FIITJEE

ALL INDIA TEST SERIES

OPEN TEST

JEE (Main)-2025

TEST DATE: 12-01-2025

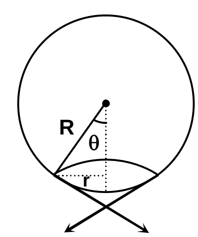
ANSWERS, HINTS & SOLUTIONS

Physics PART – A

SECTION – A

1. A

Sol. To detach



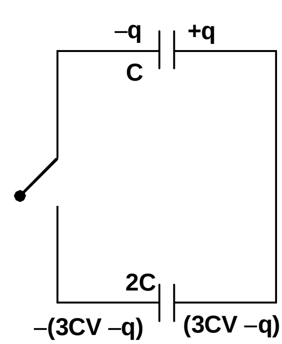
$$\rho_w\left(\frac{4}{3}\pi R^3 g\right) = T2\pi r\sin\theta$$

$$\text{So, } \rho_w\left(\frac{4}{3}\pi R^3 g\right) = T2\pi r\frac{r}{R}$$

$$\text{So, } r = R^2\sqrt{\frac{2\rho_w g}{3T}}$$

2. B

Sol. When switch is closed



$$\frac{q}{C} = \frac{3CV - q}{2C}$$

So, q = CV

$$\text{Initial energy, } U_i = \frac{C^2V^2}{2C} + \frac{(4CV)^2}{2(2C)}$$

$$\text{Final energy, } U_f = \frac{C^2V^2}{2C} + \frac{(2CV)^2}{2(2C)}$$

$$\text{So, energy lost} = U_i - U_f = 3CV^2$$

3. A

Sol. $k_1 = \frac{hC}{\lambda} - \phi$

$$3k_1 = \frac{2hC}{\lambda} - \phi$$

So, $\frac{1}{3} = \frac{\frac{hC}{\lambda} - \phi}{\frac{2hC}{\lambda} - \phi}$

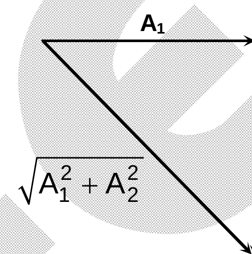
So, $\phi = \frac{hC}{2\lambda}$

4. A

Sol. From Phasor diagram

Because intensity I is proportional to square of amplitude

So, $I \propto (A_1^2 + A_2^2)$



5. A

Sol. When both S_1 and S_2 are open,

Current in the ammeter $i = \frac{1.5}{300 + 100 + 50} = \frac{1}{300}$ A

When both S_1 and S_2 are closed,

$$i = \frac{1.5}{300 + \left(\frac{100R}{100 + R}\right)}\left(\frac{R}{R + 100}\right) = \frac{1.5R}{400R + 30000}$$

So, according to the question,

$$\frac{1}{300} = \frac{1.5R}{400R + 30000}$$

$\Rightarrow R = 600\ \Omega$

6. C

Sol. $\frac{K(4)^2}{r^2(2)} = \frac{K(4 - q)(4 + q)}{r^2}$

So, $8 = 16 - q^2$

$\Rightarrow q = 2\sqrt{2}\ \mu C$

7. B

Sol. From Brewster's law

$\mu = \tan 60° = \sqrt{3}$

8. B

Sol. $\frac{dy}{dx} = \frac{2a}{y} = \tan\theta$ (slope of the wire)

