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Test Booklet Series A

ROLL No.

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TEST BOOKLET No.

13517

TEST FOR FIRST DEGREE PROGRAMMES IN ENGINEERING AND TECHNOLOGY**MATHEMATICS, PHYSICS AND CHEMISTRY**

Time: 3 Hours

Maximum Marks: 750

INSTRUCTIONS TO CANDIDATES

1. You are provided with a Test Booklet and an Optical Mark Reader (OMR) Answer Sheet with a carbonless copy to mark your responses. Do not soil the Answer Sheet. Read carefully all the instructions given on the Answer Sheet.
2. Write your Roll Number in the space provided on the top of this page.
3. Also write your Roll Number in the columns provided for the same on the Answer Sheet. Darken the appropriate bubbles with a **Ball Point Pen**. Put your signature in the column provided on the Answer Sheet in the presence of the Invigilator.
4. Darken the appropriate bubble corresponding to the Test Booklet Series, as given on the top of this page, in the Answer Sheet. **If the corresponding bubble is not darkened, such answer sheets will not be valued and will be summarily rejected.**
5. The paper consists of 250 objective type questions. Of these, Question No. 1 to 125 will be Mathematics, 126 to 200 will be Physics and 201 to 250 will be Chemistry. All questions carry equal marks.
6. Each question has four alternative responses marked **A, B, C** and **D** and you have to **darken** the bubble corresponding to the correct response fully by using a **Ball Point Pen** as indicated in the example shown on the Answer Sheet.
7. Each correct answer carries 3 marks and each wrong answer carries 1 minus mark.
8. Space for rough work is provided at the end of this Test Booklet.
9. You should return the Answer Sheet to the Invigilator before you leave the examination hall. However, you can retain the Test Booklet and the carbonless copy of the OMR sheet.
10. Every precaution has been taken to avoid errors in the Test Booklet. In the event of any such unforeseen happening, the same may be brought to the notice of the Observer/Chief Superintendent in writing. Suitable remedial measures will be taken at the time of evaluation, if necessary.

SEAL



MATHEMATICS

1. The sum of the greatest and least values of $f(x) = |x-2| + |x-4| - |2x-8|$ ($2 \leq x \leq 8$) is
- (A) 0 (B) 2
(C) 4 (D) 8
2. If the roots of the equation $ax^2 + bx + c = 0$ are the squares of the roots of $px^2 + qx + r = 0$, then
- (A) $c^2 p = a^2 r$ (B) $ar^2 = cp^2$
(C) $q^2 = 2pr - p^2$ (D) $q^2 = 2pr + p^2$
3. If $z = \frac{1-3i}{1+2i}$, then z^{12} is
- (A) 2^6 (B) 2^{12}
(C) -2^{12} (D) -2^6
4. If in a triangle ABC , $a = 25$, $b = 16$ and $c = 9$, then the value of $\tan \frac{A}{2}$ is
- (A) 1 (B) $\frac{1}{\sqrt{3}}$
(C) $\frac{1}{\sqrt{2}}$ (D) $\sqrt{3}$
5. The value of ${}^n C_1 + 2^2 {}^n C_2 + 2^2 \cdot 3 {}^n C_3 + 2^3 \cdot 4 {}^n C_4 + \dots + 2^{n-1} n {}^n C_n$ is
- (A) 2^n (B) 2^{n+1}
(C) $n3^n$ (D) $n3^{n-1}$



6. The complex number z satisfying $|z - z| = 1 + 2i$ is
- (A) $2 - 3i$ (B) $2 + 3i$
(C) $\frac{3}{2} + 2i$ (D) $\frac{3}{2} - 2i$
7. The derivative of the function $f(x) = x|x|$ (x real) at $x = 0$
- (A) does not exist (B) exists and is equal to 0
(C) exists and is equal to 1 (D) exists and is equal to -1
8. If A, B, C are any three sets, then $A \setminus (B \cap C)$ is
- (A) $(A \setminus B) \setminus C$ (B) $(A \setminus C) \setminus B$
(C) $A \cap (B^c \cap C^c)$ (D) $(A \setminus B) \cup (A \setminus C)$
9. If ω is a cube root of unity, then the value of $(1 + \omega)^4 + (1 + \omega^2)^4$ is equal to
- (A) 1 (B) -1
(C) ω (D) ω^2
10. If p and q are relatively prime positive integers, then the gcd of $p + q$ and $p \cdot q$ is
- (A) 1 or 2 (B) 2 or 3
(C) 1 or 3 (D) 1
11. If $0 < y < 1$ and $\log_y x < a$, then
- (A) $x^a = y$ (B) $x < y^a$
(C) $x = y^a$ (D) $x > y^a$



12. The lines $\frac{x-3}{k} = \frac{y-2}{6k} = \frac{z-4}{4}$ and $\frac{x-1}{2} = \frac{y-1}{m} = \frac{z-1}{2m}$ are perpendicular if
- (A) $\frac{2}{m} + \frac{3}{k} = 1$ (B) $\frac{1}{m} + \frac{4}{k} = 3$
(C) $\frac{4}{m} + \frac{1}{k} = 3$ (D) $\frac{1}{m} + \frac{1}{k} = 1$
13. If the graph of the function $y = f(x)$ is represented by the line joining $(-1, 0)$ and $(0, 1)$ in the plane, then $\int_{-1}^0 f(x) dx$ is
- (A) 0 (B) 1
(C) $\frac{1}{2}$ (D) 2
14. If A, B, C and D are four points in the plane with position vectors $\bar{a}, \bar{b}, \bar{c}, \bar{d}$ respectively and are such that $(\bar{a} - \bar{d}) \cdot (\bar{b} - \bar{c}) = 0 = (\bar{b} - \bar{d}) \cdot (\bar{c} - \bar{a})$, then D is
- (A) the circumcenter of the triangle ABC
(B) the ortho center of the triangle ABC
(C) the incenter of the triangle ABC
(D) a point on one of the sides of the triangle ABC
15. If $\lim_{x \rightarrow 0} (1+ax)^{\frac{b}{x}} = e^2$, where a, b are positive numbers, then the value of ab is
- (A) 2 (B) 4
(C) 6 (D) 1



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16. The number of divisors of the form $(2n+1)$ (n - integer) for the integer 1024 is
- (A) 10 (B) 11
(C) 0 (D) 1
17. The value of $\int_0^1 \cos^{-1} x \, dx + \int_0^1 \cos^{-1}(\sqrt{1-x^2}) \, dx$ is
- (A) $\frac{\pi}{2}$ (B) 1
(C) 0 (D) -1
18. The perimeter of the curve $2x^2 + 2y^2 + 2gx + 2fy + c = 0$ is
- (A) $2\pi\sqrt{g^2 + f^2 - c}$ (B) $\pi\sqrt{g^2 + f^2 - c}$
(C) $\pi\sqrt{g^2 + f^2 - 2c}$ (D) $2\pi\sqrt{g^2 + f^2 - 2c}$
19. The area bounded by $y = |x|$ and $y = 3$ in square units is
- (A) 6 (B) 9
(C) 12 (D) 18
20. The distance travelled by a particle moving with a velocity 'v' at time 't' given by $v = t^2 - 2t$ in the time interval $[0, 3]$ is
- (A) $\frac{8}{3}$ (B) $\frac{4}{3}$
(C) 0 (D) $\frac{16}{3}$



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21. If $0 < x < y < 1$, then the relationship between $p = x^y$ and $q = y^x$ is
- (A) $p < q$ (B) $p > q$
(C) $p = q$ (D) $p^q = q^p$
22. The value of $\sum_{k=1}^{99} \frac{1}{(k+1)\sqrt{k+k}\sqrt{k+1}}$ is
- (A) $\frac{11}{10}$ (B) $\frac{10}{11}$
(C) $\frac{9}{10}$ (D) $\frac{10}{9}$
23. The common value of $\frac{x}{a} = \frac{y}{b}$ where x, y, a, b are positive numbers is
- (A) $\frac{x+y}{a-b}$ (B) $\frac{x-y}{a+b}$
(C) $\frac{x \cdot y}{a \cdot b}$ (D) $\frac{xy}{ab}$
24. The value of $\cos(A+B)\cos(A-B)$ is
- (A) $\cos^2 A - \cos^2 B$ (B) $\cos^2 A - \sin^2 B$
(C) $\sin^2 A - \sin^2 B$ (D) $\cos^2 A + \cos^2 B$
25. If A is a non-singular matrix of size $n \times n$ and $I + A + A^2 = 0$ where I is the identity matrix, then A^{-1} is
- (A) A^2 (B) A
(C) I (D) A^3



