FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2024
FULL TEST – VII
PAPER –2
TEST DATE: 28-04-2024

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. The pressure at a depth h below the surface of sea is (assume that the density of water is ρ_0 at sea level and its bulk modulus is B)

(A) $P = P_0 - B \ln\left(1-\frac{\rho_0 gh}{B}\right)$ (B) $P = P_0 + B \ln\left(1-\frac{\rho_0 gh}{B}\right)$

(C) $P = P_0 - B \ln\left(1+\frac{\rho_0 gh}{B}\right)$ (D) $P = B \ln\left(1-\frac{\rho_0 gh}{B}\right)$

2. F_A and F_C represent adhesive and cohesive forces respectively acting in case of liquid in a capillary tube. Then if

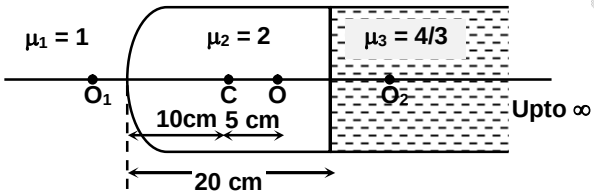
(A) $F_A = \frac{F_C}{\sqrt{2}}$, liquid will neither rise nor fall in the capillary

(B) $F_A > \frac{F_C}{\sqrt{2}}$, liquid will fall in the capillary

(C) $F_A < \frac{F_C}{\sqrt{2}}$, liquid will rise in the capillary

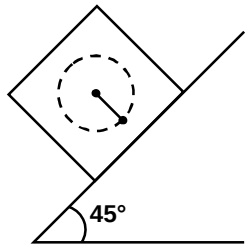
(D) $F_A = F_C$ liquid will fall in the capillary.

3. Two observer O_1 and O_2 observes the position of image of an object O from the boundary of medium II and III. Boundary of medium I and II has centre of curvature at C. Then



(A) O_1 finds a virtual image at a distance of 30 cm from the boundary of medium I and II.
(B) O_1 finds a virtual image at a distance of 35 cm from the boundary of medium I and II.
(C) O_2 finds a virtual image at a distance of 20/3 cm from the boundary of medium II and III.
(D) O_2 finds a virtual image at a distance of 10 cm from the boundary of medium II and III.

4. A person inside a cart gives speed to a bob of mass $\sqrt{2}$ kg tied to a string of length $\sqrt{2}$m, so that the bob performs vertical circular motion in a cart which slides on a smooth incline plane of inclination 45° ($g = 10\ m/s^2$)

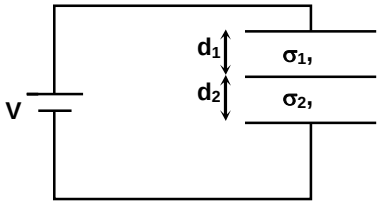


(A) The minimum speed of the bob w.r.t. cart to perform vertical circular motion is $2\sqrt{5}$ m/s
(B) The minimum speed of the bob w.r.t. cart to perform vertical circular motion is 10 m/s
(C) The maximum tension in the string is 60 N
(D) The maximum tension in the string is 50 N

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. A cell is connected with a capacitor filled with two dielectrics as shown in the figure.



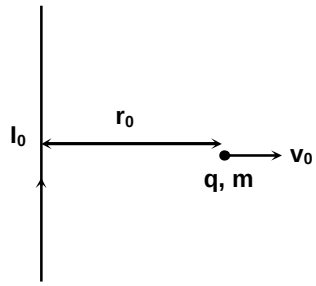
(A) The electric field inside first dielectric is $\frac{V\sigma_2}{d_1\sigma_2 + d_2\sigma_1}$

(B) $\frac{\sigma_1}{\sigma_2} = \frac{\varepsilon_1}{\varepsilon_2}$

(C) The surface charge density on the interface of the two dielectric is $\frac{\varepsilon_0 V(\sigma_2 - \sigma_1)}{d_1\sigma_2 + d_2\sigma_1}$

(D) The surface charge density on the interface of the two dielectric is $\frac{\varepsilon_0 V\sigma_2}{d_1\sigma_2 + d_2\sigma_1}$

6. A charge particle having charge q and mass m is projected away from an infinite current carrying wire from a radial distance of r_0 from the axis of the wire. Then



(A) The maximum distance of the charge particle from the wire during motion is $r_0 e^{\frac{2\pi m V_0}{q\mu_0 I_0}}$

(B) The maximum distance of the charge particle from the wire during motion is $r_0 e^{\frac{\pi m V_0}{q\mu_0 I_0}}$

(C) An observer moving parallel to the wire with constant velocity finds that the force acting on the charge particle has one more magnetic component of force other than what would have been when he was stationary.