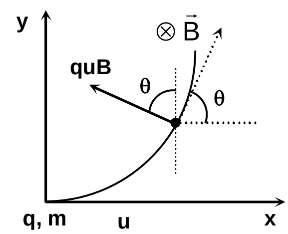
For no slipping $\tan\theta \le \mu_S$

So, $\frac{2a}{y_0} \le \mu_S$

So, $y_0 \ge \frac{2a}{\mu_S}$

9. B

Sol. Impulse momentum theorem along y-direction



$$\int quB\cos\theta dt = mu$$

$$\Rightarrow \quad q\int B_0 xu\cos\theta dt = mu$$

$$\Rightarrow \quad qB_0 \int_0^{x_m} xdx = mu$$

$$\Rightarrow \quad qB_0 \frac{x_m^2}{2} = mu$$

$$\Rightarrow \quad x_m = \sqrt{\frac{2mu}{qB_0}}$$

10. A

Sol. $i_d = \frac{dQ}{dt} = \frac{12}{100}e^{-\frac{t}{\tau}}$

So, i_d after a time constant $= \frac{12000}{100e} = \frac{120}{e}$ mA

11. D

Sol. $0.9A_0 = A_0 e^{-c(5)}$

and $\alpha A_0 = A_0 e^{-c(15)}$

So, $\alpha = (0.9)^3 = 0.729$

12. B

Sol. In the given circuit $R_{eq} = 1M\Omega$

and $C_{eq} = 4\,\mu F$

So, $V = (10)\left(1 - e^{-\frac{t}{R_{eq}C_{eq}}}\right)$

So, $4 = 10\left(1 - e^{-\frac{t}{4}}\right)$

So, $e^{-\frac{t}{4}} = \frac{3}{5}$

So, $t = 4\ell n\left(\frac{5}{3}\right)$

13. C

Sol. For a convex lens forming a real image

$\frac{1}{v} - \frac{1}{-u} = \frac{1}{f}$

So, if u = v, then

u = v = 2f

14. B
Sol. In forced oscillation
If $F = F_0\cos(\omega t)$
Then $x = A\sin(\omega t - \phi)$, where $A = \dfrac{F_0}{m(\omega_0^2 - \omega^2)}$

15. B
Sol. Suppose length AP = x
So, $\dfrac{1}{3}\left(\dfrac{m}{\ell}x\right)x^2 = \dfrac{m\ell^2}{3} - \dfrac{mx^3}{3\ell}$
So, $x = \dfrac{\ell}{2^{1/3}}$

16. A
Sol. Heat required to melt the whole of ice is
$Q_1 = mS\Delta T + mL$
$= 400 \times 0.5 \times 20 + 400 \times 80 = 36000$ cal
The maximum heat released by steam when the whole steam is converted into water at 0°C
$Q_2 = mS\Delta T + mL$
$= 50 \times 1 \times 100 + 540 \times 50 = 32000$ cal
Because $Q_2 < Q_1$, so the whole ice will not melt. Hence the final temperature of the mixture is 0°C.

17. C
Sol. Thermal stress is given by $Y \propto \Delta\theta$
So, for stress to be same
$Y_1\alpha_1 = Y_2\alpha_2$
So, $\dfrac{Y_1}{Y_2} = \dfrac{\alpha_2}{\alpha_1} = \dfrac{3}{2}$

18. B
Sol. $Q = \dfrac{p^2}{2\times 4} + \dfrac{p^2}{2\times(220-4)}$
$5.5 = p^2\left(\dfrac{1}{8} + \dfrac{1}{432}\right) = p^2\left(\dfrac{440}{8\times 432}\right)$
So, $\dfrac{p^2}{2\times 4} = \dfrac{(5.5)(8\times 432)}{2\times 4\times 440} = 5.4\text{ MeV}$

19. C
Sol. From lens C, image is formed at 1 m along the direction of incident ray. So for the position of final image from the final system is
$\dfrac{1}{v} - \dfrac{1}{1} = \dfrac{1}{1}$
$\Rightarrow v = \dfrac{1}{2}\text{ m}$
So, magnification $m = \dfrac{1}{2}$
So, separation between both the images = $\dfrac{1}{2}\times\dfrac{1}{2}\times 2 = 0.5\text{ cm}$

20. B

Sol. $X = \frac{C}{T}$

Or $\frac{X_1}{X_2} = \frac{273-173}{273-73} = \frac{100}{200}$

So, $X_2 = 2 \times 0.0060 = 0.0120$

SECTION – B

21. 770

Sol. For second pendulum

$$2 = 2\pi\sqrt{\frac{\ell}{g}} = 2\pi\sqrt{\frac{\ell(1+\alpha\Delta T)}{g+a}}$$

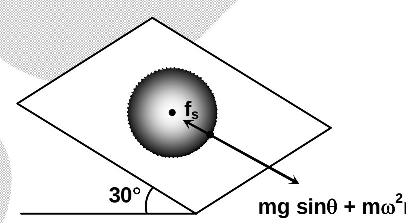
So, $1+\alpha\Delta T = \frac{g+a}{g} = 1+\frac{a}{g}$