26. The maximum value of $a \cos \theta + b \sin \theta$ as θ varies in $[0, 2\pi]$ is
- (A) $a + b$ (B) a
 (C) b (D) $\sqrt{a^2 + b^2}$
27. The solution of the differential equation $\frac{dy}{dx} + xy = xy^2$ is
- (A) $y = 1 + ce^{x^2/2}$ (B) $1 + y = ce^{x^2/2}$
 (C) $x^{-1} = 1 + ce^{x^2/2}$ (D) $y^{-1} = 1 + ce^{x^2/2}$
28. The equation of a curve through $(1, 1)$ and having a slope $\frac{x^2 + y^2}{xy}$ at (x, y) is
- (A) $y^2 = x^2 \log x$ (B) $y = x \log x$
 (C) $x = y \log y$ (D) $y^2 = x^2 \log(ex^2)$
29. If z is a complex number and $\omega = \frac{z-i}{i}$, then
- (A) $\operatorname{Re}(\omega) = (\sin(z))^{-1}$ (B) $\operatorname{Re}(\omega) = (\operatorname{Re}(z)) + 1$
 (C) $\operatorname{Re}(\omega) = (\sin(z) + 1)$ (D) $\operatorname{Re}(\omega) = (\operatorname{Re}(z)) - 1$
30. If three complex numbers are in A.P., then they lie on
- (A) a circle (B) a straight line
 (C) a parabola (D) an ellipse
31. The complex numbers $\sin x + i \cos 2x$ and $\cos x - i \sin 2x$ are conjugate to each other for
- (A) one value of x only (B) two values of x only
 (C) three values of x only (D) no value of x



32. If $a < 0$, $b > 0$ and $a < x < b$, then $0 \leq x^2 < b^2$ if
- (A) $|b| \geq |a|$ (B) $|b| < |a|$
(C) $a + b = 1$ (D) $a^2 - 1 < b^2$
33. The number of solutions of $\log_4(x-1) = \log_2(x-3)$ is
- (A) 1 (B) 2
(C) 3 (D) 4
34. If $a^x = b^y = c^z$ and x, y, z are in G.P., then
- (A) $\log_b a = \log_a b$ (B) $\log_b a = \log_c b$
(C) $\log_a x = \log_y b$ (D) $\log_x c = \log_c x$
35. If A and B are square matrices of same order and $A^2 + B^2 = (A+B)(A-B)$, then
- (A) $A = 0$ or $B = 0$ (B) $A = I$ or $B = -I$
(C) $AB = BA$ (D) $A = B$
36. The value of $2^n [1.3.5 \dots (2n-3)(2n-1)]$ is
- (A) $\frac{n!}{(2n)!}$ (B) $\frac{(2n)!}{n!}$
(C) $\frac{(2n)!}{2^n}$ (D) $\frac{n!}{2^n}$
37. The value of $\tan\left(\frac{\pi}{4} + \frac{\theta}{2}\right) + \tan\left(\frac{\pi}{4} - \frac{\theta}{2}\right)$ is
- (A) $2 \cos \theta$ (B) $2 \sec \theta$
(C) $2 \sin \theta$ (D) $2 \operatorname{cosec} \theta$



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38. If $\tan^{-1}\left(\frac{a}{x}\right) + \tan^{-1}\left(\frac{b}{x}\right) = \pi/2$, then x is equal to
- (A) $a + b$ (B) ab
(C) \sqrt{ab} (D) $\frac{a+b}{2}$
39. When the elevation of the Sun changes from 45° to 30° , the shadow of a tower increases by 60 units. Then the height of the tower is
- (A) $30\sqrt{3}$ units (B) $30\sqrt{2}$ units
(C) $30(\sqrt{3} + 1)$ units (D) $30(\sqrt{2} + 1)$ units
40. If the sum of the slopes of the lines given by $x^2 - 2cxy - 7y^2 = 0$ is four times their product, then the value of c is
- (A) 0 (B) 1
(C) -2 (D) 2
41. The eccentricity of the conic $4x^2 + 16y^2 - 24x - 32y = 1$ is
- (A) $\frac{1}{2}$ (B) $\frac{\sqrt{3}}{2}$
(C) $\sqrt{3}$ (D) 2
42. If in a ΔABC , $\frac{1}{a+c} + \frac{1}{b+c} = \frac{3}{a+b+c}$, then the value of $\cos C$ is
- (A) 1 (B) 0
(C) $\frac{1}{2}$ (D) $\frac{\sqrt{3}}{2}$



43. The value of $\tan \left[\frac{1}{2} \sin^{-1} \left(\frac{2a}{1+a^2} \right) + \frac{1}{2} \cos^{-1} \left(\frac{1-a^2}{1+a^2} \right) \right]$ is
- (A) $\frac{2a}{1+a^2}$ (B) $\frac{2a}{1-a^2}$
(C) $\frac{1-a^2}{1+a^2}$ (D) $\frac{1+a^2}{1-a^2}$
44. Let $A = (2, -3)$ and $B = (-2, 1)$ be the vertices of a triangle ABC . If the centroid moves on the line $2x + 3y = 1$, then the locus of the vertex C is
- (A) $2x + 3y = 9$ (B) $2x - 3y = 1$
(C) $-2x + 3y = 1$ (D) $2x + 6y = 9$
45. The centroid of the triangle whose three sides are given by the combined equation $(x^2 + 7xy + 2y^2)(y - 1) = 0$, is
- (A) $\left(\frac{7}{3}, \frac{2}{3} \right)$ (B) $\left(\frac{-7}{3}, \frac{2}{3} \right)$
(C) $\left(\frac{2}{3}, \frac{7}{3} \right)$ (D) $\left(\frac{2}{3}, \frac{-7}{3} \right)$
46. A circle is drawn to cut a chord of length $2a$ along x -axis and to touch the y -axis. The locus of the center of the circle is
- (A) $x^2 + y^2 = a^2$ (B) $x^2 - y^2 = a^2$
(C) $x^2 - y^2 = 4a^2$ (D) $x^2 + y^2 = 4a^2$
47. If the foci of $\frac{x^2}{16} + \frac{y^2}{b^2} = 1$ and $\frac{x^2}{144} - \frac{y^2}{81} = \frac{1}{25}$ coincide, then the value of b^2 is
- (A) 5 (B) 2
(C) 7 (D) 9



48. If $f(x) = [x'] - [x]^2$ where $[x]$ denotes the greatest integer $< x$, and $x \in [0, 2]$, then the set of values of $f(x)$ are
- (A) $\{0\}$ (B) $\{0, 1, 2\}$
(C) $\{0, 1\}$ (D) $\{1, 2\}$
49. The value of $f(x)$ at $x=0$, so that $f(x) = \frac{2^x - 2^{-x}}{x}$ $x \neq 0$ is continuous at $x=0$ is
- (A) $2 \log 2$ (B) $\log 2$
(C) $\frac{1}{2} \log 2$ (D) 1
50. If $f(x) = \frac{x}{1+|x|}$ (x - real), then $f'(0)$
- (A) equals 0 (B) equals 1
(C) equals 2 (D) does not exist
51. If $f(x)$ has a derivative at $x=a$, then $\lim_{x \rightarrow a} \frac{xf(a) - af(x)}{x-a}$ is
- (A) $f(a) - af'(a)$ (B) $f(a) + af'(a)$
(C) $f(a) + f'(a)$ (D) $f(a) - f'(a)$
52. The minimum value of $\frac{x}{\log x}$ ($x > 1$) is
- (A) e (B) $\frac{1}{e}$
(C) 0 (D) 1



