

## MATHEMATICS

1. Solution set of  $\log_3(x^2 - 2) < \log_3\left(\frac{3}{2}|x| - 1\right)$  is
- A.  $(-3, \sqrt{3}) \cup (\sqrt{3}, 3)$
  - B.  $(-2, -\sqrt{2}) \cup (\sqrt{2}, 2)$
  - C.  $(-2, -\sqrt{2})$
  - D.  $(-\sqrt{2}, 2)$
2. The function  $f: \mathbb{R} \rightarrow \mathbb{R}$  defined by  $f(x) = x|x|$  will be
- A. many-to-one and onto
  - B. one-to-one and onto
  - C. many-to-one and into
  - D. one-to-one and into
3. Solution of  $\left|1 + \frac{3}{x}\right| > 2$  is
- A.  $(0, 3)$
  - B.  $[-1, 0)$
  - C.  $(-1, 0) \cup (0, 3)$
  - D.  $(-2, 0) \cup (0, 3)$

4. Let  $p(x)$  be a polynomial in the real variable  $x$  of degree 5. Then  $\lim_{x \rightarrow \infty} \frac{p(x)}{2^x}$  is
- A. 5
  - B. 1
  - C. 0
  - D.  $\infty$
5. If the periods of the periodic functions  $\sin ax + \cos ax$  and  $|\sin x| + |\cos x|$  are equal, then  $a$  is equal to
- A. 0
  - B. 1
  - C. 2
  - D. 4
6. If  $x, y, z$  are three positive real numbers such that  $|x - y| \geq z$ ,  $|y - z| \geq x$ ,  $|z - x| \geq y$ , then
- A.  $x + y > z$
  - B.  $x + y < z$
  - C.  $x + y = z$
  - D.  $x + y + z = 0$
7.  $\cos\left(i \log \frac{a - ib}{a + ib}\right)$  is equal to
- A.  $ab$
  - B.  $\frac{a^2 - b^2}{a^2 + b^2}$
  - C.  $\frac{a^2 - b^2}{2ab}$
  - D.  $\frac{2ab}{a^2 + b^2}$



8. The equation  $z\bar{z} + a\bar{z} + \bar{a}z + b = 0$  represents a circle if
- A.  $|a|^2 = b$
  - B.  $|a|^2 > b$
  - C.  $|a|^2 < b$
  - D.  $a^2 = b$
9. If a function  $f: [2, \infty) \rightarrow B$  defined by  $f(x) = x^2 - 4x + 5$  is a bijection, then  $B$  is equal to
- A.  $\mathbb{R}$ , the set of all real numbers
  - B.  $[1, \infty)$
  - C.  $[4, \infty)$
  - D.  $[5, \infty)$
10. The area of the triangle formed by the complex numbers  $z$ ,  $iz$  and  $z + iz$  on the complex plane is
- A.  $|z|^2$
  - B.  $|\bar{z}|^2$
  - C.  $\frac{1}{2}|z|^2$
  - D.  $|z|$
11. If  $\omega (\neq 1)$  is a cubic root of unity and  $(1 + \omega^2)^n = (1 + \omega^4)$ , then the least positive value of  $n$  is
- A. 2
  - B. 3
  - C. 6
  - D. 5

12. Let  $A, B$  be two  $n \times n$  matrices such that  $BA = B^2 = I - BA^2$  where  $I$  is the  $n \times n$  identity matrix. Then
- A.  $A$  is non-singular
  - B.  $B$  is non-singular
  - C.  $A + B$  is non-singular
  - D.  $AB$  is non-singular
13. If the system of equations  $x - ky - z = 0$ ,  $kx - y - z = 0$ ,  $x + y - z = 0$  has a non-zero solution, then possible values of  $k$  are
- A.  $-1, 2$
  - B.  $1, 2$
  - C.  $0, 1$
  - D.  $-1, 1$
14. 5 books of Mathematics and 3 books of Physics are placed on a shelf so that the books on the same subject always remain together. The possible number of arrangements are
- A. 1440
  - B. 1956
  - C. 720
  - D. 15
15. If  $\sum_{n=1}^{\infty} \frac{1}{n^4} = \frac{\pi^2}{90}$ , then  $\sum_{n=1}^{\infty} \frac{1}{(2n-1)^4} =$
- (A)  $\frac{\pi^2}{45}$
  - (B)  $\frac{\pi^2}{91}$
  - (C)  $\frac{89\pi^2}{95}$
  - (D)  $\frac{\pi^2}{96}$

16. If  $y = a^{x^{a^{x^{\dots}}}}$ , then  $\frac{dy}{dx} =$
- (A)  $\frac{y^2 a^x}{(1 - xy \log a)}$
- (B)  $\frac{y^2 \log a}{x(1 - xy \log a)}$
- (C)  $\frac{y^2 \log a}{(1 - xy \log a)}$
- (D)  $\frac{xy^2 \log a}{a^x (1 - y \log a)}$
17. A line is inclined at  $60^\circ$  with the  $x$ -axis and  $45^\circ$  with the  $y$ -axis. Then its inclination with  $z$ -axis is
- A.  $30^\circ$
- B.  $45^\circ$
- C.  $60^\circ$
- D.  $90^\circ$
18. The centre of the sphere  $(x+5)(x-5) + (y-2)(y+2) + (z-3)(z+3) = 0$  is
- A.  $(-3, 2, 3)$
- B.  $(2, -2, -3)$
- C.  $(0, 0, 0)$
- D.  $(1, 2, 3)$
19. The last two digits of  $7^{81}$  are
- A. 07
- B. 17
- C. 37
- D. 47

20. Let  $M = \{(a_1, a_2, a_3) : a_i \in \{1, 2, 3, 4\}, a_1 + a_2 + a_3 = 6\}$ . Then the number of elements in  $M$  is
- A. 8  
B. 9  
C. 10  
D. 12
21. The differential equation, whose linearly independent solutions are  $\cos 2x, \sin 2x, e^{-x}$ , is
- A.  $(D^3 + D^2 + 4D + 4)y = 0$   
B.  $(D^3 - D^2 + 4D - 4)y = 0$   
C.  $(D^3 + D^2 - 4D - 4)y = 0$   
D.  $(D^3 - D^2 - 4D + 4)y = 0$
22. If the circle  $x^2 + y^2 = a^2$  and the curve  $xy = 1$  intersect at four points, then the product of the ordinates of these points is
- A. 0  
B.  $a$   
C.  $a^2$   
D. 1
23. The acute angle bisector between the lines  $2x - y + 4 = 0$  and  $x - 2y - 1 = 0$  is
- A.  $x + y + 5 = 0$   
B.  $x - y + 1 = 0$   
C.  $x - y - 5 = 0$   
D.  $x - y - 1 = 0$

24. For which value of  $x$ ,  $\sin[\cot^{-1}(x+1)] = \cos(\tan^{-1}x)$ ?
- A.  $\frac{1}{2}$   
B. 0  
C. 1  
D.  $-\frac{1}{2}$
25. The number of digits in  $2^{17} \times 3^2 \times 5^{14} \times 7$  is
- A. 14  
B. 15  
C. 16  
D. 17
26. In solving a quadratic equation of the form  $x^2 + ax + b = 0$ , one student took the wrong value of  $a$  and got the roots as 6 and 2; while another student took the wrong value of  $b$  and got the roots as 6 and 1. What are the correct values of  $a$  and  $b$ , respectively?
- A. 7 and 12  
B. 3 and 4  
C. -7 and 12  
D. 8 and 12
27. What is the arithmetic mean of  $\frac{1}{1 \times 2}, \frac{1}{2 \times 3}, \frac{1}{3 \times 4}, \frac{1}{4 \times 5}, \dots, \frac{1}{100 \times 101}$ ?
- A. 0.01  
B.  $\frac{\frac{1}{49 \times 50} + \frac{1}{50 \times 51}}{2}$   
C. 0.00111...  
D.  $\frac{1}{101}$

28. The slope of the tangent to the ellipse  $\frac{x^2}{225} + \frac{y^2}{625} = 1$  at  $\theta = \frac{\pi}{4}$  is
- A.  $5/3$
  - B.  $3/5$
  - C.  $-5/3$
  - D.  $-3/5$
29. If  $f(x)$  is a linear function of  $x$  and  $f(1) = 5$ , then  $\sum_{x=1}^n f(x)$  is
- A.  $\frac{5}{2}n(n-1)$
  - B.  $\frac{5n(n+1)}{2}$
  - C.  $5n(n+1)$
  - D.  $n(n-1)$
30. For real  $x$ , let  $f(x) = x^3 + 5x + 1$ , then
- A.  $f$  is onto on  $\mathbb{R}$  but not one-one
  - B.  $f$  is one-one but not onto on  $\mathbb{R}$
  - C.  $f$  is neither one-one nor onto on  $\mathbb{R}$
  - D.  $f$  is one-one and onto on  $\mathbb{R}$
31. The complex numbers  $\sin x + i \cos 2x$  and  $\cos x - i \sin 2x$  are conjugate to each other, when
- A.  $x = n\pi$
  - B.  $x = \left(n + \frac{1}{2}\right)\pi$
  - C.  $x = 0$
  - D. for no  $x$

