FIITJEE

Solutions to JEE (Main)-2020

JEE–Main–2020 –Sept–6–First–Shift
PHYSICS, CHEMISTRY & MATHEMATICS

PART –A (PHYSICS)

1. **B**

Sol. $L.C. = \frac{0.5\,mm}{50}$

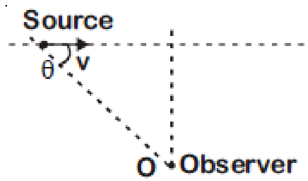
$= 10^{-2}$ mm

$= 10^{-5}$ m

$= 10\ \mu m$

2. **B**

Sol.



While approaching

$$v = v_0\left(\frac{c}{c - v\cos\theta}\right)$$

While receding

$$v = v_0\left(\frac{c}{c + v\cos\theta}\right)$$

3. **B**

Sol. $\phi_A = \frac{\pi}{2} - \frac{2\pi}{\lambda}\times\frac{5}{20} = 0$

$\phi_B = \frac{\pi}{2}$

$\phi_C = \frac{\pi}{2} + \frac{2\pi}{\lambda}\times\frac{5}{20} = \pi$

$I_A = 4I_0$; $I_B = 2I_0$; $I_C = 0$

4. **C**

Sol. $F = -\frac{dU}{dr} = -\left[\frac{6A}{r^7} - \frac{12B}{r^{13}}\right]$

F = 0

$\Rightarrow \quad r = \left(\frac{2B}{A}\right)^{1/6}$

$$U\left(\text{at } r = \left(\frac{2B}{A}\right)^{1/6}\right) = -\frac{A^2}{4B}$$

5. **A**

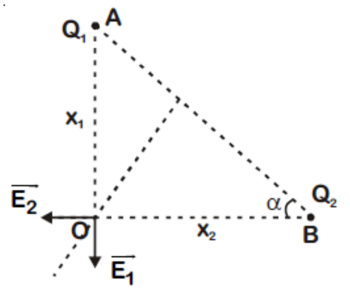
Sol. $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

$= \frac{1}{100}\sqrt{\frac{80\times10^{-3}}{2\times10^{-6}}}$

$= 2$

6. **C**

Sol.



Net field along AB at O must be zero.

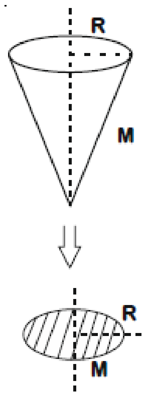
$E_2 \cos\alpha = E_1 \sin\alpha$

$$\frac{kQ_2}{x_2^2}\cdot\frac{x_2}{AB} = \frac{kQ_1}{x_1^2}\cdot\frac{x_1}{AB}$$

$$\frac{Q_1}{Q_2} = \frac{x_1}{x_2}$$

7. **A**

Sol.

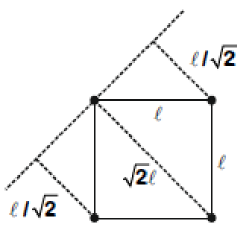


$I = \frac{MR^2}{2}$

Moment of inertia of this cone will same as circular disk of mass (M) and radius R.

8. **C**

Sol.



$$I = m\left(\frac{\ell^2}{2}\right)\times 2 + m\times(\sqrt{2}\,\ell)^2 = 3m\ell^2$$

$\therefore$ $L = I\omega = 3m\ell^2\omega$

9. **A**

Sol. $\tau = RC = 10\ \mu s$

For $0 < t < 5\ \mu s$, it will get charged. For $5 < t < 10\ \mu s$ potential is constant and again gets charged after that.

10. **C**

Sol. $r = \frac{mv}{qB_0}$

To not collide, $r < d$

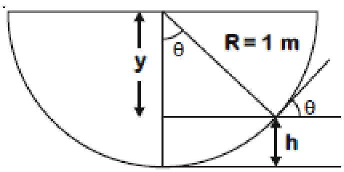
$\Rightarrow \quad \frac{mv}{qB_0} < d$

$\therefore \quad v_{max} = \frac{qB_0 d}{m}$

Note: It should be maximum instead of minimum.

