r} \cdot \vec{\omega}$  (D) None of the above
155. Angular momentum is
- (A) an axial vector (B) a polar vector  
 (C) a scalar (D) None of the above

156. Which of the following surfaces in contact has maximum coefficient of friction ( $\mu$ )?
- (A) Wood on wood                      (B) Rubber tyre and dry concrete  
(C) Steel on steel                      (D) Rubber tyre on wet concrete
157. The tidal waves in the sea are primarily due to
- (A) atmosphere of the Earth  
(B) gravitational effect of Venus on the Earth  
(C) gravitational effect of Sun on the Earth  
(D) gravitational effect of Moon on the Earth
158. The total energy of the particle executing Simple Harmonic Motion is
- (A) proportional to  $x$                       (B) proportional to  $x^2$   
(C) independent of  $x$                       (D) proportional to  $x^3$
159. When the intermolecular distance decreases due to compressive force, there is
- (A) zero resultant force between molecules  
(B) repulsive force between molecules  
(C) attractive force between molecules  
(D) no force between molecules
160. If  $S$  is stress and  $Y$  is Young's modulus of material of a wire, the energy stored in the wire per unit volume is
- (A)  $2 S^2 Y$                       (B)  $S^2 / 2Y$   
(C)  $2 Y / S^2$                       (D)  $S / Y$
161. The pressure at the bottom of a tank of liquid is not proportional to
- (A) the density of the liquid                      (B) area of the liquid surface  
(C) the height of the liquid                      (D) the acceleration
162. Persons sitting in an artificial satellite circling around the earth have
- (A) zero mass                      (B) zero weight  
(C) infinite weight                      (D) infinite mass

163. A satellite is orbiting round the earth in a circular orbit with speed  $v$ . If  $m$  is mass of satellite, its total energy is
- (A)  $\frac{1}{2}mv^2$  (B)  $mv^2$   
(C)  $-\frac{1}{2}mv^2$  (D)  $\frac{3}{4}mv^2$
164. Which one of the following is most elastic in nature?
- (A) Rubber (B) Steel  
(C) Copper (D) Putty
165. A bucketful of water is kept in a room and it cools from  $75^\circ\text{C}$  to  $70^\circ\text{C}$  in  $T_1$  min, from  $70^\circ\text{C}$  to  $65^\circ\text{C}$  in  $T_2$  min, and from  $65^\circ\text{C}$  to  $60^\circ\text{C}$  in  $T_3$  min. Then
- (A)  $T_1 = T_2$  (B)  $T_1 < T_2 < T_3$   
(C)  $T_1 > T_2 > T_3$  (D)  $T_1 < T_3 < T_2$
166. If a star emitting orange light moves away from the Earth, its colour will
- (A) appear red (B) appear yellow  
(C) remain the same (D) turns gradually blue
167. The wavelength of light coming from a star shifts towards the violet end of the spectrum. This shows that star is
- (A) receding from the earth  
(B) approaching the earth  
(C) neither approaching nor receding from the earth  
(D) sometimes approaching and sometimes receding from the earth
168. When sound travels from air to water the quantity that remains unchanged is
- (A) speed (B) frequency  
(C) intensity (D) wavelength
169. The thermodynamic process in which the pressure of system remains constant is called
- (A) Isochoric (B) Adiabatic  
(C) Isothermal (D) Isobaric