(D) The current flowing through the wire does not change with respect to an observer moving parallel to the wire.

7. A wave travelling in string 1 of density ρ_1 is transmitted to string 2 of density ρ_2, both having same radius.

(A) The ratio of intensity of transmitted wave to that of incident wave is $\frac{8}{9}$ $\left(\text{if } \frac{\rho_1}{\rho_2} = 4\right)$

(B) The ratio of intensity of transmitted wave to that of incident wave is $\frac{8}{9}$ $\left(\text{if } \frac{\rho_2}{\rho_1} = 4\right)$

(C) The reflected wave suffers a phase change of π $\left(\text{if } \frac{\rho_1}{\rho_2} = 4\right)$

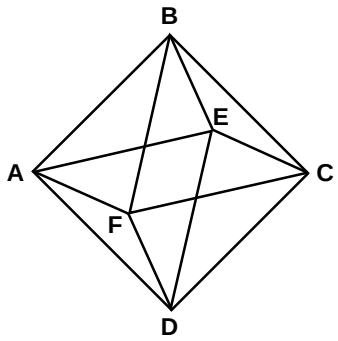
(D) The reflected wave suffers a phase change of π $\left(\text{if } \frac{\rho_2}{\rho_1} = 4\right)$

SECTION – B
(Numerical Answer Type)

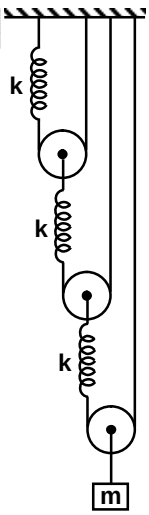
*This section contains **SIX (06)** Numerical based questions. The answer to each question is a **NON-NEGATIVE INTEGER VALUE**.*

8. A positronium consists of an electron and a positron revolving about their common centre of mass. Calculate the value of separation (to the nearest integer in Å) between the electron and positron in their second excited state. (radius r_0 of hydrogen atom in ground state is 0.53 Å)

9. 12 wires, each of resistance R = 1 Ω are used to form a circuit such that three squares lie in different plane i.e. xy, yz and zx. If the value of equivalent resistance is $x\Omega$ between nodes A and C, then find the value of $4x$ __

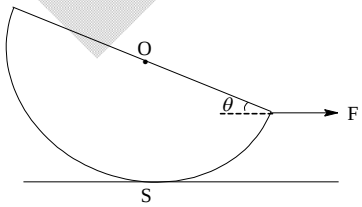


10. A block of mass m is connected with three springs of spring constant k as shown in the figure. If the time period is T sec of vertical oscillations of the block, then find the value of $8T$ __ (Take m = 1 kg, k = $21\pi^2$ N/m)



11. A body loses heat according to Newton's Law of cooling i.e. $\frac{-dT}{dt} = K(T - T_0)$. The time in which body loses 30% of the maximum heat it can lose is $\frac{1}{K}\ln\frac{10}{n}$. Find the value of n.

12. A spherical shell of radius R and mass m is pulled by a horizontal force F such that it moves with constant velocity on a rough surface $\left(\mu = \frac{1}{2}\right)$ as shown in the figure. The angle θ is $\frac{\pi}{n}$, then find the value of n.



13. A sphere and a cube having mass ratio $\frac{9\pi}{2}$ made up of same material and have got identical surface finish are heated to same high temperature and are kept in the same surrounding but are insulated from each other. Find the ratio of initial rate of cooling of cube to that of sphere.

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

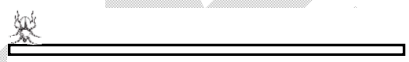


Figure shows top view of an insect dragging an object much larger and heavier than it. The insect pulls the object at one and rotating it slightly then it does the same action at the other end and so on to shift the object from one place to the other.

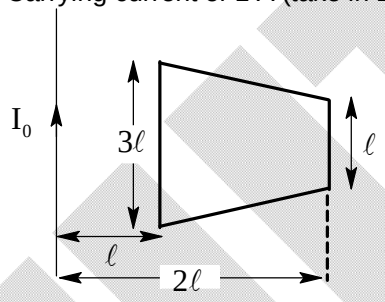
Let an insect is dragging a stick of mass m = 1 gm and length ℓ = 2 m on a rough (μ) = 1/2 horizontal ground by this technique. Answer the following questions.