32. If the cube roots of unity are  $1, \omega, \omega^2$ , then the roots of the equation  $(x-1)^3 + 8 = 0$  are
- A.  $-1, -1+2\omega, -1-2\omega^2$   
 B.  $-1, -1, -1$   
 C.  $-1, 1-2\omega, 1-2\omega^2$   
 D.  $-1, 1+2\omega, 1+2\omega^2$
33. The number of real roots of the equation  $3x^9 + 5x^7 + 9x^3 + 2x - 270 = 0$  is
- A. 9  
 B. 7  
 C. 1  
 D. more than one
34. If  $\alpha$  and  $\beta$  are the roots of  $x^2 - (a-2)x - (a+1) = 0$  where  $a$  is a variable, then the least value of  $\alpha^2 + \beta^2$  is
- A. 2  
 B. -1  
 C. 1  
 D. 5
35. 
$$\begin{vmatrix} -a^2 & ab & ac \\ ab & -b^2 & bc \\ ac & bc & -c^2 \end{vmatrix} =$$
- A.  $a^2b^2c^2$   
 B. 0  
 C.  $4a^2b^2c^2$   
 D.  $2a^2b^2c^2$

36. If  $A$  and  $B$  are two  $n \times n$  square matrices such that  $A^2 - B^2 = (A+B)(A-B)$ , then which of the following will always be true?
- A. either  $A$  or  $B$  is a zero matrix
  - B. either  $A$  or  $B$  is an identity matrix
  - C.  $A = B$
  - D.  $AB = BA$
37. The system of equations
- $$\begin{aligned}x + 2y + z &= 3 \\ 2x + 3y + z &= 3 \\ 3x + 5y + 2z &= 1\end{aligned}$$
- possesses
- A. infinite number of solutions
  - B. exactly three solutions
  - C. a unique solution
  - D. no solution
38. In a plane there are 37 straight lines of which 13 pass through the point A and 11 pass through the point B. Besides no three lines pass through the same point and no line passes through both points A and B. If no two lines are parallel, then the number of points of interaction of these lines is
- A. 535
  - B. 728
  - C. 407
  - D. 601
39. If  $2^3 + 4^3 + 6^3 + \dots + (2n)^3 = kn^2(n+1)^2$ , then  $k =$
- A. 1
  - B. 2
  - C. 4
  - D. 6

40. The coefficient of  $x^n$  in the expansion  $(1+x)(1-x)^n$  is
- A.  $(n-1)$   
 B.  $(-1)^{n-1}n$   
 C.  $(-1)^{n-1}n(n-1)$   
 D.  $(-1)^n(1-n)$
41. If  $ab \neq 0$  and the sum of the coefficients of  $x^7$  and  $x^4$  in the expansion of  $\left(\frac{x^2}{a} - \frac{b}{x}\right)^{11}$  is zero, then
- A.  $a = b$   
 B.  $a + b = 0$   
 C.  $ab = -1$   
 D.  $ab = 1$
42. Statement 1  
 Sum of the series  
 $1 + (1+2+4) + (4+6+9) + (9+12+16) + \dots + (361+380+400)$  is 8000
- Statement 2  
 $\sum_{k=1}^n [k^3 - (k-1)^3] = n^3$ , for any natural number  $n$ . Then
- A. Statement 1 is true, Statement 2 is true, Statement 2 is a correct explanation for Statement 1  
 B. Statement 1 is true, Statement 2 is false  
 C. Statement 1 is false, Statement 2 is true  
 D. Statement 1 is true, Statement 2 is true, Statement 2 is not a correct explanation for Statement 1

43. Let  $T_r$  be the  $r^{\text{th}}$  term of an A.P whose first term is  $a$  and common difference is  $d$ . If, for some positive integers  $m, n$  such that  $m \neq n$ ,  $T_m = \frac{1}{n}$  and  $T_n = \frac{1}{m}$ , then  $a - d =$
- A.  $\frac{1}{mn}$   
B. 0  
C.  $\frac{1}{m+n}$   
D.  $\frac{1}{m} + \frac{1}{n}$
44. Let  $f(x)$  be a second degree polynomial function. If  $f(1) = f(-1)$  and  $a, b, c$  are in A.P., then  $f'(a), f'(b), f'(c)$  are in
- A. A.P  
B. G.P  
C. H.P  
D. neither A.P., G.P. nor H.P.
45.  $\lim_{x \rightarrow 0} \frac{\sqrt{1 - \cos 2x}}{\sqrt{2x}}$  is
- A.  $\frac{1}{\sqrt{2}}$   
B. does not exist  
C. 1  
D. -1

46. Let  $f(x) = \begin{cases} (x-1)\sin\left(\frac{1}{x-1}\right) & \text{if } x \neq 1 \\ 0 & \text{if } x = 1 \end{cases}$ .

Then

- A.  $f$  is differentiable at both  $x = 0$  and  $x = 1$
  - B.  $f$  is differentiable at  $x = 0$  but not at  $x = 1$
  - C.  $f$  is differentiable at  $x = 1$  but not at  $x = 0$
  - D.  $f$  is neither differentiable at  $x = 0$  nor at  $x = 1$
47. The curve  $y - e^{xy} + x = 0$  has a vertical tangent at the point
- A. (1,1)
  - B. (0,0)
  - C. (0,1)
  - D. (1,0)
48. A function  $y = f(x)$  has a second order derivative  $f''(x) = 6(1-x)$ . If it passes through the point (2,1) and at that point the tangent to it is  $y = 3x - 5$ , then the function  $f(x)$  is
- A.  $(x-1)^2$
  - B.  $(x+1)^2$
  - C.  $(x-1)^3$
  - D.  $(x+1)^3$

49. The function  $f(x) = \frac{x}{2} + \frac{2}{x}$  has a local maximum at
- A.  $x = 0$
  - B.  $x = 1$
  - C.  $x = 2$
  - D.  $x = -2$
50. If  $2a + 3b + 6c = 0$ , then at least one root of the equation  $ax^2 + bx + c = 0$  lies in the interval
- A.  $(0,1)$
  - B.  $(1,3)$
  - C.  $(2,3)$
  - D.  $(1,2)$
51. The value of  $I = \int_0^{\pi/2} \frac{(\sin x + \cos x)^2}{\sqrt{1 + \sin 2x}} dx$  is
- A. 0
  - B. 3
  - C. 2
  - D. 1

52.  $\int_{-2}^3 |1-x^2| dx =$

A.  $\frac{28}{3}$

B.  $\frac{1}{3}$

C.  $\frac{7}{3}$

D.  $\frac{14}{3}$

53. The area enclosed between the curves  $y^2 = x$  and  $y = |x|$  is

A.  $\frac{2}{3}$

B. 1

C.  $\frac{1}{6}$

D.  $\frac{1}{3}$

54. The area of the region bounded by the curves  $y = x^2$  and  $y = \frac{2}{1+x^2}$  is

A.  $\pi - \frac{2}{3}$

B.  $\pi + \frac{2}{3}$

C.  $\frac{\pi}{3}$

D.  $\frac{2\pi}{3}$

55. One of the values of  $\left(\frac{1+i}{\sqrt{2}}\right)^{\frac{2}{3}}$  is
- A.  $\sqrt{3} + i$
  - B.  $-i$
  - C.  $i$
  - D.  $-\sqrt{3} + i$
56. The sum of positive terms of the series  $10 + 9\frac{4}{7} + 9\frac{1}{7} + \dots$  is
- A.  $\frac{352}{7}$
  - B.  $\frac{437}{7}$
  - C.  $\frac{842}{7}$
  - D.  $\frac{852}{7}$
57. The sum of the series  $(1+2) + (1+2+2^2) + (1+2+2^2+2^3) + \dots$  upto  $n$  terms, is
- A.  $2^{n+2} - n - 4$
  - B.  $2(2^n - 1) - n$
  - C.  $2^{n+2} - n$
  - D.  $2^{n+2} - 1$

58. If the sum of  $n$  terms of two arithmetic series are in the ratio  $2n+3:6n+5$ , then the ratio of their 13<sup>th</sup> terms is
- A. 53 : 155
  - B. 27 : 87
  - C. 29 : 83
  - D. 31 : 89
59. The equation  $\sqrt{x+3-4\sqrt{x-1}} + \sqrt{x+8-6\sqrt{x-1}} = 1$  has
- A. no solution
  - B. unique solution
  - C. two solutions
  - D. more than two solutions
60. If  $ab = 2a + 3b$ ,  $a > 0$ ,  $b > 0$ , then the minimum value of  $ab$  is
- A. 6
  - B. 12
  - C. 24
  - D. 48
61. The number of real roots of the equation  $x^4 + \sqrt{x^4 + 20} = 22$  is
- A. 4
  - B. 2
  - C. 0
  - D. 1

62. If the roots of the equations  $px^2 + 2qx + r = 0$  and  $qx^2 - 2\sqrt{pr}x + q = 0$  are real, then
- A.  $p = q$
  - B.  $q^2 = pr$
  - C.  $p^2 = qr$
  - D.  $r^2 = pq$
63. If  $\alpha + \beta = -2$  and  $\alpha^3 + \beta^3 = -56$ , then the quadratic equation whose roots are  $\alpha$  and  $\beta$  is
- A.  $x^2 + 2x - 16 = 0$
  - B.  $x^2 + 2x + 15 = 0$
  - C.  $x^2 + 2x - 12 = 0$
  - D.  $x^2 + 2x - 8 = 0$
64. Let  $A = \{x \mid x \text{ is a prime and } x < 30\}$ . The number of different rational numbers whose numerator and denominator belong to  $A$  is
- A. 45
  - B. 46
  - C. 90
  - D. 91
65.  $n$  lines are drawn in a plane such that no two of them are parallel and no three of them are concurrent. Then the number of different points at which these lines will intersect is
- A.  $\sum_{k=1}^n k$
  - B.  $n(n+1)$
  - C.  $n(n-1)$
  - D.  $n^2$