170. The source and sink temperature of a Carnot engine are 400K and 300K respectively. What is the efficiency?
- (A) 100% (B) 75%  
(C) 33.3% (D) 25%
171. If the temperature of the source and sink is increased by the same amount, the efficiency of the engine
- (A) decreases (B) increases  
(C) remains unchanged (D) may increase or decrease
172. The diamagnetic material has susceptibility
- (A)  $\chi = 0$  (B)  $\chi < 1$   
(C)  $\chi > 1$  (D)  $\chi < 0$
173. Curie temperature is the temperature above which
- (A) a paramagnetic material becomes diamagnetic  
(B) a ferromagnetic material becomes diamagnetic  
(C) a paramagnetic material becomes ferromagnetic  
(D) a ferromagnetic material becomes paramagnetic
174. The wavelength of thermal radiation is
- (A) less than that of the visible light  
(B) greater than that of the visible light  
(C) equal to that of the visible light  
(D) far shorter than that of the visible light
175. If  $\epsilon_0$  and  $\mu_0$  are the electric permittivity and magnetic permeability in free space,  $\epsilon$  and  $\mu$  are the corresponding quantities in a medium, then index of refraction of the medium is
- (A)  $\sqrt{\frac{\epsilon_0\mu}{\epsilon\mu_0}}$  (B)  $\sqrt{\frac{\epsilon}{\epsilon_0}}$   
(C)  $\sqrt{\frac{\epsilon_0\mu_0}{\epsilon\mu}}$  (D)  $\sqrt{\frac{\epsilon\mu}{\epsilon_0\mu_0}}$
176. An electron with kinetic energy 5 eV is incident on a hydrogen atom in its ground state. The collision
- (A) may be completely inelastic (B) must be completely inelastic  
(C) may be partially inelastic (D) must be elastic

177. The phenomenon of emission of electron from hot bodies is called
- (A) thermionic emission                      (B) photoelectric emission  
(C) field emission                              (D) secondary emission
178. The diode is used as
- (A) an amplifier                                  (B) an oscillator  
(C) a rectifier                                    (D) a modulator
179. A water tap leaks such that water drops fall at regular intervals. Tap is fixed 5 m above the ground. First drop reaches the ground when 4<sup>th</sup> drop is about to leave the tap. Find the separation between 2<sup>nd</sup> and 3<sup>rd</sup> drop.
- (A) 2/3 m    (B) 4/3 m  
(C) 5/3 m    (D) None of the above
180. A cube of side 'a' is placed on an inclined plane of inclination  $\theta$ . What is the maximum value of  $\theta$  for which cube will not topple?
- (A) 15°    (B) 30°  
(C) 45°    (D) 60°
181. Two spherical soap bubbles of radii  $R_1$  and  $R_2$  combine under isothermal condition to form a single bubble. The radius of the resultant bubble is
- (A)  $R = \sqrt{R_1^2 + R_2^2}$                       (B)  $R = \sqrt{R_1 R_2}$   
(C)  $R = \frac{R_1 + R_2}{2}$                               (D)  $R = \sqrt{\frac{R_1^2 + R_2^2}{R_1^2 - R_2^2}}$
182. Variation of molar specific heat of a metal with temperature is best depicted by





190. In an npn transistor circuit, the collector current is 10mA. If 90% of the electrons emitted reach the collector, then
- (A) the emitter current will be 9 mA
  - (B) the emitter current will be 10mA
  - (C) the base current will be 1 mA
  - (D) the base current will be  $-1$  mA
191. When distance between two point charges (one positive and the other negative) is halved, then the electrostatic force between the charges will
- (A) increase two times
  - (B) decrease two times
  - (C) increase four times
  - (D) decrease four times
192. Two resistors of equal value are connected in series and the total resistance is  $R_{\text{series}}$ . When the same two resistors are connected in parallel then the total resistance is  $R_{\text{parallel}}$ . The ratio between  $R_{\text{series}}$  to  $R_{\text{parallel}}$  is
- (A) 2
  - (B) 3
  - (C) 4
  - (D) 6
193. When a simple pendulum bob is made to oscillate in water, then the time period will
- (A) increase
  - (B) decrease
  - (C) remain unchanged
  - (D) immediately come to rest
194. X-rays are used as a tool to study the properties of single crystals, since
- (A) X-ray energies are comparable with the crystal cohesive energy
  - (B) X-ray wavelengths are comparable with the crystal spacing
  - (C) X-rays are easily absorbed by the crystal
  - (D) X-rays are transparent to crystal
195. Oil is used for frying food materials rather than water, since oil
- (A) viscosity is high
  - (B) vapour pressure is high
  - (C) density is high
  - (D) boiling point is high
196. Mirage is the illusion of presence of water on the surface of earth. This is due to the
- (A) dispersion
  - (B) Rayleigh scattering
  - (C) total external reflection
  - (D) total internal reflection
197. The volume of a nucleus in an atom is proportional to its
- (A) mass number
  - (B) proton number
  - (C) neutron number
  - (D) electron number