53. The two curves $x^3 - 3xy^2 + 2 = 0$ and $3x^2y - y^3 - 2 = 0$
- (A) are orthogonal
(B) touch each other
(C) cut at an angle $\pi/3$
(D) cut at an angle $\pi/4$
54. $\int \frac{dx}{2\sqrt{x}(1+x)}$ is
- (A) $\tan^{-1}(\sqrt{x}) + c$
(B) $2 \tan^{-1}x + c$
(C) $\frac{1}{2} \tan^{-1}\sqrt{x} + c$
(D) $\tan\sqrt{x} + c$
55. The value of $\int \sqrt{e^x - 1} dx$ is
- (A) $2\sqrt{e^x - 1} + \tan^{-1}\sqrt{e^x - 1} + c$
(B) $\sqrt{e^x - 1} + 2 \tan^{-1}\sqrt{e^x - 1} + c$
(C) $2\sqrt{e^x - 1} + 2 \tan^{-1}\sqrt{e^x - 1} + c$
(D) $2\sqrt{e^x - 1} - 2 \tan^{-1}\sqrt{e^x - 1} + c$
56. The area bounded by $y = x^2$ and the line $y = x$ is
- (A) $\frac{1}{3}$ units
(B) $\frac{2}{3}$ units
(C) $\frac{1}{2}$ units
(D) $\frac{1}{6}$ units
57. If the position vector of A is $\bar{a} + 2\bar{b}$ and \bar{a} divides AB in the ratio 2:3, then the position vector of B is
- (A) $\bar{a} - 3\bar{b}$
(B) $\bar{a} + 3\bar{b}$
(C) $3\bar{a} + \bar{b}$
(D) $3\bar{a} - \bar{b}$



58. If $\sum_{i=1}^n |a_i| = 0$ and $|a_i| = 1$ for all i , then $\sum_{1 \leq i < j \leq n} a_i a_j$ is
- (A) n (B) $\frac{n}{2}$
(C) n^2 (D) $\frac{-n^2}{2}$
59. The unit vector coplanar with $\vec{i} - \vec{j}$ and $\vec{i} + 2\vec{j}$ is
- (A) $\pm \frac{1}{\sqrt{2}}(\vec{i} + \vec{j})$ (B) $\pm \frac{1}{\sqrt{5}}(2\vec{i} + 2\vec{j})$
(C) $\pm \frac{1}{\sqrt{5}}(2\vec{i} + \vec{j})$ (D) $\pm \frac{1}{\sqrt{2}}(5\vec{i} + 5\vec{j})$
60. The direction cosines of the line $\frac{x-2}{2} = \frac{2y-5}{-3}, z=1$ are
- (A) $\left(\frac{3}{5}, \frac{4}{5}, 0\right)$ (B) $\left(\frac{-4}{5}, \frac{3}{5}, 0\right)$
(C) $\left(\frac{4}{5}, \frac{3}{5}, 0\right)$ (D) $\left(\frac{3}{5}, \frac{4}{5}, 1\right)$
61. Let n be a two digit number. $P(n)$ is the product of the digits of n and $S(n)$ is the sum of the digits of n . If $n = P(n) + S(n)$, then the unit digit of n is
- (A) 1 (B) 5
(C) 7 (D) 9
62. The value of $\sqrt{20 + \sqrt{20 + \sqrt{20 + \dots}}}$ is
- (A) 2^{10} (B) 5
(C) 4 (D) ∞



63. How many three-digit numbers greater than 600 can be formed by using the digits 4, 5, 6, 7, 8 ?

- (A) 75 (B) 65
(C) 55 (D) 85

64. If $A = \begin{bmatrix} 2 & 1 \\ 3 & 4 \end{bmatrix}$ is a square matrix, then $A(\text{adj}A) =$

- (A) $\begin{bmatrix} 1/5 & 0 \\ 0 & 1/5 \end{bmatrix}$ (B) $\begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix}$
(C) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ (D) $\begin{bmatrix} 4 & -1 \\ -3 & 2 \end{bmatrix}$

65. The rank of the matrix $A = \begin{bmatrix} 1 & 1 & 1 & 3 \\ 2 & -1 & 3 & 4 \\ 5 & -1 & 7 & 11 \end{bmatrix}$ is

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

66. If the projection of \vec{a} on \vec{b} and projection of \vec{b} on \vec{a} are equal for all a^{-1} and b^{-1} , then the angle between $\vec{a} + \vec{b}$ and $\vec{a} - \vec{b}$ is

- (A) $\pi/3$ (B) $\pi/2$
(C) $\pi/4$ (D) $2\pi/3$

67. If G is the centroid of a triangle ABC , then $\vec{GA} + \vec{GB} + \vec{GC}$ is equal to

- (A) $3(\vec{OA} + \vec{OB} + \vec{OC})$ (B) \vec{OG}
(C) \vec{O} (D) $\frac{\vec{OA} + \vec{OB} + \vec{OC}}{3}$



68. The skew lines are
- (A) parallel lines
 - (B) intersecting lines
 - (C) neither parallel nor intersecting lines
 - (D) coplanar lines
69. The two lines $\frac{x-1}{2} = \frac{y-1}{-1} = \frac{z}{1}$ and $\frac{x-2}{3} = \frac{y-1}{-5} = \frac{z-1}{2}$ are
- (A) parallel
 - (B) intersecting
 - (C) skew
 - (D) perpendicular
70. The polar form of the complex number $(i^{25})^3$ is
- (A) $\cos \frac{\pi}{2} + i \sin \frac{\pi}{2}$
 - (B) $\cos \pi + i \sin \pi$
 - (C) $\cos \pi - i \sin \pi$
 - (D) $\cos \frac{\pi}{2} - i \sin \frac{\pi}{2}$
71. If ω is a cube root of unity, then the value of $(1 - \omega + \omega^2)^3 + (1 + \omega - \omega^2)^3$ is
- (A) 0
 - (B) 32
 - (C) 16
 - (D) 16
72. The solution of $\frac{d^3y}{dx^3} + \frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 4y = 0$ is
- (A) $y = c_1e^{-x} + xc_2e^{-x} + x^2c_3e^{-x}$
 - (B) $y = c_1 \cos 2x + c_2 \sin 2x$
 - (C) $y = c_1 \cos 2x + c_2 \sin 2x + c_3e^{-x}$
 - (D) $y = c_1e^x + c_2e^{-x} + c_3$



73. The order and degree of the differential equation

$$\left(1 + \left(\frac{dy}{dx}\right)^2\right)^{3/2} = p \frac{d^2y}{dx^2}$$
 are respectively

- (A) 1, 2 (B) 1, 6
(C) 2, 2 (D) 2, 3

74. Which of the following is not a solution of $y'' + y = 0$?

- (A) $y = \sin x$ (B) $y = \cos x$
(C) $y = 3 \cos x$ (D) $y = \sin x + (1/2)$

75. The general solution of $ydx - xdy = 0$ is

- (A) $x/y = c$ (B) $x - y = c$
(C) $xy = c$ (D) $x + y = c$

76. The value of $\lim_{x \rightarrow \infty} \left(1 + \frac{1}{x}\right)^x$ is

- (A) ∞ (B) 0
(C) e (D) 1

77. The value of $\sin(4005^\circ)$ is

- (A) $-1/\sqrt{2}$ (B) $1/\sqrt{2}$
(C) $1/2$ (D) $-1/2$

78. The value of $\lim_{x \rightarrow \infty} x \sin(1/x)$ is

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



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79. If the straight lines $2x + 3ay - 1 = 0$ and $3x + 4y + 1 = 0$ are mutually perpendicular, then the value of a is
- (A) $8/9$ (B) $-1/2$
(C) -8 (D) $1/2$
80. If $1, \omega, \omega^2$ are the cube roots of unity, then the roots of $(x - 1)^3 + 8 = 0$ are
- (A) $1, -1, -1$ (B) $-1, 1 + 2\omega, 1 + 2\omega^2$
(C) $1, \omega, 2\omega$ (D) $-1, 1 - 2\omega, 1 - 2\omega^2$
81. The function $f(x) = |x|$ at $x = 0$ is
- (A) continuous and differentiable
(B) continuous but not differentiable
(C) not continuous but differentiable
(D) neither continuous nor differentiable
82. The collection of intelligent students in a class is
- (A) a null set (B) a singleton set
(C) a finite set (D) not a well defined one
83. The distance between the parallel lines $2x + 3y - 6 = 0$ and $2x + 3y + 7 = 0$ is
- (A) $1/\sqrt{13}$ (B) 1
(C) $\sqrt{13}$ (D) 13
84. If a polygon has 44 diagonals, then the number of its sides is
- (A) 8 (B) 12
(C) 7 (D) 11