So, $a = g\alpha\Delta T = (10)(20\times10^{-4})(50) = 1\,m/s^2$

So, $N = m(g+a) = 770$ N

22. 3

Sol. At the limiting situation



$f_S = mg\sin\theta + m\omega^2 r$

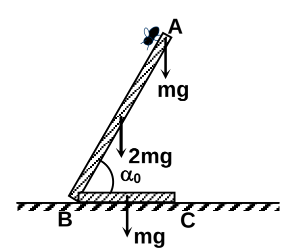
$mg\sin\theta + m\omega^2 r \le \mu_S mg\cos\theta$

So, $\mu_S \ge \tan\theta + \frac{\omega^2 r}{g\cos\theta}$

So, $\mu_S \ge \frac{1}{\sqrt{3}} + \frac{(10)^2\left(\frac{1}{10}\right)}{10\left(\frac{\sqrt{3}}{2}\right)} = \sqrt{3}$

23. 7

Sol. At the verge of toppling, normal applied by table will pass through point C. So, torque about point C,



$$mg(2d\cos\alpha_0 - d) = 2mg(d - d\cos\alpha_0) + mg\frac{d}{2}$$

$$2\cos\alpha_0 - 1 = 2 - 2\cos\alpha_0 + \frac{1}{2}$$

$$4\cos\alpha_0 = \frac{7}{2}$$

So, $\cos\alpha_0 = \frac{7}{8}$

24. 125

Sol. $\frac{dL}{dt} = \frac{dm}{dt}R(v_1 - v_2)$

$= (100)(0.5)(5-2.5) = 125$ J

25. 2

Sol. $X_C = \frac{V_C}{I} = 1000\ \Omega$

Current lags behind voltage, so box has an inductor

Power factor = 0.8 = $\frac{R}{Z} = \frac{800}{\sqrt{(800)^2 + (X_L - 1000)^2}}$

So, $X_L = 1600\ \Omega$

So, $L = \frac{1600}{2\times\pi\times\frac{400}{\pi}} = 2$ Henry

Chemistry PART – B

SECTION – A

26. C

Sol. $K_2Cr_2O_7 + \text{cold. } 4H_2SO_4 \longrightarrow 2CrO_3 + 2KHSO_4 + 2H_2O$

$2K_2Cr_2O_7 + \text{warm } 8H_2SO_4 \xrightarrow{\Delta} 2K_2SO_4 + 2Cr_2(SO_4)_3 + 8H_2O + 3O_2$

27. C

Sol. $2F_2 + 2H_2O \longrightarrow 4HF(aq) + O_2(g)$

$3F_2 + 3H_2O \longrightarrow 6HF(aq) + O_3(g)$

28. B

Sol. $Ni^{+2} \rightarrow \text{in}\left[Ni(Br_2)(PPh_3)_2\right] \longrightarrow \left[NiBr_2(PPh_3)_2\right]$

Square planar	Tetrahedral
Red colour	Green coloured
Diamagnetic	Paramagnetic

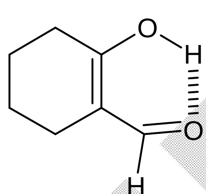
Tetrahedral splitting of Ni^{+2} in $NiBr_2(PPh_3)_2$ will have configuration $e^4t_2^4$, thus unpaired electrons.

29. D

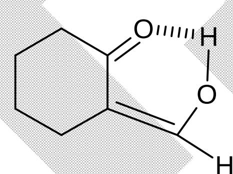
Sol. In (I) annulene systems, only peripheral bonds are counted but in (II) fused ring system only connected benzoic bonds are counted.

30. C

Sol.



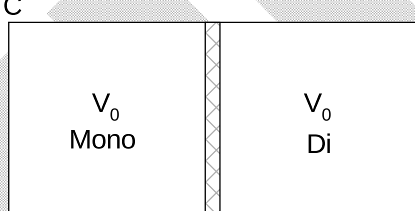
or



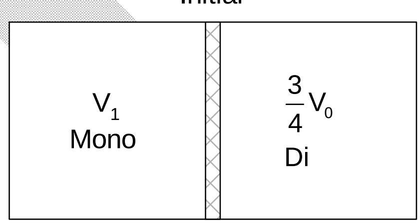
1, 2 diketones in enol form strong H-bonding with stable ring.