198. Pitch of the sound depends on
- (A) loudness (B) quality  
(C) frequency (D) amplitude
199. Water is a
- (A) linear molecule (B) planar molecule  
(C) tetrahedral molecule (D) octahedral molecule
200. If the valence electrons exactly fill one or more bands, leaving others empty, then the crystal will be
- (A) insulator (B) conductor  
(C) semiconductor (D) metal

### CHEMISTRY

201. An alkene having the molecular formula  $C_9H_{18}$  on ozonolysis gives 2,2-dimethylpropanal and 2-butanone. The alkene is
- (A) 2,2,4-trimethyl-3-hexene (B) 2,2,6-trimethyl-3-hexene  
(C) 2,3,4-trimethyl-2-hexene (D) 2,2,4-trimethyl-2-hexene
202. The compound  $C_4H_{10}O$  can show
- (A) metamerism (B) function isomerism  
(C) position isomerism (D) all types
203. Which of the following is not aromatic?
- (A) Cyclopentadienyl cation (B) Cyclopentadienyl anion  
(C) Cycloheptatrienyl cation (D) Anthracene
204. Consider the following carbocations  
(a)  $Cl_3C^+$  (b)  $Cl_2CH^+$  (c)  $ClCH_2^+$  (d)  $CH_3^+$
- The stability sequence follows the order
- (A)  $(d) < (a) < (b) < (c)$  (B)  $(a) < (b) < (c) < (d)$   
(C)  $(d) < (a) < (c) < (b)$  (D)  $(d) < (b) < (a) < (c)$
205.  $CH_3CH(OH)COOH \xrightarrow{H_2O_2/Fe^{2+}}$  the product is?
- (A) pyruvic acid (B) propanoic acid  
(C)  $\alpha$ -hydroxy propanal (D) malonic acid
206. Allyl chloride on treatment with triethylamine, it gives

- (A) propadiene (B) propylene  
(C) allyl alcohol (D) acetone
207. Aldehydes or ketones react with  $\alpha$ -bromo esters and metallic zinc to yield
- (A)  $\delta$ -keto esters (B)  $\beta$ -keto alcohols  
(C)  $\beta$ -hydroxyl esters (D)  $\delta$ -hydroxyl esters
208. Reduction of cinnamic acid ( $\text{Ph.CH=CH.COOH}$ ) with  $\text{LiAlH}_4$  gives the following product
- (A)  $\text{Ph.CH}_2\text{CH}_2\text{COOH}$  (B)  $\text{Ph.CH=CH.CH}_2\text{OH}$   
(C)  $\text{Ph.CH}_2\text{CH}_2\text{CH}_2\text{OH}$  (D) None of the above
209. An example of alkane with least number of carbon atoms which is optically active is
- (A) 2-methylpentane (B) 3-methylpentane  
(C) 2-methylhexane (D) 3-methylhexane
210. Which of the following does not react with Fehlings solution?
- (A)  $\text{CH}_3\text{-CH}_2\text{-OH}$  (B)  $\text{CH}_3\text{-O-CH}_3$   
(C)  $\text{C}_6\text{H}_5\text{-CHO}$  (D) All of the above
211. In the sequence of the reaction, the final product is
- $$\text{CH}_3\text{-COOH} \xrightarrow{\text{HVZ reaction}} \text{Product} \xrightarrow{\text{SOCl}_2} \text{Product} \xrightarrow{\text{Excess NH}_3} \text{Final product?}$$
- (A)  $\text{ClCH}_2\text{-COONH}_4$  (B)  $\text{ClCH}_2\text{-CONH}_2$   
(C)  $\text{Cl}_2\text{CH-CONH}_2$  (D)  $\text{NH}_2\text{-CH}_2\text{-CONH}_2$
212. Which one of the following amines reacts with chloroform and alkali to give an isocyanide?
- (A)  $(\text{CH}_3)_2\text{NH}$  (B)  $(\text{C}_6\text{H}_5)_2\text{NH}$   
(C)  $\text{C}_6\text{H}_5\text{-NH}_2$  (D)  $(\text{C}_2\text{H}_5)_3\text{N}$
213. The reaction of carboxylic esters with Grignard reagents is an excellent method for preparing
- (A) aldehydes (B) alkanes  
(C) primary alcohols (D) tertiary alcohols
214. Which of the following on dehydration with  $\text{P}_2\text{O}_5$  will give ethanenitrile?
- (A) ethanol (B) ethanamide  
(C) propanamide (D) ethanol

