## Section – I
### MATHEMATICS

1. If $\cos^2\theta+2, \sin^2\theta+2$ are roots of $3x^2+2bx+c=0$ whose discriminant is $\Delta_1$, and $\cos^4\theta-3, \sin^4\theta-3$ are roots of $9x^2+2bx+c=0$ whose discriminant is $\Delta_2$ then $\dfrac{\Delta_2}{\Delta_1}=$

   (a) 3                                        (b) 9

   (c) $\dfrac{1}{3}$                                    (d) $\dfrac{1}{9}$

2. Consider two positive numbers $a,b$. If AM of $a,b$ exceeds their GM by $\dfrac{3}{2}$ and GM of $a,b$ exceeds their HM by $\dfrac{6}{5}$, then the value of $b^2-a^2$ is

   (a) 35                                       (b) $-35$

   (c) $-136$                                (d) 135

3. Let $S=\sqrt{1+\dfrac{1}{1^2}+\dfrac{1}{2^2}}+\sqrt{1+\dfrac{1}{2^2}+\dfrac{1}{3^2}}+.....+\sqrt{1+\dfrac{1}{2021^2}+\dfrac{1}{2022^2}}$, then the value of $[S]$ is where $[.]$ is greatest integer function is

   (a) 2019                                (b) 2020

   (c) 2021                                (d) 2022

4. Positive numbers $x,y,z$ satisfy $xyz=10^{81}$ and $(\log_{10}x)(\log_{10}yz)+(\log_{10}y)(\log_{10}z)=468$. The value of $\sqrt{(\log_{10}x)^2+(\log_{10}y)^2+(\log_{10}z)^2}$ is

   (a) 75                                     (b) 65

   (c) 85                                     (d) 55

5. The first four terms of an arithmetic sequence are $p, 9, 3p-q$ and $3p+q$. What is the 2022th term of the sequence?

   (a) 7086                                (b) 8089

   (c) 9027                                (d) 8888

6. The minimum value of $f(x)=|x-1|+|2x-1|+|3x-1|+\cdots+|119x-1|$ is _____.

   (a) 35                                     (b) 39

   (c) 49                                     (d) 55

7. A regular hexagon has side length 6. Congruent arcs with radius 3 are drawn with the center at each of the vertices, creating circular sectors as shown. The region inside the hexagon but outside the sectors is shaded as shown What is the area of the shaded region?
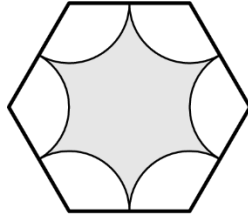


   (a) $27\sqrt{3} - 9\pi$                     (b) $27\sqrt{3} - 6\pi$

   (c) $54\sqrt{3} - 18\pi$                 (d) $54\sqrt{3} - 12\pi$

8. The sum of the digits in the decimal form of the number $10^{2022} - 2023$ is

   (a) 18192                           (b) 18172

   (c) 18156                           (d) 18213

9. Let $f(x) = x^3(1-x)^3$. What is the value of the sum

$$f\left(\frac{1}{2023}\right) - f\left(\frac{2}{2023}\right) + f\left(\frac{3}{2023}\right) - f\left(\frac{4}{2023}\right) + \cdots + f\left(\frac{2021}{2023}\right) - f\left(\frac{2022}{2023}\right) \text{ is } \_\_\_\_$$

   (a) 0                             (b) 1

   (c) $\dfrac{2021^3}{2023}$                    (d) $\dfrac{2022^3}{2023}$

10. A college awarded 38 medals in Footballs, 15 in Basketball and 20 to Cricket. If these medals went to a total of 58 men and only three men got medals in all the three sports. The number of students who received medals in exactly two of the three sports is

   (a) 18                            (b) 15

   (c) 9                             (d) 6

## Section – II
## PHYSICS

11. Let the angle between two nonzero vectors $\vec{A}$ and $\vec{B}$ be 120° and resultant be $\vec{C}$

   (a) $\vec{C}$ must be equal to $|\vec{A} - \vec{B}|$         (b) $\vec{C}$ must be less than $|\vec{A} - \vec{B}|$

   (c) $\vec{C}$ must be greater than $|\vec{A} - \vec{B}|$     (d) $\vec{C}$ may be equal to $|\vec{A} - \vec{B}|$