66. The set  $S = \{1, 2, 3, \dots, 12\}$  is to be partitioned into three sets  $A, B, C$  of equal size. That is,  $A \cup B \cup C = S$ ,  $A \cap B = B \cap C = A \cap C = \phi$ . The number of ways of partitions of  $S$  is
- A.  $\frac{12!}{3!(4!)^3}$
- B.  $\frac{12!}{3!(3!)^4}$
- C.  $\frac{12!}{(4!)^3}$
- D.  $\frac{12!}{(3!)^4}$
67. How many numbers of 6 digits can be formed from the digits of the number 112233 ?
- A. 30
- B. 60
- C. 90
- D. 120
68. Out of 6 boys and 4 girls, a group of 7 is to be formed. In how many ways can this be done, if the group is to have a majority of boys?
- A. 120
- B. 80
- C. 90
- D. 100
69. If the third term in the expansion of  $(x + x^{\log_{10} x})^5$  is  $10^6$ , then  $x$  must be
- A. 1
- B.  $\sqrt{10}$
- C. 10
- D.  $10^{\frac{3}{5}}$

70. The value of  $\sum_{0 \leq i \leq j \leq n} i \binom{n}{j}$  is equal to

A.  $n(n+1).2^{n-3}$

B.  $n^2.2^{n-3}$

C.  $n(n-1).2^{n-3}$

D.  $n(n-2).2^{n-3}$

71. If one of the roots of the equation  $\begin{vmatrix} 7 & 6 & x \\ 2 & x & 2 \\ x & 3 & 7 \end{vmatrix} = 0$  is  $x = -9$ , then the other roots are

A.  $\{2, 6\}$

B.  $\{3, 6\}$

C.  $\{2, 7\}$

D.  $\{3, 7\}$

72. If  $A = \begin{bmatrix} 1 & -1 & x \\ 1 & x & 1 \\ x & -1 & 1 \end{bmatrix}$  has no inverse, then the real value of  $x$  is

A. 2

B. 3

C. 0

D. 1

73. The number of points on the line  $x + y = 4$  which are at unit distance apart from the line  $2x + 2y = 5$  is
- A. 0
  - B. 1
  - C. 2
  - D.  $\infty$
74. A straight line through the point  $(2, 2)$  intersects the lines  $\sqrt{3}x + y = 0$  and  $\sqrt{3}x - y = 0$  at the points  $A$  and  $B$ . The equation to the line  $AB$  so that the  $\Delta OAB$  is equilateral, is
- A.  $x - 2 = 0$
  - B.  $y - 2 = 0$
  - C.  $x + y - 4 = 0$
  - D.  $x + y + 4 = 0$
75. The inverse of the point  $(1, 2)$  with respect to the circle  $x^2 + y^2 - 4x - 6y + 9 = 0$  is
- A.  $\left(1, \frac{1}{2}\right)$
  - B.  $(2, 1)$
  - C.  $(0, 1)$
  - D.  $(1, 0)$
76. If the points  $(2, 0), (0, 1), (4, 5)$  and  $(0, c)$  are con-cyclic, then the value of  $c$  is
- A. 1
  - B.  $\frac{14}{3}$
  - C. 5
  - D. -5

77. The greatest distance of the point  $P(10,7)$  from the circle  $x^2 + y^2 - 4x - 2y - 20 = 0$ , is
- A. 5
  - B. 10
  - C. 15
  - D. 0
78. If  $2x + 3y + 12 = 0$  and  $x - y + 4\lambda = 0$  are conjugates with respect to the parabola  $y^2 = 8x$ , then  $\lambda$  is equal to
- A. 2
  - B. -2
  - C. 3
  - D. -3
79. The number of values of  $c$  such that the line  $y = 4x + c$  touches the curve  $\frac{x^2}{4} + y^2 = 1$ , is
- A. 0
  - B. 1
  - C. 2
  - D.  $\infty$
80. If  $f(x) = |\cos x - \sin x|$ , then  $f'\left(\frac{\pi}{4}\right)$  is equal to
- A.  $\sqrt{2}$
  - B.  $-\sqrt{2}$
  - C. 0
  - D. does not exist

81. If  $\sin^{-1}x + \sin^{-1}y = \frac{\pi}{2}$ , then  $\frac{dy}{dx} =$

A.  $\frac{x}{y}$

B.  $-\frac{x}{y}$

C.  $\frac{y}{x}$

D.  $-\frac{y}{x}$

82. If  $x^x y^y z^z = c$ , then  $\frac{\partial z}{\partial x}$  is equal to

A.  $-\frac{1+\log x}{1+\log z}$

B.  $\frac{1+\log x}{1+\log z}$

C.  $\frac{1+\log z}{1+\log x}$

D.  $\frac{1+\log y}{1+\log x}$

83. Let  $f: \mathbb{R} \rightarrow \mathbb{R}$  be given by  $f(x) = (x+1)^2 - 1$ ,  $x \geq -1$ . Then  $f^{-1}(x)$  is

A.  $-1 + \sqrt{x+1}$

B.  $1 + \sqrt{x+1}$

C. doesnot exist because is  $f$  not one-one

D. doesnot exist because  $f$  is not onto

84. The distinct linear function(s) which map(s)  $[-1,1]$  onto  $[0,2]$  is/are
- A.  $x+1, -x+1$
  - B.  $x-1, x+1$
  - C.  $-x+1$
  - D.  $x+1$
85. The domain of  $\sin^{-1}\left[\log_3\left(\frac{x}{3}\right)\right]$  is
- A.  $[1,9]$
  - B.  $[-1,9]$
  - C.  $[-9,1]$
  - D.  $[-9,-1]$
86.  $\int \sqrt{x}e^{\sqrt{x}} dx$  is equal to
- A.  $2\sqrt{x} - e^{\sqrt{x}} - 4\sqrt{x}e^{\sqrt{x}} + c$
  - B.  $(2x - 4\sqrt{x} + 4)e^{\sqrt{x}} + c$
  - C.  $(2x + 4\sqrt{x} + 4)e^{\sqrt{x}} + c$
  - D.  $(1 - 4\sqrt{x})e^{\sqrt{x}} + c$
87. The differential equation  $y \frac{dy}{dx} + x = c$  represents
- A. a family of hyperbolas
  - B. a family of circles whose centres are on the  $y$ -axis
  - C. a family of parabolas
  - D. a family of circles whose centres are on the  $x$ -axis

88. The general solution of the equation  $\frac{dy}{dx} = \sqrt{\frac{1-y^2}{1-x^2}}$  is
- A.  $\sin^{-1} y - \sin^{-1} x = c$
  - B.  $\sin^{-1} y + \sin^{-1} x = c$
  - C.  $\sin^{-1}(xy) = 2$
  - D.  $\cos^{-1} x - \cos^{-1} y = c$
89. If  $\vec{a}, \vec{b}, \vec{c}$  are non-coplanar vectors and  $\lambda$  is a real number, then  $[\lambda(\vec{a} + \vec{b}), \lambda^2 \vec{b}, \lambda \vec{c}] = [\vec{a}, \vec{b} + \vec{c}, \vec{b}]$  for
- A. exactly two values of  $\lambda$
  - B. exactly three values of  $\lambda$
  - C. no value of  $\lambda$
  - D. exactly one value of  $\lambda$
90. A unit vector perpendicular to both the vectors  $\vec{i} + \vec{j}$  and  $\vec{j} + \vec{k}$  is
- A.  $\frac{-\vec{i} - \vec{j} + \vec{k}}{\sqrt{3}}$
  - B.  $\frac{\vec{i} + \vec{j} - \vec{k}}{\sqrt{3}}$
  - C.  $\frac{\vec{i} + \vec{j} + \vec{k}}{\sqrt{3}}$
  - D.  $\frac{\vec{i} - \vec{j} + \vec{k}}{\sqrt{3}}$

91. If  $\hat{a}$  and  $\hat{b}$  are unit vectors such that  $[\hat{a}, \hat{b}, \hat{a} \times \hat{b}] = \frac{1}{4}$ , then angle between  $\hat{a}$  and  $\hat{b}$  is

A.  $\frac{\pi}{3}$

B.  $\frac{\pi}{4}$

C.  $\frac{\pi}{6}$

D.  $\frac{\pi}{12}$

92. Resultant of two forces each equal to  $P$  and inclined at angle of  $120^\circ$ , is

A.  $\frac{1}{2}P$

B.  $\frac{3}{2}P$

C.  $P$

D.  $3P$

93. Position vector of the centre of the sphere  $|r|^2 + r \cdot (i + j + k) - 6 = 0$  is

A.  $i + j + k$

B.  $\frac{1}{2}(i + j + k)$

C.  $\frac{i + j + k}{\sqrt{3}}$

D.  $\frac{-1}{2}(i + j + k)$

94. The differential equation of the family of circles with radius 5 units and centre on the line  $y = 2$  is
- A.  $(y-2)\left(\frac{dy}{dx}\right)^2 = 25 + (y-2)^2$
- B.  $(y-2)^2\left(\frac{dy}{dx}\right)^2 = 25 - (y-2)^2$
- C.  $(x-2)^2\left(\frac{dy}{dx}\right)^2 = 25 + (y-2)^2$
- D.  $(x-2)\left(\frac{dy}{dx}\right)^2 = 25 - (y-2)^2$
95. The order of the differential equation whose solution is  $y = a \cos x + b \sin x + ce^{-x}$  is
- A. 4
- B. 1
- C. 2
- D. 3
96. The points  $(-a, -b), (0, 0), (a, b), (a^2, ab)$  are
- A. collinear
- B. vertices of a parallelogram
- C. concyclic
- D. vertices of a rectangle
97. A straight line through the point  $A(3, 4)$  is such that its intercept between the axes is bisected at  $A$ . Its equation is
- A.  $4x + 3y = 24$
- B.  $3x + 4y = 25$
- C.  $x + y = 7$