11. **A**

Sol.



$\mu = \tan\theta$

$\Rightarrow \quad \frac{3}{4} = \tan\theta$

$\Rightarrow \quad \theta = 37°$

$\therefore \quad h = R - R\cos\theta = 1 - 1 \times \frac{4}{5} = 0.2\ m$

12. **A**

Sol. $\frac{V_{max}}{V_{min}} = \frac{(1+e)}{(1-e)}$

$\frac{r_{max}}{r_{min}} = \frac{(1+e)}{1-e} = 6$

13. **C**

Sol. $\lambda = \frac{h}{p}$

$p = \sqrt{2mk}$

$\lambda \propto \frac{1}{\sqrt{m}}$

14. **A**

Sol. $a = \omega^2 \times \ell$

$= \left(\frac{2\pi}{T}\right)^2 \times 0.1$

$= \left(\frac{2\pi}{60}\right)^2 \times 0.1$

$= 1.1 \times 10^{-3}\ m/s^2$

15. **D**

Sol. ${}^7_3Li + {}^1_1H \longrightarrow 2{}^4_2He$

$\Delta m = (m_{Li} + m_H - 2m_{He})$

$= .0187$ u

Q value = Δmc^2

$= 17.42$ MeV

Energy liberated = $\frac{20}{7} \times 6.023 \times 10^{23} \times (Q - \text{value})$

$\simeq 300 \times 10^{29}$ eV

$\simeq 480 \times 10^{10}$ J

$= 1.33 \times 10^6$ kWh

16. **A**

Sol.

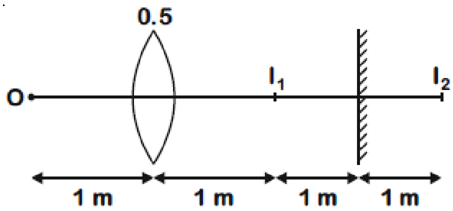


Image formed by one will be object for other.

$$\frac{1}{v_1} + \frac{1}{1} = \frac{1}{0.5} \Rightarrow v_1 = 1\text{m}$$

I_2 will be formed in behind the mirror.

$$\frac{1}{v_3} + \frac{1}{3} = \frac{1}{0.5} \Rightarrow v_3 = 0.6\text{ m}$$

So, final image will be formed at 2.6 m from the mirror, real.

17. **None**

Sol. $Y = \overline{\overline{A} \cdot \overline{B}} = \overline{\overline{A}} + \overline{\overline{B}} = A + B$

Truth table

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

18. **C**

Sol. f = 5

$\therefore \quad U = \frac{5}{2}RT$

And $\gamma = 1 + \frac{2}{f} = 1 + \frac{2}{5} = \frac{7}{5}$

19. **B**

Sol. $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

$k = \frac{YA}{L}$

$f = \left(\frac{1}{2\pi}\right)\sqrt{\frac{YA}{mL}}$

20. **C**

Sol. $F = q(\vec{E} + \vec{V} \times \vec{B})$

$\vec{E} + \vec{V} \times \vec{B} = 0$

21. **1050.00**

Sol. $\rho = \frac{m}{\frac{4}{3}\pi\left(\frac{d}{2}\right)^3}$

$\therefore \quad \% \frac{\Delta p}{p} = \frac{\Delta m}{m} + 3 \cdot \left(\frac{\Delta d}{d}\right)$

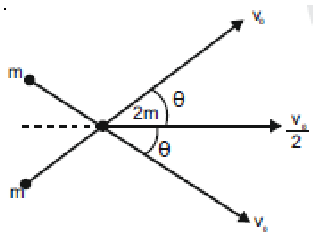
= 6 + 3 × 1.5

= 10.5%

$= \left(\frac{1050}{100}\right)\%$

22. **120.00**

Sol.



