PACE-IIT & MEDICAL

MUMBAI / DELHI-NCR / PUNE / HYDERABAD / AKOLA / GOA / JALGOAN / BOKARO / AMRAVATI / PATNA / BARAMATI

IIT – JEE: 2026 | **MAJOR TEST - 3** | **DATE: 28/12/24**

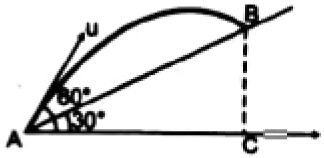
ANSWER KEY

PHYSICS		CHEMISTRY		MATHEMATICS	
1.	A	**26.**	B	**51.**	A
2.	D	**27.**	B	**52.**	A
3.	C	**28.**	B	**53.**	C
4.	A	**29.**	A	**54.**	C
5.	A	**30.**	A	**55.**	C
6.	D	**31.**	A	**56.**	D
7.	C	**32.**	A	**57.**	C
8.	B	**33.**	A	**58.**	A
9.	C	**34.**	C	**59.**	C
10.	D	**35.**	D	**60.**	C
11.	A	**36.**	B	**61.**	D
12.	B	**37.**	B	**62.**	A
13.	A	**38.**	D	**63.**	C
14.	C	**39.**	D	**64.**	D
15.	C	**40.**	B	**65.**	A
16.	A	**41.**	C	**66.**	A
17.	C	**42.**	C	**67.**	B
18.	A	**43.**	D	**68.**	D
19.	A	**44.**	A	**69.**	D
20.	B	**45.**	C	**70.**	C
21.	30	**46.**	4	**71.**	0
22.	2	**47.**	4	**72.**	540
23.	5	**48.**	16	**73.**	16
24.	23	**49.**	4	**74.**	5
25.	7.25 to 0.07	**50.**	3	**75.**	6

PHYSICS

1. (A)

Horizontal component of velocity



$$u_H = u\cos 60° = \frac{u}{2}$$

$\therefore \quad AC = (u_H)t = \frac{ut}{2}$

and $AB = AC\sec 30°$

$$\left(\frac{ut}{2}\right)\left(\frac{2}{\sqrt{3}}\right) = \frac{ut}{\sqrt{3}}$$

2. (D)

$F - kx = M_1 a_1$

$\therefore \quad kx = F - M_1 a_1$

Only force on M_2 is kx.

$\therefore \quad a_2 = \frac{kx}{M_2} = \frac{F - M_1 a_1}{M_2}$

3. (C)

In first case, $T_1 = 2g$

$\therefore \quad a_1 = \frac{T_1 - 1\times g}{1}$

$$= \frac{2g - g}{1} = g$$

In second case,

$$a_2 = \frac{2g - 1\times g}{1+2} = \frac{g}{3}$$

$\therefore \quad |\Delta a| = a_1 - a_2 = \frac{2g}{3}$

4. (A)

$g_{\text{eff}} = g - 2 = 8\ \text{m/s}^2$

$\Rightarrow \quad m(g-a)\sin\theta = \mu m(g-a)\cos\theta$

$\Rightarrow \quad \mu = \tan\theta = \tan 30° = \frac{1}{\sqrt{3}}$

5. (A)

For round trip:

$\omega_{\text{air}} + \omega_{\text{g}} = \frac{1}{2}\text{m}\left(8^2 - 16^2\right)$

$\omega_{\text{air}} = -\frac{1}{2}\text{m}(192) = -96\ \text{m} \quad (\because \omega_{\text{g}} = 0$ as height is same)

For ground to highest point:

$\omega_{\text{air}} + \omega_{\text{g}} = \Delta\text{K}$

$-48\text{m} - \text{mgh} = 0 - \frac{1}{2}\text{m}\times 16^2$

$48 + 10\text{h} = \frac{256}{2} \Rightarrow \text{h} = 8\ \text{m}$

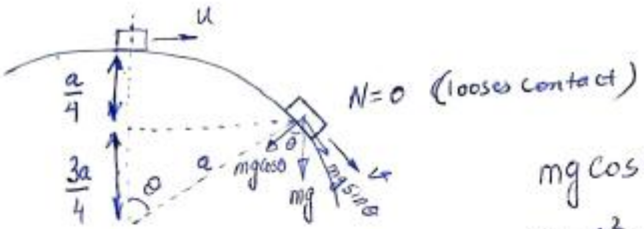
6. (D)

