FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2024
FULL TEST – V
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

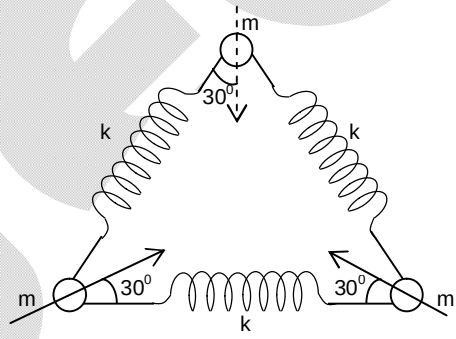
PART – I

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. A spherical object of mass 1 kg and radius 1 m is falling vertically downward inside a viscous liquid in a gravity free space. At a certain instant the velocity of the sphere is 2 m/s. If the coefficient of viscosity of the liquid is $\frac{1}{18\pi}$ N-S/m^2, then velocity of ball will become 0.5 m/s after a time
(A) ln 4 s (B) 2 ln 4 s
(C) 3 ln 4 s (D) 2 ln 2 s

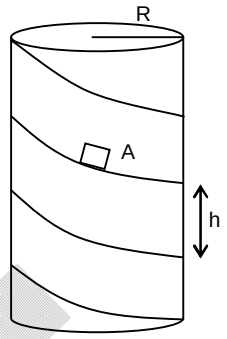
2. Three identical point masses are placed at the vertices of an equilateral triangle and joined through identical spring of spring constant K. The system is placed on an smooth table. If the masses are displaced along line as shown in figure, then period of their oscillation will be



(A) $2\pi\sqrt{\frac{m}{k}}$
(B) $2\pi\sqrt{\frac{m}{3k}}$
(C) $2\pi\sqrt{\frac{m}{2k}}$
(D) $2\pi\sqrt{\frac{m}{5k}}$

3. If R be the radius of a spherical refracting surface and ℓ is the least distance between conjugate focii then the refractive index of the surface will be
(A) $\left(\frac{R+\ell}{R-\ell}\right)^2$ (B) $\frac{R}{\ell}$
(C) $\frac{\ell}{R}$ (D) $\left(\frac{R-\ell}{R+\ell}\right)^2$

4. Find the acceleration of body A which slides without initial velocity down a helical groove with a pitch h and a radius R at the end of the n^{th} turn. Disregard friction.



(A) $a = \dfrac{gh\sqrt{h^2 + 4\pi^2R^2 + 64\pi^4n^2R^2}}{h^2 + 4\pi^2R^2}$

(B) $a = \dfrac{gh\sqrt{h^2 + 4\pi^2R^2 + 32\pi^4n^2R^2}}{h^2 + 4\pi^2R^2}$

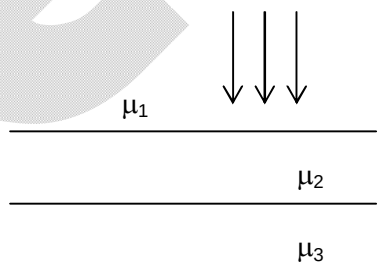
(C) $a = \dfrac{gh\sqrt{h^2 + 4\pi^2R^2 + 32\pi^4n^2R^2}}{h^2 - 4\pi^2R^2}$

(D) $a = \dfrac{gh\sqrt{h^2 + 4\pi^2R^2 - 16\pi^4n^2R^2}}{h^2 + 4\pi^2R^2}$

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. Consider a case of thin film interference as shown. Thickness of film is equal to wave length of light in μ_2



(A) Reflected light will be maximum if $\mu_1 < \mu_2 < \mu_3$

(B) Reflected light will be maximum if $\mu_1 < \mu_2 > \mu_3$

(C) Transmitted light will be maximum if $\mu_1 > \mu_2 > \mu_3$

(D) Transmitted light will be maximum $\mu_1 > \mu_2 < \mu_3$

6. A uniform rod of length ℓ and mass 2m rests on a smooth horizontal table. A point of mass m moving horizontally at right angle to the rod with velocity v collides with one end of the rod and sticks to it, then