14. The position (in meter) of a point on stick about which it rotates is (from the end where force is applied by the insect) (take $\sqrt{2} = 1.41$ and g = 10 m/s^2)

15. The minimum force (in mN) needed to drag the stick is

Paragraph for Question Nos. 16 and 17

A loop in the shape of a trapezium is placed in the field of an infinite fixed current carrying wire. Carrying current of 1 A (take ln 2 = 0.7)



16. The force (in μ N) acting on the loop if it carries a current of 1 A in clockwise direction is:

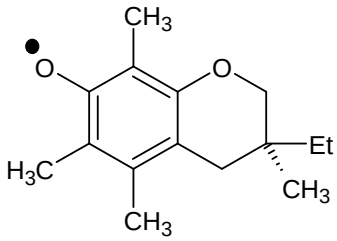
17. The induced emf (in micro volts) in the loop if it is translated with constant velocity 1 m/s away from the infinite wire is

Chemistry

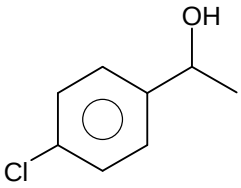
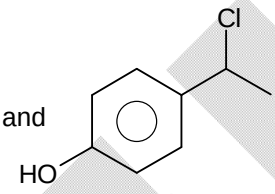
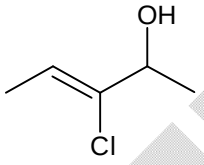
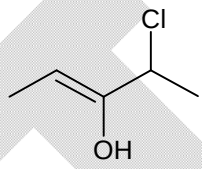
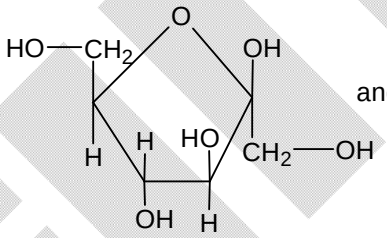
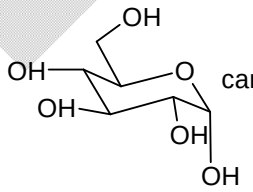
PART – II

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. 

Above free radical is stable mainly due to
(A) hyper conjugation
(B) Steric hindrance
(C) delocalisation
(D) electromeric effect

19. Select the correct option
(A)  and  can be differentiated by Victor Mayer's Test
(B)  and  can be differentiated by Beilstein test
(C) Monomer of polythene is Vinyl chloride
(D)  and  can be distinguished by Seliwanoff's test

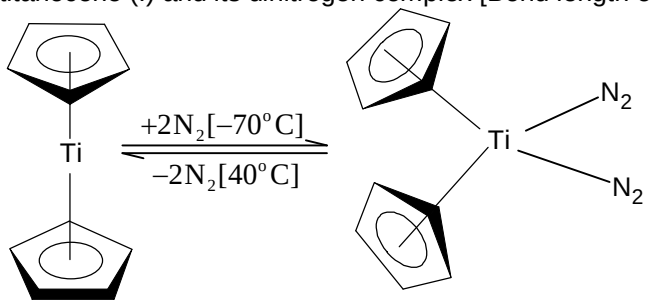
20. The coloured salt P was warmed with NaOH solution and colourless gas Q was evolved and a coloured solution R was produced. The colour of salt P was different from that of solution 'R'. On adding $BaCl_2$ to 'R', a coloured PPT was obtained. Then the correct formula for salt P is
(A) $Na_2Cr_2O_7$
(B) $Mg(NH_4)PO_4$
(C) $(NH_4)_2Cr_2O_7$
(D) PH_4I

21. The reaction of $HClO_3$ with oxalic acid gives a paramagnetic gas, which upon reaction with O_3 produces:
(A) Cl_2O
(B) ClO_2
(C) Cl_2O_6
(D) Cl_2O_7

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. The fixation of N_2 by certain bacteria is a biological reduction reaction of great interest. Very few nonbiochemical systems are know which will react with N_2 at room temperature and atmospheric pressure one such compound is the titanium (II) compound titanocene, $(C_5H_5)_2Ti$ sometimes also abbreviated as Cp_2Ti, a sandwich compound like ferrocene. Select the correct statement(s) about titanocene (I) and its dinitrogen complex [Bond length of free N_2 109.8 pm]