- D.  $3x - 4y + 7 = 0$
98. The line  $3x + 2y = 24$  meets the axes in  $A$  and  $B$ . The perpendicular bisector of  $AB$  meets the line  $y + 1 = 0$  at  $C$ . Then the area of  $\Delta ABC =$
- A. 81  
B. 91  
C. 71  
D. 61
99. If the sum of the slopes of the lines given by  $x^2 - 2cxy - 7y^2 = 0$  is four times their product, then  $c$  has the value
- A. 1  
B. -2  
C. 2  
D. -1
100. The lines  $2x - 3y = 5$  and  $3x - 4y = 7$  are two diameters of a circle of area  $49\pi$  square units. The equation of the circle is
- A.  $x^2 + y^2 - 2x + 2y - 62 = 0$   
B.  $x^2 + y^2 - 2x + 2y - 47 = 0$   
C.  $x^2 + y^2 + 2x - 2y - 47 = 0$   
D.  $x^2 + y^2 + 2x - 2y - 62 = 0$
101. If two circles  $(x - 1)^2 + (y - 3)^2 = r^2$  and  $x^2 + y^2 - 8x + 2y + 8 = 0$  intersect in two distinct points, then
- A.  $r < 2$   
B.  $r = 2$   
C.  $r > 2$   
D.  $2 < r < 8$

102. The radius of the circle passing through the foci of the ellipse  $\frac{x^2}{16} + \frac{y^2}{9} = 1$  and having its centre at  $(0,3)$  is
- A. 4
  - B. 3
  - C.  $\sqrt{12}$
  - D.  $\frac{7}{2}$
103. If  $e$  and  $e'$  are the eccentricities of the hyperbola and its conjugate hyperbola, then the value of  $\frac{1}{e^2} + \frac{1}{(e')^2}$  is
- A. 2
  - B. 3
  - C. 1
  - D.  $\frac{1}{2}$
104. The four planes  $7x + 4y - 4z + 3 = 0$ ,  $36x - 51y + 12z + 17 = 0$ ,  $14x + 8y - 8z - 12 = 0$  and  $12x - 17y + 4z - 3 = 0$  are the four faces of a
- A. parallelopiped
  - B. rectangular parallelopiped
  - C. cube
  - D. tetrahedran

105. Let  $\vec{A}, \vec{B}$  and  $\vec{C}$  be three non zero vectors, no two vectors are collinear. If the vector  $\vec{A} + 2\vec{B}$  is collinear with  $\vec{C}$  and  $\vec{B} + 3\vec{C}$  is collinear with  $\vec{A}$ , then  $\vec{A} + 2\vec{B} + 6\vec{C}$  is
- A.  $2\vec{A}$   
 B.  $3\vec{B}$   
 C.  $3\vec{C}$   
 D.  $\vec{0}$
106. If  $\begin{vmatrix} a & a^2 & 1+a^2 \\ b & b^2 & 1+b^2 \\ c & c^2 & 1+c^2 \end{vmatrix} = 0$  and the vectors  $\vec{A} = (1, a, a^2), \vec{B} = (1, b, b^2), \vec{C} = (1, c, c^2)$  are not coplanar, then
- A.  $a + b + c = 0$   
 B.  $abc = 0$   
 C.  $a + b + c = 1$   
 D.  $abc = -1$
107. If  $x^2 - 1$  is a factor of  $x^4 + ax^3 + 3x - b$ , then
- A.  $a = 3, b = -1$   
 B.  $a = -3, b = 1$   
 C.  $a = 3, b = 1$   
 D.  $a = -3, b = -1$
108. How many numbers greater than 1000, but not greater than 4000 can be formed with the digits 0,1,2,3,4, repetition of digits being allowed?
- A. 374  
 B. 375  
 C. 376  
 D. 377

109. The value of the determinant  $\begin{vmatrix} 1 & 1 & 1 \\ e & \pi & \sqrt{2} \\ 2 & 2 & 2 \end{vmatrix}$  is equal to
- A. 0
  - B.  $e$
  - C.  $\pi$
  - D.  $2(e - \pi + \sqrt{2})$
110. If the matrix  $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$  is commutative with the matrix  $\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$ , then
- A.  $a = 0, b = c$
  - B.  $b = 0, c = d$
  - C.  $c = 0, d = a$
  - D.  $d = 0, a = b$
111. If  $x = 1 + 2 + \frac{4}{2!} + \frac{8}{3!} + \frac{16}{4!} + \dots$ , then  $x^{-1}$  is
- A.  $e^{-2}$
  - B.  $e^2$
  - C.  $e^{\frac{1}{2}}$
  - D.  $e^{\frac{-1}{2}}$

112.  $R$  is a relation over the set of all real numbers and it is defined by  $mn \geq 0$ . Then  $R$  is
- A. reflexive and transitive
  - B. reflexive and symmetric
  - C. symmetric and transitive
  - D. an equivalence relation
113. The sum of the series  $\cos x - \frac{1}{2}\cos^2 x + \frac{1}{3}\cos^3 x - \frac{1}{4}\cos^4 x + \dots$  is
- A.  $\log 2 + 2 \log \left| \cos \left( \frac{x}{2} \right) \right|$
  - B.  $\log 2 - 2 \log \left| \cos \left( \frac{x}{2} \right) \right|$
  - C.  $\log 2 - \log \left| \cos \left( \frac{x}{2} \right) \right|$
  - D.  $\log 2 + 2 \log \cos \left( \frac{x}{2} \right)$
114. Let  $f: \mathbb{R}^+ \rightarrow \mathbb{R}^+$  be a mapping defined by  $f(x) = x^3 + 4$ . Then  $f$  is
- A. bijective
  - B. surjective
  - C. injective
  - D. automorphism

115. If  $f(x) = \log \frac{1+x}{1-x}$ , then  $f(a) + f(b)$  is equal to
- A.  $f\left(\frac{a+b}{1-ab}\right)$
  - B.  $f\left(\frac{a+b}{1+ab}\right)$
  - C. 0
  - D.  $f(ab)$
116. Let  $X = \{x : x \text{ is a multiple of } 3\}$  and  $Y = \{x : x \text{ is a multiple of } 5\}$ . Then  $X - Y$  is equal to
- A.  $\bar{X} \cap Y$
  - B.  $X \cap \bar{Y}$
  - C.  $\bar{X} \cap \bar{Y}$
  - D.  $\overline{X \cap Y}$
117. The probability that a man will live 10 more years, is  $\frac{3}{5}$  and the probability that his wife will live 10 more years is  $\frac{2}{7}$ . Then the probability that none of them will be alive after 10 years is
- A.  $\frac{2}{5}$
  - B.  $\frac{2}{7}$
  - C.  $\frac{3}{5}$
  - D.  $\frac{5}{7}$

118. If probability of a defective bolt is 0.1, then mean and standard deviation of distribution of bolts in a total of 400 are
- A. 30,3
  - B. 40,5
  - C. 30,4
  - D. 40,6
119. A fair die is tossed until a number greater than 4 appears. The probability that an even number of tosses shall be required is
- A.  $\frac{1}{2}$
  - B.  $\frac{1}{5}$
  - C.  $\frac{3}{5}$
  - D.  $\frac{2}{3}$
120. A committee of five is to be chosen from a group of 9 people. The probability that a certain married couple will either serve together or not at all is
- A.  $\frac{1}{2}$
  - B.  $\frac{5}{9}$
  - C.  $\frac{4}{9}$
  - D.  $\frac{2}{3}$

121. Which of the following numbers is rational?
- A.  $\sin 15^\circ$
  - B.  $\cos 15^\circ$
  - C.  $\sin 15^\circ \cos 15^\circ$
  - D.  $\sin 15^\circ \cos 75^\circ$
122. The maximum value of  $3 \cos x + 4 \sin x + 5$  is
- A. 5
  - B. 9
  - C. 7
  - D. 10
123. In a triangle  $ABC$ ,  $\angle A = \frac{\pi}{2}$ . Then  $\cos^2 B + \cos^2 C$  is equal to
- A. -2
  - B. 1
  - C. 2
  - D. 0
124. The lines  $x + 2y + 3 = 0$ ,  $x + 2y - 7 = 0$  and  $2x - y - 4 = 0$  are the 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.  $2x - y - 6 = 0$

125. The number of common tangent to the circles  $x^2 + y^2 = 4$ ,  $x^2 + y^2 - 6x - 8y = 24$  is
- A. 0
  - B. 1
  - C. 2
  - D. 4

### PHYSICS

126. When a potential difference of 100 volts is applied between the parallel plates of a capacitor whose capacitance is  $5 \times 10^{-6}$  F, then the energy stored as electrostatic potential energy in the capacitor is
- A.  $0.5 \times 10^{-3}$  J
  - B.  $5 \times 10^{-3}$  J
  - C.  $25 \times 10^{-3}$  J
  - D.  $50 \times 10^{-3}$  J
127. Two identical spherical balls of diameter 1 cm having charges  $5 \mu\text{C}$  and  $3 \mu\text{C}$  are brought in contact. After separation, the number of electrons on the first sphere is,
- A.  $25 \times 10^{12}$
  - B.  $30 \times 10^{12}$
  - C.  $40 \times 10^{12}$
  - D.  $80 \times 10^{12}$
128. The amount of work done in moving a charge of 5 C across two points having a potential difference of 15 Volts is equal to
- A. 0.333 J
  - B. 3 J
  - C. 6 J
  - D. 75 J