85. The direction cosines of $2\vec{i} + \vec{j} + 7\vec{k}$ are
- (A) $2/3\sqrt{6}, -1/3\sqrt{6}, 7/3\sqrt{6}$ (B) $-2/3\sqrt{6}, 1/3\sqrt{6}, 7/3\sqrt{6}$
(C) $-2/3\sqrt{6}, -1/3\sqrt{6}, 7/3\sqrt{6}$ (D) $2/\sqrt{6}, -1/\sqrt{6}, 7/\sqrt{6}$
86. The value of $[\vec{a} \times \vec{b}, \vec{b} \times \vec{c}, \vec{c} \times \vec{a}]$ is
- (A) $[\vec{a}, \vec{b}, \vec{c}]$ (B) 0
(C) $[\vec{a}, \vec{b}, \vec{c}]^2$ (D) 1
87. The absolute value of $\frac{(1+3i)(1-2i)}{(3+4i)}$ is
- (A) $\sqrt{2}$ (B) 2
(C) $\sqrt{5}$ (D) 5
88. The equation of the chord of contact of tangents from (2,1) to the hyperbola $\frac{x^2}{16} - \frac{y^2}{9} = 1$ is
- (A) $9x - 8y - 72 = 0$ (B) $9x + 8y + 72 = 0$
(C) $8x - 9y - 72 = 0$ (D) $8x + 9y + 72 = 0$
89. The ratio of actual change in y to actual value of y is
- (A) percentage error (B) relative error
(C) absolute error (D) truncation error



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90. If u is a homogeneous function of x and y of degree n , then

$$(A) \quad y \frac{\partial^2 u}{\partial x \partial y} + x \frac{\partial^2 u}{\partial y^2} = (n+1) \frac{\partial u}{\partial y} \quad (B) \quad x \frac{\partial^2 u}{\partial y^2} + y \frac{\partial^2 u}{\partial x^2} = (n-1) \frac{\partial u}{\partial x}$$

$$(C) \quad x \frac{\partial^2 u}{\partial x^2} + y \frac{\partial^2 u}{\partial y^2} = (n-1) \frac{\partial u}{\partial y} \quad (D) \quad x \frac{\partial^2 u}{\partial x \partial y} + y \frac{\partial^2 u}{\partial y^2} = (n-1) \frac{\partial u}{\partial y}$$

91. If $F(1) = 2$ and $F(n) = F(n-1) + \frac{1}{2}$ for all integers $n > 1$, then the value of $F(51)$ is

$$(A) \quad 25$$

$$(B) \quad 26$$

$$(C) \quad 27$$

$$(D) \quad 28$$

92. $\lim_{n \rightarrow \infty} \left(\frac{3}{2}\right)^n$ is

$$(A) \quad 1$$

$$(B) \quad 0$$

$$(C) \quad \frac{3}{2}$$

$$(D) \quad \infty$$

93. Assume that $p(x)$ is a polynomial on the set of real numbers. If

$p(0) = p(2) = 3$ and $p'(0) = p'(2) = -1$, then $\int_0^2 xp''(x) dx$ is

$$(A) \quad -3$$

$$(B) \quad -2$$

$$(C) \quad -1$$

$$(D) \quad 1$$



94. If $\cos x$ is an integrating factor of the differential equation $\frac{dy}{dx} + Py = Q$, then P is

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

95. In the multiplicative group of cube roots of unity, the order of ω^2 is

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

96. If $A = [a_{ij}] = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & -3 \\ 2 & -1 & 3 \end{bmatrix}$, then the cofactor of a_{23} is

- (A) 3 (B) -9
(C) -5 (D) 1

97. Two aeroplanes I and II bomb a target in succession. The probabilities of I and II hitting the target correctly are 0.3 and 0.2 respectively. The second plane will bomb only if the first misses the target. The probability that the target is hit by the second plane is

- (A) 0.2 (B) 0.06
(C) 0.14 (D) 0.7

98. If $-i + 2$ is one root of the equation $ax^2 - bx + c = 0$, then the values of a, b, c are

- (A) $a = 1, b = 4, c = 5$ (B) $a = 1, b = -4, c = 5$
(C) $a = 1, b = -4, c = -5$ (D) $a = 1, b = 4, c = -5$



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99. If A , B and C are three sets such that $A \cap B = A \cap C$ and $A \cup B = A \cup C$, then
- (A) $A = C$ (B) $B = C$
(C) $A \cap B = \phi$ (D) $A = B$
100. An investigator interviewed 100 students to determine their preferences for the three drinks: milk(M), coffee(C) and tea(T). He reported the following: 10 students had all the three drinks M,C,T; 20 had M and C; 30 had C and T; 25 had M and T only; 12 had M only; 5 had C only; 8 had T only. Find how many did not take any of the three drinks
- (A) 10 (B) 20
(C) 36 (D) 42
101. Let $R = \{(1,3), (4,2), (2,4), (2,3), (3,1)\}$ be a relation on the set $A = \{1, 2, 3, 4\}$. The relation R is
- (A) a symmetric (B) reflexive
(C) not symmetric (D) transitive
102. If $f(x)$ is a function such that $f(x+y) = f(x) + f(y)$ and $f(1) = 7$, then $\sum_{r=1}^n f(r) =$
- (A) $\frac{7n}{2}$ (B) $\frac{7(n+1)}{2}$
(C) $7n(n+1)$ (D) $\frac{7n(n+1)}{2}$



103. Let $f: N \rightarrow Y$ be a function defined as $f(x) = 4x + 3$ where $Y = \{y \in N : y = 4x + 3 \text{ for some } x \in N\}$. Then the inverse of f
- (A) does not exist (B) is $\frac{3y+4}{4}$
(C) is $\frac{y-3}{4}$ (D) is $4 + \frac{y+3}{4}$
104. The domain of the function $f(x) = \frac{1}{\sqrt{|x|-x}}$ is
- (A) $(-\infty, 0)$ (B) $(-\infty, \infty) - \{0\}$
(C) $(-\infty, \infty)$ (D) $(0, \infty)$
105. If $\begin{vmatrix} 6i & -3i & 1 \\ 4 & 3i & -1 \\ 20 & 3 & i \end{vmatrix} = x + iy$, then
- (A) $x = 3, y = 1$ (B) $x = -1, y = -3$
(C) $x = 0, y = 3$ (D) $x = 0, y = 0$
106. If $|z + 4| < 3$, then the maximum value of $|z + 1|$ is
- (A) 4 (B) 10
(C) 6 (D) 0
107. If $|z^2 - 1| = |z|^2 + 1$, then z lies on
- (A) the real axis (B) an ellipse
(C) a circle (D) the imaginary axis
108. If $1 - p$ is a root of quadratic equation $x^2 + px + (1 - p) = 0$, then its roots are
- (A) 0, 1 (B) -1, 2
(C) 0, -1 (D) -1, 1