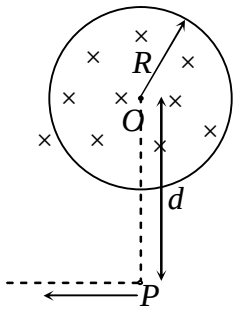
(A) Angular velocity of the system after collision is v/ℓ

(B) angular velocity of the system after collision is $v/2\ell$

(C) the loss in kinetic energy of the system as a whole as a result of the collision is $mv^2/6$

(D) the loss in kinetic energy of the system as a whole as a result of the collision is $7mv^2/24$

7. In a cylindrical region of radius *R*, there exists a time varying magnetic field *B* such that $\dfrac{dB}{dt} = k(>0)$. A charged particle having charge q is placed at the point *P* at a distance *d* (> R) from its centre O. Now, the particle is moved in the direction perpendicular to OP (see figure) by an external agent upto infinity so that there is no gain in kinetic energy of the charged particle. Choose the correct statement/s.



(A) Work done by external agent is $\dfrac{q\pi R^2}{4}k$ if d = 2R

(B) Work done by external agent is $\frac{q\pi R^2}{8}k$ if d = 4R

(C) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 4R

(D) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 6R

SECTION – B

(Numerical Answer Type)

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

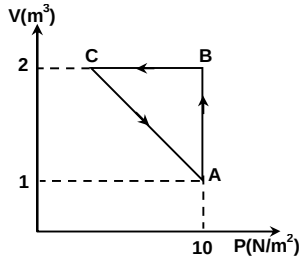
8. The period of oscillation of a simple pendulum is given by $T = 2\pi\sqrt{\frac{\ell}{g}}$ where I is about 100 cm and is known to have 1mm accuracy. The period is about 2s. The time of 100 oscillations is measured by a stop watch of least count 0.1 s. The percentage error in g is x% then 10x is

9. In an experiment the angle are required to be measured using an instrument. 29 divisions of the main scale exactly coincide with the 30 divisions of the vernier scale. If the smallest division of the main scale is half – a – degree (= 0.5^o) then the least count of the instrument is (in minutes).

10. Potential energy of a particle moving along x-axis is given by $U = \frac{x^3}{3} - \frac{9x^2}{2} + 20x$. Find out position of stable equilibrium state.

11. The average kinetic energy per molecule at temperature T for an equimolar mixture of two ideal gases A and B where A is monoatomic and B is diatomic is x KT then find the value of 'x'.

12. An ideal gas is taken through the cycle A→B→C→A as shown in the figure. If the net heat supplied to the gas in the cycle is 5 J, the work done (in J) on the gas in the process C→A is



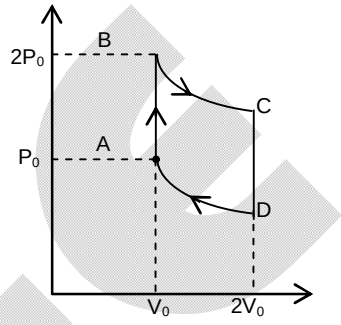
13. 2 kg of ice at -22.5^0C is mixed with 2.5 kg of water at 25^0C in an insulating container. If the specific heat of ice and water are 0.5 cal/gm°C and 1 cal/gm°C respectively. Latent heat of fusion of ice = 80 cal/gm. Find the amount of water present in the container (In kg).