31. C

Sol.



Initial



Monoatomic : $P_1.V_0^{5/3} = P_2.V_1^{5/3}$

$$\text{Diatomic}: P_1.V_0^{7/5} = P_2.\left(\frac{3}{4}V_0\right)^{7/5}$$

$$\therefore \frac{V_1}{V_0} = \left(\frac{3}{4}\right)^{\frac{21}{25}}$$

32. B

Sol.

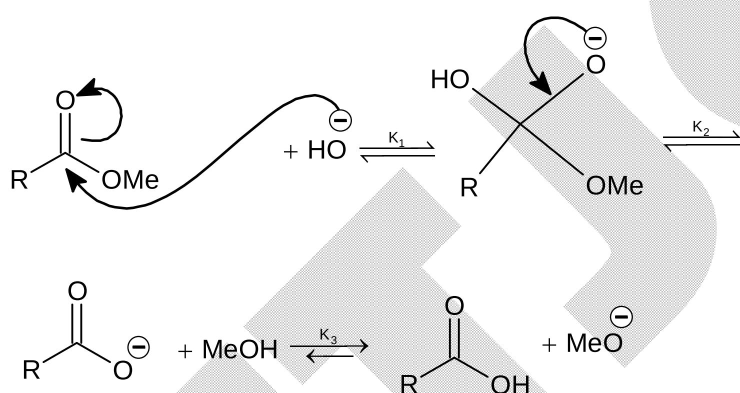
	I_2	+	I^-	$\rightleftharpoons$	I_3^-
	1		0.5		–
Volume = 1L	1 – 0.25		0.5 – 0.25		0.25

$$K_c = \frac{0.25}{0.75 \times 0.25} = \frac{4}{3}$$

$$\therefore K_c \text{ for } \frac{1}{2}I_2 + \frac{1}{2}I^- \rightleftharpoons \frac{1}{2}I_3^- \text{ is } \sqrt{\frac{4}{3}} = 1.15$$

33. C

Sol.



3 step mechanism where $K_1 \simeq K_2$ but K_3 is largely formed.

34. B

Sol. $\frac{1}{\lambda} = R_H.Z^2\left[\frac{1}{2^2} - \frac{1}{5^2}\right]$

$$\frac{1}{108.5 \times 10^{-9}} = R_H.Z^2\left[\frac{25-4}{25 \times 4}\right]$$

$$Z^2 = \frac{1}{R_H}.\frac{1}{1085 \times 10^{-10}} \times \frac{25 \times 4}{21}$$

$$= \frac{916 \times 25 \times 4}{1085 \times 21}$$

$$\text{B. E.} = 13.6 \times \frac{Z^2}{n^2}$$

$$\text{B.E.} = \frac{+13.6 \times 916 \times 25 \times 4}{1085 \times 21}$$

B.E. = 54.4 eV

35. B

Sol.

	$A(g) \xrightarrow{K_1} 2B(g)$			$A(g) \xrightarrow{K2} C(g)$	
$t=0$	1 atm	0	$t=0$	1 atm	0
t = 10 min	$(1-x-y)$	2x	t = 10 min	$(1-x-y)$	y
$t=\infty$	$(1-a-b)$	2a	$t=\infty$	$(1-a-b)$	b
	≈ 0		≈ 0		

From question, a + b = 1 and 2a + b = 1.5

$\therefore a=b=0.5$

Now, $\frac{P_B}{P_C}=\frac{2K_1}{K_2}=\frac{2a}{b}=\frac{2x}{y} \Rightarrow \frac{K_1}{K_2}=1=\frac{x}{y}$