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109. If x is real, the maximum value of $(3x^2 + 9x + 17) / (3x^2 + 9x + 7)$ is
- (A) 1 (B) 17/7
(C) 1/4 (D) 41
110. The value of a for which the sum of the squares of the roots of the equation $x^2 - (a-2)x - a - 1 = 0$ assumes the least value is
- (A) 0 (B) 1
(C) 2 (D) 5
111. If $A = \begin{bmatrix} a & b \\ b & a \end{bmatrix}$ and $A^2 = \begin{bmatrix} \alpha & \beta \\ \beta & \alpha \end{bmatrix}$, then
- (A) $\alpha = a^2 + b^2, \beta = 2ab$ (B) $\alpha = a^2 + b^2, \beta = a^2 - b^2$
(C) $\alpha = 2ab, \beta = a^2 + b^2$ (D) $\alpha = a^2 + b^2, \beta = ab$
112. If $D = \begin{vmatrix} 1 & 1 & 1 \\ 1 & 1+x & 1 \\ 1 & 1 & 1+y \end{vmatrix}$ for $x \neq 0, y \neq 0$, then D is
- (A) divisible by neither x nor y
(B) divisible by both x and y
(C) divisible by x but not by y
(D) divisible by y but not by x
113. Statement-1: the maximum area of rectangle in a circle of radius 5 is 50 sq.units
Statement-2: the maximum rectangle inscribed in a circle is square
- (A) Statement-1 is true, Statement-2 is false
(B) Statement-1 is false, Statement-2 is true
(C) Statement-1 is true, Statement-2 is true, Statement-2 is correct explanation for Statement-1
(D) Statement-1 is true, Statement-2 is true, Statement-2 is not correct explanation for Statement-1



114. Consider the system of linear equation $x_1 + 2x_2 + x_3 = 3$; $2x_1 + 3x_2 + x_3 = 3$; $3x_1 + 5x_2 + 2x_3 = 1$. The system has
- (A) infinite number of solutions
 - (B) exactly three solutions
 - (C) a unique solution
 - (D) no solution
115. The number of ways that 5 Mathematics, 4 Physics and 2 Chemistry books can be arranged so that the 3 Physics books kept together and 2 Chemistry books not together is
- (A) 1, 81, 440
 - (B) 1, 80, 430
 - (C) 1, 18, 316
 - (D) 1, 18, 430
116. The set $S = \{1, 2, 3, \dots, 12\}$ is to be partitioned into three sets A, B, C of equal size. The number of ways to partition S is
- (A) $\frac{12!}{3!(4!)^3}$
 - (B) $\frac{12!}{3!(3!)^4}$
 - (C) $\frac{12!}{(4!)^3}$
 - (D) $\frac{12!}{(3!)^4}$
117. From 6 different novels and 3 different dictionaries, 4 novels and 1 dictionary are to be selected and arranged in a row on a shelf so that the dictionary is always in the middle. Then the number of such arrangements is
- (A) at least 500 but less than 750
 - (B) at least 750 but less than 1000
 - (C) at least 1000
 - (D) less than 500
118. The coefficient of x^7 in the expansion of $(1 - x - x^2 + x^3)^6$ is
- (A) 144
 - (B) 132
 - (C) 144
 - (D) -132



119. For natural numbers m, n if $(1 - y)^m(1 + y)^{n-1} = a_1 y + a_2 y^2 + \dots$, and $a_1 = a_2 = 10$, then (m, n) is
- (A) (45, 35) (B) (35, 45)
(C) (20, 45) (D) (35, 20)
120. If $|x| < 1$, then the coefficient of x^n in expansion of $(1 + x + x^2 + x^3 + \dots)^2$ is
- (A) n (B) $n - 1$
(C) $n + 2$ (D) $n + 1$
121. Fifth term of a G.P. is 2. Then the product of its first 9 terms is
- (A) 256 (B) 512
(C) 1024 (D) 128
122. If $b + c, c + a, a + b$ are in A.P., then a, b, c are in
- (A) A.P. (B) G.P.
(C) H.P. (D) neither A.P., G.P. nor H.P.
123. $\frac{1}{2.3} + \frac{1}{4.5} + \frac{1}{6.7} + \dots =$
- (A) $\log_e 2$ (B) $\log_e 2 - 1$
(C) $1 - \log_e 2$ (D) $1 + \log_e 2$
124. Let $f: R \rightarrow R$ 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) 1 (B) $2/3$
(C) $3/2$ (D) 3



125. $\lim_{x \rightarrow 1} \frac{x^2 - 1}{|x - 1|} =$

- (A) 2
(C) ∞

- (B) -2
(D) does not exist

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126. The wave particle nature of an object is related through the equation

(A) $\frac{\lambda}{p} = h$

(B) $\lambda \cdot p = h$

(C) $\Delta x \cdot \Delta p < h$

(D) $\frac{\Delta p}{\Delta x} > h$

127. When a plane electromagnetic wave propagates through a very good conducting medium, the magnetic component of the wave lags behind the electric field by

(A) 90°

(B) 60°

(C) 45°

(D) 180°

128. A plane wave is represented mathematically as

(A) e^{+kx}

(B) e^{-kx^2}

(C) $e^{+i \ln x}$

(D) e^{+ikx}

129. Choose among the pairs listed below the one which has the same dimensionality.

(A) Velocity - Energy

(B) Mass - Energy

(C) Velocity - Momentum

(D) Angular momentum - Planck's const.



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130. The anti-particle of electron is known as
- (A) Neutrino (B) Proton
(C) Muon (D) Positron
131. The polarisation vector \vec{P} of a dielectric material is related to its displacement current vector \vec{D} as
- (A) $\vec{P} = \left(\frac{\epsilon_r - 1}{\epsilon_r}\right)\vec{D}$ (B) $\vec{P} = \left(\frac{\epsilon_r + 1}{\epsilon_r}\right)\vec{D}$
(C) $\vec{P} = \left(\frac{\epsilon_r}{\epsilon_r - 1}\right)\vec{D}$ (D) $\vec{P} = \epsilon_r\vec{D}$
132. The statement that 'the line integral of the tangential component of the magnetic field strength around a closed path is equal to the current enclosed by a path' represents
- (A) Faraday's Law (B) Biot-Savart's Law
(C) Ampere's Law (D) Ampere-Maxwell Law
133. The angle of incidence of light at the interface of two dielectric media which results into zero reflection is called
- (A) Angle for total internal reflection
(B) Brewster angle
(C) Rayleigh's angle
(D) Angle of polarisation
134. The magnetic field \mathbf{H} produced at the centre of a square current loop of side length L kept in $x-y$ plane carrying a current I is given by
- (A) $\frac{2\sqrt{2}I}{\pi L} \hat{z}$ (B) $\frac{2\sqrt{2}I}{\pi L} \hat{x}$
(C) $\frac{2\sqrt{2}IL}{4\pi} \hat{z}$ (D) $\frac{\sqrt{2}I}{4\pi L} \hat{y}$



135. The intensity of 60 dB sound corresponds to
- (A) 60 W/m^2 (B) 1 W/m^2
(C) $1 \mu\text{W/m}^2$ (D) $60 \mu\text{W/m}^2$
136. An ideal gas in a cylinder is compressed adiabatically to $1/3$ of its original volume. During the process, if 45J of work is being done, then how much heat flowed into the gas?
- (A) 45J (B) 22.5J
(C) Zero (D) 15J
137. How much of the charge will be stored in a capacitor consisting of two concentric spheres of radii 30 cm and 31 cm if you apply a potential difference of 250 V?
- (A) 517 nC (B) 258 nC
(C) 278 μC (D) 400 C
138. Torque is generally measured in units of
- (A) N/m (B) N/m^2
(C) $N.m^2$ (D) Nm
139. What would be the magnetic field produced due to a wire carrying 3A current at a point $1/2$ m away?
- (A) 0.12 Gauss (B) 0.22 Gauss
(C) 3.4 Tesla (D) 0.12 Tesla
140. One light year is equivalent to
- (A) 9.47×10^{12} years (B) 2.998×10^{10} years
(C) 9.47×10^{12} km (D) 2.998×10^{12} m/sec



