FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Main)-2025

TEST DATE: 26-12-2024

ANSWERS, HINTS & SOLUTIONS

Physics

PART – A

SECTION – A

1. A

Sol. y_{cm} of solid hemisphere = 3R/8

y_{cm} of solid cone = R/4

2. A

Sol. $-\frac{1}{F} = P = 2P_{l_1} + 2P_{l_2} + P_m$ …(1)

$P_{l_1} = \frac{1}{f_1} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$P_{l_1} = [(1.5-1]\left[-\frac{1}{10} - \frac{1}{15}\right] = -\frac{1}{12}$ …(2)

$P_{l_2} = \frac{1}{f_2} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$P_{l_2} = \left(\frac{4}{3} - 1\right)\left[\frac{2}{15}\right] = \frac{2}{45}$ …(3)

$P_m = -\frac{1}{f} = +\frac{2}{15}$ …(4)

$-\frac{1}{F} = P = 2\left[-\frac{1}{12} + \frac{2}{45}\right] + \frac{2}{15} = -\frac{1}{6} + \frac{4}{45} + \frac{2}{15} = \frac{1}{18}$

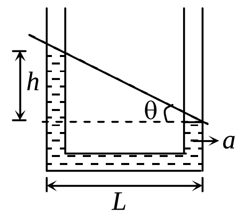
$F = -18\text{cm}$. Focus is negative means system will behave as concave mirror.

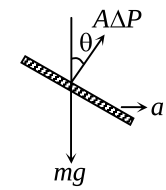
3. D

Sol. Newton's equations are :

$A\Delta P\sin\theta = ma$ ...(i)

And $A\Delta P\cos\theta = mg$ ...(ii)





By (i) and (ii)

$\tan\theta = \frac{a}{g} = \frac{h}{L}$

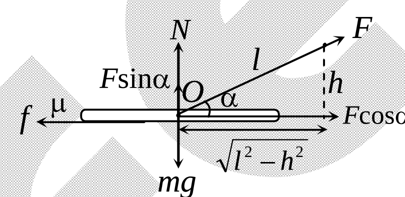
or $h = \frac{aL}{g}$

4. A

Sol. $N = mg - F\sin\alpha$

$F\cos\alpha = f = \mu N$

$F\cos\alpha = \mu(mg - F\sin\alpha)$



$$\mu = \frac{F\cos\alpha}{mg - F\sin\alpha} = \frac{F\times\frac{\sqrt{l^2-h^2}}{l}}{mg - F\times\frac{h}{l}}$$

$$\mu = \frac{F\sqrt{l^2-h^2}}{mgl - Fh}$$

5. C

Sol. Time taken her oscillation her any tunnel through earth is $\omega = \sqrt{\frac{g}{R}}$ consider earth tunnel and add total displacement.

$A \to S - \frac{\pi}{3}$

$S \to P - \frac{\pi}{2}$

$P \to C - \frac{\pi}{2}$

Total phase travelled $= \frac{4\pi}{3}$

$T = \frac{4\pi}{3\omega} = \frac{4\pi}{3}\sqrt{\frac{R}{g}}$

6. C

Sol. The net torque produced by the spring when the disc is rotated through an angle θ is

$\tau_C = (kx)R = (I_C + mr^2)\alpha$

Where x = $R\theta$ and $I_c = MR^2$

or $\alpha = \frac{kR^2}{\left(\frac{MR^2}{2} + mr^2\right)}\theta$ or $\omega = \sqrt{\frac{2kR^2}{MR^2 + 2mr^2}}$

7. D

Sol. $\begin{bmatrix}(33+a)(100)=(67+b)(50)\\(67+a)(50)=(33+b)(100)\end{bmatrix}$

$\left.\begin{matrix}66+2a=67+b\\67+a=66+2b\end{matrix}\right]\times 2$

$65+3a=68$

$a=1$ and $b=1$

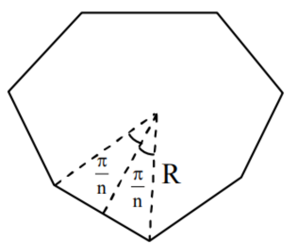
8. B

Sol. $U=-\vec{M}\cdot\vec{B}$

U is max when θ = 180°

9. C

Sol.