215. Aniline was acetylated, then the resulting product on nitration followed by hydrolysis gives
- (A) o-nitro-acetanilide
  - (B) m-nitroaniline
  - (C) acetanilide
  - (D) a mixture of o-nitroaniline and p-nitroaniline
216. DNA molecules contain nitrogenous bases linked to other constituents of the molecule. Which of the following is not found in DNA?
- (A) guanidine
  - (B) thymine
  - (C) adenine
  - (D) guanine

217. The hydrogen ion concentration of a solution with pH value 3.69 is given by
- (A)  $2.042 \times 10^{-4}$  M (B)  $3.69 \times 10^{-2}$  M  
(C)  $4.31 \times 10^{-4}$  M (D) 0.369 M
218. Which of the following two gases can be cooled from room temperature by the Joule-Thomson effect?
- (A) Hydrogen and oxygen (B) Helium and nitrogen  
(C) Helium and hydrogen (D) Nitrogen and oxygen
219. Calculate the concentration of  $\text{H}_2\text{SO}_4$  when 10 mL of 0.2 M of  $\text{H}_2\text{SO}_4$  is added to 90 mL of  $\text{H}_2\text{O}$ .
- (A) 0.02 N (B) 0.04 M  
(C) 0.04 N (D) 0.002 M
220. The increase in internal energy of the system is 100 J when 300 J heat is supplied to it. What is the amount of work done by the system?
- (A) -200 J (B) +200 J  
(C) -300 J (D) -400 J
221. The efficiency of a heat engine is given by
- (A)  $\frac{W}{q_2} = \frac{T_2 - T_1}{T_2}$  (B)  $\frac{W}{q_2} = \frac{T_1 - T_2}{T_2}$   
(C)  $\frac{W}{q_2} = \frac{T_2 - T_1}{T_1}$  (D)  $\frac{W}{q_2} = \frac{T_1 - T_2}{T_1}$
222. A metallic element has a cubic lattice. Each edge of the unit cell is  $2 \text{ \AA}$ . The density of the metal is  $2.5 \text{ g cm}^{-3}$ . The unit cells in 200g of the metal are
- (A)  $1 \times 10^{25}$  (B)  $1 \times 10^{24}$   
(C)  $1 \times 10^{22}$  (D)  $1 \times 10^{20}$
223. The hydrogen electrode is dipped in a solution of pH = 3 at  $25^\circ\text{C}$ , the potential of the cell would be (the value of  $\frac{2.303 RT}{F} = 0.059 \text{ V}$ )
- (A) +0.177 V (B) -0.177 V  
(C) +0.087 V (D) +0.
224. To protect iron against corrosion the most durable metal plating on it is
- (A) Tin plating (B) Copper plating  
(C) Zinc plating (D) Nickel plating