129. An LED having a resistance of one kilo ohm is connected across a dry cell of 1.5 V. Then the current flowing through the LED is,
- A. 0.66 mA
  - B. 1.0 mA
  - C. 1.5 mA
  - D. 3.0 mA
130. The potentiometer wire is made up of the material
- A. copper
  - B. silver
  - C. tungsten
  - D. manganin
131. The temperature coefficient of resistance of a manganin wire is 0.002 per degree centigrade and its resistance is 7.6 ohm at 300K. When a potential is applied, its temperature increases to 77 °C. Now what will be its resistance?
- A. 8.36 ohm
  - B. 9.12 ohm
  - C. 9.88 ohm
  - D. 10.99 ohm
132. Microwave oven cooks food faster without heating the vessel since its principle is
- A. radiation
  - B. conduction
  - C. convection
  - D. water molecules in the food serve as electric dipoles

133. A step down transformer has a total power input of 220 kW at 11000 V. What will be the input current?
- A. 20 A
  - B. 40 A
  - C. 0.10 A
  - D. 0.05 A
134. In a solenoid having a diameter of 3 cm, length 50 cm with 1000 turns, a second layer of 100 turns is wound over the first layer. What will be mutual inductance between the coils, if the relative permeability of the core is 400?
- A. 36 H
  - B. 0.71 mH
  - C. 108 mH
  - D. 144 mH
135. In sodium vapour lamp the difference between  $D_1$  and  $D_2$  lines is
- A. 4 nm
  - B. 6 nm
  - C. 4 Å
  - D. 6 Å
136. When a 300 mm long tube filled with 60 cc of sugar solution produces an optical rotation of  $9^\circ$ , find the quantity of sugar in the solution ( $\rho$  for sugar is  $6^\circ/\text{cm}$ ).
- A. 3 mg
  - B. 30mg
  - C. 300mg
  - D. 3gm

137. In the third orbit, the energy of the electron is
- A.  $-7.85 \text{ eV}$
  - B.  $-4.53 \text{ eV}$
  - C.  $-1.51 \text{ eV}$
  - D.  $-9.43 \text{ eV}$
138. Half life of a radioactive element is 3 months. What will be the fraction of that element left over after one year?
- A. 75%
  - B. 50%
  - C. 25%
  - D. 6.25%
139. De-Broglie wavelength of an electron is given by the relation
- A.  $h/(2meV)$
  - B.  $h/\sqrt{(2meV)}$
  - C.  $\sqrt{(2eV/m)}$
  - D.  $h/\sqrt{(2meE)}$
140. The propagation of radio waves through the troposphere of the Earth is called as \_\_\_\_\_ propagation.
- A. surface wave
  - B. space wave
  - C. sky wave
  - D. skip wave

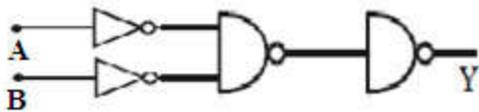
141. The principle of the microphone is to convert
- A. electrical energy into sound energy
  - B. sound energy into electrical energy
  - C. electrical energy into mechanical energy
  - D. mechanical energy into electromagnetic energy
142. One light year is equal to
- A.  $1.496 \times 10^{11}$  m
  - B.  $9.467 \times 10^{15}$  m
  - C.  $6.673 \times 10^{-11}$  N m<sup>2</sup>kg<sup>-2</sup>
  - D.  $5.98 \times 10^{24}$  kg
143. The unit of permittivity is
- A. NC<sup>-2</sup> m<sup>-2</sup>
  - B. Hm<sup>-1</sup>
  - C. C<sup>2</sup>N<sup>-1</sup>m<sup>-2</sup>
  - D. Nm<sup>2</sup>C<sup>-2</sup>
144. Which of the waves does not belong to electromagnetic wave spectrum?
- A. X-rays
  - B. Visible light
  - C. Sound waves
  - D. Infra-red rays
145. Mirage formation is due to the variation of layers of
- A. refractive index
  - B. colour
  - C. frequency
  - D. None of the above

146. The maximum kinetic energy of electrons in a photoelectric effect depends on
- A. intensity of incident light
  - B. frequency of the incident light
  - C. polarization of the incident light
  - D. angle of incidence
147. A sensitive galvanometer is converted into an ammeter by connecting a \_\_\_ resistance in \_\_\_ with its coil
- A. low, parallel
  - B. low, series
  - C. high, parallel
  - D. high, series
148.  $ML^2T^{-2}$  is the dimensional formula of
- A. angular momentum
  - B. linear momentum
  - C. angular velocity
  - D. None of the above
149. A passenger in a moving train tosses a coin. If the coin falls behind him, the train must be moving with
- A. an acceleration
  - B. retardation
  - C. uniform speed
  - D. any of these
150. The resistance of a device dropped drastically when the polarity of the meter changed. The device could be a
- A. resistor
  - B. inductor
  - C. capacitor

- D. diode
151. A star is at 10 light years away from the surface of the earth. If we use convex lens of focal length 50cm, then the image of the star is formed at
- A. 25cm
  - B. 100cm
  - C. 50cm
  - D. 77cm
152. Light of wave length  $2000 \text{ \AA}$  falls on a photosensitive material having work function 4.2 eV. The kinetic energy of the fastest electron is
- A. 1 eV
  - B. 2 eV
  - C. 3 eV
  - D. 4 eV
153. The size of the coil is \_\_\_ in moving coil galvanometer in comparison with tangent galvanometer
- A. equal
  - B. big
  - C. small
  - D. None of the above
154. Number of P-N junctions that are there in a bipolar junction transistor is
- A. 0
  - B. 1
  - C. 2
  - D. 3

155. If Hooke's law is obeyed, then the restoring force is
- A. equal to strain
  - B. a linear function of strain
  - C. a non-linear function of strain
  - D. independent of strain
156. In which the following decays the element does not change?
- A.  $\gamma$ -decays
  - B.  $\beta^-$ -decays
  - C.  $\beta^+$ -decays
  - D.  $\alpha$ -decays
157. Two equal forces act at a point. The square of their resultant is three times their product. What is the angle between them?
- A.  $60^\circ$
  - B.  $30^\circ$
  - C.  $15^\circ$
  - D.  $50^\circ$
158. A particle starts moving from the position of rest under a constant acceleration. It travels a distance  $x$  in the first 10 seconds and a distance  $y$  in the next 10 seconds. Then
- A.  $y = 3x$
  - B.  $y = 2x$
  - C.  $y = x$
  - D.  $y = 4x$

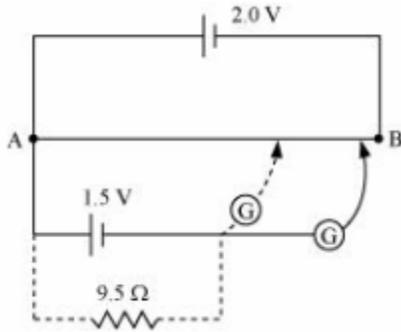
159. In a 2 slit interference experiment, the maximum intensity of light would be \_\_\_\_\_ the maximum intensity of a slit single slit experiment.
- A. same as
  - B. twice
  - C. four times
  - D. half
160. A magnetic needle is kept in a non-uniform magnetic field. It experiences
- A. a force and torque
  - B. a force but not a torque
  - C. a torque but not a force
  - D. neither a force nor a torque
161. In SI system, unit of radioactivity is
- A. Becquerel
  - B. Curie
  - C. Rutherford
  - D. Rad
162. The following arrangement performs the logic function of



- A. AND
- B. OR
- C. NAND
- D. NOR

163. The particle which has zero mass but has energy is
- A. electron
  - B. photon
  - C. proton
  - D. neutron
164. What is the name of the instrument that measures and records the relative humidity of the air?
- A. Hygroscope
  - B. Hygrograph
  - C. Hygrometer
  - D. Hygrister
165. In a potentiometer arrangement, a cell of emf 1.25 V gives a balance point at 35.0 cm length of the wire. If the cell is replaced by another cell and the balance point shifts to 63.0 cm, what is the emf of the second cell?
- A. 4.25V
  - B. 3.25
  - C. 2.25
  - D. 1.75

166. Figure shows a 2.0 V potentiometer used for the determination of internal resistance of a 1.5 V cell. The balance point of the cell in open circuit is 76.3 cm. When a resistor of  $9.5 \Omega$  is used in the external circuit of the cell, the balance point shifts to 64.8 cm length of the potentiometer wire. Determine the internal resistance of the cell.



