FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2024
FULL TEST – I
PAPER –2
TEST DATE: 28-12-2023

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.

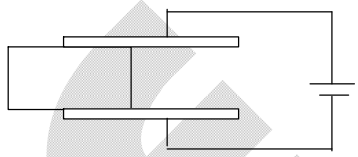
Physics

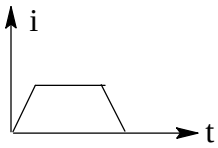
PART – I

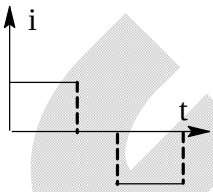
SECTION – A
(One Options Correct Type)

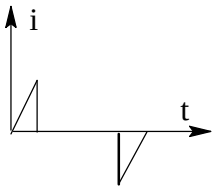
*This section contains **FOUR (04)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.*

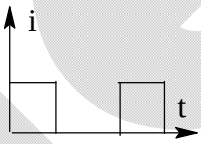
1. A dielectric slab of area A passes between the capacitor plates of area 2A with a constant speed v. The variation of current (i) through the circuit as function of time (t) can be qualitatively represented as



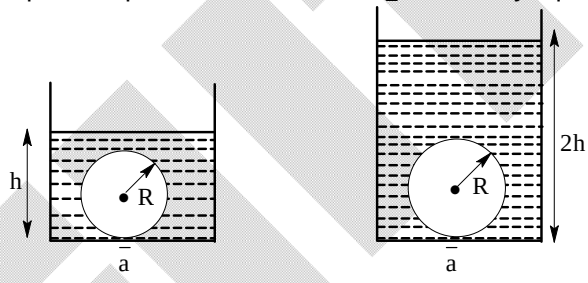
(A) 

(B) 

(C) 

(D) 

2. Two identical cylinders have a hole of radius a (a<<R) at its bottom. A ball of radius R is kept on the hole and water is filled in the cylinder such that there is no water leakage from bottom. In case-1 water is filled upto height h and in second case it is filled upto height 2h. If F_1 is force by liquid on sphere in case-1 and F_2 is force by liquid on sphere in case-2 then.

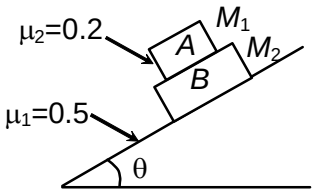


(A) $F_1=F_2=0$
(B) $F_1>F_2$
(C) $F_2>F_1$
(D) $F_1=F_2\neq 0$

3. The x-z plane separates two media A and B of refractive indices $\mu_1=1.5$ and $\mu_2=2$. A ray of light travels from A to B. Its directions in the two media are given by unit vectors $\vec{\mu}_1=a\hat{i}+b\hat{j}$ and $\vec{\mu}_2=c\hat{i}+d\hat{j}$. Then:

(A) $\frac{a}{c}=\frac{4}{3}$
(B) $\frac{a}{c}=\frac{3}{4}$
(C) $\frac{b}{d}=\frac{4}{3}$
(D) $\frac{b}{d}=\frac{3}{4}$

4. Two blocks M_1 and M_2 rest upon each other on an inclined plane. Coefficient of friction between surfaces are shown. If the angle θ is slowly increased, then ($M_1 < M_2$)

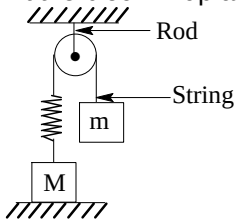


(A) block *A* slips first
(B) block *B* slips first
(C) both slip simultaneously
(D) both remain at rest

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. In figure, a block of mass m is released from rest when spring was in its natural length. The pulley also has mass m but it is frictionless. Suppose the value of m is such that finally it is just able to lift the block M up after releasing it.