$\because$ power is same in both cases

$$P = \frac{\text{Work}}{\text{time}} = \frac{\frac{1}{2} m v^2}{t} = \frac{\frac{1}{2} m(2v)^2}{t'}$$

$$\therefore t' = 4t$$

7. (C)



$\cos\theta = \frac{3}{4}$

$$mg\cos\theta = \frac{mv^2}{a}$$

$$\Rightarrow v^2 = \frac{3}{4}ag$$

$$\frac{1}{2}mu^2 + mg\frac{a}{4} = \frac{1}{2}mv^2$$

$$u = \sqrt{v^2 - \frac{ga}{2}} = \frac{\sqrt{ag}}{2}$$

8. (B)

Say plank moves through 'x' towards left when man moves 'L' w.r.t. plank towards right

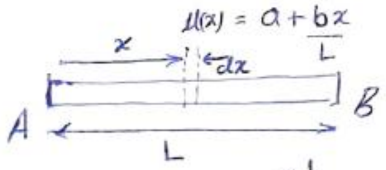
$$0 = M_1 \Delta x_1 + M_2 \Delta x_2$$

$$0 = M(L - x) + 3M(-x)$$

$$x = \frac{L}{4}$$

$\therefore$ man moves $L - \frac{L}{4} = \frac{3L}{4}$ relative to ground.

9. (C)



$$dm = \mu(x) \cdot dx$$

$$X_{CM} = \frac{\int_0^L x\,dm}{\int_0^L dm} = \frac{\int_0^L \left(a + \frac{bx}{L}\right) x\,dx}{\int_0^L \left(a + \frac{bx}{L}\right) dx} = \frac{\left[\frac{ax^2}{2} + \frac{bx^3}{3L}\right]_0^L}{\left[ax + \frac{bx^2}{2L}\right]_0^L}$$

$$\frac{7}{12} L = \frac{(3a + 2b)L}{3(2a + b)}$$

$$2a = b$$

10. (D)

$$e = \frac{\text{relative } \cancel{\text{speed}}\ \overset{\text{velocity}}{} \text{ of separation}}{\text{relative } \cancel{\text{speed}}\ \underset{\text{velocity}}{} \text{ of approach}} = \frac{\sqrt{2 \times g \times 3.2}}{\sqrt{(6)^2 + 2 \times g \times 3.2}} = \frac{8}{10} = 0.8$$

11. (A)

$$\omega(t) = \alpha - \beta t \qquad \left\{ \begin{matrix} \omega = 0 \\ \text{at } t = \frac{\alpha}{\beta} \end{matrix} \right\}$$

$$\frac{d\theta(t)}{dt} = \alpha - \beta t$$

$$\theta(t) = \int_0^{\alpha/\beta} (\alpha - \beta t)\,dt = \left[\alpha t - \frac{\beta t^2}{2}\right]_0^{\alpha/\beta} = \frac{\alpha^2}{2\beta}$$

12. (B)

Say mass density is uniform and equal to 'σ'

total Mass of disc, $M = \sigma \pi a^2$

and Moment of inertia, $I = \frac{Ma^2}{2}$

Mass of removed portion $= \sigma . \frac{\pi a^2}{12} = \frac{M}{12}$

remaining Mass $= \frac{11}{12} M$

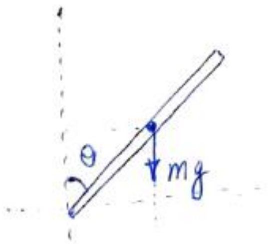
New moment of inertia $= \frac{\frac{11}{12} M a^2}{2} = \frac{11}{12} I$

13. (A)

