Test Pattern

ALLEN® CAREER INSTITUTE KOTA (RAJASTHAN) path to success

CLASSROOM CONTACT PROGRAMME

(Academic Session : 2024-2025)

JEE (Main)
MINOR
29-06-2024

IIT-NURTURE (ELITE) PHASE-03

Time : 3.00 Hours | Maximum Marks : 300

T1

IMPORTANT NOTE : Students having 8 digits **Form No.** must fill two zero before their **Form No.** in OMR. For example, if your **Form No.** is 12345678, then you have to **fill 0012345678**.

READ THE INSTRUCTIONS CAREFULLY

Important Instructions :

1. Immediately fill in the form number on this page of the Test Booklet and OMR sheet (Side-1 & Side-2) with Blue/Black Ball Point Pen. Use of pencil is strictly prohibited.
2. The candidates should not write their Form Number anywhere else (except in the specified space) on the Test Booklet/Answer Sheet.
3. The Test Booklet consists of 90 questions.
4. There are **three** parts in the question paper 1,2,3 consisting of **Physics**, **Chemistry** and **Mathematics** having **30 questions** in each subject and each subject having **Two sections**.
   (a) Section-I contains 20 **multiple choice** questions with **only one correct** option.
   Marking scheme : +4 for correct answer, 0 if not attempted and –1 in all other cases.
   (b) Section-II contains 10 **Numerical Value Type** questions. Attempt any 5 questions. First 5 attempted questions will be considered for marking.
   Marking scheme : +4 for correct answer, 0 if not attempted and –1 in all other cases.
5. No candidate is allowed to carry any textual material, printed or written, bits of papers, mobile phone any electronic device etc, except the Identity Card inside the examination hall/room.
6. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
7. On completion of the test, the candidate must hand over the Answer Sheet to the invigilator on duty in the Room/Hall. **However, the candidate are allowed to take away this Test Booklet with them**.
8. **Do not fold or make any stray marks on the Answer Sheet**.
9. **Take g = 10 m/s^2 unless otherwise stated**.

Name of the Candidate (in Capitals) : _____

Form Number : in figures _____

: in words _____

Centre of Examination (in Capitals) : _____

Candidate's Signature : _____ **Invigilator's Signature :** _____

DO NOT BREAK THE SEALS WITHOUT BEING INSTRUCTED TO DO SO BY THE INVIGILATOR

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Topic : Basic Mathematics (Except Vectors).

PHYSICS

SECTION-I : (Maximum Marks: 80)

This section contains **20 questions**. Each question has 4 options for correct answer. Multiple-Choice Questions (MCQs) **Only one option is correct**. For each question, marks will be awarded as follows:

Full Marks : +4 If correct answer is selected.

Zero Marks : 0 If none of the option is selected.

Negative Marks : –1 If wrong option is selected.

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1. $\frac{d}{dx}\left(x^5 + x^7 + x^9\right) =$