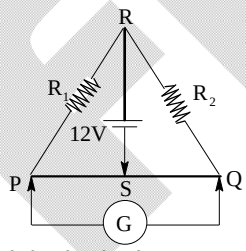
(A) The weight of m required to just lift M is $\frac{\mathrm{M}}{2}\mathrm{g}$

(B) The tension in the rod, when m is in has zero acceleration $\frac{\mathrm{M}}{2}\mathrm{g}$

(C) The normal force acting on M when m has zero acceleration $\frac{\mathrm{M}}{2}\mathrm{g}$

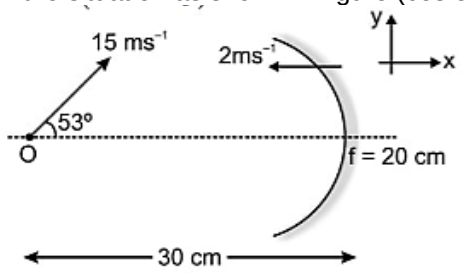
(D) The tension in the string when displacement of m is maximum possible is Mg

6. In the circuit shown $R_1 - R_2 = 10\Omega$ and resistance per unit length of wire $PQ = 1\Omega/cm$ and length $PQ = 10cm$. If R_2 is made 20Ω the to get zero deflection in galvanometer. S is midpoint of wire PQ?



(A) The jockey at P can be moved towards the right 2 cm.
(B) The jockey at Q can be moved towards right 2 cm.
(C) The jockey at S can be moved towards left a distance 5/3 cm.
(D) The jockey at all positions fixed and R_1 should be made 20

7. In the situation as shown in figure (cos 53° = 3/5)



(A) Velocity of image w.r.t. mirror is $-22i-24\hat{j}$

(B) Velocity of image w.r.t. mirror is $-44i-24\hat{j}$

(C) Velocity of image w.r.t. ground is $-46i-24\hat{j}$

(D) Velocity of image w.r.t. ground is $-24i-24\hat{j}$

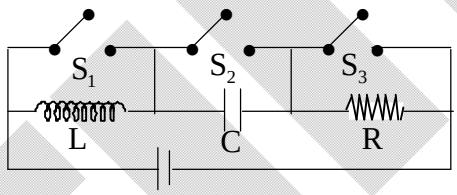
SECTION – B

(Numerical Answer Type)

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

8. In a slow reaction, heat is evolving at a rate about 10 mW in a liquid. If the heat were being generated by the decay of ^{32}P, a radioactive isotope of phosphorus that has half-life of 14 days and emits only beta-particles with a mean energy of 700 KeV. The number of ^{32}P atoms in the liquid is $A\times77\times10^{15}$ find a: [Take: ln 2 = 0.7]

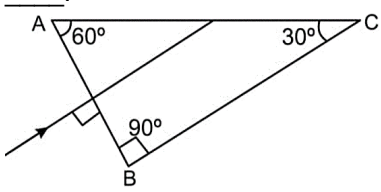
9. Consider the circuit shown in figure. With switch S_1 closed and the other two switches open, the circuit has a time constant 0.05 sec. With switch S_2 closed and the other two switches open, the circuit has a time constant 2 sec. With switch S_3 closed and the other two switches open, the circuit oscillates with a period T. Find T (in sec). (Take $\pi^2=10$)



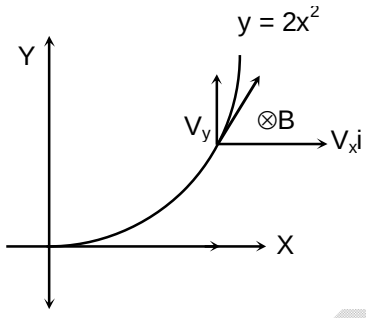
10. A uniform rod of length l = 1 m is free to move and rotate in gravity-free space. When an impulse is given to one end of the rod, perpendicular to its length, its centre of mass moves with velocity v = 1 m/s. What will be its angular velocity (in rad/s) about its centre of mass?

11. Two wires are made of the same material and have the same volume. However, wire 1 has cross-sectional area A and wire-2 has cross-sectional area 3A. If the length of wire 1 increases by Δx on applying force 1 newton, how much force (in Newton) is needed to stretch wire 2 by the same amount?

12. As shown in figure, light is incident normally on one face of the prism. A liquid of refractive index μ is placed on the horizontal face AC. The refractive index of prism 3/2. If total internal reflection taken place on face AC, μ should be less than $\frac{1\sqrt{3}}{4}$, where I is an integer. Find the value of I _____.