(I) (II)

(A) The IUPAC name for the complex (II) would be bis(cyclopentadienyl) bis (dinitrogen) titanate (II)
(B) NN bond lengths in the complex will be higher than 109.8 pm
(C) The NN bond length in the complex is less than 109.8 pm
(D) Of the two complexes, only complex (II) follows Sidgwick EAN rule

23. Which of the following is correct:
(A) Dialysis is a process of complete removal of impurities from a lyophilic solution
(B) An electrolyte can coagulate both positive solution and negative solution.
(C) There is a transition region corresponding to a range of concentrations around CMC whereas surface tension vary smoothly.
(D) CMC of a nonionic surfactant is greater than of ionic surfactant

24. Which of the following statements is/are False?
(A) If heat of vaporization of water 100°C is 40.6 KJ/mol, then when 9gm of water vapours are condensed to liquid at 100°C & 1 atm, then $\Delta S_{system} = 54.42\ J/K$
(B) When $\left(\Delta G_{system}\right)_{P,T} < 0;$ the reaction must be exothermic.
(C) $dG = Vdp - SdT$ is applicable for closed system in which both PV and non – PV work occurs.
(D) If $\left(\Delta G_{system}\right)_{P,T} < 0,$ then process can be work producing.

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. Considered the $Al_2(OH)_6$ compound and calculate the value of $\frac{(x+y)}{Z}$

Where X = Total number of $(2C-2e^-)$ bond

Y = Total number of $(3C-2e^-)$ bond

Z = Total number of $(3C-4e^-)$ bond

26. How many of the following elements produces NO_2 gas on reaction with concentrated HNO_3?
Zn, Fe, Pb, Cu, Ag, Au, Pt, Sn

27. Find the number of impurities which deposited as anode mud in electrorefining of copper.
Sb, Se, Te, Ag, Pt, Al

28. Reagents which can convert $CH_3 - CHO$ into carboxylic acid/salt:

(i) $\left[Ag(NH_3)_2\right]OH$ (ii) $CH_3\text{-}CO_3H$

(iii) $NaOI$ (iv) DIBAL-H

(v) $Cu, 300°C$

(vi) $K_2Cr_2O_7/H^+$

(vii) $Al\left(-O-HC(CH_3)(CH_3)\right)_3 / H_3C-CH(CH_3)-OH$

29. Find sum of number of B – O – B bonds in

(i) $\left[B_4O_5(OH)_4\right]^{2-}$

(ii) $\left[B_5O_6(OH)_4\right]^-$

30. How many of the following are redox reactions?

(i) $Zn + \text{dil. } H_2SO_4 \rightarrow$

(ii) $H_2C_2O_4 + \text{conc. } H_2SO_4 \rightarrow$

(iii) $P_4 + SOCl_2 \rightarrow$

(iv) $NH_3 + O_2 \xrightarrow{Pt}$

(v) $H_3PO_3 \xrightarrow{\Delta}$

(vi) $Fe^{3+} + SO_2 \rightarrow$

(vii) $NaCl + H_2SO_4 \rightarrow$

(viii) $HCl + O_2 \xrightarrow{CuCl_2}$

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

$AgBr$ (s) is dissolved in ammonia solution till saturation and concentration of ammonia is maintained at 0.2 molar. Ag^+ ions form a complex with NH_3 molecules.

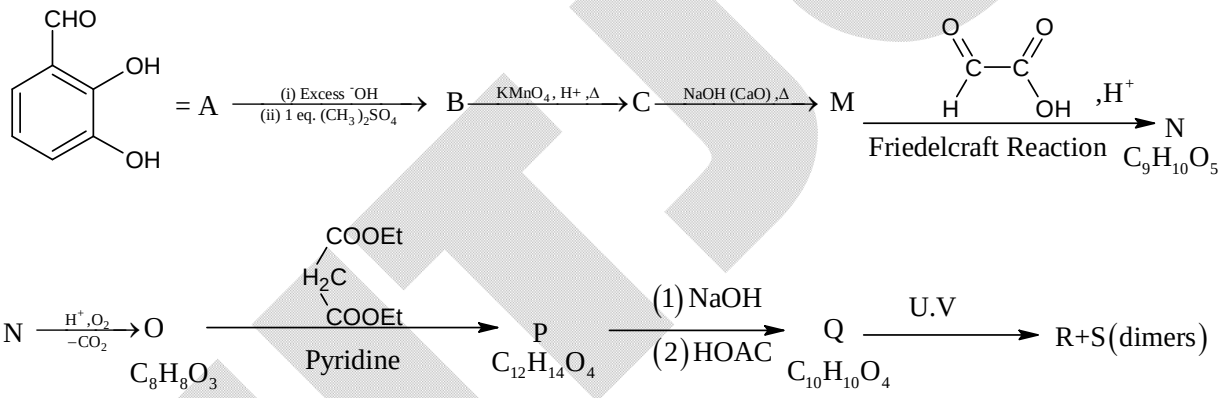
$K_{sp(AgBr)} = 2\times10^{-10}$, $K_{diss\left[Ag(NH_3)_2\right]^+} = \dfrac{1}{8\times10^6}$