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

One mole of a monatomic gas undergoes the cycle shown in the diagram: The pressure, volume and temperature at A are P_0, V_0 and T_0 respectively; the pressure at B is $2P_0$ and the volume at D is $2V_0$. The processes AB and CD are isochoric. During BC DA, the gas undergoes the processes such that during an infinitesimal contraction or expansion, the heat absorbed dQ, the change in internal energy dU and dW, the work done satisfy the relation:



$$dQ = \frac{1}{2}dU + \frac{2}{3}dW$$

For the process BC, DA, we can write

$$dQ = \frac{1}{2}dU + \frac{2}{3}dW = dU + dW$$

or, $+\frac{1}{2}dU = -\frac{1}{3}dW$; or, $\frac{1}{2}\cdot\frac{3}{2}RdT = -\frac{1}{3}dW$

$pdV + Vdp \Rightarrow RdT$; or, $\frac{13}{9}pdV + Vdp = 0$

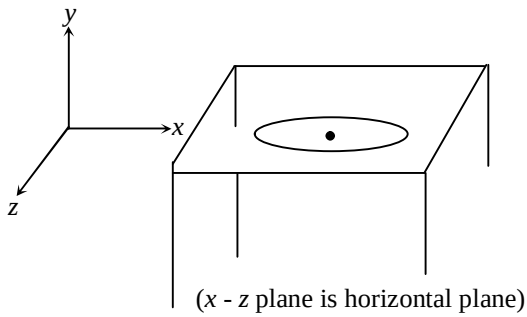
or, $pV^{\frac{13}{9}}$ = constant

14. If temperature at C is xT_0. Find the value of 'x'.

15. What is the efficiency of the cycle? Assume $2^{5/9} = 1.5, 2^{4/9} = 4/3$ approximately.

Paragraph for Question Nos. 16 and 17

A uniform conducting ring of mass π kg and radius 1 m is kept on smooth horizontal table. A uniform but time varying magnetic field $\vec{B} = (\hat{i} + t^2\hat{j})$ Tesla is present in the region. (Where *t* is time in seconds). Resistance of ring is 2Ω. Then, ($g = 10\ m/s^2$)



(x - z plane is horizontal plane)

16. Time (in second) at which ring start toppling is:

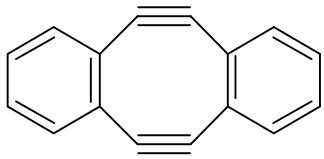
17. Heat generated (in kJ) through the ring till the instant when ring start toppling is:

Chemistry

PART – II

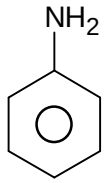
SECTION – A
(One Options Correct Type)

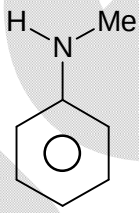
*This section contains **FOUR (04)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.*

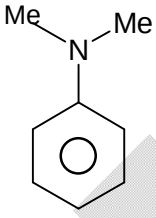
18. 

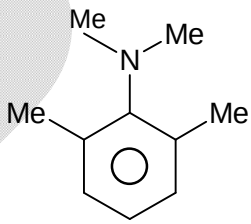
(A) aromatic
(B) non-aromatic
(C) anti-aromatic
(D) quasi-aromatic

19. Which of the following amine do not undergo coupling reaction when treated with PhN_2^+ (benzene diazonium) ion?

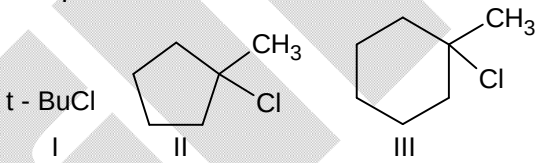
(A) 

(B) 

(C) 

(D) 

20. Correct order for relative rate of solvolysis (formation of carbocation) in given compounds



(A) I > II > III
(B) III > II > I
(C) II > I > III
(D) I > III > II

21. Correct stability order of silicones if substituents are:
(A) Me > Et > Ph
(B) Et > Me > Ph
(C) Ph > Me > Et
(D) Me = Et = Ph

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. Correct statements about interstitial compounds is/are
(A) they have higher melting point than those of pure metals
(B) they retain metallic conductivity
(C) they are chemically inert
(D) they have greater hardness than the pure metal

