MATHEMATICS

NOTE:
1. Attempt all questions.
2. Rough work must be enclosed with answer book.
3. There is no negative marking.
4. Answer each of Sections A, B, C at one place.
5. Use of calculators, slide rule, graph paper and logarithmic, trigonometric and statistical tables is not permitted.

Note: All answers to questions in Section-A, Section-B and Section-C must be supported by mathematical arguments. In each of these sections order of the questions must be maintained.

SECTION-A

This section has Four Questions. Each question is provided with 4 alternative answers. Exactly one of them is the correct answer. Indicate the correct answer by A, B, C, D. (4x3=12 MARKS)

1. The digit in the units place of $2017^{28} + 28^{2017}$ is
   A) 2   B) 5   C) 9   D) 8

2. Two circles having different radii are touching each other. A common tangent $PQ$ is touching one circle at $P$ and the other at $Q$. If $PQ = 12$ then the product of their radii is equal to
   A) 36   B) 24   C) 12   D) 8/3

3. If $a$, $b$, $c$ and $d$ are four real numbers such that $a^2 + 2b^2 + 13c^2 + 5d^2 - 2ab + 4bc - 12cd - 6d + 9 = 0$ then $2a + b + 11c + 2d$ is equal to
   A) 0   B) 16   C) -28   D) 2017

4. On a level ground there is a tree and a building. A girl standing in front of the tree started backing until she could see just the top edge of the building from above the tree top. She marked her place and measured it from the tree and it was 5m. If tree height is 2.8m, her eyes at a height of 1.6m and distance between the tree and the building is 30m, height of the building in meters is
   A) $\frac{20}{3}$   B) 28   C) 14   D) 10

SECTION-B

This section has Four Questions. In each question a blank is left. Fill in the blank. (4x3=12 MARKS)

5. If $98765^2 = 9754525225$ then $98766^2 =$

6. Two chords $AB$ and $CD$ of a circle are intersecting in a point $P$. A relation between the lengths of all the line segments $PA$, $PB$, $PC$ and $PD$ is

7. The number of real solutions $(a, b)$ of the equation $\frac{a+b}{a} = \frac{b}{a+b}$ is

8. $ABC$ is an equilateral triangle of side 'a' units. Midpoint of the side $BC$ is $D$. $D$ is also the midpoint of the side $PQ$ of a rectangle $PQRS$ having its side $PQ$ along $BC$. Also $P$ is the midpoint of the line segment $BD$. If the vertex $A$ of the triangle lies on the side $RS$ of the rectangle, the area of the rectangle is

SECTION-C

State True or False in each of the following statements. (4x3=12 MARKS)

9. If $a$ and $b$ are two positive integers greater than $20172017$ and $b - a > 4034$ then there exist at least one pair $a$, $b$ such that the product $(a - 2017)(b + 2017)$ is greater than the product $(a + 2017)(b - 2017)$

10. There is a diagram of a triangle $ABC$ right angled at $A$ and the perpendicular drawn from $A$ onto the side $BC$ is meeting the side $BC$ in $D$. There are exactly two similar triangles in the diagram.

11. There is at least one system of linear equations $ax + by = c$, $dx + ey = f$, in variable $x$, $y$, having exactly 2017 solutions.

12. $r_1$, $r_2$ are the radii of two circles passing through the centres of one another. If $3r_1 + r_2 = 15$ then $r_1$ is equal to $15/4$
13. Write \(2ab^3 + a^2c^2 + b^2c^2 - a^2b^2 - 2abc^2 - b^4\) as a product of linear factors.

14. ABCD is a square of area 64 sq. units. AEEF is another square of area 25 sq. units such that E, G lie on the line segments AB, AD respectively. If the line segments ED and FG meet in N, then find the ratio of the area of the region EBCDGNE to the area of the region AGNE.

15. Two functions \(f, g\) are defined on the set of real numbers \(\mathbb{R}\), such that \(f(x) = |x|, g(x) = \lfloor x \rfloor\), for all \(x \in \mathbb{R}\). (where \(\lfloor x \rfloor\) denotes the greatest integer less than or equal to \(x\)). Draw the graphs of the functions \(fog(x)\), \(gof(x)\).

16. A prime year is a year in which the calendar year number is a prime number. For example, 2017 is a prime year. Assume that a person born in 2017 graduates turns 21 years in the same year. What is the sum of all the prime years starting from the year of his birth to the year of his graduation?

**PHYSICS**

*Attempt all questions* (10 × 6 = 60 Marks)

17. A body ‘A’ floats with 50% of its volume submerged in a liquid B and 75% of its volume submerged in a liquid C. What is the ratio of the densities of A, B and C? What fraction of the body A will be seen above the surface of a homogenous mixture of equal volumes of the liquids B and C?