The limiting molar conductivity of Ag^+ and Br^- ions are 6 and 8 (in $mS.m^2/mol$)

31. The conductivity of Br^- ions (in mS/m) in the above solution is?

32. The conductivity of Ag^+ ions (in μS/m) in the above solution is?

Paragraph for Question Nos. 33 and 34



33. If yield of 'B' is 13 %, then amount of 'B' (in gm) formed from 1mole of 'A' _____

34. The degree of unsaturation in R is _____

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. Let $f(x) = x^3 - px^2 + qx - 1$, $g(x) = x^3 - qx^2 + px - 1$ be polynomials having complex coefficients and p, q are roots of $x^2 + x + 2 = 0$. Then $\left.\frac{d^2}{dx^2}\left(f(x)g(x)\right)\right|_{x=-1}$ is equal to

(A) 31 (B) 63
(C) 61 (D) 18

36. Suppose $\vec{P}_k = \left(\left(a\sin\left(\frac{2\pi k}{N}\right) - b\cos\left(\frac{2\pi k}{N}\right)\right)\frac{\hat{i}}{\sqrt{2}}\right) + \left(a\sin\left(\frac{2\pi k}{N}\right) + b\cos\left(\frac{2\pi k}{N}\right)\frac{\hat{j}}{\sqrt{2}}\right)$ then

$\lim\limits_{N\to\infty}\sum\limits_{k=0}^{N-1}\left[N\vec{P}_k \quad \vec{P}_{k+1} \quad \vec{P}_k \times \vec{P}_{k+1}\right]$ (where $\left[\vec{a}\ \vec{b}\ \vec{c}\right]$ denotes the scalar triple product of non-zero vectors $\vec{a},\vec{b}\ \&\ \vec{c}$) is equal to:

(A) a^2b^3 (B) πab
(C) $4\pi^2a^2b^2$ (D) $2\pi ab\left(a^2+b^2\right)$

37. The number of n digit numbers formed by using digits {1, 2, 3} such that if 1 appears, it appears even number of times

(A) $2^n + 1$ (B) $\frac{1}{2}\left(3^n+1\right)$
(C) $\frac{1}{2}\left(3^n-1\right)$ (D) $\frac{1}{2}\left(2^n-1\right)$

38. $A = \{x \mid x \in N\ \forall\ x \le 10\}$, $p, q \in A$ such that $\tan\alpha = \frac{p}{q}$ and $\tan2\beta = \tan3\alpha$ then number of pairs (p, q) possible such that $\tan\beta \in Q$ is/are

(A) 1 (B) 2
(C) 3 (D) not possible

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. The circumcircle of ΔABC is $x^2 + y^2 - 5x - 4y + 6 = 0$, if the parabola $(k + 1)y^2 = x + 3$ have sides AB, BC, CA as tangents then k can be

(A) $-\frac{19}{20}$ (B) $-\frac{7}{8}$
(C) $-\frac{11}{12}$ (D) $-\frac{23}{24}$

40. At the point P(a, a^n) on the graph of $y = x^n \ \forall \ n \in Q^+$, a > 0, a normal is drawn to intersect the y-axis at point (0, b) and if $\lim_{a\to 0} b = l$, then

(A) l = 0 if $n < \frac{1}{2}$ (B) l = $\frac{1}{2}$ if $n > \frac{1}{2}$

(C) l = 2 if n > 2 (D) l = $\frac{1}{2}$ if n = 2

41. ABCD is a rhombus. If M, N, P are points taken on sides AB, BC, CD respectively such that centroid of ΔMNP is G. If AM ≡ $\frac{1}{12}$ units, BN ≡ $\frac{1}{5}$ units then