$I_{solid} + I_{hollow} = I_{system}$

$\frac{2}{5}\left(\frac{m}{2}\right) R^2 + \frac{2}{3}\left(\frac{m}{2}\right) R^2 = \frac{8mR^2}{15}$

14. (C)



Torque $= I \alpha$

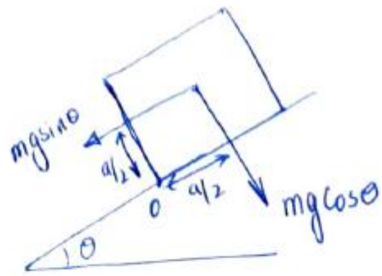
$\frac{mgl\sin\theta}{2} = \frac{ml^2}{3} . \alpha$

$\frac{3g\sin\theta}{2l} = \alpha$

15. (C)

for sliding $\mu = \tan\theta$

torque of $mg\sin\theta$ should be less than torque of $mg\cos\theta$ about O for sliding before toppling

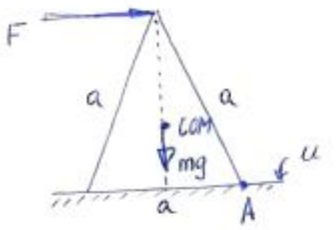


$mg\sin\theta . \frac{a}{2} < mg\cos\theta . a/_2$

$\tan\theta < 1$

$\mu < 1$

16. (A)

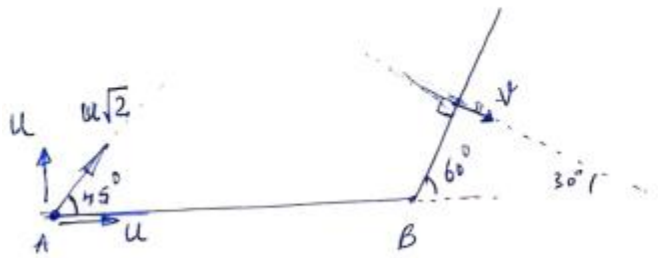


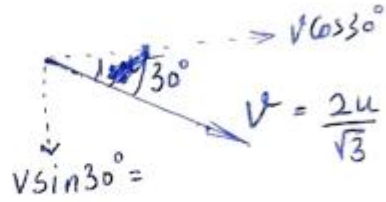
about point A balance torque of f & mg

$$f \times \frac{\sqrt{3}}{2}a = mg \times \frac{a}{2}$$

$$f = \frac{mg}{\sqrt{3}}$$

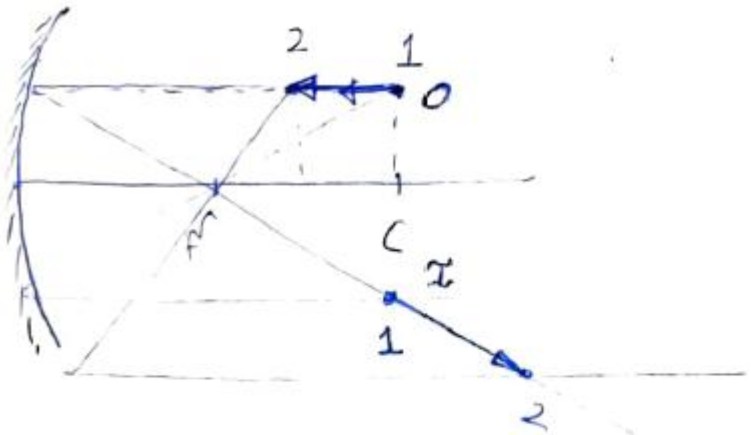
17. (C)





horizontal velocity remains same

18. (A)



19. (A)

$$v = \frac{uf}{u-f} = \frac{(-30)(-10)}{(-30)-(-10)} = -15\text{ cm} \quad ; \quad m = \frac{-v}{u} = \frac{-(-15)}{(-30)} = \frac{-1}{2}$$

$$\frac{h_I}{h_o} = m$$

$$h_I = -0.5 \times 0.5 = -0.25$$

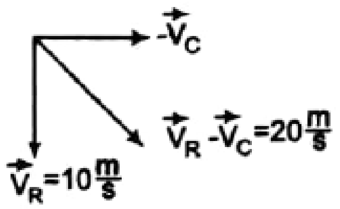
20. (B)

$$\frac{h}{2} = \frac{h/4}{\mu} + \frac{3h/4}{1.5\mu}$$

Solving we get,

$$\mu = \frac{3}{2}$$

21. (30)



$$V_C = \left|-\vec{V}_C\right| = \sqrt{(20)^2 - (10)^2} = 10\sqrt{3}\,\text{m/s}$$