225. The half-life of a first order reaction
- (A) depends on the reactant concentration raised to the first power
  - (B) is inversely proportional to the square of the reactant concentration
  - (C) is inversely proportional to the reactant concentration
  - (D) is totally independent of the reactant concentration
226. The pH of the blood is maintained by buffer system given by
- (A) NaCl and HCl
  - (B)  $\text{NH}_4\text{Cl}$  and  $\text{NH}_4\text{OH}$
  - (C) Sodium citrate and citric acid
  - (D)  $\text{HCO}_3^-$  and  $\text{H}_2\text{CO}_3$
227. Which of the following sets of conditions makes a process spontaneous at all temperatures?
- (A)  $\Delta H = 0; \Delta S > 0$
  - (B)  $\Delta H = 0; \Delta S < 0$
  - (C)  $\Delta H > 0; \Delta S > 0$
  - (D)  $\Delta H < 0; \Delta S > 0$
228. How many Bravais lattices are possible in a crystal?
- (A) 23
  - (B) 7
  - (C) 230
  - (D) 14
229. The Clausius-Clayperon equation helps to calculate
- (A) Latent heat of vaporization
  - (B) Melting point of the solvent
  - (C) Heat of neutralization
  - (D) Molecular weight of solute
230. The solubility 's' of a sparingly soluble salt is related to its equivalent conductance at infinite dilution by the relation (k in specific conductance)
- (A)  $s = \frac{k \times 1000}{\lambda_{\infty} - \lambda}$
  - (B)  $s = \frac{c \times 1000}{\lambda_{\infty} - \lambda}$
  - (C)  $s = \frac{k \times 1000}{\lambda_{\infty}}$
  - (D)  $s = \frac{c \times 1000}{\lambda_{\infty}}$
231. Electrical conductivity of an electrolyte depends upon
- (A) the number of molecules in the electrolytes
  - (B) the number of ions present in the electrolytes
  - (C) the number of charges carried by the ions
  - (D) the number of ions present in the solution and the number of charges carried by the ions
232. The energy of an electron in an orbital depends on
- (A) n
  - (B) n, l
  - (C) n, l, m
  - (D) n, l, m,  $m_s$

233. In the atomic spectrum of H, lines were observed at  $\frac{5}{36}R$ ,  $\frac{3}{16}R$ ,  $\frac{21}{100}R$  and  $\frac{2}{9}R$  (R=Rydberg constant). It belongs to ..... series.
- (A) Lyman (B) Balmer  
(C) Paschen (D) Pfund
234. Out of the oxides given below which of them cannot be reduced by  $H_2$  ?  
I -  $Al_2O_3$  ; II -  $CuO$  ; III -  $ZnO$
- (A) Only I (B) I and II  
(C) I, II, III (D) III and II
235. In diamond the bonds present are
- (A) ionic and covalent (B) covalent dative  
(C) covalent only (D) electrovalent dative
236. A mixture of 3g of sulphur and 12.7g of copper was placed in a quartz tube. The tube was sealed under vacuum and then heated to the melting. The cooled tube contains
- (A) copper(I) sulphide  
(B) mixture of copper (I) sulphide and copper  
(C) mixture of sulphur and copper  
(D) mixture of copper(I) sulphide and sulphur
237. Which of the following oxide cannot be used as reducing agent?
- (A)  $SO_2$  (B)  $NO_2$   
(C)  $CO_2$  (D)  $ClO_2$
238. Which of the following metal is the most abundant in the Earth's crust?
- (A) Mg (B) Na  
(C) Ca (D) K
239. Which of the following is used as antacid in medicine?
- (A) Milk of magnesium (B) Milk of lime  
(C) Lime water (D) Baryta
240. Which of the following has the lowest melting point?
- (A) Lithium (B) Potassium  
(C) Sodium (D) Cesium

241. Which nitrogen trihalide is least basic?
- (A)  $\text{NF}_3$  (B)  $\text{NBr}_3$   
(C)  $\text{NCl}_3$  (D)  $\text{NI}_3$
242. Deep sea divers use the following mixture for respiration
- (A) Oxygen and nitrogen (B) Oxygen and argon  
(C) Oxygen and hydrogen (D) Oxygen and helium
243. Symmetric intermolecular hydrogen bonding is shown by which of the following compound?
- (A)  $\text{HF}_2$  (B)  $(\text{HF})_n$   
(C) Ice (D)  $\text{H}_3\text{BO}_3$
244. Which one of the following element do not occur in nature?
- (A) Mo (B) Re  
(C) Tc (D) Pr
245. Hybridization of iron in  $\text{K}_3[\text{Fe}(\text{CN})_6]$
- (A)  $\text{sp}^3$  (B)  $\text{dsp}^3$   
(C)  $\text{sp}^3\text{d}^2$  (D)  $\text{d}^2\text{sp}^3$
246. Predict the element resulting from two  $\alpha$  decay, two consecutive  $\beta$  decay and one  $\gamma$  decay of Th-232
- (A) Ra (B) Po  
(C) Th (D) Rn
247. The blue colour produced when a starch solution is added to a solution containing traces of  $\text{I}_2$  and KI is due to
- I) formation of  $\text{I}_3^-$  II) formation of an inclusion complex  
III) Oxidation of starch IV) Oxidation of  $\text{I}_2$
- (A) I and II (B) I and III  
(C) II and III (D) II and IV
248.  $\text{XeF}_6$  reacts with KF to give
- (A)  $\text{K}[\text{XeF}_6]$  (B)  $[\text{XeF}_5]^+[\text{KF}_2]^-$   
(C)  $[\text{XeF}_4]^{2+}[\text{KF}_3]^{2-}$  (D)  $\text{XeF}_4$
249. Which of the following is not a target molecule for drug function in the body?
- (A) Carbohydrate (B) Lipid  
(C) Vitamins (D) Proteins