$r=R\cos H/n$

B due to one side $=\frac{\mu_0 i}{4\pi r}\left[\sin\frac{\pi}{n}+\sin\frac{\pi}{n}\right]$

$=\frac{\mu_0 i}{2\pi r}\sin\frac{\pi}{n}$

$=\frac{\mu_0 i}{2\pi r}\frac{\sin\pi/n}{R\cos\pi/n}$

$=\frac{\mu_0 i}{2\pi r}\tan\frac{\pi}{n}$

$B_{net}=\frac{n\mu_0 i}{2\pi R}\tan\frac{\pi}{n}$

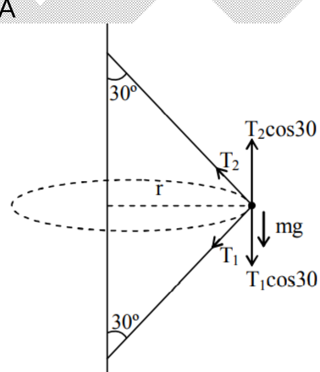
$=\frac{\mu_0 i\tan\pi/n}{2R\frac{\pi}{n}}$

10. D

Sol. Conceptual

11. A

Sol.



r = 0.4 sin 30
= 0.2 m

$$(T_1 + T_2)\sin 30 = \frac{200}{100} 10^2 \times 0.2$$

$$\frac{T_1 + T_2}{2} = \frac{0.4}{10}\omega^2$$

$$T_1 \cos 30 + mg = T_2 \cos 30$$

$$T_1 \frac{\sqrt{3}}{2} + \frac{200}{100} 10 = T_2 \frac{\sqrt{3}}{2}$$

$$\sqrt{3}\frac{(T_2 - T_1)}{2} = 2$$

$$T_2 - T_1 = \frac{4}{\sqrt{3}}$$

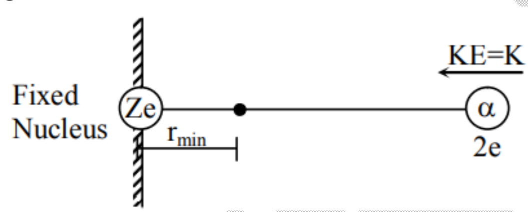
T_1 = 4N given

$$T_2 = 4 + \frac{4}{\sqrt{3}} = 6.26 \text{ N}$$

$$\frac{6.26 + 4}{2} = \frac{0.4}{10}\omega^2$$

$$\omega^2 = 128.25 = 11.32 \text{ rad/s}$$

12. C
Sol.



Mechanical energy conservation

$$0 + K = 0 + \frac{Ze \times 2e}{4\pi \epsilon_0 r_{min}}$$

$$r_{min} = \frac{Ze^2 \times 2}{4\pi \epsilon_0 K}$$

$$r_{min} \propto Z$$

So when Z become 2 Z r_{min} also get double so new r_{min} = 2b

13. A
Sol. $V_1 R_1 = V_2 R_2$

14. B
Sol. Conceptual

15. C
Sol. Conceptual

16. D
Sol. Conceptual

17. C
Sol. Speed of block at the bottom of board = $\sqrt{2gh}$
Applying conservation of linear momentum in horizontal direction,
$$m\sqrt{2gh}\cos\alpha = (M+m)v$$
$$v = \frac{m\sqrt{2gh}\cos\alpha}{M+m}$$

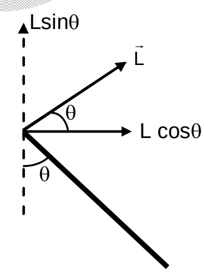
18. A
Sol. Conceptual

19. C
Sol. Conceptual

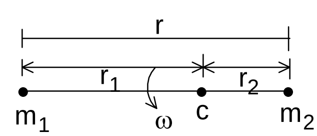
20. A
Sol. Conceptual

SECTION – B

21. 6
Sol. $\left|\frac{d\vec{L}}{dt}\right| = L\cos\theta\omega$
$$= \frac{m\ell^2}{3}\omega\sin\theta\cos\theta\omega$$
$$= \frac{m\ell^2}{3}\omega^2\sin\theta\cos\theta$$



22. 7
Sol. Given that $m_1 - m_2 = 6$ unit ....(i)
equation of motion
$$\frac{Gm_1m_2}{r^2} = m_1\omega^2 r_1 = m_1\omega^2\frac{m_2 r}{m_1+m_2}$$
$$\therefore m_1 + m_2 = \frac{\omega^2 r^3}{G} = 8 \text{ unit ......(ii)}$$
by (i) & (ii)
$$\frac{m_1}{m_2} = 7$$