141. A ray of light passes from crown glass to water. If the refractive index of the crown glass is 1.52 and that of water is 1.333, then the critical angle of incidence is equal to
- (A) 90° (B) 45°
(C) 33.6° (D) 61.3°
142. The average distance a molecule travels between successive collisions is called as
- (A) RMS displacement (B) Drift velocity
(C) Mean free path (D) Impact parametre
143. Mixture of solid or liquid particles suspended in air is known as
- (A) moist (B) fog
(C) aerosols (D) pollutants
144. The motion of a particle whose acceleration is always directed towards a fixed point and directly proportional to its distance from that point is referred as
- (A) Forced harmonic motion (B) Damped harmonic motion
(C) Simple harmonic motion (D) Coupled harmonic motion
145. 'The total energy flux radiated by a black body is related to its temperature' according to
- (A) Boltzmann relation (B) Stefan's T^4 Law
(C) Planck's Law (D) Wein's T^{-2} Law
146. A diffraction grating having 7000 lines/cm is illuminated with a laser beam. If its second order spectral line is seen at 62.4° , then what is the colour of the laser light?
- (A) Green (B) Violet
(C) Red (D) White



147. As a satellite sweeps past the Earth with a speed of 800 km/min, it sends out a pulse of light ahead of it. How fast does the light pulse move as observed by a person on the Earth? (v = velocity of light)
- (A) 800 km/min
(B) 100 km/min
(C) $\sqrt{1 - 800/v}$ km/min
(D) v
148. The Newton's formula for the velocity of the longitudinal waves in a medium is expressed as
- (A) $\sqrt{\frac{\text{density}}{\text{bulk modulus}}}$
(B) $\sqrt{\frac{\text{mass}}{\text{bulk modulus}}}$
(C) $\sqrt{\text{density} \cdot \text{bulk modulus}}$
(D) $\sqrt{\frac{\text{bulk modulus}}{\text{density}}}$
149. Farad per metre is the unit of
- (A) Capacitance of a parallel plate capacitor kept at one metre separation
(B) Permittivity of free space
(C) Relative permittivity of the medium
(D) Permeability of vacuum
150. At what temperature the velocity of sound in air be double than that at 27°C ?
- (A) 927°C
(B) 54°C
(C) 819°C
(D) 1200°C
151. The pressure and kinetic energy of ideal molecular gas numerically is related as
- (A) $P = E$
(B) $P = \frac{2}{3} E$
(C) $P = \frac{1}{3} E$
(D) $P = \frac{3}{2} E$



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152. The total number of Helium atoms in 1 gm of Helium gas would be close to
- (A) 3×10^{23} (B) 6×10^{23}
(C) 12×10^{23} (D) 6×10^{26}
153. The number of atoms in a body centered cubic unit cell is equal to
- (A) one (B) two
(C) four (D) six
154. Good optical reflectors are conventionally made of
- (A) ionic crystals (B) any materials
(C) metals (D) semi conductors
155. Among the solar planetary systems the planet that is made disqualified recently from the nine major planets is
- (A) Mercury (B) Venus
(C) Neptune (D) Pluto
156. As a car starts to move from rest with acceleration 1.4 m/s^2 , another car moving with a constant speed of 12 m/s passes in a parallel lane. At what time span the first can overtake the second car?
- (A) 17 s (B) 20 s
(C) 13.4 s (D) 12.4 s
157. 5 litre of water at 80°C is to be cooled down to 20°C by mixing cold water at 0°C . How much of the cold water is required?
- (A) 1.5 litre (B) 3.0 litre
(C) 15.0 litre (D) 5.0 litre



158. The relationship between the current density \vec{J} and the electric field \vec{E} given by $\vec{J} = \sigma\vec{E}$ equivalently represents
- (A) Maxwell's Law (B) Ohm's Law
(C) Coulomb's Law (D) Gauss's Law
159. Generally the temperature of a distant star is estimated using
- (A) the luminosity measurements
(B) the red shift measurements
(C) Doppler broadening of spectral lines
(D) absorption spectra
160. Dark lines in the solar spectrum are known as
- (A) Fresnel's lines (B) Emission lines
(C) Balmer lines (D) Fraunhofer lines
161. A dielectric cube of side L and centre at the origin has a radial polarisation given by $\vec{P} = a\vec{r}$, where a is a constant and $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$. The total bound volume charge density is given by
- (A) $3a$ (B) $-6a$
(C) $+12a$ (D) $+6a$
162. The angle between the two vector quantities $\vec{A} = 4\hat{i} - 2\hat{j} - \hat{k}$ and $\vec{B} = \hat{i} + 4\hat{j} - 4\hat{k}$ is equal to
- (A) 0° (B) 60°
(C) 90° (D) 30°
163. The Planck's constant h is physically equivalent to
- (A) Energy (B) Power
(C) Energy flow (D) Angular momentum



164. Wavelength associated with 1.0 eV is given by
- (A) 8066 cm (B) 1.24×10^{-4} cm
(C) 1.6×10^{-8} cm (D) 1780 cm
165. According to the liquid drop model the ratio of the electrostatic energy and the surface energy of a stable nucleus is related to its atomic number (Z) and mass number (A) as
- (A) $\frac{Ze^3}{A}$ (B) $\frac{Ze}{A^2}$
(C) $\frac{Z^2e^2}{A}$ (D) $\frac{Ze^2}{A^3}$
166. Which of the following is the dimension of Magnetic flux?
- (A) $ML^2T^{-2}I^{-1}$ (B) $ML^{-2}T^{-2}I^{-2}$
(C) $ML^2T^{-2}I^{-1}$ (D) $ML^2T^{-2}I^{-2}$
167. The acceleration 'a' (in ms^{-1}) of a body, starting from rest varies with time 't' (in sec) according to the relation, $a = 4t + 2$. The velocity of the body at time $t = 3s$ will be
- (A) $18 ms^{-1}$ (B) $20 ms^{-1}$
(C) $24 ms^{-1}$ (D) $14 ms^{-1}$
168. Body moving in a straight line traces a path of 40 m in the 4th second and a distance of 60 m in the 6th second. The initial velocity and acceleration respectively will be
- (A) $10 ms^{-1}, 5 ms^{-2}$ (B) $5 ms^{-1}, 10 ms^{-2}$
(C) $10 ms^{-1}, 10 ms^{-2}$ (D) $10 ms^{-1}, 10 ms^{-1}$



169. A chain hanging from the ceiling of a bus is inclined towards the rear of the bus. This implies that the bus is
- (A) at rest
 - (B) decelerated
 - (C) in a constant speed
 - (D) accelerated
170. What will be the directions of velocity and acceleration for a body which is at the highest point of its trajectory?
- (A) Parallel to each other
 - (B) Perpendicular to each other
 - (C) Inclined to each other at an angle of 60°
 - (D) Antiparallel to each other
171. If a body is projected with a maximum range of 300 m, what is the maximum height attained by it?
- (A) 175m
 - (B) 75m
 - (C) 150m
 - (D) 100m
172. Which of the following parameters do not vary during the motion of a launch vehicle, when it is fired?
- (A) Kinetic energy
 - (B) Momentum
 - (C) Horizontal component
 - (D) Vertical component
173. The tension in the rope used to pull a body on an inclined surface remains constant at all the points, if and only if
- (A) the rope is not accelerated
 - (B) the rope is mass less
 - (C) this condition is satisfied always
 - (D) either the rope is not accelerated or it is mass less



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174. A boy travelling in a bus tosses a coin. The coin falls behind him. This is due to the bus which is moving
- (A) forward with a finite acceleration
 - (B) forward with a finite retardation
 - (C) backward with uniform speed
 - (D) forward with uniform speed
175. A rope of mass 8 kg and length 4 m is hanging vertically from a rigid support. The tension in the rope at a point 1 m from the support will be
- (A) 20 N
 - (B) 30 N
 - (C) 40 N
 - (D) 60 N
176. Particles of masses m and $3m$ have linear momenta in the ratio of 3:1. What is the ratio of their kinetic energies?
- (A) 9
 - (B) 27
 - (C) 18
 - (D) 3
177. A position dependent force $F = 4 - 2x + 6x^2$ Newton acts on a body and displaces it from $x = 0$ to $x = 4$ m. The work done in Joules is
- (A) 128 J
 - (B) 64 J
 - (C) 192 J
 - (D) 256 J
178. A rocket works on the principle of conservation of
- (A) Linear momentum
 - (B) Kinetic energy
 - (C) Angular momentum
 - (D) Mass
179. Optical power of a thin lens in a medium, when ' n_0 ' is the refractive index of the medium and ' n ' is the refractive index of the lens is
- (A) $\phi = (n + n_0)(1/R_1 - 1/R_2)$
 - (B) $\phi = (n - n_0)(1/R_1 + 1/R_2)$
 - (C) $\phi = (n - n_0)(1/R_1 - 1/R_2)$
 - (D) $\phi = (n + n_0)(1/R_1 + 1/R_2)$