18. A particle is moving along a straight line with constant acceleration. If the distance travelled by the body in \(n^{th}\) and \((n+1)^{th}\) seconds is 100 m, find its velocity at the end of \(n^{th}\) second.

19. Two particles A and B are moving around a circular path of radius 35 m at 2.2 m/s and 4.4 m/s respectively and are located as shown (Figure A, below) at a certain moment. Find the time elapsed before they meet. Also find the angle covered by A in this duration.

20. A block of 100g of ice at 0˚C is added to some water at 40˚C contained in a vessel of negligible water equivalent. What should be the least amount of water for entire block to melt? If the amount of water (at 40˚C) is twice the required amount to just melt the block, what is the final temperature of the mixture?

21. A bright object is fixed at a distance of 100 cm from a wall. A convex lens placed between the object and the wall at position A forms a sharp image of the object magnified 4 times on the wall. Find the focal length of the lens. The lens is moved to a new position B to obtain sharp image again. Find the distance between positions A and B.

22. A ray of light incident at the boundary of two media travels along the path shown (figure B, below). Find the angle in the denser medium if the angle in the rarer medium is doubled.

23. A uniform wire of resistance 6Ω is bent to form a regular hexagon. Find the least and largest resistance possible between any two corners of the hexagon.

24. Find the equivalent resistance between A and B.\(\)(Figure C, above)
Some current enters the terminal A and leaves through B. This current splits at various junctions and flows through different resistances. If the current in the 2Ω resistance is 1 A, find the potential difference between A to B.

25. A long horizontal conductor carries a current eastward. A moving positively charged particle is located vertically above the conductor at a given moment. Find the direction of the force acting on it if its velocity is directed (i) downward (ii) westward (iii) northward.

26. A 1000 MW thermal power plant burns \(10^6\) kg of coal in one hour. How many kg of coal is burnt to produce the energy required to provide electrical energy to a 2000 W water heater for 2 hours a day in a month (Assume 30 days to a month).
CHEMISTRY

Attempt all questions. No partial marking. Each question carries 3 marks.

SECTION-A : Each question is provided with 4-alternative answers. One or more than one of them are correct answers. Indicate the correct answer by A,B,C,D.

27. Consider the following ionization enthalpies of two elements ‘A’ and ‘B’

<table>
<thead>
<tr>
<th>Element</th>
<th>1&lt;sup&gt;st&lt;/sup&gt; Ionisation enthalpy KJ/mol</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; Ionisation enthalpy KJ/mol</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt; Ionisation enthalpy KJ/mol</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>899</td>
<td>1757</td>
<td>14,847</td>
</tr>
<tr>
<td>B</td>
<td>737</td>
<td>1450</td>
<td>7731</td>
</tr>
</tbody>
</table>

Which of the following statements is/are correct?
A) both A and B belong to group-2, where ‘A’ comes below ‘B’
B) both A and B belong to group-2, where ‘B’ comes below ‘A’
C) both A and B belong to group-1, where ‘B’ comes below ‘A’
D) both A and B belong to group-1 where ‘A’ comes below ‘B’

28. Which electron is associated with least energy
A) n=3, l=2, m=−2, s=+½     B) n=4, l=0, m=0, s=+½
C) n=4, l=1, m=1, s=+½     D) n=5, l=0, m=0, s=+½

29. The periodic table consists of 18 groups. An isotope of copper on bombardment with protons undergoes a nuclear reaction yielding element ‘x’ as shown below. To which group, the element X-belongs in the period table $\frac{1}{2}Cu+\uparrow H \rightarrow 6\downarrow n+\alpha +2\downarrow H \rightarrow X$
A) 10<sup>th</sup> group  B) 18<sup>th</sup> group  C) 8<sup>th</sup> group  D) 11<sup>th</sup> group

30. Which of the following pairs carry same no.of electrons, but electronic configuration is not same
A) Cr<sup>+</sup>, Mn<sup>2+</sup>  B) Fe<sup>3+</sup>, Mn<sup>2+</sup>  C) Co<sup>3+</sup>, Ni<sup>4+</sup>  D) Cu<sup>3+</sup>, Ni

31. The correct order of anions present for the following CaC<sub>2</sub>, Al<sub>4</sub>C<sub>3</sub>, Mg<sub>2</sub>C<sub>3</sub>
A) C<sup>−3</sup>, C<sup>−2</sup>, C<sup>−</sup>  B) C<sup>−2</sup>, C<sup>−4</sup>, C<sup>−3</sup>  C) C<sup>−2</sup>, C<sup>−4</sup>, C<sup>−3</sup>  D) C<sup>−4</sup>, C<sup>−3</sup>, C<sup>−2</sup>

32. 80% of a first order chemical reaction completed in 100 sec, what time it will take for the completion of 99.2%
A) 200 sec  B) 400 sec  C) 300 sec  D) 150 sec