23. 2
Sol. Conceptual

24. 4
Sol. Thermal resistance of AC $R_{AC} = \frac{L}{KA} = \frac{0.1}{336\times1\times10^{-4}}$

Thermal resistance of BC $R_{BC} = \frac{0.2}{336\times10^{-4}} = 2R$

Tc

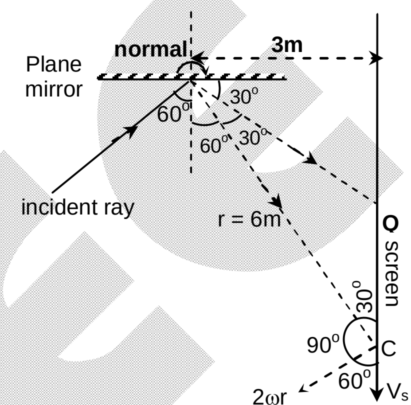
$H_1 = \frac{20}{R}$; $H_2 = \frac{40}{2R} = \frac{20}{R}$

$H = H_1 + H_2 = \frac{40}{R} = 13.44\,W.$

Rate $= \frac{H}{Li} = \frac{13.44/4.2}{80}$ g/s = 40 mg/sec.

25. 2

Sol. When incident ray is fixed the angular velocity of reflected ray becomes twice in the same sense as that of reflected ray. After t = 15 sec, the mirror rotates 15° then reflected ray rotates 30° in the same sense.



In ΔABC, $\cos 60° = \frac{3}{r}$

Where $\omega = \frac{\pi}{180}$ rad / sec. $r = 6\,m$

Then, there are two components of velocity of spot on the screen.

(a) radial component which increase the length of r i.e., $V_s \sin 60° = \frac{dr}{dt}$

(b) perpendicular component

$V_s \cos 60° \quad \Rightarrow V_s \times \frac{1}{2} = 2 \times \frac{\pi}{180} \times 6 \Rightarrow V_s = \left(\frac{2\pi}{15} m/s\right)$

Chemistry

PART – B

SECTION – A

26. C
Sol. Hydrolysis of sucrose brings about a change in the sign of rotation from dextro to laevo.

27. C
Sol. Factual

28. B
Sol. $\left[Fe(CN)_6\right]^{3-}, \left[Mn(CN)_6\right]^{3-} . [CoF_6]^{3-}, [MnBr_4]^{2-}$
have 1, 2, 4 & 5 unpaired electron respectively.

29. B
Sol. Factual

30. B
Sol. Factual

31. A
Sol. Tetrahedral complex has intense color.

32. A
Sol. Eu & Gd have half-filled f-orbitals (factual)

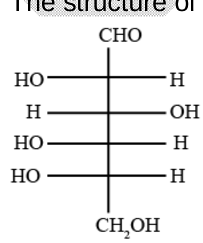
33. C
Sol.
- (2, 4-DNP) test given by aldehyde 1 ketones
- Tollen test
- Canizaro
- Must be at 1, 2 position

34. A
Sol. $pH = pK_a + \frac{\log\left[CH_3COO^-\right]}{CH_3COOH}$
C_p is temperature dependent

35. B
Sol. The entropy change for reaction in given by
$\Delta S^\circ_{reactant} = \Delta S^\circ_{product} - \Delta S^\circ_{reactant}$

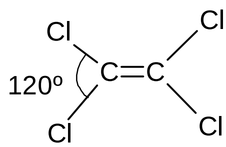
36. C
Sol. Higher order reaction are rare due to low probability of simultaneous collision of all the reacting species.

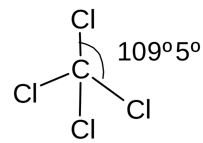
37. A
Sol. The structure of L-Glucose is



38. C
Sol. De pression in free ring point
$\Delta T_f = ik_{fm}$

39. A
Sol. Tetrachloroethene & tetrachloromethane





40. B
Sol. i = 2
π = iCRT

41. B
Sol. Most polar and weakest bond will break first.

42. D
Sol. VSEPR

43. A
Sol.
$$\begin{bmatrix} \Delta G^o = -nFE^\circ_{cell} \\ \Delta S^o = nF\left(\dfrac{\delta E^\circ_{cell}}{\delta T}\right) \\ \Delta H = \Delta G^o + T\Delta S^o \end{bmatrix}$$