13. A non-uniform magnetic field B varies with x. It exists for $x \geq 0$, into the xy plane. A particle having charge q and of mass m, enters the magnetic field at the origin with speed $v\hat{i}$. It is seen that it travels along $y = 2x^2$ curve where y and x are in meters. Find the value of B (in tesla) at x = 0 (Given: m = 1 gm, v = 1m/s, q = 1 mc)

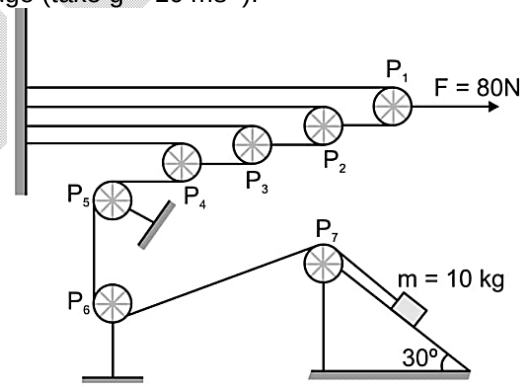


SECTION – C
(Numerical Answer Type)

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

In figure all the pulleys and strings are massless, and all the surfaces are frictionless. A small block of mass m is placed on fixed wedge (take $g = 10\ ms^{-2}$):

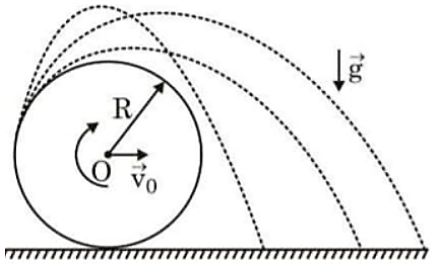


14. The acceleration of m is____.

15. The acceleration of pulley P_4 is _____.

Paragraph for Question Nos. 16 and 17

A wheel of radius R = 10.0 cm moves without slippage along horizontal surface with a constant velocity V_0 = 2.0 m/s.



16. Determine maximum height H (in cm) that can be reached by a splash of mud, which is separated from that moving wheel. Assume that friction with air can be neglected, while height H is measured from the horizontal surface. For calculations due acceleration due to gravity as 10 m/s^2.

17. Find the maximum height (in cm) from the ground reached by the splash of mud that just grazes the moving wheel again when it is travelling downwards.

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.*

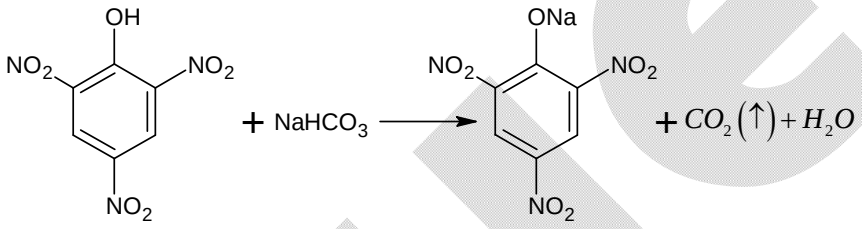
18. In a crystal structure of an element, atoms are present in fcc arrangement as well as in tetrahedral voids. Which of the following relation between the atomic radius and the edge length is correct?

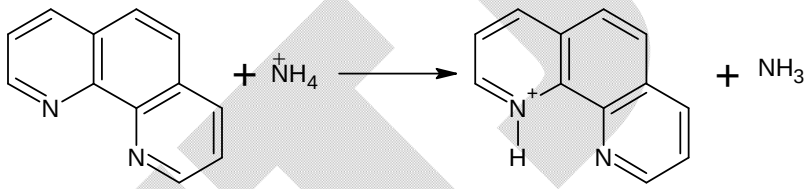
(A) $\sqrt{2}a = 4r$ (B) $\sqrt{3}a = 8r$

(C) $\sqrt{3}a = 4r$ (D) $a = 2r$

19. Which one of the following reactions is not correct?

(A) $CH_3COOK + CF_3COOH \longrightarrow CH_3COOH + CF_3COOK$

(B) 