33. A metal M reacts with nitrogen gas to afford M<sub>3</sub>N. M<sub>3</sub>N on heating at high temperature gives back M and on reaction with water produces gas B. Gas B reacts with aqueous solution of CuSO<sub>4</sub> to form a deep blue compound. M and B respectively
A) Li and NH<sub>3</sub>  B) Al and N<sub>2</sub>  C) Ba and N<sub>2</sub>  D) Na and NH<sub>3</sub>

34. Match the fuel gases with main component present in them

<table>
<thead>
<tr>
<th>List-I (fuel gases)</th>
<th>List-II (main component gas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) LPG</td>
<td>p) N&lt;sub&gt;2&lt;/sub&gt;</td>
</tr>
<tr>
<td>B) Natural gas</td>
<td>q) n-butane</td>
</tr>
<tr>
<td>C) Coal gas</td>
<td>r) CH&lt;sub&gt;4&lt;/sub&gt;</td>
</tr>
<tr>
<td>D) Producer gas</td>
<td>s) H&lt;sub&gt;2&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

A) A→r, B→q, C→p, D→s  B) A→s, B→r, C→p, D→q
C) A→q, B→r, C→s, D→p  D) A→p, B→q, C→r, D→s

35. Match the List-I with List-II

<table>
<thead>
<tr>
<th>List-I (type of velocity)</th>
<th>List-II (equation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) Root mean square velocity</td>
<td>p) $\frac{3p}{\sqrt{d}}$</td>
</tr>
<tr>
<td>B) Average velocity</td>
<td>q) $\frac{3RT}{m}$</td>
</tr>
<tr>
<td>C) Most probable velocity</td>
<td>r) $\frac{8P}{\sqrt{nld}}$</td>
</tr>
<tr>
<td>D) Velocity possessed by maximum fraction of molecules</td>
<td>s) $\frac{2RT}{m}$</td>
</tr>
</tbody>
</table>

A) A→r, B→p,q, C→s, D→s  B) A→s, B→s, C→p,q, D→r
C) A→s, B→r, C→s, D→p,q  D) A→p,q, B→r, C→s, D→s
36. The molality and mole fraction of the solute in an aqueous solution containing 6 gm of urea per 500 gm of water (mol.wt. of urea=60)
A) 0.1 M, 0.001  B) 0.2 M, 0.00359  C) 0.3 M, 0.2  D) 0.01, 0.0012

SECTION–B: In each question a blank or blanks are left. Fill in the blank(s) with relevant answer(s).

37. Complete the decomposition reaction of
(i) LiNO₃ \( \xrightarrow{\Delta} \) ____________
(ii) NaNO₃ \( \xrightarrow{\Delta} \) ____________

38. Give the hybridization and no.of lone pairs over the central atom

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Hybridisation</th>
<th>No.of lone pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>XeO₂F₂</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICl₂⁻</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO₂</td>
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<td></td>
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</tbody>
</table>

39. Give the nature of oxides i.e. acidic, basic neutral (or) amphoteric

<table>
<thead>
<tr>
<th>Oxide</th>
<th>nature of oxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td></td>
</tr>
<tr>
<td>Al₂O₃</td>
<td></td>
</tr>
<tr>
<td>SiO₂</td>
<td></td>
</tr>
</tbody>
</table>

40. Write structural formula of all the isomeric alcohols having the molecular formula C₄H₁₀O
(i) ______________
(ii) ______________
(iii) ______________
(iv) ______________

41. Complete the reactions
(i) CaO + C \( \xrightarrow{\Delta} \) A+B
(ii) A + N₂ \( \xrightarrow{electric furnace} \) D + graphite
(iii) D + H₂O \( \rightarrow \) E + NH₃
Identify the compound A ____________, B ____________, D ____________, E ____________

42. The concentration of H⁺ ions in 0.10 M solution of a weak acid is 1x10⁻⁵ mol.lit⁻¹. Calculate the dissociation constant of the acid ____________ [Note:- [HA] can be taken as 0.1 M as 1x10⁻⁵ is very small]

43. If one mole of electrons per sec are passing through a point across metallic wire, calculate the charge in coloumb passing in one sec. ____________

44. Out of the given metals Zn, Mg, Al, Be which will give H₂ gas on reaction with NaOH solution ____________

45. Exactly 2 gm of NaOH is dissolved in water to makeup 1 litre of solution. The pH of the solution found to be higher than 7. The HCl gas is then bubbled through this solution at the rate of 1 gm/min. After how many minutes will the pH become 7? ____________

46. The two elements A and B form the compounds A₂B₃ and AB₂. If 0.5 mole of A₂B₃ weighs 15.9 grams and 0.15 mole of AB₂ weighs 9.3 gm. Find the atomic weights of A and B ____________