12. The vector sum of two forces is perpendicular to their vector differences. In that case, the forces

   (a) Are equal to each other in magnitude      (b) Are not equal to each other in magnitude

   (c) Cannot be predicted                 (d) Are equal to each other

13. How many minimum number of non-zero coplanar vectors having different magnitudes can be added to give zero resultant

   (a) 2                             (b) 3

   (c) 4                             (d) 5

14. A body sliding on a smooth inclined plane requires 4 seconds to reach the bottom starting from rest at the top. How much time does it take to cover one-fourth distance starting from rest at the top (assume it us uniformly accelerating down)

    (a) 1 s                                                         (b) 2 s

    (c) 4 s                                                         (d) 16 s

15. A body thrown vertically upwards with an initial velocity $u$ reaches maximum height in 6 seconds. The ratio of the distances travelled by the body in the first second and the seventh second is

    (a) 1 : 1                                                       (b) 11 : 1

    (c) 1 : 2                                                       (d) 1 : 11

16. A very large number of balls are thrown vertically upwards in quick succession in such a way that the next ball is thrown when the previous one is at the maximum height. If the maximum height is $5m$, the number of ball thrown per minute is (take $g = 10 ms^{-2}$)

    (a) 120                                                         (b) 80

    (c) 60                                                          (d) 40

17. The coordinates of a moving particle at any time are given by $x = at^2$ and $y = bt^2$. The speed of the particle at any moment is ____.

    (a) $2t(a+b)$                                                   (b) $2t\sqrt{(a^2 - b^2)}$

    (c) $t\sqrt{a^2 + b^2}$                                         (d) $2t\sqrt{(a^2 + b^2)}$

18. A particle starts moving rectilinearly at $t = 0$ such that its velocity as function of time is $v = t^2 - t$, where $v$ is in $ms^{-1}$ and $t$ is in seconds. The time interval in which the particle decelerates is ____

    (a) $t > 1\ s$                                                  (b) $t < \frac{1}{2}$

    (c) $\frac{1}{2}\ s < t < 1\ s$                                 (d) $t < \frac{1}{2}\ s\ and\ t > 1s$

19. A particle is projected with a velocity $v$ such that its range on the horizontal plane is twice the greatest height attained by it. The range of the projectile is (where $g$ is acceleration due to gravity)

    (a) $\dfrac{4v^2}{5g}$                                          (b) $\dfrac{4g}{5v^2}$

    (c) $\dfrac{v^2}{g}$                                            (d) $\dfrac{4v^2}{\sqrt{5}g}$

20. A ball of mass $m$ is thrown vertically upwards. Another ball of mass $2\ m$ is thrown at an angle θ with the vertical. Both of them stay in air for same period of time. The heights attained by the two balls are in the ratio of

    (a) 2 : 1                                                       (b) $1 : \cos θ$

    (c) 1 : 1                                                       (d) $\cos θ : 1$

### Section – III
### CHEMISTRY

21. At low pressure, the Vander waal's equation is written as:

(a) $\dfrac{PV}{RT} = \left[1 - \dfrac{a}{RTV}\right]$  (b) $\dfrac{PV}{RT} = \left[1 - \dfrac{RTV}{a}\right]$

(c) $\dfrac{PV}{RT} = \left[1 + \dfrac{a}{RTV}\right]$  (d) $\dfrac{PV}{RT} = \left[1 + \dfrac{RTV}{a}\right]$

22. Aspirin has the molecular formula $C_9H_8O_4$. How many atoms of oxygen are there in a tablet weighing 360 mg?

    (a) $1.204 \times 10^{23}$  (b) $1.08 \times 10^{22}$

    (c) $1.204 \times 10^{24}$  (d) $4.81 \times 10^{21}$

23. One mol. of equimolar mixture of ferric oxalate and ferrous oxalate is to be completed oxidized by $KMnO_4$ solution in acidic medium. Find the volume of $10^{-2}$ M $KMnO_4$ solution required for this oxidation ____
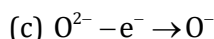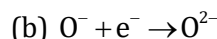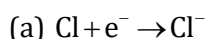
    (a) 90 L  (b) 45 L

    (c) 60 L  (d) 30 L

24. In which of the following processes energy is absorbed?

    (a) $Cl + e^- \rightarrow Cl^-$  (b) $O^- + e^- \rightarrow O^{2-}$

    (c) $O^{2-} - e^- \rightarrow O^-$  (d) $Na^+ + e^- \rightarrow Na$
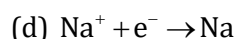
25. Aspirin contains 35.55% $\left(\dfrac{w}{w}\right)$ of oxygen. If each molecule of oxygen has four oxygen atoms, the mol. mass of aspirin is ___.

