FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2024
FULL TEST – III
PAPER –2
TEST DATE: 08-02-2024

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 51 questions.
- Each subject (PCM) has 17 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Three Sections**: **Section-A, Section-B & Section-C**.
  Section – A *(01 – 04, 18 – 21, 35 – 38)*: This section contains **TWELVE (12)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.
  Section – A *(05 –07, 22 – 24, 39 – 41)*: This section contains **NINE (09)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
  Section – B *(08 – 13, 25 – 30, 42 – 47):* This section contains **EIGHTEEN (18)** numerical based questions. The answer to each question is a **NON-NEGATIVE INTEGER VALUE**.
  Section – C *(14 –17, 31 – 34, 48 – 51)*: This section contains **SIX (06) paragraphs.** Based on each paragraph, there are **TWO (02)** questions of numerical answer type. The answer to each question is a **NUMERICAL VALUE (XXXXX.XX).** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.

MARKING SCHEME

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct option is chosen.
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–1	In all other cases.

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If only (all) the correct option(s) is (are) chosen;
Partial Marks	:	+3	If all the four options are correct but ONLY three options are chosen;
Partial marks	:	+2	If three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks	:	+1	If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–2	In all other cases.

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

Full Marks	:	+4	If ONLY the correct integer is entered;
Zero Marks	:	0	Question is unanswered;
Negative Marks	:	0	In all other cases.

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

Full Marks	:	+3	If ONLY the correct integer is entered;
Zero Marks	:	0	Question is unanswered;
Negative Marks	:	0	In all other cases.

Physics

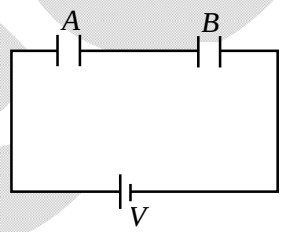
PART – I

SECTION – A
(One Options Correct Type)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.*

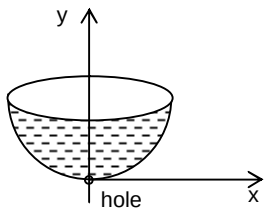
1. When the centre of earth is at a distance of 1.5×10^{11} m from the centre of sun, the intensity of solar radiation reaching at the earth's surface is 1.26 kW/m^2. There is a spherical cloud of cosmic dust, containing iron particles. The melting point for iron particles in the cloud is 2000 K. Find the distance of iron particles from the centre of sun at which the iron particle starts melting. (Assume sun and cloud as a black body, $\sigma = 5.6 \times 10^{-8}$ W/m^2 K^4.)
(A) 2.81×10^6 m (B) 2.81×10^{10}m
(C) 2.81×10^9 m (D) 1.40×10^{10} m

2. Two identical parallel plate capacitors *A* and *B* are connected in series through a battery of potential difference *V* (see figure). Area of each plate is *a* and initially plates of capacitors are separated by a distance *d*. Now, separation between plates of capacitor *B* starts increasing at constant rate *v*, find the rate by which work is done on the battery when separation between plates of capacitor *B* is 2*d*.

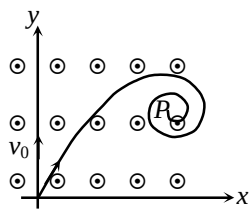


(A) $\frac{a\varepsilon_0 vV^2}{d^2}$ (B) $\frac{a\varepsilon_0 vV^2}{2d^2}$
(C) $\frac{a\varepsilon_0 vV^2}{9d^2}$ (D) $\frac{2a\varepsilon_0 vV^2}{d^2}$

3. A small hole is made at the bottom of a symmetrical jar shown in figure. A liquid is filled into the jar upto certain height. The rate of descension of liquid is independent of the level of the liquid in the jar. Then, the surface of the jar is a surface of revolution of the curve
(A) $y = kx^2$ (B) $y = kx^4$
(C) $y = kx^3$ (D) $y = kx^5$
(Where k is constant)



4. A particle having mass *m*, charge *q* is projected with velocity v_0 along *y*-axis in a region of uniform magnetic field B_0 which is outward and perpendicular to the plane of the paper as shown in the figure. The particle is continuously subjected to a frictional force which varies with velocity as $\vec{F}_r = -\alpha\vec{v}$, where α is a constant. Consequently the particle moves on a spiral path till it comes to rest at point *P*. The *x*- co-ordinate of point *P* is