(A) $\frac{x^6}{6} + \frac{x^8}{8} + \frac{x^{10}}{10}$

(B) $5x^4 + 7x^6 + 9x^8$

(C) $\frac{x^5}{5} + \frac{x^7}{7} + \frac{x^9}{9}$

(D) $5x^3 + 7x^5 + 9x^7$

2. $\frac{d}{dx}(\log_e x) =$

(A) $\frac{1}{e}$ (B) $\frac{1}{\log_e x}$

(C) $\frac{1}{x}$ (D) $x\log_e x - x$

3. $\frac{d}{dx}\left(e^{2x}\right) =$

(A) e^{2x} (B) e^x

(C) $2e^{2x}$ (D) $2e^x$

4. The maximum value of the function $y = \sin x + \cos x$ is

(A) 1 (B) 2

(C) $\sqrt{2}$ (D) $-\sqrt{2}$

5. $\frac{d}{dx}[\log_e(\cos x)] =$

(A) $\cot x$ (B) $-\cot x$

(C) $\tan x$ (D) $-\tan x$

6. The tangent to the curve $y = 3x^2 - 5$ at the point (2,7) makes an angle θ with the positive x-axis. Then

(A) $\tan\theta = 7$ (B) $\tan\theta = 10$

(C) $\tan\theta = 11$ (D) $\tan\theta = 12$

7. $\frac{d}{dx}(e^x \sin x) =$

(A) $e^x \cos x$

(B) $e^x(\cos x + \sin x)$

(C) $-e^x \cos x$

(D) $e^x(\sin x - \cos x)$

8. If $x \approx 0$ then

(A) $\sin x \approx \tan x$

(B) $\cos x \approx 0$

(C) $\tan x \approx \cos x$

(D) $\cos ecx \approx x$

9. If $y = \sin^2 x + 2$, then

(A) $2 \leqslant y \leqslant 3$

(B) $0 \leqslant y \leqslant 2$

(C) $-1 \leqslant y \leqslant 1$

(D) $-2 \leqslant y \leqslant 2$

10. Area under $y = \sin x$, from $x = 0$ to $x = 2\pi$ is:

(A) 0 (B) 1

(C) –1 (D) 2

11. A water sprinkler sprays water over a distance of 7 m while rotating through an angle of $\frac{2\pi}{7}$ radian. The area of the lawn that receives water from the sprinkler is

(A) 12 m^2 (B) 22 m^2

(C) 44 m^2 (D) 33 m^2

12. Use the small angle approximation to find approximate value for $\left(\frac{\sin 1^\circ}{\cos 2^\circ}\right)$:-

(A) 1 (B) $\frac{\pi}{30}$

(C) $\frac{\pi}{60}$ (D) $\frac{\pi}{180}$

13. If $y = \sin(2x + 3)$ then $\int y\,dx$ will be :

(A) $\frac{\cos(2x+3)}{2}$

(B) $\frac{-\cos(2x+3)}{2}+C$

(C) $-\cos(2x + 3)$

(D) $-2\cos(2x + 3)$

14. If $x = 5t^2 + 4t + 300$. Then find value of $\frac{dx}{dt}$:-

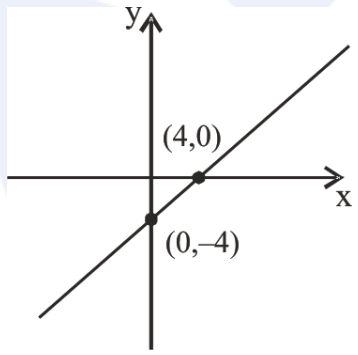
(A) $5t + 4 + 300$

(B) $5t + 4$

(C) $10\,t + 4$

(D) $10\,t + 4 + 300$

15. Write equation for given straigth line



(A) $y = -x + 4$

(B) $y = x - 4$

(C) $4y = x + 4$

(D) $y = 4x - 4$

16. $(0.99)^{\frac{1}{2}} = ?$

(A) 0.99 (B) 0.92

(C) 0.33 (D) 0.995

17. $\int \sec(\sec x - \tan x)dx.$

(A) $\tan x - \sec x + C$

(B) $\sec x + \tan x + C$

(C) $\sec x - \cot x + C$

(D) $\sec x + \cot x + C$

18. Find $\int e^x \sin(e^x)dx$

(A) $\int e^x \cos(e^x) + C$ (B) $-\cos(e^x) + C$

(C) $\sin(e^x) + C$ (D) None

19. $\cos(330°) = ...$

(A) $\frac{1}{2}$ (B) $\frac{\sqrt{3}}{2}$

(C) $-\frac{1}{2}$ (D) $-\frac{\sqrt{3}}{2}$

20. The charge flowing through a conductor beginning with time $t = 0$ is given by the formula $q = 4t^2 - 2t + \ell nt$ (colulombs). Find the current $i = \frac{dq}{dt}$ at the end of the 2^{nd} seconds.

(A) 11.5 amp (B) 12.5 amp

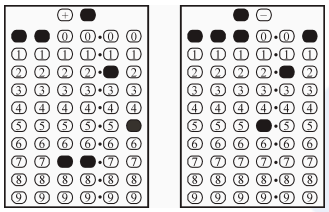
(C) 13.5 amp (D) 14.5 amp

SECTION-II : (Maximum Marks: 20)

This section contains 10 questions Candidates have to attempt any 5 questions out of 10. If more than 5 questions are attempted, then only first 5 attempted questions will be evaluated.

The answer to each question is a **Numerical Value** Type questions.

For each question, enter the correct numerical value (in decimal notation, truncated/rounded off to the second decimal place; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct)



Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If correct answer is entered.

Zero Marks : 0 If the question is unanswered.

Negative Marks : –1 If wrong answer is entered.

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1. A particle projected upwards it's height h is given by $h = 10t - 5t^2$. Find the time when it is at maximum height?