$mv_0 \times \cos\theta \times 2 = 2\,m \times \left(\frac{v_0}{2}\right)$

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

$\Rightarrow \quad \theta = 60°$

$\therefore \; 2\theta = 120°$

23. **194**

Sol. $\because \quad I = \frac{1}{2}\varepsilon_0 E_0^2 c$

$\Rightarrow \quad E_0 = \sqrt{\frac{2I}{\varepsilon_0 c}}$

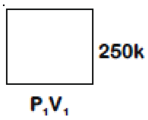
$\therefore \quad E_{rms} = \frac{E_0}{\sqrt{2}} = \sqrt{\frac{1}{\varepsilon_0 c}}$

$= \sqrt{\frac{315}{\pi} \times \frac{1}{8.86 \times 8.86 \times 10^{-12} \times 3 \times 10^8}}$

= 194

24. **05.00**

Sol. $n_0 = \frac{P_1V_1}{R \times 250}$



$n' = 0.75\ n_0 + 0.5\ n_o$

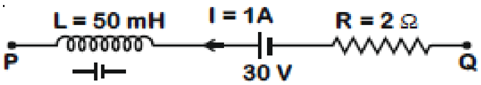
$= 1.25\ n_0$ moles

$$P_2 \times 2V_1 = (1.25)\frac{P_1V_1}{R \times 250} \times R \times 2000$$

$\Rightarrow \quad \frac{P_2}{P_1} = 5$

25. **33.00**

Sol.



$V_Q - 2 \times 1 + 30 + (50 \times 10^{-3}) \times 10^2 = V_P$

$\Rightarrow \quad V_P - V_Q = 33.0$

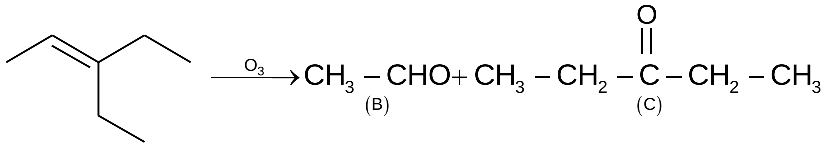
PART –B (CHEMISTRY)

26. D

Sol. Due to triple bond N_2 is inert.

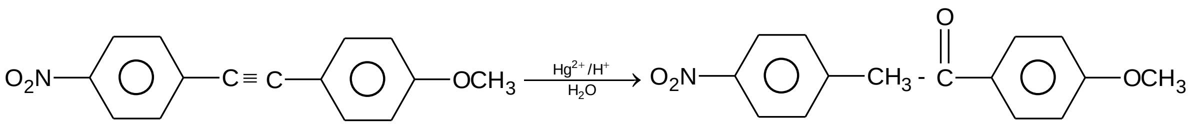
27. D

Sol.



28. A

Sol.



29. C

Sol. Let total mole = 1

$n_2 = x_2 \qquad n_1 = (1 - x_2)$

$m_2 = x_2M_2 \qquad m_1 = (1 - x_2)M_1$

$\therefore m_{soln} = [x_2M_2 + (1 - x_2)M_1]$

$= [M_1 + x_2(M_2 - M_1)]$

$$V_{sol^n} = \frac{M_{sol^n}}{d} = \frac{M_1 + x_2(M_2 - M_1)}{d} \text{mole}$$

$$\therefore C_2 = \frac{x_2 \times 1000}{V_{sol^n}} = \frac{dx_2 \times 1000}{M_1 + x_2(M_2 - M_1)}$$

30. D

Sol. Fact based

31. C

Sol. Fact based

32. B

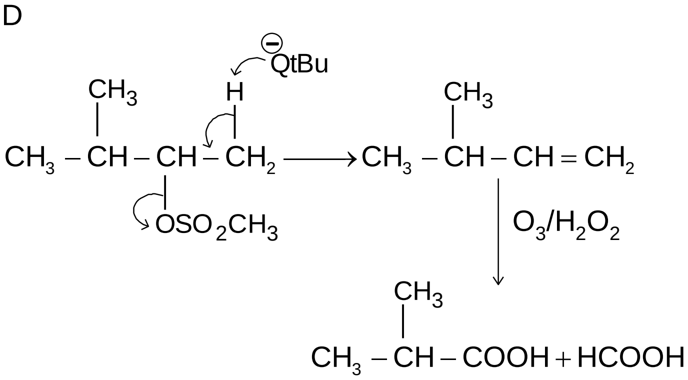
Sol. Most acidic has highest pOH

33. C

Sol. Solubility of sulphate decreases down.