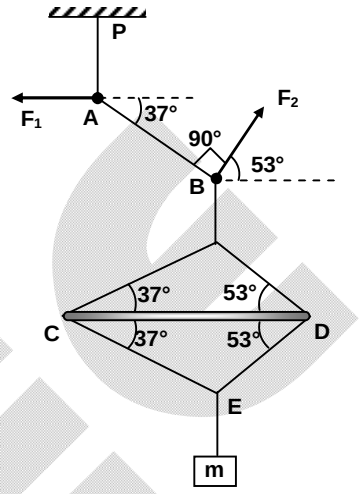
(Take $\alpha = 10^{-3}$ kg/s, $q = 10^{-3}$C, $B_0 = 1\text{T}$, $v_0 = 1\text{m/s}$, m = 20 gm)
(A) 10 m (B) 4 m
(C) 6 m (D) 8 m

SECTION – A

(One or More than one correct type)

*This section contains **THREE (03)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

5. Block is in equilibrium and the tension in the string AB is 300 N. Then choose the correct option(s). (Take g = 10 m/s^2, $\tan 37^\circ = \frac{3}{4}$ and neglect the mass of the rod CD)



(A) The tension in the string CE is 300 N

(B) The ratio of force F_2 and F_1, $\left(\left|\frac{F_2}{F_1}\right|\right)$ is $\frac{5}{3}$.

(C) Force of compression in the rod CD is 480 N.

(D) Mass of the block is 50 Kg

6. A particle of mass *m* and charge *q* is projected in a region where an electric field is existing and given by $\vec{E} = E_0\hat{i}$, with a velocity $v_0\hat{j}$ from the origin at time *t* = 0, then choose the correct statements (assuming $m^2v_0^2 = 2qE_0mx_0$).

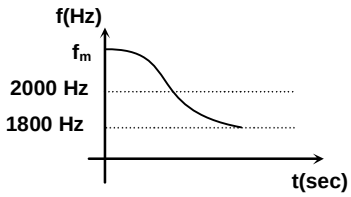
(A) radius of curvature of the particle when its *x*-coordiante becomes x_0 is $2x_0$.

(B) radius of curvature of the particle when its *x*-coordiante becomes x_0 is $4\sqrt{2}\,x_0$.

(C) speed of the particle when its *x*-coordinate becomes x_0 is $\sqrt{2}v_0$.

(D) speed of the particle when its *x*-coordinate becomes x_0 is $2v_0$.

7. The apparent frequency 'f' observed by a stationary observer varies with time 't' as shown in the figure, when the source moves with a constant velocity. If the actual frequency emitted by the source is 2000 Hz, then (speed of sound 300 m/s)



(A) Speed of source is 33.33 m/sec

(B) f_m shown in figure is equal to 2200 Hz

(C) f_m shown in figure is equal to 2250 Hz

(D) Speed of source is 66.66 m/sec

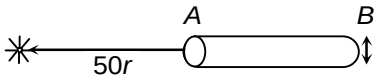
SECTION – B

(Numerical Answer Type)

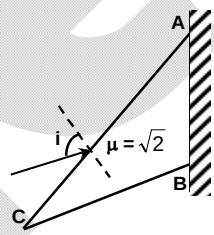
*This section contains **SIX (06)** Numerical based questions. The answer to each question is a **NON-NEGATIVE INTEGER VALUE**.*

8. The excess pressure inside one soap bubble is three times that inside a second bubble. The ratio of the volume of the first bubble to that of the second is (1/X). Find the value of X.

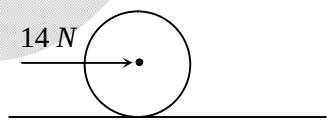
9. A cylindrical rod of length $l = 64$ cm and cross-sectional radius $r = \left(2/\sqrt{\pi}\right)$ cm is placed at a distance 50 *r* from a infrared point source *S* of power 1.25 kW as shown in the figure. The lateral surface of the rod is perfectly insulated from the surroundings. The cross-section A absorbs 80% of the incident energy, has temperature T_A in steady state. The surface *B* is radiating energy into space and the wavelength emitted by it with maximum energy density is 100,000 Å. Determine the temperature of end *B* and find the value of T_A if conductivity varies with temperature as $K = \frac{T}{T_A}$. Assume that the rate of flow of heat through the rod is steady. (Wein's constant = 0.003 mK)