180. If the Earth be in half of its distance from the Sun, how many days will be in one year?
- (A) 183 (B) 730
(C) 129 (D) 365
181. Energy in electron volt corresponding to Compton wavelength 0.0242 \AA is
- (A) 0.1586 MeV (B) 0.5168 MeV
(C) 0.6518 MeV (D) 0.1856 MeV
182. A piece of Gold (Au) and Germanium (Ge) are cooled from room temperature to 75 K. Then the resistance of
- (A) each of them increases
(B) Au increases and that of Ge decreases
(C) Au decreases and that of Ge increases
(D) each of them decreases
183. "Spectral line of the emission is same as that of the absorption" is the statement of
- (A) Planck's law (B) Kirchhoff's law
(C) Huygen's hypothesis (D) Soddy's law
184. Number of photons emitted by 100 W Sodium lamp in one second is (Given $\lambda = 5.89 \times 10^{-9}$; $h = 6.625 \times 10^{-34}$)
- (A) 2.9×10^{20} (B) 1.9×10^{18}
(C) 2.9×10^{18} (D) 1.9×10^{20}
185. Which of the following is correct for a transistor?
- (A) Collector current increases as increase in emitter area
(B) Collector current decreases as increase in emitter area
(C) Collector current increases as decrease in emitter area
(D) Collector current decreases as decrease in emitter area

186. A radian per second is a unit of
(A) angular displacement (B) angular velocity
(C) angular acceleration (D) angular momentum
187. If the resultant force acting on a body of constant mass is zero, then the body's momentum is
(A) increasing (B) decreasing
(C) constant (D) zero
188. Mass defect ΔM is always
(A) positive (B) negative
(C) constant (D) zero
189. Which of the following pairs are vector quantities?
(A) Time and Space (B) Mass and Force
(C) Force and Momentum (D) Time and Energy
190. Consider two long, straight and parallel conducting wires carrying currents flowing in opposite directions in them. Then, the force per unit length between them is always
(A) Attractive (B) Repulsive
(C) Infinite (D) Zero
191. To get an n-type doped semiconductor, the impurity to be added should have its electron valency equal to
(A) 1 (B) 3
(C) 2 (D) 5
192. The angle of rotation of plane of vibration produced by 0.30 m length of solution of concentration $0.2 \times 10^3 \text{ kg/m}^3$ and $S = 0.01 \text{ radian/m/kg/m}^3$ is
(A) 34.37 degrees (B) 32.36 degrees
(C) 36.20 degrees (D) 35.50 degrees



193. Number of electrons crossing a point every second in a conductor, when current of 1 amp flows through it, is
- (A) 1.602×10^{-19} (B) 1
(C) 3×10^8 (D) 6.25×10^{18}
194. Two uniform brass rods A and B of lengths l and $2l$ and radii $2r$ and r respectively are heated to the same temperature. The ratio of the increase in the length of A to that of B is
- (A) 1 : 1 (B) 1 : 2
(C) 1 : 4 (D) 2 : 1
195. The average kinetic energy of a molecule of a gas at absolute temperature T is proportional to
- (A) $1/T$ (B) \sqrt{T}
(C) T (D) T^2
196. The amount of energy radiated by a body depends upon
- (A) the nature of its surface
(B) the area of its surface
(C) the temperature of its surface
(D) All the above factors
197. When a capacitor is connected to a battery
- (A) no current flows in the circuit
(B) a current flows in the circuit for some time and then decreases to zero
(C) the current keeps on increasing, reaching maximum value when the capacitor is charged to the voltage of the battery
(D) an alternating current flows in the circuit



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198. A wire of length ' L ' carrying a current I is bent into a circle. The magnitude of the magnetic field at the centre of the circle is

(A) $\frac{II\mu_0 I}{L}$

(B) $\frac{\mu_0 I}{2L}$

(C) $\frac{2II\mu_0 I}{L}$

(D) $\frac{\mu_0 I}{2II L}$

199. Thin oil films on water show brilliant colours. This is due to

(A) dispersion

(B) diffraction

(C) polarisation

(D) interference

200. In Young's double slit experiment, if the distance between the slits and the screen is doubled and the separation between the slits is reduced to half, the fringe width

(A) is doubled

(B) becomes four times

(C) is halved

(D) remains unchanged

CHEMISTRY

201. The major organic compound formed by the reaction of 1,1,1-Trichloroethane with silver powder is

(A) 2-Butene

(B) Acetylene

(C) Ethene

(D) 2-Butyne

202. An aromatic compound 'A' (C_7H_9N) on reacting with $NaNO_2/HCl$ at $0^\circ C$ forms benzyl alcohol and nitrogen gas. The number of isomers possible for the compound 'A' is

(A) 3

(B) 6

(C) 7

(D) 5



203. Arrange p-toluidine(I), N, N-dimethyl-p-toluidine(II), p-nitroaniline(III) and aniline(IV) in order of decreasing basicity.

- (A) $I > IV > III > II$ (B) $I > II > III > IV$
(C) $II > I > IV > III$ (D) $III > I > II > IV$

204. Examine the following statements regarding S_N2 reaction.

1. The rate is independent of concentration of nucleophile
2. The nucleophile attacks the carbon atom on the side of molecule opposite to the group displaced
3. The reaction proceeds with simultaneous bond formation and rupture

Which of the above statements are correct?

- (A) 1 and 2 (B) 1 and 3
(C) 1, 2 and 3 (D) 2 and 3

205. Among the following statements on the nitration of aromatic compounds, which one is false?

- (A) The rate of nitration of benzene is almost the same as that of hexadeuterobenzene
(B) The rate of nitration of toluene is greater than that of benzene
(C) The rate of nitration of benzene is greater than that of hexadeuterobenzene
(D) Nitration is an electrophilic substitution reaction

206. Reaction of trans-2-phenyl-1-bromocyclopentane on reaction with alcoholic KOH produces

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

207. Hydroboration followed by Oxidation of 2-Methylpropene gives

- (A) 2-Methyl-2-propanol (B) 1,2,3-Propanetriol
(C) 2-Methyl-1-propanol (D) 1,2-Propanediol

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208. A hydrocarbon C_6H_{12} on ozonolysis gives only one product which does not give silver mirror with Tollens reagent. The hydrocarbon is
- (A) 2,3-Dimethyl-2-butene (B) 2-Hexene
(C) 2-Methyl-2-pentene (D) 3-Hexene
209. Which statement is false regarding acetaldehyde and acetone?
- (A) Both react with hydrazine to form hydrazones
(B) Both react with hydroxylamine to form oximes
(C) Both reduce ammonical silver nitrate to silver
(D) Both react with sodium bisulphate to form addition products
210. Decreasing order of reactivity towards nucleophilic addition reactions for the following compounds is
I) $HCHO$ II) CH_3COCH_3 III) CH_3CHO IV) $C_6H_5COCH_3$
- (A) $I > III > II > IV$ (B) $I > III > IV > II$
(C) $III > I > II > IV$ (D) $II > IV > III > I$
211. Identify the products A and B of the following reaction.
- $$C_6H_5CHO + HCHO + NaOH \xrightarrow{\text{aqueous}} A + B$$
- (A) $C_6H_5COONa + CH_3OH$ (B) $C_6H_5COONa + HCOONa$
(C) $C_6H_5CH_2OH + CH_3OH$ (D) $C_6H_5CH_2OH + HCOONa$
212. The product 'Y' of the following reaction
- $$2CH_3CHO \xrightarrow[\text{aqueous}]{\text{OH}^-} X \xrightarrow{\text{heat}} Y$$
- (A) $CH_3CHOHCH_2CHO$ (B) $CH_3CH=CHCHO$
(C) $CH_3CH=CHCOOH$ (D) $CH_3CH=CHCH_2OH$
213. An aldehyde(X) reduces Tollen's reagent and fails to restore pink colour of Schiff's reagent. The aldehyde(X) is
- (A) 2-Hydroxybutanal (B) 3-Hydroxybutanal
(C) 4-Hydroxybutanal (D) Butanal