22. (2)

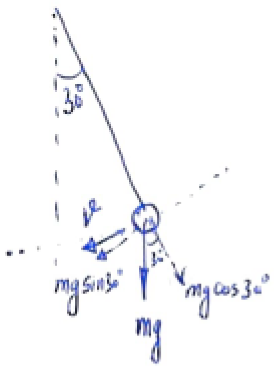
$$T.E. = P.E. + K.E.$$

$$20\,J = P.E_{Max} + KE_{min} = 16\,J + KE_{min}$$

$$4 = \frac{1}{2} \times 2 \times (V_{Min})^2$$

$$\therefore V_{Min} = 2\,m/s$$

23. (5)



$$\frac{d|\vec{v}|}{dt} = a_{tangential} = g\sin 30° = g/2$$

24. (23)

$$I_{system} = (Mr^2 + Mr^2) + \left(\frac{Mr^2}{2} + M(3R)^2\right)$$

$$I_{system} = 11.5\,mr^2$$

25. (7.25 to 0.07)

26. (B)

First line of Balmer in H

$$\nu_0 = \frac{c}{\lambda} = c \times R \times \left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

First line of Balmer in He^+

$$\nu = c \times R \times 4 \times \left(\frac{1}{2^2} - \frac{1}{3^2}\right) = 4\nu_0$$

27. (B)

O_2, O_2^+, O_2^- are paramagnetic

$O_2^{2-}, O_2^{2+}, O^{2-}$ are diamagnetic

28. (B)

$$A_2(g) + B_2(g) \rightleftharpoons C_2(g) + D_2(g)$$

	A_2	B_2	C_2	D_2
i	1	1	1	1
e	$1-x$	$1-x$	$1+x$	$1+x$

$$\left(\frac{1+x}{1-x}\right)^2 = \frac{1}{4} \Rightarrow x = -\frac{1}{3}$$

$$[A_2]_{eq} = \frac{1-\left(-\frac{1}{3}\right)}{10} = \frac{4}{30} = 0.13$$

29. (A)

$$2AB(s) \rightleftharpoons A_2(g) + B_2(g)$$

	A_2	B_2
i	0.5	0
e	$0.5+P$	P

$0.06 = P(0.5+P)$

$\Rightarrow P = 0.1$

$P_{total} = 0.5 + 2P = 0.7$ atm

30. (A)

$$2A_2B(g) \rightleftharpoons 2A_2(g) + B_2(g)$$

	A_2B	A_2	B_2
i	4	0	0
e	$4(1-\alpha)$	4α	2α

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

$$\Rightarrow \alpha = \frac{2}{3}$$

31. (A)

$2KClO_3 \rightarrow 2KCl + 3O_2$

$n_{O_2} = \dfrac{0.384}{32} = 0.012$

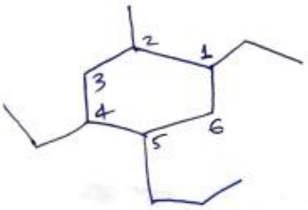
$\Rightarrow \ n_{KClO_3} = 0.012 \times \dfrac{2}{3} = 0.008$

$\% \ KClO_3 = \dfrac{0.008 \times 122.5}{4.9} \times 100 = 20\%$

32. (A)

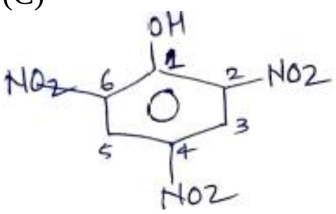
$x = 131 - 282 - 242 = -393$

33. (A)