2. Ratio of area bounded by $y_1 = \sin x$ and $y_2 = \cos x$ from $x_1 = 0$ & $x_2 = \pi/2$ is ___.

3. Find the value of $\cos 100\pi$.

4. Radius of a soap bubble is increasing at the rate of $\frac{1}{\pi}$m/s. Find the rate of growth of volume. When R = 1m.

5. Find the maximum value of $\frac{8}{x^2+4}$.

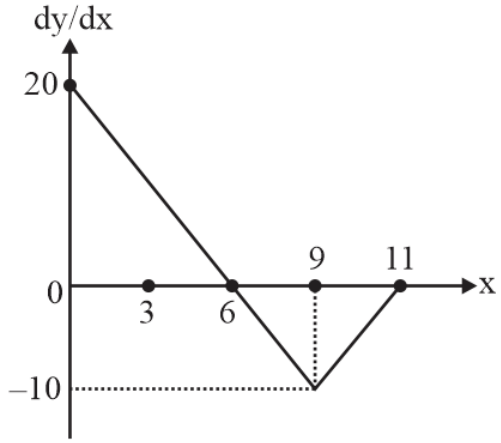
6. If $f(x) = x^2 + 3x + 4$ then find the value of $f'(1) - f(-1)$.

7. The displacement is given by $x = 2t^2 + t + 5$, the acceleration at t = 2s is (in m/s^2).

$\left[\text{Given acceleration} = \frac{d^2x}{dt^2}\right]$

8. $\frac{\pi}{30}$ Radian = ___ degrees.

9. The following curve represents rate of change of a variable y w.r.t x. The change in the value of y when x changes from 0 to 11 is_____.



10. Determine the average value of $y = 2x + 3$ in the interval $0 \leqslant x \leqslant 1$.

Topic : Atomic Structure (Except Schrodinger Wave Equations).

CHEMISTRY

SECTION-I : (Maximum Marks: 80)

This section contains **20 questions**. Each question has 4 options for correct answer. Multiple-Choice Questions (MCQs) **Only one option is correct**. For each question, marks will be awarded as follows:

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1. The potential energy of the electron present in the ground state of Li^{2+} ion is represented by : (r = radius of ground state)

(A) $\frac{3e}{4\pi\varepsilon_0}$ (B) $-\frac{3e}{4\pi\varepsilon_0 r}$

(C) $-\frac{3e^2}{4\pi\varepsilon_0 r^2}$ (D) $-\frac{3e^2}{4\pi\varepsilon_0 r}$

2. Which of the following are isobars?

(i) Atom, whose nucleus contains 20p + 15n.

(ii) Atom, whose nucleus contains 20p + 20n.

(iii) Atom, whose nucleus contains 18p + 17n.

(iv) Atom, whose nucleus contains 18p + 22n.

(A) (i) and (iii) (B) (ii) and (iii)

(C) (iii) and (iv) (D) (i) and (iv)

3. Which of the following are isoelectronic?

(I) CH_3^+ (II) H_3O^+ (III) NH_3 (IV) CH_3^-

(A) I and III (B) III and IV

(C) I and II (D) II, III and IV

4. The wavenumber of the spectral line of shortest wavelength of Balmer series of He^+ ion is : (R = Rydberg's constant)

(A) R (B) 3R

(C) 4R (D) $\frac{4R}{9}$

5. If λ_1 and λ_2 are respectively the wavelengths of the series limit of Lyman and Balmer series of Hydrogen atom, then the wavelength of the first line of the Lyman series of the H-atom is :

(A) $\lambda_1 - \lambda_2$ (B) $\sqrt{\lambda_1\lambda_2}$

(C) $\frac{\lambda_2 - \lambda_1}{\lambda_1\lambda_2}$ (D) $\frac{\lambda_1\lambda_2}{\lambda_2 - \lambda_1}$

6. Which of the following ion will have maximum deflection under given electrical field?

(A) H^+ (B) Li^{3+} (C) He^+ (D) F^-

7. The total number of subshells in n^{th} main energy level are

(A) n^2 (B) $2n^2$

(C) (n – 1) (D) n

8. The electromagnetic radiation having correct order of the property indicated is

(A) Energy : X-rays > UV-rays

(B) Frequency : Micro wave > Infra red

(C) Wavelength : Short (radio) waves > Long (radio) waves

(D) Wave number : Gamma rays > Cosmic rays

9. In which of the following is the radius of the first orbit minimum?

(A) A hydrogen atom

(B) A tritium atom

(C) Triply ionized beryllium

(D) Double ionized helium

10. Uncertainty in the position of an electron (mass = 9.1×10^{-31} kg) moving with a velocity 300 m/s accurate up to 0.001% will be :