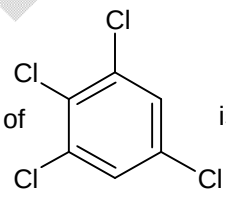
(C) 

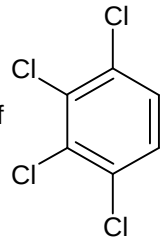
(D) $CH_3CH_2OH + NaHCO_3 \longrightarrow CH_3CH_3ONa + H_2O + CO_2(\uparrow)$

20. The stopping potentials in an experiment of photoelectric effect are V_1 and V_2, with incident light of wavelength λ and $\frac{\lambda}{2}$ respectively. The correct relation between V_1 and V_2 may be:

(A) $V_2 > 2V_1 > V_1$ (B) $V_1 < V_2 < 2V_1$

(C) $V_2 = 2V_1$ (D) $V_2 < 2V_1$

21. The dipole moment of 

is $1.5\,D$. The dipole moment of 

is:

(A) zero (B) $1.5D$

(C) $2.6D$ (D) $2.12D$

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. Identify the correct relationship:

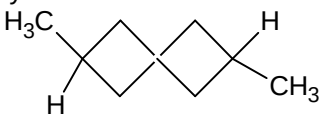
(A) $\left[Cu\left(NH_3\right)_4\right]^{2+}$ complex is square planar.

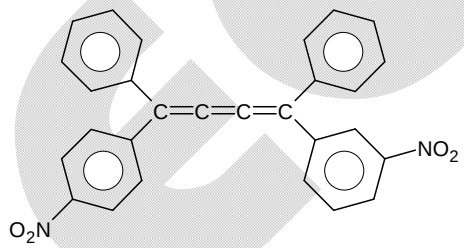
(B) $Fe(CO)_x$ exists at x = 5

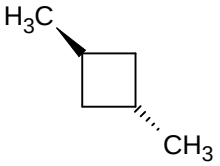
(C) Zn^{2+} Octahedral complexes are sp^3d^2 hybridization and diamagnetic in nature

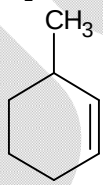
(D) Cr^{3+} Complexes are paramagnetic in nature

23. Identify the chiral molecule/molecules:

(A) 

(B) 

(C) 

(D) 

24. Which of the following is/are can produce H_2O_2 on hydrolysis?

(A) BaO_2 (B) PbO_2

(C) MnO_2 (D) Na_2O_2

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. A certain buffer solution contains equal concentration of X^- and HX. The K_b for X^- is 10^{-10}. Find the pH of this buffer solution?

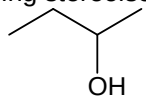
26. Co forms dinuclear complex with a sigma bond within two Co atoms. Consider that metal carbonyls follow EAN rule. The complex can be written as $Co_2(CO)_x$. Find the value of x?

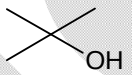
27. The cost of electricity required to deposit 1 g Mg is Rs. 5.00. The cost of 30 g of Al to be deposited is Rs. X. Find the value of $\frac{x}{40}$?

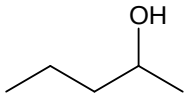
28. A weak acid type indicator was found to be 60% dissociated at pH = 9.18. If the degree of dissociation at pH = 9.0 is 'α '? Then the value of '10α ' will be $(\log 2 = 0.3, \log 3 = 0.48)$

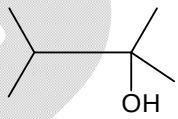
29. How many statement(s) are correct?
(a) if the critical micelle concentration (CMC) of a soap is $10^{-3}M$, then $10^{-4}M$ solution of this soap will have colloidal nature.
(b) charge on the colloidal particles may be determined with the help of dialysis
(c) peptization is the process of conversion of precipitate into a colloidal sol.
(d) when some oil-soluble dye is added in the water in oil emulsion, the back ground becomes coloured
(e) For the coagulation of a particular colloidal solution, the order of coagulation power of some electrolytes is in the order: $Na_3PO_4 > BaSO_4 > AlCl_3$, in electro-osmosis, the dispersion medium move towards the anode
(f) diffused layer around colloidal particles in the electric double layer mostly contains negatively charged particles. (colloid is of 'e' part)
(g) it may be basic dye such as methylene blue (colloid is of 'e' part)
(h) it may be metal sol (colloid is of 'e' part)

30. Total number of products (Alkenes) obtained in below reactions including minor products is (including stereoisomer)

(a)  $\xrightarrow[\Delta]{H^+}(x)$

(b)  $\xrightarrow[\Delta]{H^+}(y)$

(c)  $\xrightarrow[\Delta]{H^+}(z)$

(d)  $\xrightarrow[\Delta]{H^+}(p)$

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.