10. One face of a prism ABC of $\mu = \sqrt{2}$ is silvered and the ray incident at angle 45° retraces its initial path. Then the angle $\angle$CAB is n $\times$ 10°. Then the value of n is

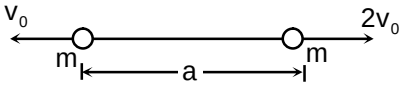


11. A uniform sphere of mass 20 kg and radius 10 cm is placed on a rough horizontal surface. The coefficient of friction between the sphere and the surface is 0.5. A horizontal force of magnitude 14 *N* is applied on the sphere as shown. Friction force acting on the sphere is x. Find the value of x. (g = 10 ms^{-2})



12. A cubical block 'A' of mass m_0(= $a^3\rho$ = 3 kg) of edge 'a' and density ρ floats in a liquid of density 3ρ. The lower surface of the cube just touches the free end of massless spring of spring constant k(= $a^2\rho g$) fixed at the bottom of the vessel. Another block 'B' of mass 'm' put over the block 'A', so that it is completely immersed in liquid without wetting the block 'B'. Then find the value of m in kg.

13. Initial velocities of masses separated by 'a' are shown in figure. The maximum separation between them during motion is $r = \frac{4Gma}{4gm - kv_0^2 a}$, where value of k is?

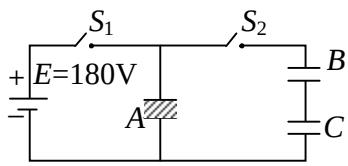


SECTION – C
(Numerical Answer Type)

*This section contains **TWO (02) paragraphs.** Based on each paragraph, there are **TWO (02)** questions of numerical answer type. The answer to each question is a **NUMERICAL VALUE (XXXXX.XX).** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

Paragraph for Question Nos. 14 and 15

When the capacitor *A* is filled with a dielectric slab (*K* = 2) it has capacitance C_1 = 2μF as circuit shown. Capacitors *B* and *C* are air capacitors and have capacitances C_2 = 2μF and C_3 = 4μF respectively



14. Find charge on capacitor A when only S_1 is closed and S_2 is open

15. After charging capacitor A through S_1 alone, S_2 is closed and S_1 released. The charge on capacitor B is

Paragraph for Question Nos. 16 and 17

In a photoelectric effect, a point source of green light of power 40 W emits mono-energetic photons that can just emit photoelectrons from an isolated metallic sphere of radius r = 1 cm, placed at a distance of 1m from the light source. Now, four other separate sources of violet, blue, red and yellow light emitting same number of photons as that of green light are brought near the source of green light.
Assume one photoelectron is emitted out of every 10^6 incident photons on sphere.
(Take λ_{violet} = 4136 Å, λ_{blue} = 5000 Å, λ_{red} = 7200 Å, λ_{green} = 4963 Å, hc = 12408 eV Å)

16. The potential of the sphere when emission of photoelectrons will stop is

17. The time in (ms) after which the emission of photoelectron will stop is

FIITJEE

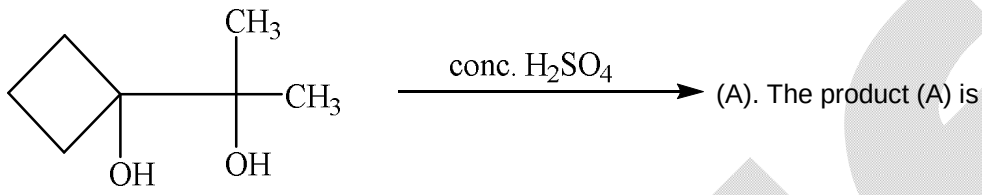
Chemistry

PART – II

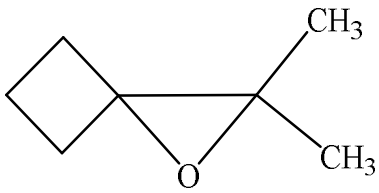
SECTION – A
(One Options Correct Type)

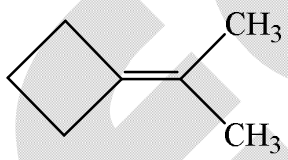
*This section contains **FOUR (04)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.*

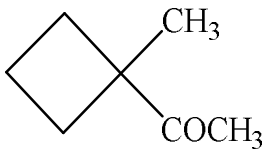
18. In the reaction

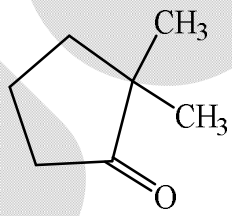


(A). The product (A) is

(A)


(B)


(C)


(D)


19. Ge(II) compounds are powerful reducing agents, whereas Pb(IV) compounds are strong oxidants. It can be due to
(A) lead is more electropositive than germanium.
(B) the ionization potential of lead is less than that of germanium.
(C) the ionic radii of Pb^{2+} and Pb^{4+} are larger than those of Ge^{2+} and Ge^{4+}
(D) in lead the inert pair effect in more pronounced than in germanium.