Now, $P_{10\text{ min}}=(1-x-y)+2x+y=1.4$

$\Rightarrow x=y=0.4 \therefore P_A=1-x-y=0.2$ atm at t =10 min

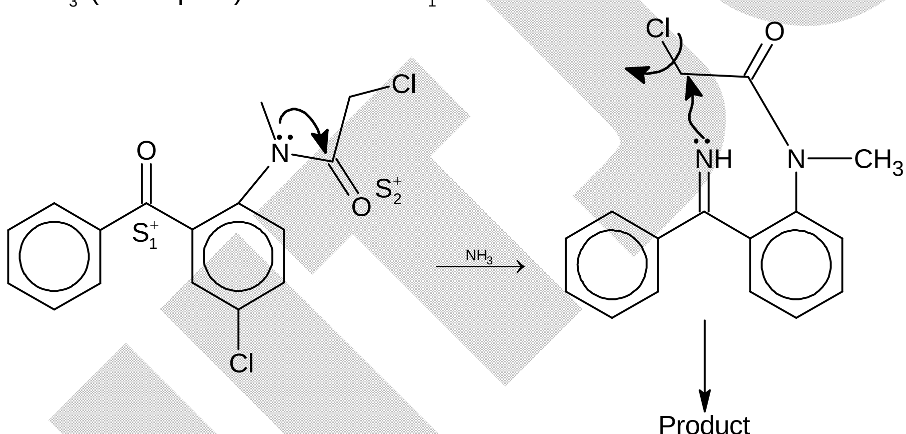
Now, $K_1+K_2=\frac{1}{t}.\ln\frac{P_A^o}{P_A}=\frac{1}{10}.\ln\frac{1}{0.2}=0.16\text{ min}^{-1}$

$\therefore K_1=K_2=0.08\text{ min}^{-1}$

36. C

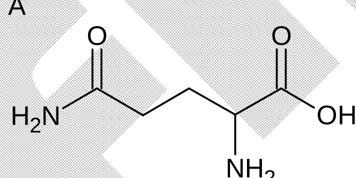
Sol. Rate: Addition of nucleophilic on polar $\pi-$bond > Nucleophilic substitution $S_1^+ > S_2^+$

$\therefore NH_3$ (nucleophile) attacks 1^{st} at S_1^+



37. A

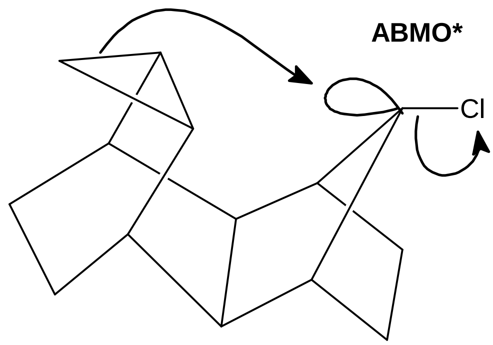
Sol.



Glutamine

38. C

Sol.



3 membered ring act as an internal nucleophile.

39. C

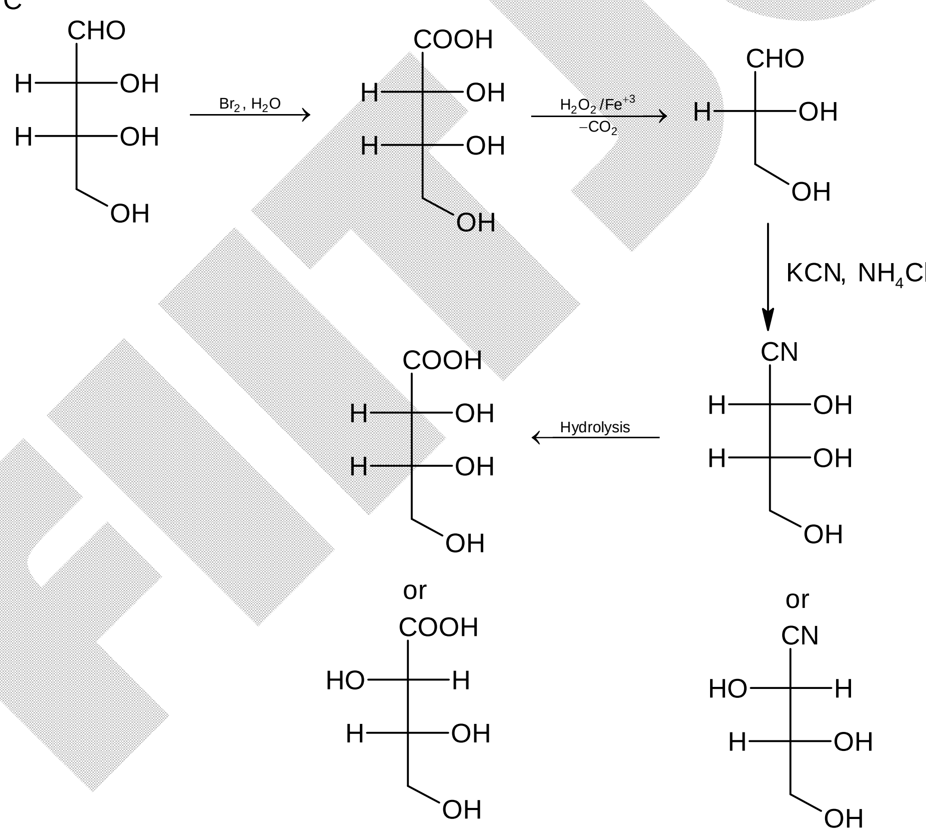
Sol. $H_2C_2O_4$ is obtained in pure form and is not much effected by surrounding conditions and is therefore suitable as a primary standard.