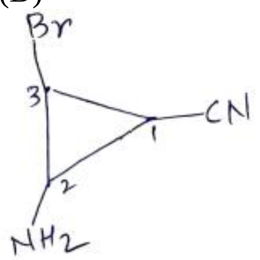
1,4-Di~~m~~ethyl-2-methyl-5-propyl cyclohexane

34. (C)



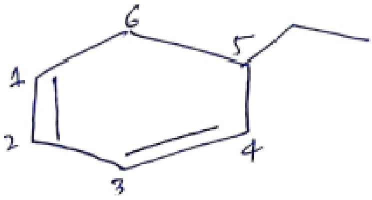
2,4,6-Trinitrophenol

35. (D)



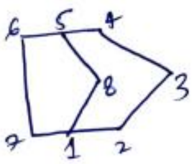
2-amino-3-Bromo cyclopropane-1-carbonitrile

36. (B)



5-ethyl cyclohexa-1,3-diene

37. (B)



Bicyclo[3·2·1] ~~hept~~ octane

38. (D)

$-NO_2 > -CN > F- > -NH_2$

39. (D)

$-COO^{\ominus}$

40. (B)

La > Y (Size)

41. (C)

XeF_5^- $\sigma = 5, \ell p = 2$

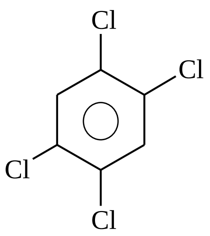
$\Rightarrow$ pentagonal planar & non-polar

$XeF_6 \rightarrow$ capped octahedral ($\sigma = 6, \ell p = 1$)

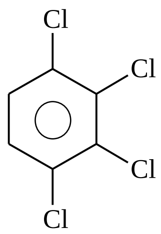
$XeOF_4 \rightarrow$ square pyramid ($\sigma = 5, \ell p = 1$)

$XeF_4 \rightarrow$ square planar ($\sigma = 4, \ell p = 2$)

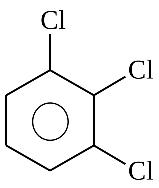
42. (C)

(A) 

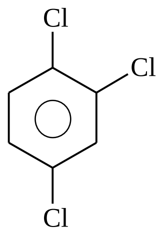
$\mu_{net} = 0$

(B) 

$\mu_{net} = p\sqrt{3}$

(C) 

$\mu_{net} = 2p$

(D) 

$\mu_{net} = p$

43. (D)

$(P_1 + P_2)^2 = 36 + 64$

$\Rightarrow P_1 + P_2 = 10$

$P_{total} = 2(P_1 + P_2) = 20 \text{ atm}$

44. (A)

$W_{AB} = -P_0V_0$

$W_{BC} = -2P_0V_0\ell n2$

$W_{CD} = +P_0V_0$

45. (C)

$$1 \times \frac{5}{2}R \times (T_f - 300) = -2\left(\frac{1R \times T_f}{2} - \frac{1 \times R \times 300}{5}\right)$$

$\Rightarrow T_f = 248.5 \text{ K}$

46. (4)

$$NO(g) + NO_3(g) \rightleftharpoons 2NO_2(g)$$

i	1	3	0
e	$1-\frac{x}{2}$	$3-\frac{x}{2}$	x
e′	$3-x$	$3-x$	2x

$$\frac{x^2}{\left(1-\frac{x}{2}\right)\left(3-\frac{x}{2}\right)} = \left(\frac{2x}{3-x}\right)^2$$

Solving $x = \frac{3}{2}$

$$K_p = \frac{\frac{3}{2}\times\frac{3}{2}}{\frac{1}{4}\times\frac{9}{4}} = 4$$

47. (4)
(iii), (iv), (v), (vii) are wrong.