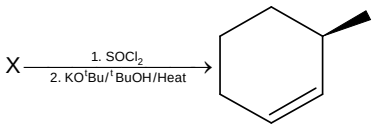
20. While testing BO_3^{3-}, there is green-edged flame on heating the salt with conc H_2SO_4 and CH_3OH. Green colour is of
(A) $(CH_3)_3B$ (B) $(CH_3O)_3B$
(C) B_2O_3 (D) H_3BO_3

21. In Van-Arkel method, if I_2 is introduced at 1700 K over impure metal, the product will be
(A) Iodide of the metal (B) No reaction takes place
(C) Impurities react with iodine (D) None of these

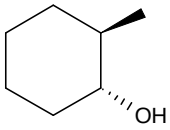
SECTION – A

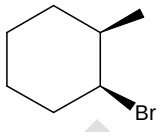
(One or More than one correct type)

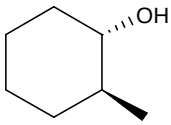
*This section contains **THREE (03)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

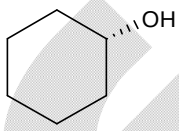
22. 

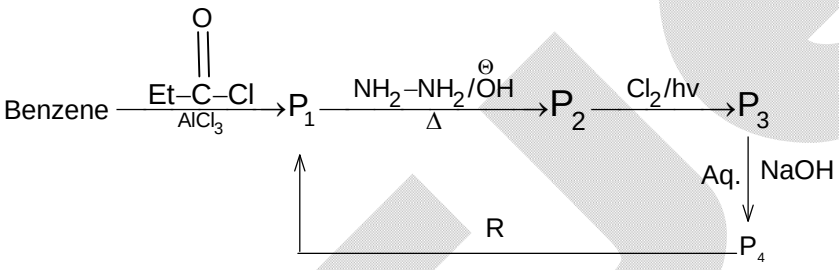
Compound X is/are ?

(A) 

(B) 

(C) 

(D) 

23. 

Reagent R can be?

(A) MnO_2/Δ

(B) P.C.C

(C) $Br_2 + H_2O$

(D) LAH

24. Which of the following statements regarding silicon are correct?
(A) silicones have good thermal stability
(B) liquid silicones are lubricants
(C) silicones are chemically inert substances
(D) silicon rubbers are made up of straight chain polymers of 100–500 silicon units

SECTION – B

(Numerical Answer Type)

*This section contains **SIX (06)** Numerical based questions. The answer to each question is a **NON-NEGATIVE INTEGER VALUE**.*

25. The unit cell of $TlAl(SO_4)_2.xH_2O$ is face-centered cubic with a = 1.221 nm. If ρ = 2.32 g cm^{-3}, then the value of x will be? (Tl-204u)

26. Chromium plating of an article was carried out by treating it as cathode in an electrolysis. If during electrolysis the weight of the article increased by 2.6 g and 0.56 dm^3 of oxygen (corrected up to STP) evolves at inert anode, the oxidation state of the chromium ions being discharged will be? (Cr-52u)

27. Certain mass, say x g, of urea was dissolved in 500 g of water and cooled upto –0.5°C whereby 128 g of ice separates out from the solution. If Cryoscopic constant for water be 1.86° C m^{-1}, the value of x will be?

28. The number of Stereoisomers of 1, 2, 4-trimethylcyclohexane will be?

29. How many methoxy groups/molecule of a compound (A) would be present by the results of a Zeisel method. Treatment of compound (A) ($C_{20}H_{11}O_4N$) with hot, conc. HI gives CH3I indicating presence of methoxy groups. When 4.24 mg of a compound (A) is treated with hot. conc. HI and CH_3I thus produced is digested with alc. $AgNO_3$, 11.62 mg of AgI is obtained.