40. C

Sol. Glycerin and H_2O are highly miscible and most water molecules turned to glycerin via H-bond, therefore, vapour pressure of solution decreases. Hence, depression in freezing point is observed.

41. C

Sol.



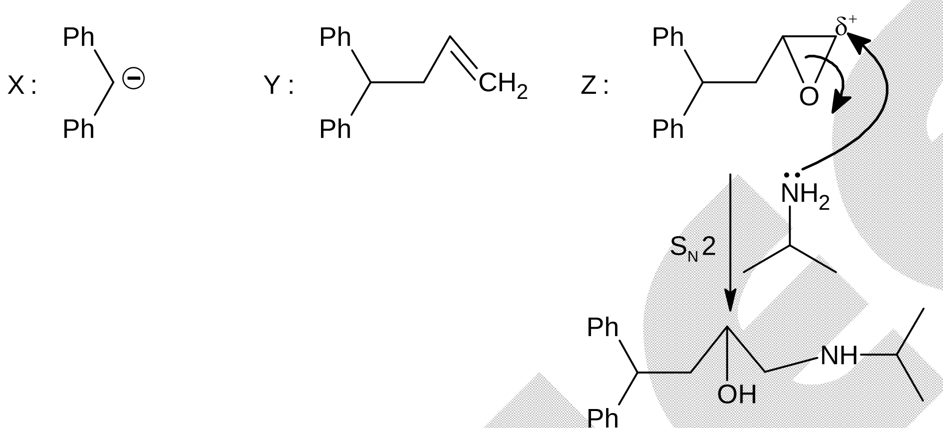
42. B

Sol. $E_{cell} = E^{o}_{cell} - \frac{0.06}{n}.\log\frac{[H^+]^2}{P_{H_2}}$

Or, $0.70 = (0.28 - 0) - \frac{0.06}{2}.\log\frac{[H^+]^2}{1} \Rightarrow pH = 7.0$

43. B

Sol.



44. B

Sol. Factual

45. D

Sol. Covalent character $\propto \frac{\text{Charge of cation}}{\text{Size of cation}}$

Covalent character $\propto$ size of anion.

SECTION – B

46. 3

Sol. $2x - 8 + 0 + 0 = -2$

$2x = 6$

$x = +3$

47. 6

Sol.

$$XeF_x + \frac{x}{2}H_2 \longrightarrow Xe \quad + \quad xHF$$

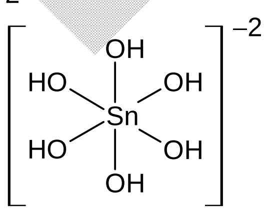
a mole   a x mole

$a = \frac{56}{22400}$

and $ax \times 1 = \frac{60 \times 0.25}{1000} \times 1 \Rightarrow x = 6$

48. 2

Sol.



$\rightarrow$ sp^3d^2

$x = 1$

$y = 3$

$z = 2$

49. 9

Sol. Statement number 1, 3 and 5 are correct.