48. (16)

$$W = -1(4-1) = -3\text{ L.atm} = -300\text{ J}$$

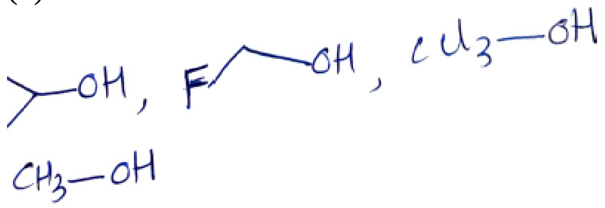
$$T_f = \frac{300}{10}\times 20 = 600\text{ K}$$

$$Q = 51\times 300 = 15{,}300\text{ J}$$

$$\Delta U = 15.3 - 0.3 = 15\text{ kJ}$$

$$\Delta H = 15 + (20-10)\times\frac{100}{1000} = 16\text{ kJ}$$

49. (4)



50. (3)

$-\overset{\oplus}{N}H_3$, $-NO2$, $-C\equiv N$

MATHEMATICS

51. (A)

52. (A)

$x = \sqrt[3]{7} + \sqrt[3]{49}$

$\Rightarrow \quad x^3 = 7 + 49 + 3\sqrt[3]{7} \qquad \sqrt[3]{49}(\sqrt[3]{7} + \sqrt[3]{49}) = 56 + 21x$

$\Rightarrow \quad x^3 - 21x - 56 = 0$

Therefore, the product of roots is 56.

53. (C)

Since, $\alpha, \beta, \gamma, \sigma$ are the roots of the given equation, therefore

$$x^4 + 4x^3 - 6x^2 + 7x - 9 = (x-\alpha)(x-\beta)(x-\gamma)(x-\sigma)$$

Putting $x = i$ and then $x = -i$, we get

$$1 - 4i + 6 + 7i - 9 = (i-\alpha)(i-\beta)(i-\gamma)(i-\sigma)$$

and $1 + 4i + 6 - 7i - 9 = (-i-\alpha)(-i-\beta)(-i-\gamma)(-i-\sigma)$

Multiplying these two equations, we get

$$(-2+3i)(-2-3i) = (1+\alpha^2)(1+\beta^2)(1+\gamma^2)(1+\sigma^2)$$

$\Rightarrow \quad 13 = (1+\alpha^2)(1+\beta^2)(1+\gamma^2)(1+\sigma^2)$

54. (C)

$$y = \frac{4x(x^2+1)}{x^2 + (x^2+1)^2} = \frac{4\left(x + \frac{1}{x}\right)}{1 + \left(x + \frac{1}{x}\right)^2}$$

Let $x + \frac{1}{x} = t$

For $x > 0, t \geq 2$

$$y = \frac{4t}{1+t^2} = \frac{4}{\frac{1}{t} + t}$$

For $t \geq 2, t + \frac{1}{t} \geq \frac{5}{2}$

$0 < y \leq \frac{8}{5}$ and $y = 0$ for $x = 0$

$\therefore$ range of $f(x)$ is $\left[0, \frac{8}{5}\right]$

55. (C)

56. (D)

Number on die are 1, 2, 3, 4, 5, 6.

Prime numbers are 2, 3, 5 and non-prime numbers are 1, 4, 6.

Now, let weight assigned to non-prime numbers is λ, then weight assigned to prime number is 2λ

$\therefore \quad \lambda + 2\lambda + 2\lambda + \lambda + 2\lambda + \lambda = 1$

$\Rightarrow \quad \lambda = \frac{1}{9}$

$\therefore$ Probability that an odd number will be show up when the die is tossed 1 or 3 or 5

$\lambda + 2\lambda + 2\lambda = 5\lambda = \frac{5}{9}$

57. (C)

The probability of not drawing the ace in the first draw, in the second draw and in the third draw are (here all spades i.e., 13 cards) $\frac{12}{13}, \frac{11}{12}, \frac{10}{11}$, respectively.

