IIT – JEE: 2024 **TW TEST (MAIN)** **DATE: 18/09/22**

TOPIC: KINEMATICS - I

ANSWER KEY

1.	(C)	2.	(D)	3.	(A)	4.	(B)	5.	(B)
6.	(D)	7.	(B)	8.	(B)	9.	(A)	10.	(D)
11.	(B)	12.	(C)	13.	(A)	14.	(A)	15.	(B)
16.	(B)	17.	(B)	18.	(B)	19.	(B)	20.	(C)
21.	(C)	22.	(C)	23.	(D)	24.	(A)	25.	(D)

SOLUTIONS

1. (C)

Speed of maximum height $= u\cos\theta = \frac{u}{2} \Rightarrow \theta = 60^\circ$

$$R = \frac{u^2 \sin 120^\circ}{g} = \frac{\sqrt{3}u^2}{2g}$$

2. (D)

$$\frac{u^2 \sin 30^\circ}{g} = 100\sqrt{3}$$

So, $\frac{u^2 \sin 60^\circ}{g} = 300\,\text{m}$

3. (A)

$S_{p/b} = x;\ u_{p/b} = u;\ a_{p/b} = -a$

$x = ut - \frac{1}{2}at^2$.

Also, this equation should have real root.

So, $u^2 - 2ax \geq 0 \Rightarrow u \geq \sqrt{2ax}$

4. (B)

$S_{1\text{st}} = \frac{1}{2} \times 10 \times 1^2 = 5\,\text{m}$.

$S_{n\text{th}} = \frac{1}{2} \times 10 \times (2n-1) = 5 \times 7 = 35\,\text{m}$

$\Rightarrow n = 4\,\text{sec}$.

5. (B)

Time to fall from height H is $\sqrt{\frac{2H}{g}}$

6. (D)

$u_y^2 = 2^2 + 2\times10\times0.4 \Rightarrow u_y = 2\sqrt{3}\ \text{m/s}$

$u_x = 6\,\text{m/s}$

So, $\tan\theta = \frac{u_y}{u_x} = \frac{1}{\sqrt{3}} \Rightarrow \theta = 30^\circ$

7. (B)

8. (B)

$\vec{r}_f = \vec{r}_t + \vec{u}t + \frac{1}{2}\vec{a}\,t^2 = 20\hat{i} + 20\,\hat{j}$

9. (A)

$-1500 = -100t - 5t^2 \Rightarrow t = 10\,\text{s}$

Now, $S_x = \frac{400}{3}\times10 = \frac{4000}{3}\,\text{m}$

10. (D)

11. (B)

12. (C)

$a = \frac{v}{n}$

$S_{n\text{th}} = \frac{1}{2}a(2n-1)$

13. (A)

Time to drop 5 m, $\Delta t = \sqrt{\frac{2\times5}{10}} = 1\text{sec}$

Now, $H = \frac{1}{2}\times10\times t^2;\ H - 25 = \frac{1}{2}\times10\times(t-1)^2$

Solving, $t = 3\text{sec}$.

So, H = 45 m

14. (A)

15. (B)

$(3u)^2 = u^2 + 2gH \Rightarrow H = \frac{4u^2}{g}$

16. (B)

$$\upsilon_{avg} = \frac{20\times3+30\times3+25\times2}{8} = 25\ \text{km/h}$$

17. (B)

18. (B)

$$S = 8\times5+\frac{1}{2}(-4)5^2 = -10\,\text{m}$$

But it stops after displacement of S'

$$0 = 8^2 - 2\times4\times S' \Rightarrow S' = 8\,\text{m}$$

Total distance = 8 + 8 + 10 = 26 m

19. (B)

$$\upsilon_y = 40-10\times1 = 30\ \text{m/s};\ \upsilon_x = 40\ \text{m/s}$$

20. (C)

21. (C)

$$t_1+t_2 = \text{ time of flight } = \frac{2u}{g}$$

22. (C)

$$\frac{1}{2}gt^2 = 20 \qquad ...(1)$$

$$\frac{1}{2}g\left(t+\Delta t\right)^2 = 22.05 \qquad ...(2)$$

$$\Delta t = 0.1\,\text{sec}$$

23. (D)

$$2 = \frac{2u\sin\theta}{g} \Rightarrow u\sin\theta = g \qquad ...(1)$$

$$-H = u\sin\theta\times3-\frac{1}{2}g\times3^2 = -15\,\text{m}$$

24. (A)

$$R = 4H\cot\theta = 25\times\frac{3}{4}\times4 = 75\,\text{m}$$

25. (D)

$$\left(\frac{u}{2}\right)^2+\left(\frac{u\sqrt{3}}{2}-10t\right)^2 = \frac{1}{4}u^2$$