250. How do d orbitals split in a square planar crystal field?

- (A)  $dx^2 - y^2 \rangle dxy \rangle dxz = dyz \rangle dz^2$
- (B)  $dx^2 - y^2 \rangle dxy \rangle dz^2 \rangle dxz = dyz$
- (C)  $dx^2 - y^2 \rangle dz^2 \rangle dxy \rangle dxz = dyz$
- (D)  $dx^2 - y^2 = dz^2 \rangle dxy = dxz = dyz$

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**MATHEMATICS (UG) Final (Shift I)**  
**(Corrected questions for image)**

4. Two distinct polynomials  $f(x)$  and  $g(x)$  are defined by  
 $f(x) = x^2 + ax + 2$  and  $g(x) = x^2 + 2x + a$ . If the equations  $f(x) = 0$  and  $g(x) = 0$  have a common root then the sum of the roots of the equation  $f(x) = 0 + g(x) = 0$  is
- (A)  $-\frac{1}{2}$  (B) 0  
(C)  $\frac{1}{2}$  (D) 1
10. If the three points  $A(1,6)$ ,  $B(3,-4)$  and  $C(x,y)$  are collinear, then the equation satisfying by  $x$  and  $y$  is
- (A)  $5x + y - 11 = 0$  (B)  $5x + 13y + 5 = 0$   
(C)  $5x - 13y + 5 = 0$  (D)  $13x - 5y + 5 = 0$
13. From a circular disk of radius 13 cm a sector is cut with centre angle  $\theta$ . If the height of the right circular cone formed using the above sector is 12 cm, then the  $\theta$  is
- (A)  $\frac{10\pi}{13}$  (B)  $\frac{9\pi}{13}$   
(C)  $\frac{5\pi}{13}$  (D)  $\frac{6\pi}{13}$
15. If  $p$  and  $q$  are coefficients of  $x^n$  in the expansions of  $(1+x)^{2n}$  and  $(1+x)^{2n-1}$  respectively, then  $\frac{p}{q}$  is equal to
- (A) 4 (B) 1  
(C) 9 (D) 2

18. There are 30 questions in a multiple choice test. A student gets 1 mark for each unanswered question, 0 marks for each wrong answer and 4 marks for each correct answer. A student answered  $x$  questions correctly and scored 60 marks. Then the number of possible values of  $x$  is

- (A) 15 (B) 10  
(C) 6 (D) 5

26. Let  $I$  denote the  $3 \times 3$  identity matrix and  $P$  be a matrix obtained by rearranging the columns of  $I$ . Then

- (A) there are six distinct choices for  $P$  and  $\det(P) = 1$   
(B) there are six distinct choices for  $P$  and  $\det(P) = \pm 1$   
(C) there are more than one choices for  $P$  and some of them are not invertible  
(D) there are more than one choices for  $P$  and  $P^{-1} = I$  in each choice

33. Let  $\mathbf{R}$  be the set of all real numbers and  $f : [-1, 1] \rightarrow \mathbf{R}$  be defined by

$$f(x) = \begin{cases} x \sin \frac{1}{x}, & x \neq 0 \\ 0, & x = 0 \end{cases}$$