Probability of drawing ace of spades in the 4th draw

$= \frac{1}{10}$ (Only one ace and remaining cards = 10)

$\therefore$ Required probability $= \frac{12}{13} \times \frac{11}{12} \times \frac{10}{11} \times \frac{1}{10} = \frac{1}{13}$

58. (A)

Digits to be used are ≥ 6

$999996 \Rightarrow 6;\ 999987 \Rightarrow 30;\ 999888 \Rightarrow 20 \qquad \therefore \text{ total} = 56$

59. (C)

Required number $= \frac{8!}{5! \times 3!} + \frac{8! \times 2!}{4! \times 4! \times 2!} = 126$

60. (C)

61. (D)

62. (A)

$\left(1 + x + x^2 + x^3 + x^4\right)^{1001} (1 - x)^{1002}$

$= (1 - x)\left(1 - x^5\right)^{1001}$

So all the powers of x will be of the $5m$ or $5m + 1(m \in 1)$

63. (C)

$\sum_{k=1}^{\infty} \sum_{r=0}^{k} \frac{1}{3^k}\left({}^kC_r\right)$

$= \sum_{k=1}^{\infty}\left(\frac{1}{3^k}\left(\sum_{r=0}^{k} {}^kC_r\right)\right)$

$= \sum_{k=1}^{\infty}\left(\frac{2^k}{3^k}\right)$

$= \frac{2}{3} + \left(\frac{2}{3}\right)^2 + \ldots\ldots\infty$

$= \frac{2/3}{1 - \frac{2}{3}} = 2$

64. (D)

General term in the expansion of $(\sqrt{2}+\sqrt[3]{3}+\sqrt[6]{5})^{10}$ is

$\dfrac{10!}{a!b!c!}(\sqrt{2})^a(\sqrt[3]{3})^b(\sqrt[6]{5})^c$ where $a + b + c = 10$.

65. (A)

66. (A)

67. (B)

68. (D)

69. (D)

We have, $f(x)=4\cos^4\left(\dfrac{x-\pi}{4\pi^2}\right)-2\cos\left(\dfrac{x-\pi}{2\pi^2}\right)$

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

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

Clearly, period of $f(x)=\dfrac{\pi}{\dfrac{1}{2\pi^2}}=2\pi^3$

70. (C)

$k\cos^2 x-k\cos x+1\geq 0\ \forall\ x\in(-\infty,\infty)$

$\Rightarrow\quad k\left(\cos^2 x-\cos x\right)+1\geq 0 \qquad\qquad ...(\text{i})$

But $\cos^2 x-\cos x=\left(\cos x-\dfrac{1}{2}\right)^2-\dfrac{1}{4}$

$\Rightarrow\quad -\dfrac{1}{4}\leq\cos^2 x-\cos x\leq 2$

Now, from (i), we get

$2k+1\geq 0\ \Rightarrow\ k\geq-\dfrac{1}{2}$

Also, $-\dfrac{k}{4}+1\geq 0$

$\Rightarrow\quad k\leq 4$

$\Rightarrow\quad -\dfrac{1}{2}\leq k\leq 4$

71. (0)

$S=\left\{x\in(-\pi,\pi):x\neq 0,\pm\dfrac{\pi}{2}\right\}$

The given equation is

$\sqrt{3}\sec x+\operatorname{cosec} x+2(\tan x-\cot x)=0$

$\Rightarrow\quad \dfrac{\sqrt{3}}{\cos x}+\dfrac{1}{\sin x}+2\left(\dfrac{\sin x}{\cos x}-\dfrac{\cos x}{\sin x}\right)=0$

$\Rightarrow \quad \sqrt{3}\sin x + \cos x + 2\left(\sin^2 x - \cos^2 x\right) = 0$

$\Rightarrow \quad \sqrt{3}\sin x + \cos x = 2\cos 2x$

$\Rightarrow \quad \frac{\sqrt{3}}{2}\sin x + \frac{1}{2}\cos x = \cos 2x$

$\Rightarrow \quad \cos x \cos\frac{\pi}{3} + \sin x \sin\frac{\pi}{3} = \cos 2x$

$\Rightarrow \quad \cos x \cos\frac{\pi}{3} + \sin x \sin\frac{\pi}{3} = \cos 2x$

$\Rightarrow \quad \cos 2x = \cos\left(x - \frac{\pi}{3}\right)$

$\Rightarrow \quad 2x = 2n\pi \pm \left(x - \frac{\pi}{3}\right)$

72. (540)

73. (16)

74. (5)

75. (6)