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TOPIC: PERIODIC TABLE

ANSWER KEY

26.	(D)	27.	(C)	28.	(C)	29.	(D)	30.	(D)
31.	(D)	32.	(B)	33.	(C)	34.	(A)	35.	(B)
36.	(B)	37.	(D)	38.	(D)	39.	(D)	40.	(B)
41.	(D)	42.	(C)	43.	(A)	44.	(D)	45.	(C)
46.	(C)	47.	(C)	48.	(B)	49.	(C)	50.	(C)

SOLUTIONS

26. (D)
Hg, Br

27. (C)

28. (C)

29. (D)

30. (D)

31. (D)

32. (B)

33. (C)

34. (A)

35. (B)

36. (B)

37. (D)

38. (D)

39. (D)

40. (B)

41. (D)

42. (C)

43. (A)

44. (D)

45. (C)
IE_1 : B < Be < C

46. (C)

47. (C)

48. (B)

49. (C)

50. (C)

ANSWER KEY

51.	(C)	52.	(D)	53.	(C)	54.	(A)	55.	(C)
56.	(B)	57.	(A)	58.	(C)	59.	(C)	60.	(B)
61.	(B)	62.	(B)	63.	(C)	64.	(D)	65.	(C)
66.	(C)	67.	(B)	68.	(C)	69.	(D)	70.	(A)
71.	(B)	72.	(A)	73.	(B)	74.	(A)	75.	(C)

SOLUTIONS

51. (C)

$\Rightarrow \quad 1+\tan^2\theta-2\tan^2\theta=0$

$\Rightarrow \quad \tan^2\theta=1 \Rightarrow \tan\theta=\pm1$

$\Rightarrow \quad \theta=n\pi\pm\frac{\pi}{4} \Rightarrow$ (C) option.

52. (D)

$\Rightarrow \quad 1-\cos 2\theta=3+3\cos 2\theta$

$\Rightarrow \quad 4\cos 2\theta=-2 \Rightarrow \cos 2\theta=-\frac{1}{2}$

$\Rightarrow \quad 2\theta=2n\pi\pm\frac{2\pi}{3}$

Alternative:

$\frac{1-\cos 2\theta}{1+\cos 2\theta}=\tan^2\theta=\left(\sqrt{3}\right)^2=\tan^2\left(\frac{\pi}{3}\right)$

$\therefore \quad \theta=n\pi\pm\frac{\pi}{3}$

53. (C)

$\sin^2\theta+\sin\theta-2=0$

$\Rightarrow \quad \sin\theta=-2,1$

$\Rightarrow \quad \theta=2n\pi+\frac{\pi}{2}.\ n\in I$.

$\Rightarrow$ (C) options.

54. (A)

$\sin^4 x+\cos^4 x=\sin x\cos x$

$\Rightarrow \left(\sin^2 x+\cos^2 x\right)^2-2\sin^2 x\cos^2 x=\sin x\cos x$

$\Rightarrow 1-\frac{\sin^2 2x}{2}=\frac{\sin 2x}{2}$

$\Rightarrow \sin^2 2x+\sin 2x-2=0$

$\Rightarrow \left(\sin 2x+2\right)\left(\sin 2x-1\right)=0$

$\Rightarrow 2x=\left(4n+1\right)\frac{\pi}{2}$

$\Rightarrow x=\left(4n+1\right)\frac{\pi}{4}, n\in Z$

$\Rightarrow x=\frac{\pi}{4},\frac{5\pi}{4}\left(\because x\in\left[0,2\pi\right]\right)$

55. (C)

$\Rightarrow \cos\theta=-\frac{5}{4},\ \cos\theta=-\frac{1}{2}$

No solutions,

$\Rightarrow \theta=\frac{2\pi}{3},\frac{4\pi}{3}$

$\Rightarrow$ (C) option.

56. (B)

$4\cos^2 x+6\sin^2 x=5$

$\Rightarrow 4+2\sin^2 x=5 \Rightarrow \sin^2 x=\frac{1}{2}$

$\Rightarrow \sin x=\pm\frac{1}{\sqrt{2}}$

$\Rightarrow x=n\pi\pm\frac{\pi}{4}, n\in I$

$\Rightarrow$ (B) option.