34. D

Sol.



35. D

Sol. $-NO_2$ will repell $\oplus$

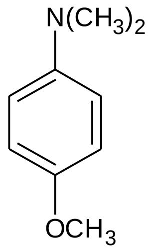
$-CH_3$ will attract $\oplus$

36. D

Sol. Fact based

37. B

Sol.



Due to +R of $-OCH_3$

This is most basic hence pK_b is less

38. B

Sol.

$$CH_3-CH=CH-\underset{}{\overset{CH_3}{\overset{|}{C}}}H-CH_3$$

It will show geometrical isomerism

39. B

Sol. Fact based

40. C

Sol. $\log\frac{100}{10}=\frac{\Delta H}{2.303R}\left[\frac{1}{298}-\frac{1}{373}\right]$

$\frac{2.303\times 6.31\times 298\times 373}{75}=\Delta H$

$\Delta H=28.36$

ΔG_1 = -2.303 $\times$ 8.31 $\times$ 298 log10 = -5.7

ΔG_2 = -2.303 $\times$ 8.31 $\times$ 373 log10 = -14.276

41. D

Sol. Fact based

42. C

Sol. $\Delta n_g = -\frac{1}{2}$

$K_P = K_c(RT)^{-1/2}$

$K_c = K_P(RT)^{+1/2}$

43. D

Sol. μ = 5.9 B.M

i.e. it has 5 unpaired electrons

hence $[MnBr_4]^{2-}$

44. C

Sol. Fact based

45. D

Sol. rate = K[Conc]^n

Log[rate] = logK + nlog[conc]

$\therefore$ "n" is slope

Higher the stope, higher order

46. 50

Sol. AgBr = 1.88 g

$\therefore$ Br = 0.8 gm

%Br = $\frac{0.8}{1.6\times 100} = 50\%$

47. 11

Sol. $n_{KClO_3} = \left[\frac{10}{122}\right]$

No. of F = $\left[\frac{10}{122}\times 6\right]$

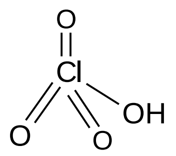
No. of F supplied = $\left[\frac{10\times 6}{122}\times\frac{100}{60}\right] = \frac{100}{122}$

$\therefore \frac{100}{122} = \frac{2\times t}{96500}$

T = 11 hrs

48. 3

Sol.



49. 5

Sol. i of $CaCl_2$ = 3

Molality effective = 3 $\times$ 0.09 = 0.15

Molality effective of complex = 0.15 $\times$ 2 = 0.3

$\therefore [Cr(NH_3)_5Cl]Cl_2$

50. 750

Sol. $P_1V_1 = P_2V_2$

$48 \times 10^{-3} \times 3^3 = P_2 \times 12^3$

$P_2 = \frac{48\times 10^{-3}}{4\times 4\times 4} = 0.75\times 10^{-3} = 750\times 10^{-6}$

PART–C (MATHEMATICS)

51. A

Sol. $\alpha+\beta=64;\ \alpha\beta=256=2^8$

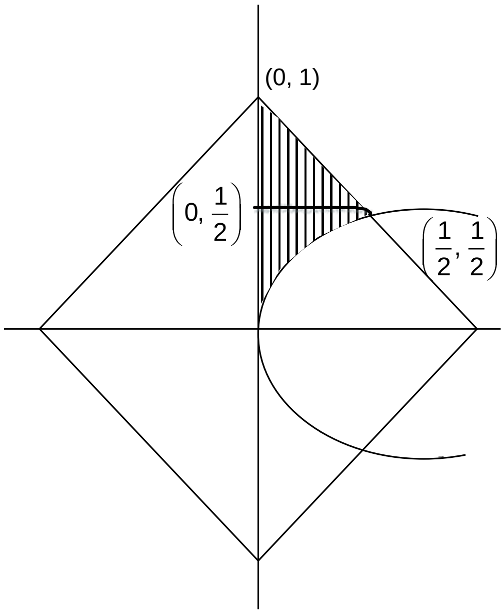
$$\left(\frac{\alpha^3}{\beta^5}\right)^{1/8}+\left(\frac{\beta^3}{\alpha^5}\right)^{1/8}$$