Statement 3: $\underset{}{Fe^{+3}} \longrightarrow \underset{\text{Red-brown}}{Fe(OH)_3}$; $\quad Cr^{+3} \longrightarrow \underset{\text{Green}}{Cr(OH)_3}$

Statement 5: $2CuSO_4 + K_4[Fe(CN)_6] \longrightarrow \underset{\text{Chocolate brown}}{Cu_2[Fe(CN)_6]} + K_2SO_4$

50. 7

Sol. At 2nd equivalence point; only $[HA]^{-2}$ is left.

$$[H^+] = \sqrt{K_{a_2} \times K_{a_3}} = 10^{-10}$$

Now; $K_{a_1} \times K_{a_2} \times K_{a_3} = [H^+]^3 \dfrac{[A_3^-]}{[H_3A]}$

$$\frac{[A^{-3}]}{[H_3A]} = \frac{10^{-3} \times 10^{-8} \times 10^{-12}}{[10^{-10}]^3} = 10^7$$

Mathematics

PART – C

SECTION – A

51. D

Sol. $f(0).f\left(\frac{5}{4}\right)$ can be positive, negative or equal to zero.

52. D

Sol. $\theta \in \left[0, \frac{\pi}{2}\right]$

53. C

Sol. A = I

54. B

Sol. Centroid, G ≡ (2, 0)

Slope of GH = $\frac{1}{3}$

55. A

Sol. Minimum distance between $x = 4\sqrt{1+y^2}$ and $x = -2\sqrt{2y-y^2}$ x is 4.

56. D

Sol. $y^2\cos(x^2y)(2xy + x^2y') + x^2y' - 2xy = 0$

$\Rightarrow \cos(x^2y)\, d(x^2y) = d\left(\frac{x^2}{y}\right)$

$\Rightarrow \sin(x^2y) = \frac{x^2}{y} + c$ where c = 0

57. B

Sol. $\bar{y} = \frac{\sum_{i=1}^{100} y_i}{100} = \frac{2\cdot 100\cdot 101\cdot 201}{100\cdot 6} = 6767$

58. A

Sol. (B, B) ∈ R ∀ B ∈ P(A) ⇒ R is reflexive

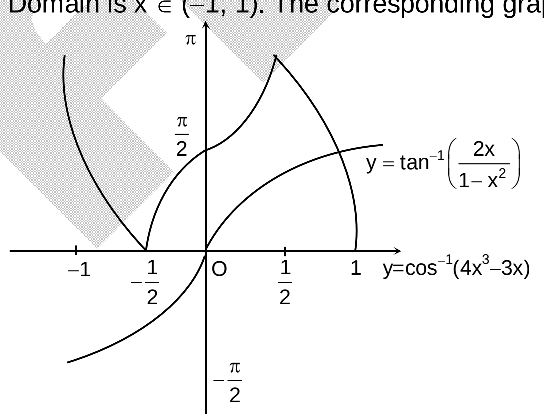
R is not symmetric

(B, C), (C, D) ∈ R ⇒ (B, D) ∈ R ∀ B, C, D ∈ P(A)

So, R is transitive.

59. C

Sol. Domain is x ∈ (–1, 1). The corresponding graph in this interval is given



60. A

Sol. $a^3 = 45^3 \Rightarrow a = 45, 45\omega, 45\omega^2$

61. D

Sol. $f(x) = \begin{cases} -\left(\dfrac{e^{x^2-1}-1}{x^2-1}\right) & |x|>1 \\ \sin\left((2x-1)\dfrac{\pi}{2}\right) & |x|<1 \\ 1 & |x|=1 \end{cases}$

62. D

Sol. Displacement = $\dfrac{3}{2\sqrt{2}}\left[\left(1-\dfrac{1}{\sqrt{2}}\right)\hat{i}+\left(1-\sqrt{\dfrac{3}{2}}\right)\hat{j}\right]$

time, t = $\dfrac{\dfrac{3}{\sqrt{2}}\left(\sqrt{\dfrac{3}{2}}-1\right)}{0.2}$

Use, velocity = $\dfrac{\text{displacement}}{\text{time}}$

63. D

Sol. $P = \dfrac{\dfrac{11!}{2!2!2!}-\dfrac{10!}{2!2!}\times 2+\dfrac{9!}{2!}}{\dfrac{9!}{2!2!}\ {}^{10}C_2} = \dfrac{37}{45}$