- A.  $0.68 \Omega$   
 B.  $1.68 \Omega$   
 C.  $11.68 \Omega$   
 D.  $21.68 \Omega$
167. A bar magnet of magnetic moment  $1.5 \text{ J T}^{-1}$  lies aligned with the direction of a magnetic field of  $0.22 \text{ T}$ . What is the amount of work required by an external torque to turn the magnet so as to align its magnetic moment normal to the field direction A?
- A.  $3.33 \text{ J}$   
 B.  $2.33 \text{ J}$   
 C.  $1.33 \text{ J}$   
 D.  $0.33 \text{ J}$
168. A stone tied to the end of a 30m long string is whirled in a horizontal circle. If the centripetal acceleration is  $14.7 \text{ m/s}^2$ , then its angular speed will be
- A.  $7 \text{ rad/s}$   
 B.  $14 \text{ rad/s}$   
 C.  $21 \text{ rad/s}$   
 D.  $22/7 \text{ rad/s}$

169. Three particles of masses 1kg, 2kg, 3kg are placed at the corners of an equilateral triangle of side 1m. The center of mass will be
- A.  $\frac{\sqrt{3}}{4(1,2)}$
- B.  $\frac{\sqrt{3}}{4(1,0)}$
- C.  $\frac{\sqrt{3}}{4(1,1)}$
- D.  $\frac{\sqrt{3}}{4(2,1)}$
170. For a particle executing uniform circular motion
- A. velocity is transverse, acceleration is radial
- B. velocity is transverse, acceleration is transverse
- C. velocity is radial , acceleration is transverse
- D. velocity is radial, acceleration is radial
171. A small telescope has an objective lens of focal length 144 cm and an eyepiece of focal length 6.0 cm. What is the separation between the objective and the eyepiece?
- A. 150 cm
- B. 138 cm
- C. 156 cm
- D. 122 cm
172. Ex-OR gate is nothing but a
- A. half adder
- B. half adder without carry
- C. full adder
- D. full adder without a carry

173. When a forward bias is applied to a pn junction diode, it
- A. reduces the minority current
  - B. raises the potential barrier
  - C. reduces the majority carrier current to zero
  - D. lowers the potential barrier
174. A tuning fork is vibrating with a frequency of 400 vibrations per sec. If the velocity of sound is 330 m/sec., find the distance travelled by the sound in 20 vibrations.
- A. 16.5 cm
  - B. 17.5 cm
  - C. 18.5 cm
  - D. 18.75 cm
175. The series limit of Balmer series is at 3646 Å. Calculate the wavelength of the first member of this series.
- A. 6165 Å
  - B. 6365 Å
  - C. 6565 Å
  - D. 5365 Å
176. The coordination number for face centered cubic lattice is
- A. 12
  - B. 8
  - C. 6
  - D. 26
177. A sphere has a mass of  $12.2\text{kg} \pm 0.1 \text{ kg}$  and radius  $10\text{cm} \pm 0.1 \text{ cm}$ . The maximum percentage error in density is
- A. 8.33%
  - B. 3.83%
  - C. 12.1%

- D. 38.3%
178. The efficiency of a Carnot engine operating between reservoirs maintained at  $27^{\circ}\text{C}$  and  $-123^{\circ}\text{C}$  is
- A. 0.75
  - B. 0.4
  - C. 0.25
  - D. 0.55
179. A quartz crystal is used to produce ultrasound. The frequency will be inversely related to
- A. Young's modulus
  - B. Thickness
  - C. Density
  - D. Length
180. Three capacitors of  $4\mu\text{F}$  each are to be connected in such a way that the net capacitance is  $6\mu\text{F}$ . Then
- A. all the three be in series
  - B. all the three be in parallel
  - C. connect two in parallel and one in series
  - D. connect two in series and one in parallel
181. The earth radiates in the infra-red region of the spectrum. The spectrum is correctly given by
- A. Planck's law of radiation
  - B. Stefan's law of radiation
  - C. Wein's law
  - D. Rayleigh-Jean's law

182. The force experienced by charged particle in a magnetic field is maximum when the particle
- A. moves in a direction parallel to the magnetic field
  - B. moves in a direction perpendicular to the magnetic field
  - C. moves in a direction making an angle  $45^\circ$  with the magnetic field
  - D. is at rest
183. The half life period of neutron is 13 minutes approximately. The intensity of neutron beam traveling in free space with a velocity of 30 km per sec is reduced to half when it covers a distance of
- A. 6300 km
  - B. 11700 km
  - C. 46800 km
  - D. 23400 km
184. The maximum number of electrons in an atomic orbit of principal quantum number = 3 n is
- A. 18
  - B. 6
  - C. 9
  - D. 3
185. Half life of a substance is 20 minutes. What is the time between 33% decay and 67% decay?
- A. 20 minutes
  - B. 25 minutes
  - C. 30 minutes
  - D. 40 minutes

186. In television, blanking pulse is applied to
- A. horizontal plate
  - B. vertical plate
  - C. control grid
  - D. filament
187. If a particle moves according to the equation  $x = 3t^2 + 4t$ , then find instantaneous velocity at  $t = 4s$  ( $x$  in cm)
- A.  $28 \text{ cm s}^{-1}$
  - B.  $64 \text{ cm s}^{-1}$
  - C.  $48 \text{ cm s}^{-1}$
  - D.  $16 \text{ cm s}^{-1}$
188. Two parallel rail tracks run north-south. Train A moves north with a speed of 54 km/h and train B moves south with a speed of 90 km/h. What is the velocity of B with respect to A?
- A. 15 m/s
  - B. 25 m/s
  - C. 40 m/s
  - D. 36 m/s
189. The frequency of tuning fork is 384 Hz and velocity of sound in air is 352 m/s. How far sound has travelled when fork completes 36 vibration?
- A. 33 m
  - B. 16.5 m
  - C. 11 m
  - D. 22 m

190. Which of the following will pair up to produce stationary wave?
- (1)  $Z_1 = A \cos(kx - \omega t)$
  - (2)  $Z_2 = A \cos(kx + \omega t)$
  - (3)  $Z_3 = A \cos(ky - \omega t)$
  - (4)  $Z_4 = A \cos(kz + \omega t)$
- A. 1 and 2
  - B. 2 and 3
  - C. 3 and 4
  - D. 1 and 3
191. A wire of  $9\Omega$  is bent to form an equilateral triangle. Find the resistance across one of the sides.
- A.  $5\Omega$
  - B.  $2\Omega$
  - C.  $3\Omega$
  - D.  $3/2\Omega$
192. For the expression  $P = X + XY$ , how many gates are required for its implementation?
- A. 2
  - B. 1
  - C. 3
  - D. None of the above
193. A silver wire has a resistance of  $2.1\Omega$  at  $27.5^\circ\text{C}$ , and a resistance of  $2.7\Omega$  at  $100^\circ\text{C}$ . Determine the temperature coefficient of resistivity of silver.
- A.  $0.039^\circ\text{C}^{-1}$
  - B.  $0.0039^\circ\text{C}^{-1}$
  - C.  $0.00039^\circ\text{C}^{-1}$
  - D.  $0.39^\circ\text{C}^{-1}$

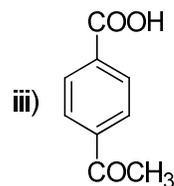
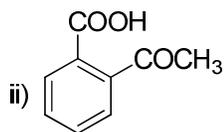
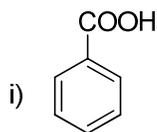
194. A storage battery of emf 8.0 V and internal resistance  $0.5 \Omega$  is being charged by a 120 V dc supply using a series resistor of  $15.5 \Omega$ . What is the terminal voltage of the battery during charging?
- A. 11.5V  
B. 12.8V  
C. 11.2V  
D. 12.4V
195. A body of mass 2Kg is hung on a spring balance mounted vertically in a lift. If the lift descends with an acceleration equal to the acceleration due to gravity  $g$ , then the reading of the balance will be changed by
- A. 2 Kg  
B. 4 Kg  
C.  $2/g$  Kg  
D. zero
196. If  $g$  is acceleration due to gravity at the earth's surface, then the gain in the potential energy of an object of mass  $m$  raised from the surface of the earth to height equal to the radius  $R$  of the earth is
- A.  $mgR$   
B.  $\frac{1}{2}mgR$   
C.  $\frac{1}{4}mgR$   
D.  $\frac{1}{3}mgR$
197. A screen is placed 90 cm from an object. The image of the object is formed on the screen by a convex lens at two different locations separated by 20 cm. Determine the focal length of the lens.
- A. 22.19cm  
B. 23.39cm  
C. 21.79cm  
D. 21.39cm

198. The energy flux of sunlight reaching the surface of the Earth is  $1.388 \times 10^3 \text{ W/m}^2$ . How many photons (nearly) per square metre are incident on the Earth per second? Assume that the photons in the sunlight have an average wavelength of 550 nm.
- A.  $3.84 \times 10^{23}$   
B.  $3.84 \times 10^{22}$   
C.  $3.84 \times 10^{21}$   
D.  $3.84 \times 10^{20}$
199. Carbon, silicon and germanium have four valence electrons each. These are characterised by valence and conduction bands separated by energy band gap respectively equal to  $(E_g)C$ ,  $(E_g)Si$  and  $(E_g)Ge$ . Which of the following statements is true?
- A.  $(E_g)Si < (E_g)Ge < (E_g)C$   
B.  $(E_g)C < (E_g)Ge > (E_g)Si$   
C.  $(E_g)C > (E_g)Si > (E_g)Ge$   
D.  $(E_g)C = (E_g)Si = (E_g)Ge$
200. An electric heater supplies 1.8 kW of power in the form of heat to a tank of water. How long will it take to heat 100 kg of water in the tank from 10 to  $70^\circ \text{C}$ . Assume heat losses to the surrounding to be negligible.
- A. 3.97 hrs  
B. 3.87 hrs  
C. 3.77 hrs  
D. 3.67 hrs

### CHEMISTRY

201. The most acidic  $\alpha$ -hydrogen is in the following compound:
- A.  $\text{CH}_3\text{COCH}_2\text{CHO}$   
B.  $\text{CH}_3\text{COCH}_2\text{COCH}_3$   
C.  $\text{CH}_3\text{COCH}_2\text{COOCH}_3$   
D.  $\text{CH}_3\text{CHO}$