    (a) 120u  (b) 180u

    (c) 240u  (d) 90u

26. What is the volume of water mixed in 500 ml 0.5 M NaOH solution so that its concentration becomes 10 mg NaOH per ml?

    (a) 100 ml  (b) 200 ml

    (c) 250 ml  (d) 500 ml

27. If 3L of 0.1 M HCl is added to 2 L of 0.5 M HCl, calculate the molarity of resultant solution?

    (a) 0.48  (b) 0.26

    (c) 0.12  (d) 0.4

28. $FeS + KMnO_4 \longrightarrow Fe_2O_3 + SO_2 + MnO$ in this reaction the equivalent mass of FeS is ___

    (a) M/8  (b) M/7

    (c) M/6  (d) M/5

29. It requires 40 ml of 0.5 M $Ce^{4+}$ to titrate 10 ml of 1.0M $Sn^{2+}$ to $Sn^{4+}$. The oxidation state of Ce in the reduction product is ____
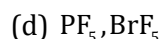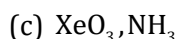
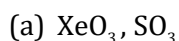    (a) +2  (b) +3

    (c) +6  (d) +1

30. An isostructural pair is ___

    (a) $XeO_3$, $SO_3$  (b) $CF_4$, $SF_4$

    (c) $XeO_3$, $NH_3$  (d) $PF_5$, $BrF_5$

**Section – IV**

**Aptitude**

31. $4, 6, 9, 13\dfrac{1}{2}, ?$

   (a) $17\dfrac{1}{2}$               (b) 19

   (c) $20\dfrac{1}{4}$              (d) $22\dfrac{3}{4}$

32. 9360, 1560, 312, 78, 26, ?

   (a) 4                     (b) 13

   (c) 2                     (d) 5

33. NOS, OQV, PSY, QUB, ?

   (a) SWE               (b) RWE

   (c) RVE               (d) RWF

34. X L R, Y K S, Z J T, A I U, ?

   (a) B H V            (b) C H V

   (c) B I V             (d) B H W

35. – – s t L L t s – – L t – – L – t s t –

   (a) L s t s L t L s       (b) L t L t s t L t

   (c) L t t L s t L L       (d) L LL t s t L t

36. Find the odd-numeral pair.

   (a) 8 – 27           (b) 125 – 216

   (c) 343 – 512       (d) 1009 – 1331

37. Find the odd-numeral pair.

   (a) 72 – 45          (b) 51 – 24

   (c) 47 – 20          (d) 32 – 13

38. Find the odd-numeral pair.

   (a) 13 – 21          (b) 19 – 27

   (c) 15 – 23          (d) 16 – 24

39. In a certain code language, STRING is written as % = *4+÷ and PRAISE as ?*@4%x How will the word GRAPES be written in that code language,?

   (a) ÷*@x?%        (b) ÷@*? x %

   (c) ÷*@ ?x%       (d) ÷*–?x%

40. Analogy find the missing the number 20 : 11 : : 102 : ?

   (a) 49                (b) 52

   (c) 61                (d) 98

ANSWER KEY

| 1. B | 2. C | 3. B | 4. A | 5. B | 6. C | 7. C | 8. A | 9. A | 10. C |
|------|------|------|------|------|------|------|------|------|-------|
| 11. B | 12. A | 13. B | 14. B | 15. B | 16. C | 17. D | 18. C | 19. A | 20. C |
| 21. A | 22. D | 23. A | 24. B | 25. B | 26. D | 27. B | 28. B | 29. B | 30. C |
| 31. C | 32. B | 33. B | 34. A | 35. C | 36. D | 37. D | 38. D | 39. C | 40. B |