64. B

Sol. $\int_0^1 1-\dfrac{x^2}{6}dx < \int_0^1 \dfrac{\sin x}{x}dx < \int_0^1 1-\dfrac{x^2}{6}+\dfrac{x^4}{120}dx$

$\Rightarrow \quad \dfrac{17}{18} < \int_0^1 \dfrac{\sin x}{x}dx < \dfrac{1703}{1800}$

65. D

Sol. $\overrightarrow{AB}-\overrightarrow{BC}+\overrightarrow{CD}-\overrightarrow{DE}+\overrightarrow{EF}-\overrightarrow{FA} = -6\left(\overrightarrow{GH}\right)$

66. A

Sol. $g(xy) + h\left(\dfrac{x}{y}\right) = \dfrac{\left[(xy)^2+xy\right]-\left[(xy)^2-xy\right]}{2}+\dfrac{\left(\dfrac{x}{y}\right)^2+\dfrac{x}{y}+\left(\dfrac{x}{y}\right)^2-\dfrac{x}{y}}{2} = xy+\left(\dfrac{x}{y}\right)^2$

67. A

Sol. Let $\alpha = x + iy$; $x, y \in I^+$

$\Rightarrow \quad x^2 - y^2 = 4 \Rightarrow x = 2, y = 0$

$\Rightarrow$ slope = 0

68. D

Sol. $\sum_{n=1}^{\infty}\dfrac{1}{(3n-2)!}+\dfrac{1}{(3n-1)!} = e-\dfrac{\left(e+\dfrac{2\cos\left(\dfrac{\sqrt{3}}{2}\right)}{\sqrt{e}}\right)}{3} = \dfrac{2}{3}\left(e-\dfrac{1}{\sqrt{e}}\cos\left(\dfrac{\sqrt{3}}{2}\right)\right)$

69. A

Sol. $\alpha = \frac{7}{2}$, $\beta = -\frac{27}{2}$

70. C

Sol. The circles have 3 common tangents of lengths $2\sqrt{2}$, $2\sqrt{2}$ and 0 respectively.

SECTION – B

71. 9036

Sol. $^5C_1(^{10}C_2 + {}^{10}C_3 + ... + {}^{10}C_5) + {}^5C_2(^{10}C_1 + ... + {}^{10}C_4) + {}^5C_3(^{10}C_0 + ... + {}^{10}C_3) + {}^5C_4(^{10}C_0 + {}^{10}C_1 + {}^{10}C_2) + {}^5C_5(^{10}C_0 + {}^{10}C_1) = 9036$

72. 7

Sol. Let $\tan x = t \Rightarrow \alpha t^2 + 4t(-3-\alpha) + 64 = 0$

$D < 0 \Rightarrow \alpha \in (1, 9)$.

73. 7

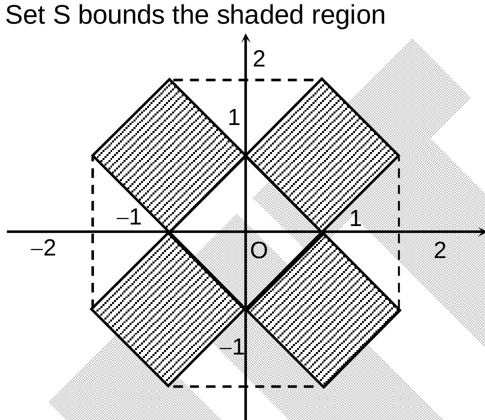
Sol. $I(x) = \frac{1}{2}\ln(xe^x + 1) - \ln(xe^x) + \frac{1}{2}\ln(xe^x - 1) + c$

$= \frac{1}{4}\ln\left(\frac{x^4e^{4x} - 2x^2e^{2x} + 1}{x^4e^{4x}}\right) + c$

$= \alpha = 4, \beta = 2, \gamma = 1$

74. 8

Sol. Set S bounds the shaded region



75. 50

Sol. Coeff. of x^{20} in $(1 - x^2)^{30} = {}^{30}C_{10}$ or ${}^{30}C_{20}$