57. (A)

$\tan\theta=1,\sqrt{3}$

$\Rightarrow \theta=n\pi+\frac{\pi}{4}, n\pi+\frac{\pi}{3}$

$\Rightarrow$ (A) option.

58. (C)

$\tan^2\alpha+2\sqrt{3}\tan\alpha-1=0$

$\Rightarrow \tan\alpha=\frac{-2\sqrt{3}\pm\sqrt{12+4}}{2}=-\sqrt{3}\pm 2$

$\Rightarrow \tan\alpha=2-\sqrt{3}$ and $-(2+\sqrt{3})$

$\Rightarrow \alpha=\left(6n+1\right)\frac{\pi}{12}, n\in I \Rightarrow$ (C) option.

59. (C)

$\sin 2x - 2\cos x + 4\sin x - 4 = 0$

$\Rightarrow 2\sin x \cdot \cos x - 2\cos x + 4(\sin x - 1) = 0$

$\Rightarrow 2\cos x(\sin x - 1) + 4(\sin x - 1) = 0$

$\Rightarrow (2\cos x + 4)(\sin x - 1) = 0$

$\Rightarrow \sin x = 1,\ \cos x = -2$

No solutions.

$\Rightarrow x = \frac{\pi}{2}, \frac{5\pi}{2}, \frac{9\pi}{2}$

$\Rightarrow$ (C) option.

60. (B)

$\cos\theta = \frac{2\sqrt{2} \pm \sqrt{8 + 4 \times 4}}{8}$

$\cos\theta = \frac{2\sqrt{2} + 2\sqrt{6}}{8} = \frac{\sqrt{3}+1}{2\sqrt{2}}$ or $\frac{-\sqrt{3}+1}{2\sqrt{2}}$

$\Rightarrow \quad \theta = \frac{\pi}{12}, \frac{7\pi}{12}, \frac{17\pi}{12}, \frac{23\pi}{12}$

61. (B)

$\sin 3x + (\sin 5x + \sin x) = 0$

$\Rightarrow \quad \sin 3x + (2\sin 3x \cos 2x) = 0$

$\Rightarrow \quad \sin 3x = 0$ or $\cos 2x = -\frac{1}{2} = \cos\frac{2\pi}{3}$

$\Rightarrow \quad x = n\pi/3$ or $x = n\pi \pm \frac{\pi}{3}, n \in Z$

Then $x = 0,\ \pi/3$, and $2\pi/3$, and π.

Hence there are four solutions.

62. (B)

$\Rightarrow \quad \tan(3\theta) = 0 \ \Rightarrow\ 3\theta = n\pi,\ n \in I$

$\Rightarrow \quad \theta = \frac{n\pi}{3} \ \Rightarrow$ (B) option

(using $\tan(A+B)$ formula)

63. (C)

$1 + 4\cos^3 x - 3\cos x - 2(2\cos^2 x - 1) = 0$

$4\cos^3 x - 4\cos^3 x - 3\cos x + 3 = 0$

$4\cos^2 x(\cos x - 1) - 3(\cos x - 1) = 0$

$(4\cos^2 x - 3)(\cos x - 1) = 0$

$\cos x = \frac{\sqrt{3}}{2},\ \cos x = -\frac{\sqrt{3}}{2};\ \cos x = 1$

So the smallest positive solution is $x = 30^o$.

64. (D)

$\sin\theta - \sqrt{2} = \sqrt{3}\cos\theta$

$\sin\theta - \sqrt{3}\cos\theta = \sqrt{2}$

$\frac{1}{2}\sin\theta - \frac{\sqrt{3}}{2}\cos\theta = \frac{1}{\sqrt{2}}$

$\sin\left(\theta - \frac{\pi}{3}\right) = \sin\frac{\pi}{4}$

$\theta - \frac{\pi}{3} = n\pi + (-1)^n \frac{\pi}{4}$

$\theta = n\pi + (-1)^n \frac{\pi}{4} + \frac{\pi}{3}$

65. (C)

$\Rightarrow \quad 4.16^{\sin^2 x} = 2^{6\sin x}$

$\Rightarrow \quad 2^2.2^{4\sin^2 x} = 2^{6\sin x}$

$\Rightarrow \quad 2 + 4\sin^2 x = 6\sin x$

$\Rightarrow \quad 2\sin^2 x - 3\sin x + 1 = 0$

$\Rightarrow \quad 2\sin^2 x - 2\sin x - \sin x + 1 = 0$

$\Rightarrow \quad 2\sin x(\sin x - 1) - 1(\sin x - 1) = 0$

$\sin x = \frac{1}{2}, 1$

$\Rightarrow \quad x = \frac{\pi}{6}, \frac{5\pi}{6}, \frac{\pi}{2}$

$\Rightarrow$ (C) option

66. (C)

Minimum $(a, b) \Rightarrow$ means which even is minimum out of 'a' & 'b'.