23. Which of the following statement is correct about lattice structure of diamond?
(A) Packing fraction is approximately 0.34
(B) Effective number of atoms per unit cell(Rank) = 8
(C) In terms of edge length 'a' nearest distance between two particles is $\frac{\sqrt{3}\,a}{4}$
(D) Coordination number of each carbon atom is 4

24. $\psi = \frac{1}{162}\left(\frac{1}{\pi a_0^3}\right)^{1/2} P^2 e^{-P/3} \sin^2\theta\, e^{i2\phi}$

Where $P = \frac{r}{a_0}$ and a_0 = Bohr's radius

Correct statement about above Schrodinger wave equation
(A) for 'p' subshell (B) for 'd' sub-shell
(C) total no. of angular nodes will be 2 (D) it has no radial node

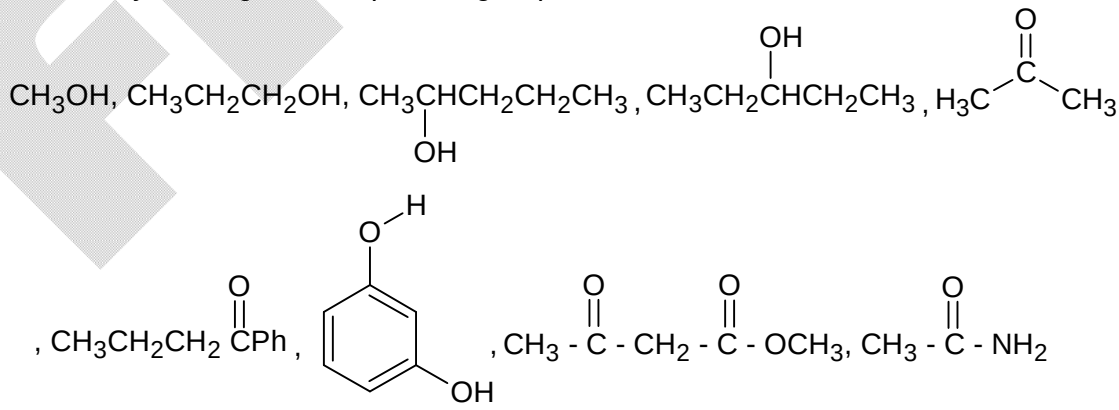
SECTION – B

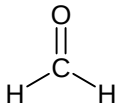
(Numerical Answer Type)

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

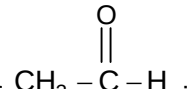
25. When platinum is dissolved in aqua regia the oxidation number of platinum in the product is expressed as +x, what is x.

26. How many of the given compounds give positive haloform test:



27. When  reacts with NH_3. The difference in number of carbon and nitrogen in the product is

28. When toluene reacts with CrO_2Cl_2/CS_2 in Etard reaction. The equivalent weight of toluene in Etard reaction is $\frac{M}{x}$. The value of x is

29. If  is treated with dil. OH^-, in aldol reaction. Order of given aldol reaction is

30. If racemic mixture of simplest optically active amino acid is treated with Pt^{2+} salt, maximum number of square planar complex formed is/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

The strength of H_2O_2 is expressed in several ways like molarity, normality, %w/v, volume strength etc. The strength of "10V" means 1 volume of H_2O_2 solution on decomposition gives 10 volumes of O_2 at 1 atm and 273 K or 1 litre of H_2O_2 solution gives 10 litre of O_2 at 1 atm and 273 K. The decomposition of H_2O_2 occur as

$$H_2O_2(aq) \longrightarrow H_2O(l) + \frac{1}{2}O_2(g)$$

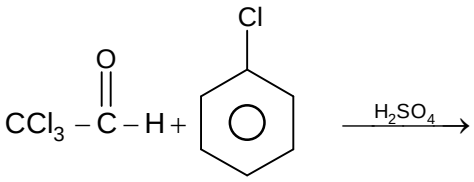
H_2O_2 can acts as oxidizing as well as reducing agent. As oxidizing agent H_2O_2 is converted into H_2O and as reducing agent H_2O_2 is converted into O_2 for both cases its n-factor is 2.
Answer the following questions