(A) if G lies on AC, PD ≡ $\frac{7}{60}$ units (B) if G lies on BD, PD ≡ $\frac{31}{60}$ units

(C) if G lies on AC, PC ≡ $\frac{13}{20}$ units (D) if G lies on BD, PC ≡ $\frac{17}{60}$ 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**.*

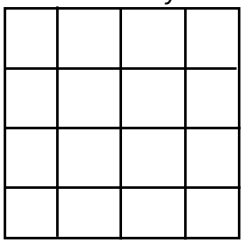
42. If $\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}\sum_{k=1}^{\infty} \frac{mnk\left(3m^2n+mnk\right)5^{-(m+n+k)}}{(m+n)(n+k)(k+m)} = \frac{p}{q}$ where p and q co-prime integers, then the value of $p+q=$

43. If f(x) = $\sin^{-1}(m^2-3m+1)\sec\frac{|x|}{3} - [e^{m-4}](\sin\{x\})$, where $\{\ \}$ denotes fractional part of x and [.] denotes G.I.F. If f(x) is periodic, then number of possible integral values of m is……

44. Let us suppose an event A_N defined as'' All outcomes are head when a fair coin is flipped N times". Assuming $P_N = \frac{1}{p(A_N)}$ where p(E) denotes the probability of occurrence of event E. Suppose $[X]_{2\times 2} = \begin{bmatrix} 1 & 0 \\ 2-w & w \end{bmatrix}$ where $w \neq 1$ is a cube root of unity then find $\sqrt{\left|\sum_{k=1}^{2020}(w)^{P_k}[X]^{R_k}\right|}$ where $|X|$ denotes determinant of matrix X.

45. If ω is imaginary root of $z^{28} = 1$ and such that |ω + 1| is maximum and $x = \frac{1}{2}\left|\omega - \frac{1}{\omega}\right|$, then $8x^4 + 4x^3 - 8x^2 - 3x + 4$ is equal to _____

46. Four letters, two 'a' and two 'b' are filled into 16 cells of a matrix as given. It is required that each cell contains atmost one letter and each row or column cannot contain same letters. Then the number of ways the matrix can be filled is____



47. If $\begin{vmatrix} a & 2 & b \\ p & 4 & q \\ m & 9 & n \end{vmatrix} = 100$ and $\begin{vmatrix} a & p & m \\ b & q & n \\ 1 & 3 & 2 \end{vmatrix} = 300$ where $a,b,p,q,m,n \in \mathbb{R}$ then the value of

$$\begin{vmatrix} 5 & a & b \\ 13 & p & q \\ 15 & m & n \end{vmatrix} =$$

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

Suppose f(x) is a surjective function defined as f : R $\to$ [–1, 2], f(x) = $\frac{x^2+9mx+17}{nx^3+x^2+mx+33}$, f′(p) = f′(q) = 0 where, m, n, p, q $\in$ R and p < q then

48. If $e_1, e_2, e_3, \ldots, e_\mu$ are eccentricities of all possible curves $1-(p+q)^{-2}x^2-(m+1)^{-1}y^2=0$, Then sum of all possible values of product $\left(\frac{3}{e_i}\right)^2 . \left(\frac{2}{e_j}\right)^4$ is equal to ____

49. Suppose $S_1 = \left\{\{z \in C : |z+1-|m+n+p+q|\,| = \frac{1}{2}\right\}$ and $S_2 = \left\{z \in C : |z-|z+1|| = |z+|z-1|\,|\right\}$ provided that $\forall\ z_1 \in S_1$ and $z_2 \in S_2$ then Min.$|z_1 - z_2|$ is equal to___

Paragraph for Question Nos. 50 and 51

In a family get together, 3 sisters Satakshi, Akanshi and Ditya invites 8 other members of their family for a party where they all will sit around a round table in such a way that these sisters have their seats fixed and at least one person must be sitting between any 2 fixed seats. Two members Pramod and Ajay do not wish to sit together.

50. If the number of ways in which this seating arrangement can be done in___

51. If the probability that each of these 11 members will throw a fair dice once such that no 2 neighbours throw the same number is $\frac{m^{11}-n}{p^{11}}$, where m, n p $\in N$ and HCF (m, p) = 1, then the value of $\left(\frac{29m+30n}{(p+1)}\right)$ is equal to _____

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