44. B
Sol. $[R] = \dfrac{K_2}{K_1 + K_2}[P]\left(1 - e^{-(k_1+k_2)t}\right)$

45. B
Sol. % ionic character = $\dfrac{\text{observed dipole moment}}{\text{calculated dipole momet}} \times 100$

SECTION – B

46. 0
Sol. No. of radical nodes = n – l –1
= 4 –3 –1
= 0

47. 2
Sol. $\dfrac{[B]}{[C]} = \dfrac{k_1}{k_2} = \dfrac{2k_2}{k_2} = 2$

48. 5
Sol. K_{final} $P(g) \rightleftharpoons D(g)$ = $K_{C_1} \times K_{C_2} \times K_{C_3}$
$= 10 \times 2 \times 0.01 = \dfrac{20}{100} \times \dfrac{2}{10}$
$= 1/5$

$$D \rightleftharpoons P(g)$$

$$k_f^1 = \frac{1}{k_{final}} = \frac{1}{1/5} = 5$$

49. 4

Sol. $E_n = -\frac{13.5}{n^2} Z^2$

50. 3

Sol. Paramagnetic species are those which have unpaired of electron present in then NO, O_2 & B_2 have unpaired electron

Mathematics

PART – C

SECTION – A

51. C

Sol. In expression $\left(ax^2+\frac{1}{bx}\right)^{11}$, we have

$T_{r+1}={}^{11}C_r\left(\frac{a^{11-r}}{b^r}\right)(x)^{22-3r}$ for x^7

$\Rightarrow 22-3r=7 \Rightarrow r=5$

Also in the expansion of $\left(ax-\frac{1}{bx^2}\right)^{11}$

$t_{r+1}=(-1)^r\ {}^{11}C_r.\frac{a^{11-r}}{b^r}.x^{11-3r}$ for x^{-7}

$11-3r=-7 \Rightarrow r=6$

Comparing, $T_6=t_7 \Rightarrow ab=1$

Now $\frac{a^2+b^2}{2}\ge|ab| \Rightarrow a^2+b^2\ge 2$

52. D

Sol. Equation of common chord is $15\alpha x+(\beta+\gamma)y+(\alpha+1)=0$

Comparing with $15x+\delta y-\alpha=0$ passes through A and B for

$\therefore$ No real solution for α.

53. C

Sol. $\arg\left(z(1+\bar{z})\right)+\arg\left(\frac{z\bar{z}}{z(1-\bar{z})}\right)=0$

$\Rightarrow \arg z+\arg(1+\bar{z})+\arg\bar{z}-\arg(1-\bar{z})=0$

$\Rightarrow \arg\left(\frac{1+\bar{z}}{1-\bar{z}}\right)=0$

$\Rightarrow \frac{1+\bar{z}}{1-\bar{z}}=k>0$

$\Rightarrow \bar{z}=\frac{k-1}{k+1}$

$\Rightarrow |\bar{z}|<1$

54. D

Sol. $\left|\sqrt{(x^2-2)^2+(x-3)^2}-\sqrt{(x^2+2)^2+x^2}\right|$

i.e. $\left|\sqrt{(y-2)^2+(x-3)^2}-\sqrt{(y+2)^2+x^2}\right|$

Here $y=x^2$. If P(x, y) be any point on the parabola, then $|PA-PB|\le AB$

Where A(3, 2), B(0, –2) $\Rightarrow AB=\sqrt{9+16}=5$

55. D

Sol. $f(x)=\frac{x^3+x-2}{x^3-1}\Rightarrow f(x)=\left(\frac{x-1}{x-1}\right)\left(\frac{x^2+x+2}{x^2+x+1}\right)=\frac{x^2+x+2}{x^2+x+1}$, when $x\ne 1$

Hence range is $\left(1,\frac{7}{3}\right]$.