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219. After the emission of an α -particle from the atom of ${}_{92}\text{U}^{238}$ the number of neutrons in the atom will be
- (A) 138 (B) 140
(C) 144 (D) 150
220. The correct ground state electronic configuration of chromium atom is
- (A) $[\text{Ar}] 3d^4 4s^2$ (B) $[\text{Ar}] 3d^5 4s^1$
(C) $[\text{Ar}] 3d^6 4s^0$ (D) $[\text{Ar}] 4d^5 4s^1$
221. Diagonal relationship is not shown by
- (A) Li and Mg (B) C and P
(C) B and Si (D) Be and Al
222. In the isoelectronic species, the ionic radii (Å) of N^{3-} , O^{2-} and F^{-} are respectively given by
- (A) 1.36, 1.40, 1.71 (B) 1.36, 1.71, 1.40
(C) 1.71, 1.40, 1.36 (D) 1.71, 1.36, 1.40
223. Both geometrical and optical isomerism are shown by
- (A) $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ (B) $[\text{Co}(\text{NH}_3)_5\text{Cl}]^{2+}$
(C) $[\text{Co}(\text{NH}_3)_5\text{Cl}_2]^+$ (D) $[\text{Cr}(\text{ox})_3]^{3-}$
- (en = ethylenediamine) (ox²⁻ = oxalato)
224. The spin magnetic moment of cobalt in the compound $\text{Hg}[\text{Co}(\text{SCN})_4]$ is
- (A) $\sqrt{3}$ (B) $\sqrt{8}$
(C) $\sqrt{15}$ (D) $\sqrt{24}$



225. Sea divers go deep in the sea water with a mixture of the following gases
- (A) O_2 and He (B) O_2 and Ar
(C) O_2 and N_2 (D) O_2 and Ne
226. Lanthanide contraction is due to
- (A) strong shielding by 4f electrons
(B) ineffective shielding by d electrons
(C) effective nuclear charge
(D) weak shielding of s electrons
227. Which one of the following metals is obtained by leaching its ore with a dilute solution of potassium cyanide?
- (A) Au (B) Cu
(C) Zn (D) Ru
228. Pure zirconium metal is obtained by
- (A) Mond's process (B) van Arkel method
(C) zone refining (D) electrolytic refining
229. When $KMnO_4$ solution is added to oxalic acid solution, decolourisation of $KMnO_4$ is slow in the beginning but afterwards, it becomes instantaneous. This is because of the fact that
- (A) carbon dioxide formed easily escapes
(B) the reaction becomes exothermic
(C) MnO_4^- catalyses the reaction
(D) Mn^{2+} acts as autocatalyst
230. BOD value of less than 5 ppm indicates water sample to be
- (A) rich in dissolved oxygen (B) poor in dissolved oxygen
(C) highly polluted (D) not suitable for aquatic life



231. Which of the following belongs to secondary air pollutants?
- (A) Carbon monoxide (B) Hydrocarbon
(C) Nitric oxide (D) Peroxyacetyl nitrate
232. Radioactive isotope of hydrogen is
- (A) Protium (B) Deuterium
(C) Tritium (D) Hydronium
233. When sodium is dissolved in liquid ammonia, it results in the formation of a deep blue coloured solution. The colouration is due to
- (A) sodium ion (B) sodium amide
(C) ammoniated sodium ion (D) ammoniated electron
234. Hybridisation involves
- (A) separation of orbitals
(B) addition of an electron pair
(C) removal of an electron pair
(D) mixing up of atomic orbitals
235. The unit for the velocity constant of the second-order reaction is
- (A) s^{-1} (B) $dm^3 mol^{-1} s^{-1}$
(C) $mol dm^{-3} s^{-1}$ (D) None of the above
236. Which of the following solution has pH = 11?
- (A) $1 \times 10^{-3} M HCl$ (B) $1 \times 10^{-3} M NaOH$
(C) $1 \times 10^7 M NaOH$ (D) $1 \times 10^{-11} M NaOH$
237. The molecule which does not exhibit dipole moment is
- (A) NH_3 (B) $CHCl_3$
(C) H_2O (D) CCl_4



238. In the steady state approximation, if I is the intermediate formed, then

- (A) $[I] = 0$ (B) $[I] \neq 0$
(C) $\frac{d[I]}{dt} = 0$ (D) None of the above

239. Which of the following molecules may show absorbance in the infrared?

- (A) N_2 (B) H_2
(C) Cl_2 (D) $CH_3.CH_3$.

240. This ion has the high value for equivalent ionic conductance at infinite dilution.

- (A) H^+ (B) OH^-
(C) Li^+ (D) $\frac{1}{2} SO_4^{2-}$

241. For a perfect gas

- (A) $C_{p,m} - C_{v,m} = R$ (B) $C_{p,m} - C_{v,m} > R$
(C) $C_{p,m} - C_{v,m} < R$ (D) $C_{p,m} - C_{v,m} = 0$

242. The de Broglie relation is given by

- (A) $\lambda = h\nu$
(B) $\lambda = \frac{h}{p}$ (where p is linear momentum)
(C) $\lambda\nu = c$
(D) $\bar{\nu} = \frac{1}{\lambda}$



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243. The unit of the gas constant is
- (A) $\text{J K}^{-1} \text{mol}^{-1}$ (B) s^{-1}
(C) L mol^{-1} (D) atm
244. Amount of H_2O molecules present in 10.0 g of water is equal to
- (A) 0.555 mol H_2O (B) 0.18 mol H_2O
(C) 5.55 mol H_2O (D) 1.80 mol H_2O
245. The standard enthalpy of sublimation of ice at 0°C from its standard enthalpy of fusion at 0°C (6.01 kJ mol^{-1}) and the standard enthalpy of vapourisation of water at 0°C ($45.07 \text{ kJ mol}^{-1}$) is equal to
- (A) $39.06 \text{ kJ mol}^{-1}$ (B) $25.04 \text{ kJ mol}^{-1}$
(C) $51.08 \text{ kJ mol}^{-1}$ (D) $270.87 \text{ kJ mol}^{-1}$
246. If the heat capacity of cylinder containing water is 0.40 kJ K^{-1} for a temperature rise of 3.0 K, amount of heat energy transferred to the water is equal to
- (A) 1.0 kJ (B) 1.4 kJ
(C) 3.0 kJ (D) 1.2 kJ
247. For an adiabatic change
- (A) $\Delta S_{sur} > 0$ (B) $\Delta S_{sur} = 0$
(C) $\Delta S_{sur} < 0$ (D) $\Delta S_{sur} \rightarrow \phi$
248. A compound melts into its components and does not itself form a liquid phase is called
- (A) Incongruent melting (B) Congruent melting
(C) Sublimation (D) Diffusion



249. The mean speed of the molecules in a gas is given as

$$(A) \left(\frac{2RT}{M} \right)^{\frac{1}{2}}$$

$$(B) \left(\frac{8RT}{\pi M} \right)^{\frac{1}{2}}$$

$$(C) \frac{3}{2} kT/M$$

$$(D) \frac{8RT}{\pi M}$$

where M is the molar mass of the molecule.

250. The formation of products in the reaction
 $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightleftharpoons 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g})$ is favoured by

- (A) expansion
- (B) compression
- (C) by both expansion and compression
- (D) neither compression nor expansion