(A) 5.76×10^{-3} m (B) 1.92×10^{-2} m

(C) 3.84×10^{-3} m (D) 19.2×10^{-4} m

11. For which of the following species, Bohr model is not valid?

(A) He^{+} (B) H

(C) Li^{2+} (D) Mg^{2+}

12. Wavelength of radiations emitted when an electron in a H-like atom jumps from a state A to C is $2000\overset{o}{A}$ and it is $6000\overset{o}{A}$, when the electron jumps from state B to state C. Wavelength of the radiations emitted when an electron jumps from state A to B will be

(A) $2000\overset{o}{A}$ (B) $3000\ \overset{o}{A}$

(C) $4000\overset{o}{A}$ (D) $6000\overset{o}{A}$

13. If the radius of the first Bohr orbit of the H-atom is r, then for Li^{2+} ion, it will be

(A) 3r (B) 9r

(C) $\frac{r}{3}$ (D) $\frac{r}{9}$

14. In a certain electronic transition in the Hydrogen atom from an initial state i to a final state f, the difference in the orbit radius ($r_i - r_f$) is seven times the first Bohr radius. Identify the transition

(A) $4 \longrightarrow 1$ (B) $4 \longrightarrow 2$

(C) $4 \longrightarrow 3$ (D) $3 \longrightarrow 1$

15. The velocity of electron in the ground state of H atom is 2.184×10^8 cm/sec. The velocity of electron in the second orbit of Li^{2+} ion in cm/sec would be

(A) 3.276×10^8 (B) 2.185×10^8

(C) 4.91×10^8 (D) 1.638×10^8

16. If the angular momentum of an electron in a Bohr orbit is $\frac{2h}{\pi}$, then the value of potential energy of this electron present in He^{+} ion is

(A) -13.6 eV (B) -3.4 eV

(C) -6.8 eV (D) -27.2 eV

17. The ratio of the energy of a photon of wavelength $3000\overset{o}{A}$ to that of a photon of wavelength $6000\overset{o}{A}$ respectively is

(A) 1 : 2 (B) 2 : 1

(C) 3 : 1 (D) 1 : 3

18. A certain dye absorbs light of certain wavelength and then fluorescence light of wavelength $5000\overset{o}{A}$. Assuming that under given conditions, 50% of the absorbed energy is re-emitted out as fluorescence and the ratio of number of quanta emitted out to the number of quanta absorbed is 5 : 8, find the wavelength of absorbed light (in $\overset{o}{A}$). (hc = 12400 eV $\overset{o}{A}$)

(A) $4000\overset{o}{A}$ (B) $3000\overset{o}{A}$

(C) $2000\overset{o}{A}$ (D) $1000\overset{o}{A}$

19. Determine the de-Broglie wavelength associated with an electron in the 3rd Bohr's orbit of He^{+} ion

(A) $10\overset{o}{A}$ (B) $2\overset{o}{A}$

(C) $5\overset{o}{A}$ (D) $1\overset{o}{A}$

20. If the radius of first Bohr's orbit of H-atom is x, which of the following is the **CORRECT** conclusion about the de-Broglie wavelength of electron in 3rd Borh orbit of H?

(A) $2\pi x$ (B) $3\pi x$

(C) $\frac{3}{2}\pi x$ (D) $6\pi x$

SECTION-II : (Maximum Marks: 20)

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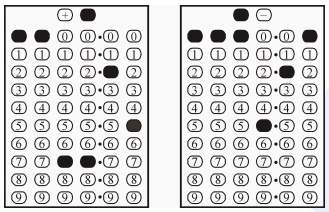
For each question, enter the correct numerical value (in decimal notation, truncated/rounded off to the second decimal place; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct)



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1. The total number of isoelectronic species from the given set is ___.

O^{2-}, F^-, Al, Mg^{2+}, Na^+, O^+, Mg, Al^{3+}, F

2. The orbital angular momentum of an electron in 3s orbital is $\frac{xh}{2\pi}$. The value of x is ___. (Nearest Integer)

3. Values of work function (W) for a few metals are given below :

Metal	Li	Na	K	Mg	Cu	As	Be
W/eV	2.42	2.3	2.25	3.7	4.8	4.3	4.98

The number of metals which will show photoelectric effect when light of wavelength 400 nm falls on it is ___.