56. D
Sol. Total cases = $2 \times 3 \times 3 \times 2 = 36$

57. B
Sol. $t_n = \cot^{-1}\left(2 + \frac{n(n+1)}{2}\right)$

$$= \tan^{-1}\left(\frac{2}{4+n(n+1)}\right) = \tan^{-1}\left(\frac{\frac{1}{2}}{1+\frac{n}{2}\left(\frac{n+1}{2}\right)}\right) = \tan^{-1}\left(\frac{n+1}{2} - \tan^{-1}\frac{n}{2}\right)$$

$$\Rightarrow S_\infty = \frac{\pi}{2} - \tan^{-1}\frac{1}{2} = \cot^{-1}\frac{1}{2} = \tan^{-1}2$$

58. D
Sol.
(i) $a \neq b \neq c$ all (distinct) and $c \neq 0$ — Total cases $2\ {}^9C_3$
(ii) $a \neq b$, $c = 0$ $(a = b > c)$ — Total cases ${}^9C_2$
(iii) $a = b$, $c \neq 0$ $(a = b > 0)$ — Total cases ${}^9C_2$
(iv) $a = b$, $c = 0$ $(a = b > 0)$ — Total cases ${}^9C_1$
(v) $a = c \neq 0$, $(a < b > c)$ — Total cases ${}^9C_2$
$2\,{}^9C_3 + 3\,{}^9C_2 + {}^9C_1$

59. C
Sol. If n = even $\Rightarrow$ N is odd
If n = odd N is even for b = 26, 27, …..35 and 25 and N is odd for b = 17, 18, ….24

60. A
Sol. $b + c = 2a$ and $g_1^3 = b^2c$
$g_2^3 = bc^2$
Now $\frac{g_1^3 + g_2^3}{abc} = 2$

61. D
Sol. $\text{Log}_6(abc) = 6$
$\Rightarrow (abc) = 6^6$
Let $a = \frac{b}{r}$ and $c = br$
$\Rightarrow b = 36$ and $a = \frac{36}{r} \Rightarrow r = 2, 3, 4, 6, 9, 12, 18$
Also, $36\left(1 - \frac{1}{r}\right)$ is a perfect cube.
$\Rightarrow 36\left(1 - \frac{1}{r}\right)$ is a perfect cube for r = 4.
$\Rightarrow a + b + c = 36 + 9 + 144 = 189$.

62. A
Sol. $1 + a = \frac{4 - 3z}{z^2 - 3z + 4}$
Where $z = \frac{x^2}{1+x^2}$; $\quad 0 \le z < 1$

Let $f(z)=\dfrac{4-3z}{z^2-3z+4}$, then $f'(z)=\dfrac{z(3z-8)}{(z^2-3z+4)^2}$

f(z) is decreasing in [0, 1), $\Rightarrow \dfrac{1}{2}<1+a\le 1;\ -\dfrac{1}{2}<a\le 0.$

63. B

Sol. XY is parallel to BC

64. B

Sol. $\cos\dfrac{\pi}{15}\cos\dfrac{2\pi}{15}\cos\dfrac{4\pi}{15}\cos\dfrac{7\pi}{15}=\dfrac{1}{16}$

$\cos\dfrac{3\pi}{15}\cos\dfrac{6\pi}{15}=\dfrac{1}{4}$

$\cos\dfrac{5\pi}{15}=\dfrac{1}{2}$

$\Rightarrow$ required value is $\dfrac{1}{128}$

65. A

Sol. $\overrightarrow{AB}$ can be in any direction but not in the plane of 2i + 3j + 4k and 3i + 7j + 6k since lines are skew.

66. A

Sol. When $[\alpha]$ = 0, 1, –1.

67. A

Sol. $f(x)=\dfrac{4}{\pi}(\pi-\cot^{-1}(-x))-\dfrac{\pi}{4\cot^{-1}(-x)}$

$=4-\left(\dfrac{4\cot^{-1}(-x)}{\pi}+\dfrac{\pi}{4\cot^{-1}(-x)}\right)\le 4-2=2$

Equality when $\cot^{-1}(-x)=\dfrac{\pi}{4}$

$\Rightarrow x=-1$

68. B

Sol. Area = $37\times 3-\int_0^3(x^3+3x+1)dx$

69. B

Sol. $S_1P=S_2P\Rightarrow a-e\alpha=E\alpha-\dfrac{a}{2}$. Also, $\alpha=\dfrac{ae+\frac{a}{2}E}{2}$

Eliminating α we get, $E^2+3eE+(2e^2-6)=0$

Now, as $e=\sqrt{1-\dfrac{b^2}{a^2}}=\dfrac{1}{\sqrt{7}},E=\dfrac{5}{\sqrt{7}}\Rightarrow\dfrac{a}{c}=\dfrac{1}{\sqrt{E^2-1}}=\dfrac{\sqrt{7}}{\sqrt{18}}$