202. Find the increasing order of acid strength of the following acids



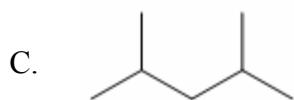
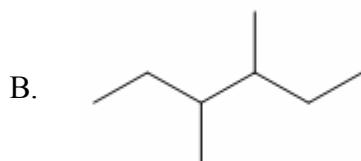
A.  $i < ii < iii$

B.  $ii < iii < i$

C.  $iii < i < ii$

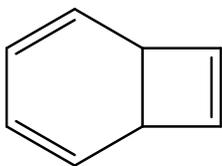
D.  $ii < i < iii$

203. Which of the following substances is not an isomer of 3-ethyl-2-methylpentane?



D. None of the above

204. The compound shown has ..... $sp^2 - sp^2\sigma$  (sigma) bonds.



A. 1

B. 3

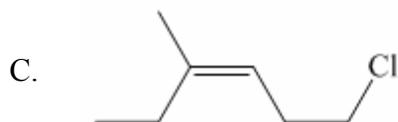
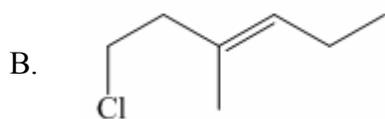
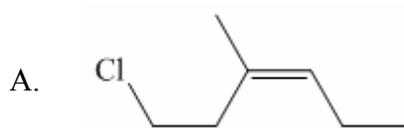
C. 4

D. 5

205. A certain alcohol has the functional class IUPAC name 1-ethyl-3-methylbutyl alcohol. What is its substitutive name?

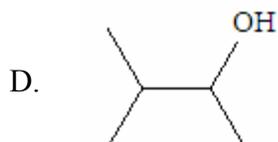
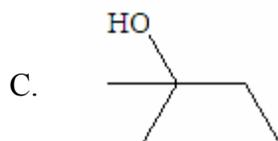
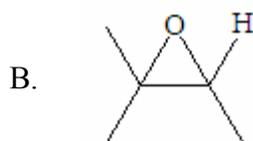
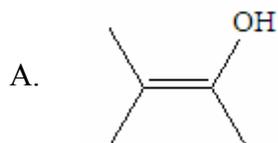
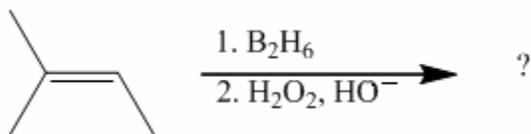
- A. 1-Ethyl-3-methyl-1-butanol
- B. 2-Methyl-1-hexanol
- C. 3-Methyl-1-hexanol
- D. 5-Methyl-3-hexanol

206. The structure of (E)-1-chloro-3-methyl-3-hexene is



D. None of the above

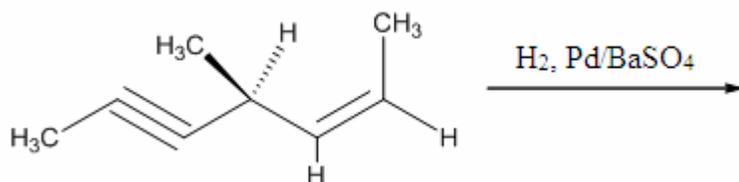
207. The major product of the following reaction sequence is



208. Treatment of 2-methyl-2-butene with HBr in the presence of a peroxide yields

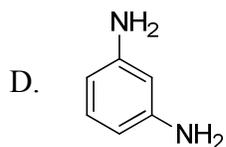
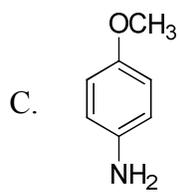
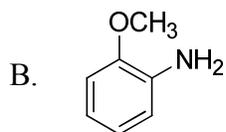
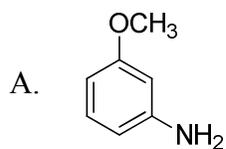
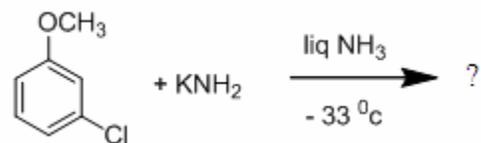
- A. a primary alkyl bromide
- B. a secondary alkyl bromide
- C. a tertiary alkyl bromide
- D. a vicinal dibromide

209. The product of the following reaction is

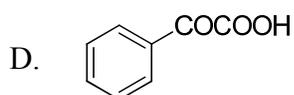
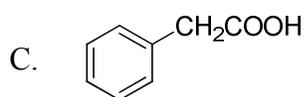
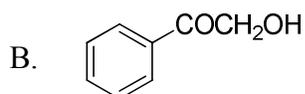
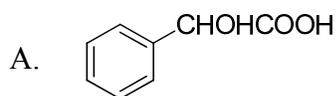
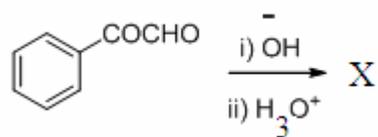


- A. an optically active compound
  - B. an optically inactive compound
  - C. a racemic mixture
  - D. a diastereoisomeric mixture
210. Non – sticking frying pans are coated with
- A. polythene
  - B. polystyrene
  - C. chlorofluoromethane
  - D. polytetrafluoroethylene

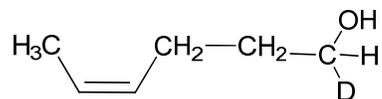
211. The major product of the following reaction is



212. In the following intramolecular Cannizzaro's reaction, X is formed. What is X ?



213. The correct stereochemical descriptions for the following structure are



A. 1S, 4E

B. 1R, 4E

C. 1R, 4Z

D. 1S, 4Z

214. Reaction of benzoic acid with diazomethane gives

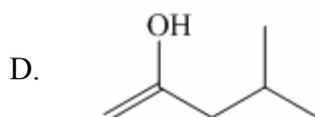
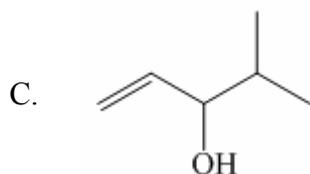
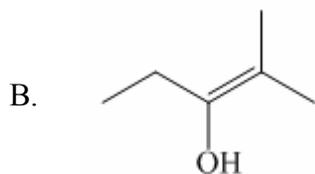
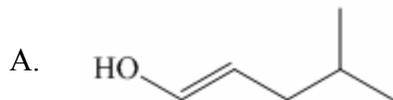
A. phenyl acetic acid

B. p-methyl benzoic acid

C. methyl benzoate

D. phenyldiazoketone

215. Which one of the following is the intermediate in the preparation of a ketone by hydration of an alkyne in the presence of sulfuric acid and mercury(II) sulphate?



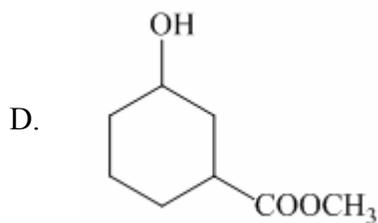
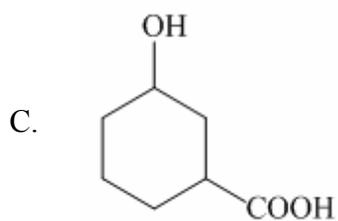
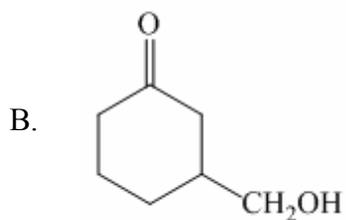
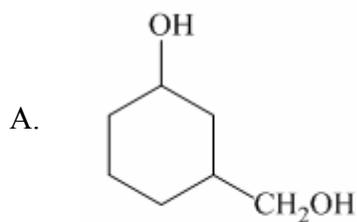
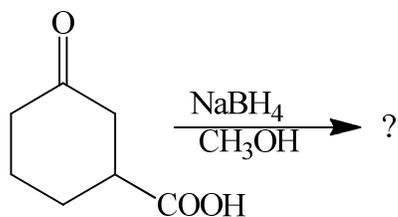
216. Consider the following statements concerning the effect of a trifluoromethyl group,  $-\text{CF}_3$  on an electrophilic aromatic substitution.

1. The  $\text{CF}_3$  group will activate the ring.
2. The  $\text{CF}_3$  group will deactivate the ring.
3. The  $\text{CF}_3$  group will be a meta director.
4. The  $\text{CF}_3$  group will be an ortho, para director.

Which of these statements are correct?

- A. 1,3
- B. 1,4
- C. 2,3
- D. 2,4

217. What is the major product of the following reaction?



218. If the concentration of glucose in a solution is  $0.9 \text{ g L}^{-1}$ , what will be the molarity of glucose in the solution?

A. 5 M

B. 50 M

C. 0.005 M

D. 0.5 M

219. Which of the following pairs have the same number of atoms?

(i) 16 g of  $O_2(g)$  and 4 g of  $H_2(g)$ (ii) 16 g of  $O_2$  and 44 g of  $CO_2$ (iii) 28 g of  $N_2$  and 32 g of  $O_2$ (iv) 12 g of  $C(s)$  and 23 g of  $Na(s)$ 

A. (iii) and (iv)

B. (iii) and (i)

C. (iii) and (ii)

D. (ii) and (i)

220. The Heisenberg's uncertainty can be applied to

A. electrons only

B. neutrons only

C. protons only

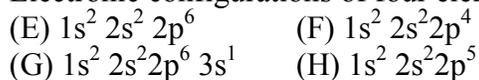
D. all material objects in motion

221. Match the following

|                                 |   |
|---------------------------------|---|
| (i) Photon                      | (a) Value is 4 for N shell                |
| (ii) Electron                   | (b) Probability density                   |
| (iii) $\psi^2$                  | (c) Always positive value                 |
| (iv) Principal quantum number n | (d) Exhibits both momentum and wavelength |

A. (i)  $\rightarrow$  (a), (ii)  $\rightarrow$  (b), (iii)  $\rightarrow$  (c), (iv)  $\rightarrow$  (d)B. (i)  $\rightarrow$  (d), (ii)  $\rightarrow$  (c), (iii)  $\rightarrow$  (b), (iv)  $\rightarrow$  (a)C. (i)  $\rightarrow$  (c), (ii)  $\rightarrow$  (d), (iii)  $\rightarrow$  (b), (iv)  $\rightarrow$  (a)D. (i)  $\rightarrow$  (d), (ii)  $\rightarrow$  (a), (iii)  $\rightarrow$  (b), (iv)  $\rightarrow$  (d)

222. Electronic configurations of four elements E, F, G and H are given below:



Which of the following is the correct order of increasing tendency to gain electron?

