

NOTE:-

1. Attempt all questions. There is no negative marking. No additional sheets are provided
2. Answer all the questions of the **same subject at one place.**
3. Students may take around 80 minutes for Mathematics, 50 minutes for Physics and 50 minutes for Chemistry.
4. Use of calculators, slide rule, graph paper and logarithmic, trigonometric and statistical tables is not permitted.

PART-A : MATHEMATICS

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. a, b, c, d are digits in 2014 such that $\{a, b, c, d\} = \{2, 0, 1, 4\}$. Then the number of different values $((a^b)^c)^d$ takes is
A) 2 B) 16 C) 8 D) 7
2. The maximum value of n such that 2^n divides $21!$ is
A) 20 B) 15 C) 18 D) 7
3. A circle C has radius 6. Two circles P and Q having equal radii are touching each other externally and touching C internally. Another circles S is touching the circle C internally and the circles P, Q externally. The radius of the circle S is
A) 1 B) $\sqrt{3}$ C) $\sqrt{2}$ D) 2
4. If $f: \mathbf{R} \rightarrow \mathbf{R}$ is a function defined by $f(x) = \frac{x^2}{x^2 + 1}$ then the number of integral values taken by f is
A) 1 B) 2 C) finitely many D) not finite

SECTION-B

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

5. $\sqrt[3]{20 + 14\sqrt{2}} + \sqrt[3]{20 - 14\sqrt{2}} = \underline{\hspace{2cm}}$
6. A circle of radius 1 is concentric with circles of radii a and b with $b > a > 1$. The area of the smallest circle equals the area of the ring with outer radius a and inner radius 1 and also equals the area of the ring with outer radius b and inner radius a. Then $a + b$ is $\underline{\hspace{2cm}}$
7. The sides of a cyclic quadrilateral lie along the lines $a_1x + b_1y = 2013$, $a_2x + b_2y = 2014$, $a_1x + b_1y = 2015$, $a_2x + b_2y = 2018$ then $a_1a_2 + b_1b_2 = \underline{\hspace{2cm}}$
8. Given $\cos(A-B) = \cos A \cos B + \sin A \sin B$, the value of $\cos 15^\circ = \underline{\hspace{2cm}}$

SECTION-C

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

9. There exists a function f from the set of integers \mathbf{Z} to the set of natural numbers \mathbf{N} that is an onto function.
10. The quadratic equation the sum of whose roots is the sum of the roots of $5x^2 + 4x - 3 = 0$ and the product of the roots is the product of the roots of $7x^2 + 24x + 2 = 0$ has real roots.
11. In a circle if a chord of length $\sqrt{2}$ subtends an angle of 45° at a point on the circumference of the circle then the radius of the circle is 1.
12. It is not possible to write the polynomial $x^4 + 1$ as a product of two quadratic polynomials.

SECTION-D

(4x6=24 MARKS)

13. In a circle having A(2, 2) and B(10, 8) as extremities of a diameter if a triangle ABC is inscribed then what is the maximum possible area of the triangle?
14. If $f: \mathbf{R} \rightarrow [0, \infty)$ is defined by $f(x) = x^2$ and $g: [0, \infty) \rightarrow \mathbf{R}$ is defined by $g(x) = \sqrt{x}$ then does the function $\text{gof}(x)$ exist? If so what is the value of $\text{gof}(-4)$?

15. A square is inscribed in a sector having angle 60° at its vertex. Find the ratio of the area of the square to that of the sector.

16. If $[x]$ denotes the greatest integer less than or equal to x then what is the value of $\sum_{k=1}^{2014} \left[\frac{k}{1007} \right]$?

PART-B : PHYSICS

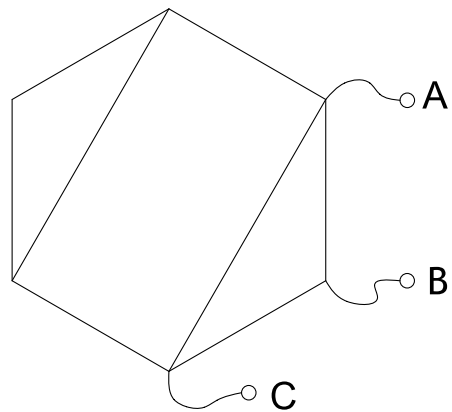
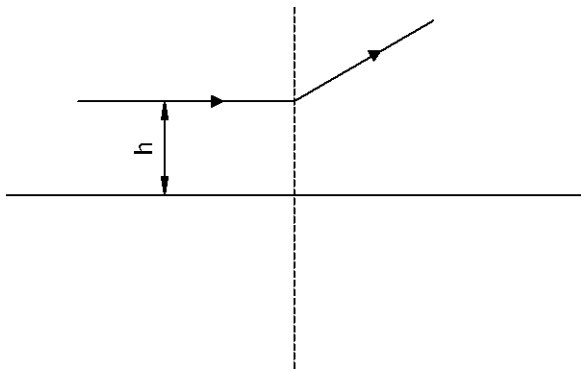
(10x6=60 Marks)

17. A car travels between places A and B covering first $\frac{1}{3}$ of the distance at 25 kmph and the remaining distance at 40 kmph for some time and 60 kmph for an equal amount of time. Find the average speed of the car.

18. A mirror produces inverted twice magnified image of an object at a distance of 30 cm from the object. Find the focal length of the mirror.

19. A block is made with equal volumes of two materials whose densities are in the ratio 1:2. This block floats with $\frac{3}{4}$ of its volume submerged in a certain liquid. Find the ratio of the volumes of the materials for $\frac{2}{3}$ of the volume of the block to be just submerged.

20. A ray of light is incident at a height h above the principal axis of a lens (position indicated by dotted line) and deviates through 30° as it passes through the lens. Find the focal length of the lens.



21. In the figure shown resistance between any two corners connected by short wires is half of the resistance of the wires connected by long wires. Terminals A, B and C are connected to the corners by resistanceless wires. If the equivalent resistance between A and C is R , find the equivalent resistance between A and B.

22. If 4.2 milligram of mass were to be completely converted into heat energy and this heat is used to raise the temperature of a million kg of water, find the temperature raise of water.

23. A bullet moving horizontally at v strikes a stationary block lying on a smooth horizontal surface and gets embedded in it. The block moves at V after the bullet strikes it. Find the ratio of masses of the bullet and the block.

24. Wavelength of light in a certain medium is λ where its velocity is 2.5×10^8 m/s. If the wavelength of this light in some other medium is 0.6λ , find the velocity of light in this medium. What is the ratio of frequencies of the light in the two media.

25. A positively charged particle to the east of a long vertical current carrying wire having a velocity directed eastward experiences a vertical upward force. Find the direction of the force on a positively charged particle located south of the conductor and having a velocity directed vertically upward.

26. Two small identical charged conducting spheres have charges in the ratio 1:3 and exert a force 'F' on each other when they are some distance apart. The spheres are brought in to contact and then they are arranged at a distance twice the earlier. Knowing that the total charge on the two spheres divides equally between them when they make contact, find the force between them.