$$=\frac{\alpha+\beta}{(\alpha\beta)^{5/8}}=\frac{64}{32}=2$$

52. D

Sol. Required area

$$=4\left[\int_0^{\frac{1}{2}}2y^2dy+\frac{1}{2}\times\frac{1}{2}\times\frac{1}{2}\right]=\frac{5}{6}$$



53. A

Sol.

$$\sqrt{1+x^2+y^2+x^2y^2}+xy\frac{dy}{dx}=0$$

$$\sqrt{(1+x^2)(1+y^2)}+xy\frac{dy}{dx}=0$$

$$\Rightarrow\int\frac{\sqrt{1+x^2}}{x}dx+\int\frac{y}{\sqrt{1+y^2}}dy=0$$

$$\sqrt{1+x^2}+\frac{1}{2}\ell n\left|\frac{\sqrt{1+x^2}-1}{\sqrt{1+x^2}+1}\right|+\sqrt{1+y^2}=C$$

$$\Rightarrow\sqrt{1+x^2}+\sqrt{1+y^2}=\frac{1}{2}\ell n\left|\frac{\sqrt{1+x^2}+1}{\sqrt{1+x^2}-1}\right|+C$$

54. A

Sol. Equation of tangent to $y^2 = 4(x+1)$ is $y = m(x+1) + \frac{1}{m}$

Equation of tangent to $y^2 = 8(x+2)$ is $y = -\frac{1}{m}(x+2) - 2m$

Solving for point of intersection: $m(x+1) + \frac{1}{m} = \frac{-1}{m}(x+2) + \frac{1}{m} + 2m$

$\Rightarrow \left(m + \frac{1}{m}\right)(x+3) = 0 \Rightarrow x + 3 = 0$

55. D

Sol. $f(x+y) = f(x)f(y)$

$f(2) = (f(1))^2$

$f(3) = f(2+1) = f(2)f(1) = f(1)^3$

:

:

and so on

$f(n) = (f(1))^2$

$\Rightarrow \sum_{x=1}^{\infty} f(x) = 2 \Rightarrow \sum_{x=1}^{\infty} (f(1))^x = 2$

$\Rightarrow \frac{f(1)}{1 - f(1)} = 2 \Rightarrow f(1) = \frac{2}{3}$

$\Rightarrow f(2) = \frac{4}{9} \Rightarrow f(4) = \frac{16}{81} \Rightarrow \frac{f(4)}{f(2)} = \frac{4}{9}$

56. C

Sol. $I_2 = \int_0^1 (1 - x^{50})^{101} dx$

$= x(1 - x^{50})^{101}\Big|_0^1 - \int_0^1 x.101(1 - x^{50})^{100}(-50x^{49})dx$

$= 0 + 5050\int_0^1 \{1 - (1 - x^{50})\}(1 - x^{50})^{100} dx$

$I_2 = 5050I_1 - 5050I_2$

$\Rightarrow 5051(I_2) = 5050(I_1)$

$I_2 = \frac{5050}{5051}I_1 \Rightarrow \alpha = \frac{5050}{5051}$

57. C

Sol. If we select any two even numbers then their A.M. will be a natural number.