- A.  $E < G < F < H$   
 B.  $E < F < G < H$   
 C.  $H < F < G < E$   
 D.  $H < E < F < G$

223. Match the correct atomic radius with the element.

| Element | Atomic radius (pm) |
|---------|--------------------|
| (i) Be  | (a) 74             |
| (ii) C  | (b) 88             |
| (iii) O | (c) 111            |
| (iv) B  | (d) 77             |
| (v) N   | (e) 66             |

- A. (i)  $\rightarrow$  (a), (ii)  $\rightarrow$  (b), (iii)  $\rightarrow$  (c), (iv)  $\rightarrow$  (d), (v)  $\rightarrow$  (e)  
 B. (i)  $\rightarrow$  (c), (ii)  $\rightarrow$  (d), (iii)  $\rightarrow$  (e), (iv)  $\rightarrow$  (b), (v)  $\rightarrow$  (a)  
 C. (i)  $\rightarrow$  (e), (ii)  $\rightarrow$  (d), (iii)  $\rightarrow$  (c), (iv)  $\rightarrow$  (b), (v)  $\rightarrow$  (a)  
 D. (i)  $\rightarrow$  (c), (ii)  $\rightarrow$  (d), (iii)  $\rightarrow$  (a), (iv)  $\rightarrow$  (b), (v)  $\rightarrow$  (c)

224. Which of the following options represents the correct bond order?

- A.  $O_2^- > O_2 > O_2^+$   
 B.  $O_2^- < O_2 < O_2^+$   
 C.  $O_2^- > O_2 < O_2^+$   
 D.  $O_2^- < O_2 > O_2^+$

225. Which of the following statements are not correct?
- (i) NaCl being an ionic compound is a good conductor of electricity in the solid state.
  - (ii) In canonical structures there is a difference in the arrangement of atoms.
  - (iii) Hybrid orbitals form stronger bonds than pure orbitals.
  - (iv) VSEPR theory can explain the square planar geometry of  $\text{XeF}_4$
- A. (iii) and (iv)
  - B. (i) and (iv)
  - C. (i) and (iii)
  - D. (i) and (ii)
226. The radioactive isotope of hydrogen is
- A. protium
  - B. deuterium
  - C. tritium
  - D. hydronium
227. Permanent hardness of water is due to the presence of
- (i) chlorides of Ca and Mg in water
  - (ii) sulphates of Ca and Mg in water
  - (iii) hydrogen carbonates of Ca and Mg in water
  - (iv) carbonates of alkali metals in water
- A. (i) and (iii)
  - B. (i) and (ii)
  - C. (i) and (iv)
  - D. (iii) and (iv)
228. Which of the metal carbonates is most stable thermally?
- A.  $\text{MgCO}_3$
  - B.  $\text{CaCO}_3$
  - C.  $\text{SrCO}_3$

D.  $\text{BaCO}_3$

229. Which of the following are the correct reasons for anomalous behaviour of lithium?

- (i) Exceptionally small size of its atom
- (ii) Its high polarising power
- (iii) It has high degree of hydration
- (iv) Exceptionally low ionisation enthalpy

A. (i) and (iii)

B. (i) and (iv)

C. (iii) and (iv)

D. (i) and (ii)

230. Which of the following statements are correct?

- (i) Fullerenes have dangling bonds
- (ii) Fullerenes are cage-like molecules
- (iii) Graphite is thermodynamically most stable allotrope of carbon
- (iv) Graphite is slippery and hard and therefore used as a dry lubricant in Machines

A. (ii) and (i)

B. (ii) and (iv)

C. (i) and (iv)

D. (ii) and (iii)

231. Which of the following gases is not a green house gas?

A. CO

B.  $\text{O}_3$

C.  $\text{CH}_4$

D.  $\text{H}_2\text{O}$  vapour

232. Which of the following practices will not come under green chemistry?
- A. Using soap made of vegetable oils instead of using synthetic detergents.
  - B. Using  $\text{H}_2\text{O}_2$  for bleaching purpose instead of using chlorine based bleaching agents.
  - C. Using bicycle for travelling small distances instead of using petrol/diesel based vehicles.
  - D. Using plastic cans for neatly storing substances.
233. Salvarsan is an arsenic containing drug which was first used for the treatment of
- A. syphilis
  - B. typhoid
  - C. meningitis
  - D. dysentery
234. In which of the following are the magic numbers of both protons and neutrons present?
- A.  ${}_{50}\text{Sn}^{123}$
  - B.  ${}_{82}\text{Pb}^{208}$
  - C.  ${}_{82}\text{Pb}^{206}$
  - D.  ${}_{50}\text{Sn}^{118}$
235. Which of the following nucleides has the least stability?
- A.  ${}_{28}\text{Ni}^{58}$
  - B.  ${}_{20}\text{Ca}^{39}$
  - C.  ${}_{2}\text{He}^4$
  - D.  ${}_{5}\text{B}^{10}$
236. CSFE is highest for
- A. Fe(III) high spin octahedral complex
  - B. Mn(II) high spin octahedral complex
  - C. Co(II) high spin octahedral complex
  - D. Cr(III) high spin octahedral complex

237. The first noble gas compound prepared by Niel Bartlett was
- A.  $\text{XeF}_2$
  - B.  $\text{XeO}_3$
  - C.  $\text{XePtF}_6$
  - D.  $\text{XeF}_4$
238. A person living at high altitude region observed that cooking food without using pressure cooker takes more time. The reason for this observation is that
- A. pressure increases
  - B. temperature decreases
  - C. pressure decreases
  - D. temperature increases
239. How will the viscosity of liquid be affected by the increase in temperature?
- A. Increase
  - B. No effect
  - C. Decrease
  - D. No regular pattern will be followed
240. With regard to freezing of water in a glass beaker, choose the correct statement amongst the following
- A.  $S$  (system) decreases but  $S$  (surroundings) remains the same.
  - B.  $S$  (system) increases but  $S$  (surroundings) decreases.
  - C.  $S$  (system) decreases but  $S$  (surroundings) increases.
  - D.  $S$  (system) decreases and  $S$  (surroundings) also decreases
241. Which of the following options will be correct for the stage of half completion of the reaction  $A \rightarrow B$ ?
- A.  $\Delta G = 0$
  - B.  $\Delta G > 0$

- C.  $\Delta G < 0$   
D.  $\Delta G = -RT \ln 2$
242. Which of the following statement(s) is/are not true about the following decomposition reaction?  
 $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$
- (i) Potassium is undergoing oxidation  
(ii) Chlorine is undergoing oxidation  
(iii) Oxygen is reduced  
(iv) None of the species are undergoing oxidation or reduction
- A. (i) and (ii)  
B. (i) and (iv)  
C. (i) and (iii)  
D. (ii) and (iii)
243. Low concentration of oxygen in the blood and tissues of people living at high altitude is due to
- A. low temperature  
B. low atmospheric pressure  
C. high atmospheric pressure  
D. both low temperature and high atmospheric pressure
244. In comparison to a 0.01 M solution of glucose, the depression in freezing point of a 0.01 M  $\text{MgCl}_2$  solution is
- A. the same  
B. about twice  
C. about three times  
D. about six times
245. In which pair most efficient packing is present?
- A. *hcp* and *bcc*  
B. *hcp* and *ccp*  
C. *bcc* and *ccp*

D. *bcc* and simple cubic cell

246. An electrochemical cell can behave like an electrolytic cell when
- A.  $E_{\text{cell}} = 0$
  - B.  $E_{\text{cell}} > E_{\text{ext}}$
  - C.  $E_{\text{ext}} > E_{\text{cell}}$
  - D.  $E_{\text{cell}} = E_{\text{ext}}$
247. What will happen during the electrolysis of aqueous solution of  $\text{CuSO}_4$  by using platinum electrodes?
- (i) Copper will deposit at cathode
  - (ii) Copper will deposit at anode
  - (iii) Oxygen will be released at anode
  - (iv) Copper will dissolve at anode
- A. (i) and (iii)
  - B. (i) and (ii)
  - C. (i) and (iv)
  - D. (ii) and (iv)
248. Activation energy of a chemical reaction can be determined by
- A. determining the rate constant at standard temperature
  - B. determining the rate constants at two temperatures
  - C. determining probability of collision
  - D. using catalyst
249. The value of rate constant of a pseudo first order reaction
- A. depends on the concentration of reactants present in small amount
  - B. depends on the concentration of reactants present in excess
  - C. is independent of the concentration of reactants.
  - D. depends only on temperature

250. Physisorption of a gas increases with
- A. increase in temperature
  - B. decrease in temperature
  - C. decrease in surface area of adsorbent
  - D. decrease in strength of van der Waals forces

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