31. What will be the volume strength of 100 mL of H_2O_2 required to react completely with 61 mL of $KMnO_4$ in acidic medium? (Given that 61 mL of $KMnO_4$ reacts completely with 5 mL of 1 M of $K_4[Fe(CN)_6]$, where it convert into K^+, Fe^{3+}, CO_3^{2-} and NO_3^-)

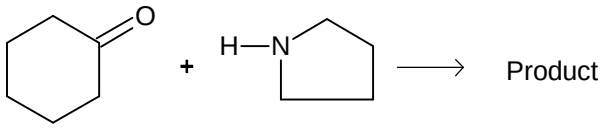
32. 'x V' of 40 mL of H_2O_2 solution is consumed for oxidizing 10 mL of 0.2 M 1, 3, 5-trihydroxy benzene into oxalic acid, in acidic medium. The value of 'x' is

Paragraph for Question Nos. 33 and 34

The most common reaction of aldehyde and ketone is nucleophilic addition reaction. Greater the positive polarity of carbonyl carbon and smaller the steric hindrance faster will be the rate of nucleophilic addition reaction. Carbonyl compounds very commonly used in synthesis of many drug, cosmetics, insecticides and medicines etc.
Answer the following questions

33. 

The Mol. Wt of organic product in above reaction is M. Value of $\frac{M}{8}$ is . . . . . gm

34. 

Find the $\frac{\text{Molecular weight}}{6}$ of product of above reaction

FIITJEE

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 z_1, z_2 be two distinct complex numbers satisfying $\left|\left(z_1^2 - z_2^2\right)\right| = \left|\overline{z_1}^2 + \overline{z_2}^2 - 2\overline{z_1}\,\overline{z_2}\right|$. If $\left(\arg z_1 - \arg z_2\right) = \frac{a\pi}{b}$ then the least possible value of $\frac{|a+b|}{2}$ is

(A) $\frac{1}{4}$ (B) $\frac{3}{2}$

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

36. Let $A = \begin{bmatrix} x & y & -z \\ 1 & 2 & 3 \\ 1 & 1 & 2 \end{bmatrix}$ where $x, y, z \in N$ if $\left|\text{adj}\left(\text{adj}\left(\text{adj}\left(\text{adj}\,A\right)\right)\right)\right| = 4^8.5^{16}$ then the number of such matrix is p and value of $\int_{-\pi/2}^{\pi/2} 2^{\sin x}\,dx + \int_{5/2}^{4} \sin^{-1}\left(\log_2\left(x-2\right)\right)dx = \frac{q\pi}{4}$, then $p+q$ is

(A) 40 (B) 41

(C) 42 (D) 44

37. Consider the function $f\left(x\right) = xe^x + \left(xe^x\right)^{-1}$ where $x \in R - \{0\}$ then which of following statement(s) is CORRECT?

(A) $f\left(x\right)$ attains it's local maxima at $x = x_0$ where $x_0 \in (0,1)$

(B) $f\left(x\right)$ attains local minima at $x = -1$

(C) $f\left(x\right)$ attains local minima at $x = x_0$ where $x_0 \in (1,\infty)$

(D) $f\left(x\right)$ attains it's local minima at $x = x_0$ where $x_0 \in (0,1)$

38. A polynomial $x^4 + px^2 + qx + r = 0,\ p,q,r \in R - \{0\}$ has 3 repeated real roots. If (p, r) lies on a conic, then length of semilatus rectum is

(A) 2 (B) 4

(C) 6 (D) 8

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. $\alpha,\beta,(\alpha>\beta)$ be roots of equation $x^2-x-1=0$. Define $T(n)=\frac{\alpha^n-\beta^n}{\sqrt{5}}\, n\in N$ then which of following are true?