- (A)  $f$  satisfies the conditions of Rolle's theorem on  $[1, 1]$   
(B)  $f$  satisfies the conditions of Lagrange's Mean Value Theorem on  $[1, 1]$   
(C)  $f$  satisfies the conditions of Rolle's theorem on  $[0, 1]$   
(D)  $f$  satisfies the conditions of Lagrange's Mean Value Theorem on  $[0, 1]$

46. Consider the function defined by  $f(x) = \begin{cases} \frac{\sin x^2}{x} & \text{when } x < 0; \\ x^2 + ax + b & \text{when } x \geq 0. \end{cases}$

Suppose  $f(x)$  is differentiable on  $\mathbf{R}$ , then

- (A)  $a = 0, b = 0$  (B)  $a = 1, b = 0$   
(C)  $a = 0, b = 1$  (D)  $a = 1, b = 1$

47. If  $f(x) = \begin{cases} x^3 & x \geq 1 \\ ax^2 + bx + c & x < 1 \end{cases}$  where  $a, b$  and  $c$  are constants such that  $f(x)$  has second derivative at  $x = 1$ . Then  $a$  equals

- (A)  $-6$  (B)  $-3$   
(C)  $6$  (D)  $3$

48. A coin is tossed five times. If the outcomes are 2 heads and 3 tails (in same order), then what is the possibility that the fourth toss is a head?

- (A)  $\frac{1}{4}$  (B)  $\frac{2}{5}$   
(C)  $\frac{1}{2}$  (D)  $\frac{3}{5}$

85. If  $f(x) \cdot f\left(\frac{1}{x}\right) = f(x) + f\left(\frac{1}{x}\right)$  and  $f(4) = 65$ , then  $f(6)$  is

- (A)  $65$  (B)  $217$   
(C)  $215$  (D)  $64$

102. For  $\frac{2^2 + 4^2 + \dots + (2n)^2}{1^2 + 3^2 + \dots + (2n-1)^2}$  to exceed 1.01, the maximum value of  $n$  is

- (A)  $99$  (B)  $100$   
(C)  $101$  (D)  $150$

109. The system of equations  $x + \frac{2}{3}y + \frac{1}{3}z = 0$ ,  $y + 2z = 0$ ,  $x + \frac{4}{3}y + \frac{5}{3}z = 0$  possesses

- (A) no solution (B) only trivial solution  
(C) infinite non-trivial solutions (D) one non-trivial solution

116. Coordinates of the points on the line  $\frac{x+2}{3} = \frac{y+1}{2} = \frac{z-3}{2}$  at a distance 5 units from the point  $(1,3,3)$

- (A)  $(3,7,4)$                       (B)  $(7,4,3)$   
     $(-2,-1,3)$                     (C)  $(2,-1,3)$
- (C)  $(4,3,7)$                       (D)  $(1,0,1)$   
     $(-2,-1,3)$                     (E)  $(-2,1,3)$

117. Geetha and Somu appear for an interview for two vacancies in a company. The probability of Geetha's selection is  $\frac{1}{5}$  and Somu is  $\frac{1}{6}$ . Then the probability that (i) both of them are selected (ii) both of them are not selected are respectively

- (A)  $\frac{1}{30}, \frac{2}{5}$                       (B)  $\frac{1}{30}, \frac{2}{3}$
- (C)  $\frac{7}{30}, \frac{2}{5}$                       (D)  $\frac{7}{30}, \frac{2}{3}$

118. The set of homogenous equations  $tx + (t+1)y + (t-1)z = 0$ ,  $(t+1)x + ty + (t+2)z = 0$ ,  $(t-1)x + (t+2)y + tz = 0$  has non-trivial solutions for

- (A) three values of  $t$                       (B) two values of  $t$   
(C) one value of  $t$                       (D) no value of  $t$

119. The points  $(0, 8/3)$ ,  $(1,3)$  and  $(82,30)$

- (A) form an obtuse angled triangle  
(B) form an acute angled triangle  
(C) form a right angled triangle  
(D) lie on a straight line

122. The solution of the differential equation  $e^{\frac{dy}{dx}} = x+1$  when  $y(0) = 3$  is