(Given: h = 6.6×10^{-34} Js, c = 3×10^8m/s, e = 1.6×10^{-19}c)

4. What will be the radius (in femtometer) of the nucleus of $_{13}Al^{27}$? (Nearest Integer)

5. The wavelength of an electron of kinetic 4.50×10^{-29}J is ___ $\times 10^{-5}$ m. (Nearest Integer) (Given : mass of electron is 9×10^{-31} kg, h =6.6×10^{-34} Js)

6. If the charge on proton and electron is reduced to 8×10^{-20} coulombs, the new value of Rydberg's constant charges from R to $\frac{R}{x}$. Then the value of x is ___.

7. The accelerating potential (V) that must be imparted to a proton beam to give it an effective wavelength of $0.1\overset{o}{A}$ is ___. (the closest whole number value, charge of e^- = 1.6×10^{-19}C) (Nearest Integer)

8. A transition to the ground state in hydrogen spectrum has the same wavelength as Balmer transition n = 4, n = 2 of He^+ spectrum. The higher orbit number in transition occurring in H-atom is___.

9. Using arbitrary energy units we can calculate that 864 a.u are required to transfer an electron in hydrogen atom from the most stable Bohr's orbit to the largest distance from the nucleus N = ∞, E = 0 and N = 1, E = –864 a.u. The energy required (in a.u) to transfer the electron from 3rd Bohr's orbit to the orbit n = ∞ will be :

10. If an excited H-atom emission spectrum contains ten emission lines, the highest orbit in which the electron expected to be found is ___.

SECTION-I : (Maximum Marks: 80)

This section contains **20 questions**. Each question has 4 options for correct answer. Multiple-Choice Questions (MCQs) **Only one option is correct**. For each question, marks will be awarded as follows:

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1. If $a^3 + b^3 + 3ab = 1$, where a, b are distinct number, then a + b =

(A) 1 (B) 0

(C) –1 (D) 2

2. The sum of all roots of the equation $||x-1|-2| = 5$ is :

(A) 2 (B) –2

(C) –9 (D) –1

3. The solution set of $\frac{x^2+6x-7}{x^2+1} \leqslant 2$ is:

(A) $x \in (-\infty, 3)$ (B) $x \in [3, \infty)$

(C) $x \in (-\infty, \infty)$ (D) $x \in (3, \infty)$

4. If $3^{x+y} = 243$ and $2^{2x+y} = 128$, then the value of $x^3 + y^3$ is :

(A) 35 (B) 36

(C) 17 (D) 18

5. The complete solution set of the inequality $\frac{\sqrt{x-2}}{x-3} \geqslant 0$ is:

(A) $x \in [2, \infty) - \{3\}$

(B) $x \in (3, \infty)$

(C) $x \in [3, \infty)$

(D) None of these

6. The complete solution set of the inequality $\left|\frac{3x-1}{x+1}\right| < 2$ is:

(A) $\left(-\frac{1}{5}, 3\right)$ (B) $(-1, 3)$

(C) $\left(-\frac{1}{4}, 3\right)$ (D) $(-1, 4)$

7. If a & b are two positive real number such that $2(a+b) = 5\sqrt{ab}$ (where a > b) then ratio of number $\frac{a}{b}$ is:

(A) 6 (B) 4 (C) 8 (D) 2

8. Find the value of x, $|x-3| + 2|x+1| = 4$.

(A) $x = \{-1\}$ (B) $x = \{-1, 4\}$

(C) $x = \{-1, -3\}$ (D) No solution

9. Solve: $\frac{x^2+x+1}{|x+1|} > 0$.

(A) $(-\infty, -1) \cup (1, \infty)$

(B) $(-\infty, 1) \cup (1, \infty)$

(C) $(-\infty, -1) \cup (-1, \infty)$

(D) $(1, \infty)$

10. If $|x^2 + x| - 5 < 0$, then x belongs to :

(A) $\left(-\left(\frac{1+\sqrt{21}}{2}\right), \left(\frac{\sqrt{21}-1}{2}\right)\right)$

(B) $(-\infty, -1) \cup (1, \infty)$

(C) $\left(\left(\frac{1-\sqrt{21}}{2}\right), \left(\frac{\sqrt{21}+1}{2}\right)\right)$