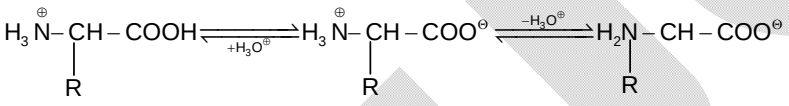
30. The number of possible enantiomeric pairs that can be produced during monochlorination of 2-methyl butane are?

SECTION – C
(Numerical Answer Type)

*This section contains **TWO (02) paragraphs.** Based on each paragraph, there are **TWO (02)** questions of numerical answer type. The answer to each question is a **NUMERICAL VALUE (XXXXX.XX).** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

Paragraph for Question Nos. 31 and 32

Amino acids contain both a basic group ($–NH_2$) and an acidic group ($–CO_2H$). In the dry solid state, amino acids exist as dipolar ions, a form in which the carboxylic group is present as a carboxylate ion, $-CO_2^-$ and the amino group is present as on ammonium ion, $-NH_3^{\oplus}$. In aqueous solution, an equilibrium exists between the dipolar ion (zwitter ions) and the anionic and cationic forms of an amino acid.



Cationic form $\left(K_{a_1}\right)$ Dipolar ion $\left(K_{a_2}\right)$ (Zwitter ion) Anionic form

In strongly acidic solution $(pH \approx 0)$ all amino acids are present primarily as cations, in strongly basic solution they are present as anions. At some intermediate pH, called the isoelectric point (pI), the concentration of the anions and cations is equal. Each amino acid has particular isoelectric point.

31. For the phenyl alanine, the first and second dissociation constants are given as $pKa_1 = 1.8$ and $pKa_2 = 9.1$. What will be the pH at isoelectric point?

32. The formula of lysine is $H_2N(CH_2)_3$. $CH_2-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$ for lysine the value of pK_{a_1}, pK_{a_2} and pK_{a_3} are 2.2, 9.0 and 10.5 respectively. The pH at isoelectric point of lysine is

Paragraph for Question Nos. 33 and 34

The adiabatic compression of a mixture of 2 volumes of Hydrogen and 1 volume of oxygen from 320 ml of 10 ml caused explosion. The initial pressure and temperature of the gaseous mixture were 1 atm and 27ºC

33. What is the temperature of the gaseous mixture at the moment of explosion?

34. What is the magnitude of maximum work (in joules) performed by the gaseous mixture before explosion?

Mathematics

PART – III

SECTION – A
(One Options Correct Type)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.*

35. If f : {1, 2, 3, 4} $\rightarrow$ {1, 2, 3, 4} y = f(x) be a function such that $|f(\alpha) - \alpha| \leq 1$, for $\alpha \in$ {1, 2, 3, 4} then total number of such functions are
(A) 81 (B) 36
(C) 54 (D) 29

36. If real numbers a, b, c satisfy 4a + 3b + c = 7, then least value of $2a^2 + b^2 + c^2$ is
(A) $\frac{\sqrt{7}}{2}$ (B) $\frac{7}{2}$
(C) $\frac{49}{18}$ (D) can't be determined

37. $y = \sqrt{3}x + \lambda$ is drawn through focus S of the parabola $y^2 = 8x + 16$. If two intersection points of the given line and the parabola are A and B such that perpendicular bisector of AB intersect the x axis at P then length of PS is
(A) $\frac{8}{7}$ (B) $\frac{7}{17}$
(C) $\frac{8}{\sqrt{3}}$ (D) $\frac{16}{3}$

38. The plane containing the line $\frac{x-3}{2} = \frac{y-1}{4} = \frac{z-2}{5}$ is rotated through an angle $\frac{\pi}{2}$ about this line to contain the point (4, 3, 7). The equation of plane before rotation is
(A) $4x + 8y + 8z = 4$ (B) $4x - 8y - 8z = 4$
(C) $4x + 8y - 8z = 4$ (D) $4x - 8y + 8z = 4$

SECTION – A
(One or More than one correct type)

*This section contains **THREE (03)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

39. A rod of fixed length k has its ends sliding along the co-ordinate axes in 1st quadrant such that rod meet the x-axis at A(a, 0) and y-axis at B(0, b), then the minimum value of $\left(a + \frac{1}{b}\right)^2 + \left(b + \frac{1}{a}\right)^2$ is equal to
(A) $k^2 + 2 + \frac{4}{k^2}$ (B) $\left(k + \frac{2}{k}\right)^2$
(C) Minimum value of $\left(a + \frac{1}{a}\right)^2 + \left(b + \frac{1}{b}\right)^2$ (D) 8