(A) $T(2023)=T(2022)+T(2021)$ (B) $T(10)=55$

(C) $\sum_{n=1}^{2021}T(n)=T(2023)-1$ (D) $\sum_{n=1}^{2021}T(n)=T(2023)+1$

40. In triangle ABC, a = 4 and $b=c=2\sqrt{2}$. A point P moves within the triangle such that the square of its distance from BC is half the area of rectangle contained by its distances from the other two sides. If D be the centre of locus of P, then

(A) locus of P is an ellipse with eccentricity $\sqrt{\frac{2}{3}}$

(B) locus of P is a hyperbola with eccentricity $\sqrt{\frac{3}{2}}$

(C) area of the quadrilateral ABDC = $\frac{16}{3}$ sq.units

(D) area of the quadrilateral ABDC = $\frac{32}{3}$ sq. units

41. Let $y=f(x)$ be a function satisfying $-e^{-x^2}\frac{dy}{dx}=2xy^2$ such that $f(0)=\frac{1}{2}$ then

(A) $f(x)$ is bounded (B) $\int_0^1 f(x)dx<\frac{1}{2}$

(C) $(e+1)\int_0^1 f(x)dx>1$ (D) Range of $f(x)$ is $\left(0,\frac{1}{2}\right]$

SECTION – B

(Numerical Answer Type)

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

42. Let B is adjoint of matrix A, having order 3 and $B^TB^{-1}=A$ (where B is non singular) then $tr(A+B)$ is (where $tr(A)$ is sum of diagonal elements of matrix A)

43. The variance of the term 2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32 is σ^2_1 and 1, 5, 9, 13, 17, 21, 25, 29, 33, 37, 41 is σ^2_2 then $9\frac{\sigma^2_2}{\sigma^2_1}$ is

44. If $a=\cos^{-1}\cos 20,\ b=\cos^{-1}\cos 30, c=\sin^{-1}\sin(a+b)$ and $5\sec^{-1}\alpha+10\sin^{-1}\beta=10(a+b+c)$ then find the value of $\alpha+\beta$ is

45. Let $A=\{1,2,3,4\}$ and $B=\{3,4,5,6,7\}$ are two sets. Let m is the number of one – one functions $f:A\to B$ such that $f(i)\neq i\ \ \forall i\in A$ and n is the number of one – one functions $f:A\to B$ such that $|f(i)-i|\leq 3\forall i\in A,$ then find the value of $(m+n)$

46. $f:R\to R,\ f(x)=\sqrt[3]{x+\sqrt{1+x^2}}+\sqrt[3]{x-\sqrt{1+x^2}}$ Then $\sum_{n=1}^{n} f^{-1}(n)=\frac{n^2(n+1)^2}{\lambda}+\frac{3n(n+1)}{\mu}$ then $\lambda+\mu$ is equal to

47. Let $\overline{V}$ be a unit vector which follows the equation $\overline{V}\times\overline{b}=\overline{c}\ \ |\overline{b}|=2$ and $|\overline{c}|=\sqrt{3}$ and also $\overline{V}=k_1\left(k_2\overline{b}+\overline{b}\times\overline{c}\right)$ then $4(k_1+k_2)$ 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

Given $f:R\to R, f(x)=(x-1)^4(x-2)^3(x-3)^2(x-4)$ then

48. $f'''(1)+f''(2)+f'(3)+f'(4)$ is equal to

49. Let $g(x)=|f(|x|)|$ then number of values of x where $g(x)$ is not differentiable is λ then $\frac{\lambda}{2}$ is

Paragraph for Question Nos. 50 and 51

Let $f(x)$ and $g(x)$ be two quadratic polynomials $f(x)=ax^2+bx+c,\ g(x)=dx^2+cx+e$ where $a,b,c,d,e,f\in R$

50. If a, b, c are positive real numbers and $f(x)\geq 0\ x\in R$ then minimum value of $\frac{a+b+c}{b}$ is

51. If $H(x)=f(x)g(x)$ where $ad=1$ and $H(1)=1, H(2)=2, H(3)=3$ then $\frac{H(-1)+H(5)}{H(0)+H(4)}$ is