(D) $(\infty, 1) \cup (-1, \infty)$

11. The solution set of $|2x+3| > 5$ is

(A) $(-\infty, -4)$

(B) $(1, \infty)$

(C) $(-\infty, -4) \cup (1, \infty)$

(D) $(-\infty, -1) \cup (4, \infty)$

12. Which of the following is incorrect?

(A) $0.\overline{125} = \frac{125}{999}$

(B) $0.2\overline{35} = \frac{233}{990}$

(C) $3.\overline{14} = \frac{22}{7}$

(D) All are correct

13. The number of real solutions of equation $x^2 - 3|x| + 2 = 0$ is

(A) 1 (B) 2

(C) 3 (D) 4

14. The solution set of the inequality $(x-1)(x-2)(x-3)(x-4) \geq 0$ is

(A) $(-\infty, 2) \cup (4, \infty)$

(B) $[1, 2] \cup [3, 4]$

(C) $(-\infty, 2] \cup [3, 4]$

(D) $(-\infty, 1] \cup [2, 3] \cup [4, \infty)$

15. The set of real values of x satisfying $|x-1| \leq 3$ and $|x-1| \geq 1$ is

(A) [2, 4]

(B) $(-\infty, 2] \cup [4, \infty)$

(C) $[-2, 0] \cup [2, 4]$

(D) None of these

16. **Solve:** $||x-1| + 2| \leq 4$.

(A) $x \in [-1, 3)$

(B) $x \in [-1, 3]$

(C) $x \in [2, 3]$

(D) $x \in (2, 3)$

17. The value of $3 + \cfrac{1}{4 + \cfrac{1}{3 + \cfrac{1}{4 + \cfrac{1}{3 + \ldots \infty}}}}$ is equal to

(A) $1.5 + \sqrt{3}$ (B) $2 + \sqrt{3}$

(C) $3 + 2\sqrt{3}$ (D) $4 + \sqrt{3}$

18. If $\left|\frac{12x}{4x^2+9}\right| \geqslant 1$ for all real values of x, the inequality being satisfied only if $|x|$ is equal to

(A) $\frac{3}{2}$ (B) $\frac{2}{3}$

(C) $\frac{1}{3}$ (D) $\frac{1}{2}$

19. The solution set of the inequality $5^{x+2} > \left(\frac{1}{25}\right)^{1/x}$ is

(A) $(-2, 0)$ (B) $(-2, 2)$

(C) $(-5, 5)$ (D) $(0, \infty)$

20. The equation $||x-4| + a| = 4$ can have real solutions for x if 'a' belongs to the interval

(A) $(-\infty, +\infty)$ (B) $(-\infty, 4]$

(C) $(4, +\infty)$ (D) $[-4, 4]$

SECTION-II : (Maximum Marks: 20)

This section contains 10 questions Candidates have to attempt any 5 questions out of 10. If more than 5 questions are attempted, then only first 5 attempted questions will be evaluated.

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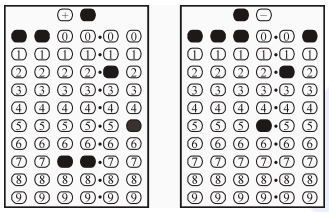

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1. If $a \in I$ and $a^4 + a^2 + 1$ is prime, then the number of possible value of 'a' is___.

2. The number of real values of x satisfying the equation $(x^2 - 9)\sqrt{x-5} = 0$ is___.

3. The number of integral values of x satisfying the inequality $x^4 - 5x^2 \leqslant -4$ is___.

4. What is the minimum values of the function $|x - 4| + 2$?

5. The product of the roots of the equation $9x^2 - 18|x| + 5 = 0$, is $\frac{a}{81}$. Then the value of a is_____.

6. The number of real solutions of the equation $x(x^2 + 3|x| + 5|x-1| + 6|x-2|) = 0$ is ___.

7. Find the number of roots of the equation $|x| + |x - 2| = 5$, $x \in R$.

8. If $x - \frac{1}{x} = 3$, then the value of the expression $2\left(x^3 - \frac{1}{x^3}\right) - 3\left(x^2 + \frac{1}{x^2}\right) - 39$.

9. The integral value of x which satisfies the inequality $x^4 - 3x^3 - x + 3 < 0$ is ___.

10. The number of real solutions of the equation, $|x + 1| - 12 = 0$.

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