40. If (x+1) (x+2).....(x+99) = $A_0 + A_1.x + A_2.x^2 + ...+ A_{99}x^{99}$, and $S = \frac{\sum_{k=1}^{99}(k.A_k)}{100!} = \sum_{i=1}^{99}\left(\frac{1}{r_i}\right), (r_i < r_j < j)$, then value of $\sum_{k=1}^{99}\frac{1}{\sqrt{r_k - 1}}$ is lying between

(A) 15 and 19 (B) 15 and 17
(C) 14 and 17 (D) 17 and 19

41. The value of x in $\left(0, \frac{\pi}{2}\right)$ satisfying equation $\frac{\sqrt{5}-1}{\sin x} + \frac{\sqrt{10+2\sqrt{5}}}{\cos x} = 8$ is

(A) $\frac{\pi}{10}$ (B) $\frac{3\pi}{10}$
(C) $\frac{9\pi}{10}$ (D) $\frac{7\pi}{10}$

SECTION – B

(Numerical Answer Type)

*This section contains **SIX (06)** Numerical based questions. The answer to each question is a **NON-NEGATIVE INTEGER VALUE**.*

42. Find the maximum possible integral value of $\frac{\beta - \alpha}{\tan^{-1}\beta - \tan^{-1}\alpha}$, where $0 < \alpha < \beta < \sqrt{3}$, is

43. Consider the following quantities $x_1, x_2....., x_{10}, -1 \le x_1, x_2, ..., x_{10} \le 1$ and $x_1^3 + x_2^3 + ... + x_{10}^3 = 0$ then $x_1 + x_2 + ... + x_{10} \le \frac{2\lambda}{3}$, where λ can be _____

44. Let A and B be two points on circle $x^2 + y^2 = 1$ in first quadrant such that $\angle AOB = 45^\circ$ (O is origin) foot of $\perp$ from A and B on x-axis are M and N and on y-axis are P and Q respectively. Area (Region ABNM) + Area (Region ABQP) = $k\pi$ then 12k is equal to _____

45. Two equal chords AB and AC of the circle $x^2 + y^2 - 6x - 8y - 24 = 0$ are drawn from the point $A(\sqrt{33} + 3, 0)$. Another chord PQ is drawn intersecting AB and AC at point R and S respectively given that AR = SC = 7 and RB = AS = 3, then the value of |PR – QS| = ...

46. Let $S_n = \sum_{k=0}^{n}(-4)^k.{}^{n+k}C_{2k}$, then value of $S_{2011} + 2.S_{2010} + S_{2009}$ is _____

47. Let $(2x^2 + 3x + 4)^{10} = \sum_{r=0}^{20} a_r x^r$, then the value of $\frac{a_7}{a_{13}}$, is .....

SECTION – C
(Numerical Answer Type)

*This section contains **TWO (02) paragraphs.** Based on each paragraph, there are **TWO (02)** questions of numerical answer type. The answer to each question is a **NUMERICAL VALUE (XXXXX.XX).** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

Paragraph for Question Nos. 48 and 49

Consider an isosceles triangle with co-ordinates (0, 0) and (4, 0) and base angle 45º. A straight line cuts the extension of the base at the point P at an angle θ and bisects the lateral side of the triangle which is nearest to P.

48. If $\tan\theta = \lim\limits_{x\to\frac{\pi}{3}} \dfrac{\sin\left(\frac{\pi}{3}-x\right)}{2\cos x-1}$ and the area of quadrilateral which the straight line cuts off from the given triangle is A square units. Then the value of [A] is (where [.] denotes the greatest integer function)

49. Number of integral values which the length of portion of straight line inside the triangle can take is/are

Paragraph for Question Nos. 50 and 51

Let $\vec{r}$ be a position vector of a variable point in Cartesian OXY plane such that $\vec{r}.\left(10\hat{j}-8\hat{i}-\vec{r}\right)=40$ and $P_1=\max\left\{\left|\vec{r}+2\hat{i}-3\hat{j}\right|^2\right\}; P_2=\min\left\{\left|\vec{r}+2\hat{i}-3\hat{j}\right|^2\right\}$. A tangent is drawn to the curve $y=\dfrac{8}{x^2}$ at the point A with abscissa 2. The drawn line cuts the x-axis at a point B.

50. $P_1 + P_2$ is equal to

51. $\overline{AB}.\overline{OB}$ is equal to