Maximum $(a, b) \Rightarrow$ means which even is maximum out of 'a' & 'b'.

$a^2 - 4a + 6 = (a-2)^2 + 2$

$\therefore \min.(a^2 - 4a + 6) = 2$

$\min.\{1, \underbrace{a^2 - 4a + 6}_{\geq 2}\} = 1$ $\qquad a^2 - 4a + 6 = (a-2)^2 + 2$

So, $\sin x + \cos x = 1$

$\Rightarrow \quad \frac{1}{\sqrt{2}}\sin x + \frac{1}{\sqrt{2}}\cos x = \frac{1}{\sqrt{2}}$

$\Rightarrow \quad \sin\left(x + \frac{\pi}{4}\right) = \sin\frac{\pi}{4}$

$\Rightarrow \quad x + \frac{\pi}{4} = n\pi + (-1)^n \frac{\pi}{4}$

$\Rightarrow \quad x = n\pi + (-1)^n \frac{\pi}{4} - \frac{\pi}{4}.$

$\Rightarrow$ (C) option.

67. (B)

$3\dfrac{\sin^2\theta}{\cos^2\theta}-2\sin\theta=0, \cos\theta\neq 0$

$\Rightarrow \quad 3\sin^2\theta-2\sin\theta\left(1-\sin^2\theta\right)=0$

$\Rightarrow \quad 3\sin^2\theta-2\sin\theta\left(1-\sin^2\theta\right)=0$

$\Rightarrow \quad \sin\theta\left(2\sin^2\theta+3\sin\theta-2\right)=0$

$\Rightarrow \quad \sin\theta\left(2\sin\theta-1\right)\left(\sin\theta+2\right)=0$

$\Rightarrow \quad \sin\theta=0,\dfrac{1}{2},-2\left(\text{rejected}\right)$

$\Rightarrow \quad \theta=n\pi, n\pi+\left(-1\right)^n\dfrac{\pi}{6}, n\in Z$

68. (C)

$3\sin^2 x-7\sin x+2=0$

$\left(3\sin x-1\right)\left(\sin x-2\right)=0$

$\sin x=\dfrac{1}{3}$ or $\left(\sin x=2\right)$ not possible

$x=n\pi+\left(-1\right)^n\sin^{-1}\left(\dfrac{1}{3}\right)$

$\sin^{-1}\left(\dfrac{1}{3}\right), \pi-\sin^{-1}\left(\dfrac{1}{3}\right), 2\pi+\sin^{-1}\left(\dfrac{1}{3}\right), 3\pi-\sin^{-1}\left(\dfrac{1}{3}\right), 4\pi+\sin^{-1}\left(\dfrac{1}{3}\right), 5\pi-\sin^{-1}\left(\dfrac{1}{3}\right)$

Total 6

69. (D)

$-1\leq\sin x\leq 1$ and $-1\leq\cos x\leq 1$

So, $\sin x.\cos x=2$ not possible

$\Rightarrow$ (D) options.

70. (A)

$\sec^2 x-\sec^{10} x=0$

$\Rightarrow \quad \sec^2 x\left(1-\sec^8 x\right)=0$

$\Rightarrow \quad \sec x=0, \ \sec x=1,-1$

No solution $\Rightarrow x=2n\pi, 2n\pi+\pi$

$\Rightarrow x=\pi, 2\pi, 3\pi$

So, option (A)

71. (B)

$1-\dfrac{3}{4}\sin^2 2x=\lambda \qquad \sin^2 2x\in\left[0,1\right] \qquad \lambda\in\left[1/4,1\right]$

72. (A)

73. (B)

74. (A)

$3^x + 3^{-x} \geq 2$ But $2\cos\frac{x}{2} \leq 2$

So, solutions exist only where $x = 0 \Rightarrow$ (A) option.

75. (C)

For $x \in \left(0, \frac{\pi}{2}\right]$

$0 < 2\cos^2\frac{x}{2} \cdot \sin^2 x < 2$

Where as $x^2 + \frac{1}{x^2} \geq 2$

So, no solution.