70. B

Sol. $\sum x = 40\times 200 - 50 + 40 = 7990$

Corrected $\bar{x} = \frac{7990}{200} = 39.95$

Incorrect $\sum x^2 = n\left[\sigma^2 + \bar{x}^2\right] = 200\left[15^2 + 40^2\right] = 365000$

Correct $\sum x^2 = 36410 - 50^2 + 40^2 = 364100$

Correct $\sigma = \sqrt{\frac{364100}{200} - (39.95)^2} = 14.98$

SECTION – B

71. 1

Sol. $\frac{2f(x).f'(x)}{\sqrt{1-(f(x))^4}} - 2x \geq 0 \Rightarrow \frac{d}{dx}(\sin^{-1}(f(x))^2 - x^2) \geq 0$

Let $g(x) = \sin^{-1}((f(x))^2) - x^2$ is a non-decreasing function.

$\Rightarrow \lim\limits_{x\to x_1} g(x) \leq \lim\limits_{x\to x_2} g(x) \Rightarrow \frac{\pi}{2} - x_1^2 \leq \frac{\pi}{6} - x_2^2$

$\Rightarrow x_1^2 - x_2^2 \geq \frac{\pi}{3} \Rightarrow \left[x_1^2 - x_2^2\right] \geq 1.$

72. 1

Sol. $\lim\limits_{x\to 1}\sec^{-1}\left(\frac{\lambda^2}{\ln x} - \frac{\lambda^2}{x-1}\right)$

Let $x - 1 = t \Rightarrow x = t + 1 \Rightarrow$ as $x \to 1, t \to 0$

$= \lim\limits_{t\to 0}\sec^{-1}\left(\frac{\lambda^2}{\ln(t+1)} - \frac{\lambda^2}{t}\right) = \lim\limits_{t\to 0}\sec^{-1}\left(\frac{\lambda^2}{t}\left(\frac{\lambda^2}{\ln(t+1)} - 1\right)\right)$

$= \lim\limits_{t\to 0}\sec^{-1}\left(\frac{\lambda^2}{2}\right) \Rightarrow \frac{\lambda^2}{2} \geq 1 \, |\lambda| \geq \sqrt{2}$

Hence minimum value of $[|\lambda|] = 1.$

73. 0

Sol. Since $\vec{x}.\vec{a} = \vec{x}.\vec{b} = \vec{x}.\vec{c} = 0$

$\Rightarrow$ ($\vec{a}, \vec{b}, \vec{c}$ are coplanar) $\vec{x}$ is perpendicular to $\vec{a}, \vec{b}, \vec{c}$

$\therefore \vec{a}(\vec{b}\times\vec{c}) = 0$

74. 2

Sol. $x^2y^2\left(\frac{dy}{y^2} - \frac{dx}{x^2}\right) + x^2y^2\left(\frac{1}{y} - \frac{1}{x}\right)dy = 0$

$\Rightarrow d\left(\frac{1}{x} - \frac{1}{y}\right) + y\left(\frac{1}{y} - \frac{1}{x}\right)dy = 0 \Rightarrow \frac{d\left(\frac{1}{x} - \frac{1}{y}\right)}{\frac{1}{x} - \frac{1}{y}} = ydy$

$\Rightarrow \ln\left|\frac{1}{x} - \frac{1}{y}\right| = \frac{y^2}{2} + c \Rightarrow k = 2.$

75. 3

Sol. $f(x) = \sin x + \int_{-\pi/2}^{\pi/2} (\sin x + t\cos x)\left(-\frac{1}{k}\sin t - \frac{2}{k}\cos t\right)dt$

$= \sin x + I_1 + I_2 + I_3 + I_4$

Where $I_1 = -\frac{\sin x}{k}\int_{-\pi/2}^{\pi/2} \sin t dt = 0$

$I_2 = -\frac{2\sin x}{k}\int_{-\pi/2}^{\pi/2} \cos t dt = -\frac{4\sin x}{k}$

$I_3 = -\frac{\cos x}{k}\int_{-\pi/2}^{\pi/2} t\sin t dt = -\frac{2\cos x}{k}$

$I_4 = \frac{4\cos x}{k}\int_{-\pi/2}^{\pi/2} t\cos t dt = 0$ $\quad(\because$ tcost is odd $)$

$\Rightarrow -\frac{1}{k}\sin x - \frac{2}{k}\cos x = \sin x - \frac{4\sin x}{k} - \frac{2\cos x}{k}$

$\Rightarrow -\frac{1}{k} = 1 - \frac{4}{k} \Rightarrow k = 3.$