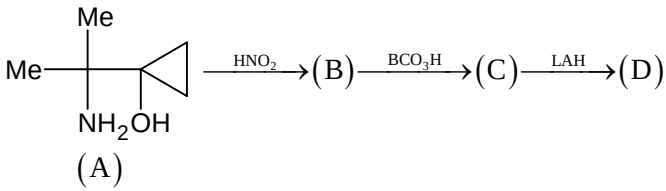
Paragraph for Question Nos. 31 and 32

Assume that water vapour behaves as an ideal gas and the volume occupied by the liquid water is negligible compared to the volume of the container. A sample of liquid water of mass 3 g is injected into an evacuated 76 L flask maintained at 320 K. At this temperature the vapour pressure of water is 32 mm of Hg. (1/0.0821 = 12.2)
Now give the answers to following questions:

31. What % of the water will be vaporized, when the system comes to equilibrium?

32. What should be the minimum volume (in litre) of the flask if no liquid water is to be present at equilibrium?

Paragraph for Question Nos. 33 and 34



(A)

33. The Molecular Formula of compound (B) is $C_xH_yO_z$. Then the value of x + y + z = ____

34. The Molecular mass (gm/mole) of compound (D) 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. From a pack of 52 playing cards; half of the cards are randomly removed without looking at them. From the remaining cards, 3 cards are drawn randomly. The probability that all are king.

(A) $\frac{1}{(25)(17)(13)}$ (B) $\frac{1}{(25)(15)(13)}$

(C) $\frac{1}{(52)(17)(13)}$ (D) $\frac{1}{(25)(51)(13)}$

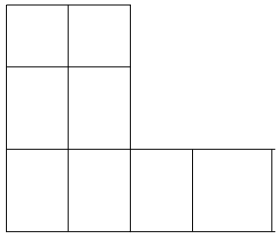
36. Let $f:R-\left\{\frac{3}{2}\right\}\to R, f(x)=\frac{3x+5}{2x-3}$. let $f_1(x)=f(x), f_n(x)=f\left(f_{n-1}(x)\right)$ for $n\geq 2, n\in N$, then.

$f_{2008}(x)+f_{2009}(x)=$

(A) $\frac{2x^2+5}{2x-3}$ (B) $\frac{x^2+5}{2x-3}$

(C) $\frac{2x^2-5}{2x-3}$ (D) $\frac{x^2-5}{2x-3}$

37. Number of ways in which the letters of the word ''NATION'' can be filled in the given figure such that no row remains empty and each box contains not more than one letter, are:



(A) $11\underline{|6}$ (B) $12\underline{|6}$

(C) $13\underline{|6}$ (D) $14\underline{|6}$

38. For any real number b, let f(b) denotes the maximum of $\left|\sin x+\frac{2}{3+\sin x}+b\right| \forall\, x\in R$. Then the minimum value of f(b) $\forall$ b $\in$ R is

(A) 1/2 (B) 3/4

(C) 1/4 (D) 1

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. $T_n=\sum_{r=2n}^{3n-1}\frac{r}{r^2+n^2}, S_n=\sum_{r=2n+1}^{3n}\frac{r}{r^2+n^2}$, then $\forall n\in\{1,2,3,.....\}$:

(A) $T_n>\frac{1}{2}\ln 2$ (B) $S_n<\frac{1}{2}\ln 2$

(C) $T_n<\frac{1}{2}\ln 2$ (D) $S_n>\frac{1}{2}\ln 2$

40. Let z_1, z_2 and z_3 be three distinct complex number, satisfying $|z_1|=|z_2|=|z_3|=1$. Which of the following is/are true:

(A) If $\arg\left(\frac{z_1}{z_2}\right)=\frac{\pi}{2}$ then $\arg\left(\frac{z-z_1}{z-z_2}\right)>\frac{\pi}{4}$ where $|z|>1$

(B) $|z_1z_2+z_2z_3+z_3z_1|=|z_1+z_2+z_3|$

(C) $\text{Im}\left(\frac{(z_1+z_2)(z_2+z_3)(z_3+z_1)}{z_1\cdot z_2\cdot z_3}\right)=0$

(D) If $|z_1-z_2|=\sqrt{2}|z_1-z_3|=\sqrt{2}|z_2-z_3|$, then $\text{Re}\left(\frac{z_3-z_1}{z_3-z_2}\right)=0$

41. Let I = $\int_0^1\sqrt{\frac{1+\sqrt{x}}{1-\sqrt{x}}}dx$ and J = $\int_0^1\sqrt{\frac{1-\sqrt{x}}{1+\sqrt{x}}}dx$ then correct statement(s) is /are

(A) I + J = 2 (B) I – J = π

(C) I = $\frac{2+\pi}{2}$ (D) J = $\frac{4-\pi}{2}$

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. Let $f(x)$ be a differentiable function in $[-1,\infty)$ and $f(0)=1$ such that $\lim_{t\to x+1}\frac{t^2f(x+1)-(x+1)^2f(t)}{f(t)-f(x+1)}=1$. Find the value of $\lim_{x\to 1}\frac{\ln(f(x))-\ln 2}{x-1}$ is

43. If $2x^2+5x+7=0$ and $ax^2+bx+c=0$ have at least one root common such that $a,b,c\in\{1,2,.....,100\}$, then the difference between the maximum minimum values of $a+b+c$ is____.

44. Let $a_1, a_2, a_3, \ldots a_n$, be real numbers in arithmetic progression such that $a_1 = 15$ and a_2 is an integer. Given $\sum_{r=1}^{10}(a_r)^2 = 1185$. If $S_n = \sum_{r=1}^{n} a_r$ and maximum value of n is N for which $S_n \geq S_{(n-1)}$, then find $N - 10$

45. The number of solutions of the system of equation
$2\sin^2 x + \sin^2 2x = 2$
$\sin 2x + \cos 2x = \tan x$
In $[0, 4\pi]$ satisfying $2\cos^2 x + \sin x \leq 2$ is

46. A straight line L intersects perpendicularly both the lines:
$\frac{x+2}{2} = \frac{y+6}{3} = \frac{z-34}{-10}$ and $\frac{x+6}{2} = \frac{y-7}{-3} = \frac{z-7}{-2}$
Then the square of perpendicular distance of origin from L is

47. Let $f(2 - x) = f(2 + x)$ and $f(4 - x) = f(4 + x)$. Function f(x) satisfies $\int_0^2 f(x)dx = 5$. If $\int_0^{50} f(x)dx = I$.
Find $\left[\sqrt{I-3}\right]$. Where [.] denotes greatest integer function.

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

Let each of the circles
$S_1 = x^2 + y^2 + 4y - 1 = 0$,
$S_2 = x^2 + y^2 + 6x + y + 8 = 0$,
$S_3 = x^2 + y^2 - 4x - 4y - 37 = 0$
Touches the other two. Let P_1, P_2, P_3 be the points of contacts of S_1 and S_2, S_2 and S_3, S_3 and S_1 respectively and C_1, C_2, C_3 be the centre of S_1, S_2, S_3 respectively

48. The value of $\sqrt{\frac{\text{area}\,(\Delta P_1P_2P_3)}{\text{area}\,(\Delta C_1C_2C_3)}}$ is_____

49. Length of direct common tangent for S_1 and S_3____.

Paragraph for Question Nos. 50 and 51

Let f(x) and g(x) be two differentiable functions, defined as
$f(x) = x^2 + xg'(1) + g''(2)$ and $g(x) = f(1)x^2 + x f'(x) + f''(x)$.

50. The value of $\frac{f(1)+g(-1)}{4}$ is

51. The value of $\left|\frac{g'(1)}{4}\right|$ is____