Similarly, if we select two odd numbers their A.M. will be natural number.
So, we need to select either two even numbers or two odd numbers to create an A.P. (Middle number is automatically fixed)

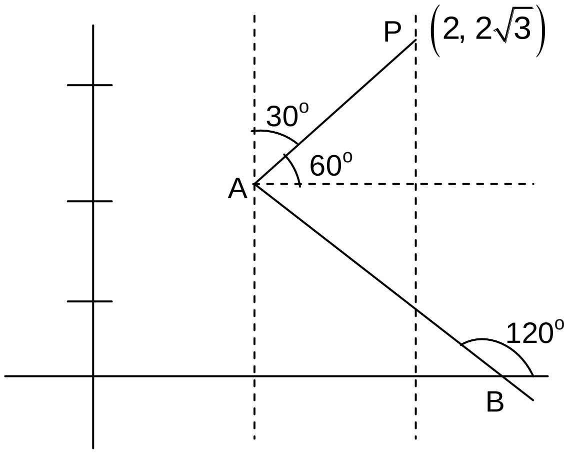
Number of ways to do so $= {}^5C_2 + {}^6C_2 = 10 + 15 = 25$

Total number of possible ways to select three numbers $= {}^{11}C_3 = 165$

$\Rightarrow$ Required probability $= \dfrac{25}{165} = \dfrac{5}{33}$

58. C

Sol. $m_{AP} = \tan 60^o = \sqrt{3}$



Equation of AP

$y - 2\sqrt{3} = \sqrt{3}(x - 2)$

Solving with x = 1

$\Rightarrow A \equiv (1, \sqrt{3})$

$m_{AB} = \tan 120^o = -\cot 30^o = -\sqrt{3}$

Equation of AB: $y - \sqrt{3} = -\sqrt{3}(x - 1)$

$\Rightarrow \sqrt{3}x + y = 2\sqrt{3}$

Clearly $(3, -\sqrt{3})$ satisfies the above equation.

59. C

Sol. Such feet of perpendicular lie on the auxiliary circle
Equation of auxiliary circle : $x^2 + y^2 = 4$
Clearly, $(-1, \sqrt{3})$ satisfies above equation.

60. B

Sol. $|z| - \text{Re}(z) \le 1$

$\sqrt{x^2 + y^2} - x \le 1$

$\sqrt{x^2 + y^2} \le 1 + x$

Squaring, $x^2 + y^2 \le 1 + x^2 + 2x$

$\Rightarrow y^2 \le 2\left(x + \dfrac{1}{2}\right)$

61. C

Sol. Average speed $= \dfrac{f(t_2) - f(t_1)}{t_2 - t_1} = \dfrac{(at_2^2 + bt_2 + c) - (at_1^2 + bt_1 + c)}{t_2 - t_1} = a(t_1 + t_2) + b$

Instantaneous speed $= 2at + b$

$\Rightarrow 2at + b = a(t_2 + t_1) + b \Rightarrow t = \frac{t_1 + t_2}{2}$

62. **BONUS**

Sol. $\lim_{x \to 1} \frac{\int_0^{(x-1)^2} t\cos t^2 dt}{(x-1)\sin(x-1)}$

$= \lim_{x \to 1} \frac{(x-1)^2 \left(\cos(x-1)^4\right).2(x-1)}{\sin(x-1) + (x-1)\cos(x-1)}$

$= \lim_{y \to 0} \frac{y^2 \cos\left(y^4\right).2y}{\sin y + y\cos y}$

$= \lim_{y \to 0} \frac{2y^2 \cos\left(y^4\right)}{\frac{\sin y}{y} + \cos y} = \frac{2(0)^2 \cos(0)}{1+1} = 0$

63. D

Sol. S.D. $= \sqrt{\frac{\sum x_i^2}{n} - \left(\frac{\sum x_i}{n}\right)^2} = \sqrt{\frac{\sum (x_i - a)^2}{n} - \left(\frac{\sum (x_i - a)}{n}\right)^2}$

$= \sqrt{n.\frac{a}{n} - \left(\frac{n}{n}\right)^2} = \sqrt{\frac{\sum (x_i - a)^2}{n} - \left(\frac{\sum (x_i - a)}{n}\right)^2}$

$= \sqrt{n.\frac{a}{n} - \left(\frac{n}{n}\right)^2} = \sqrt{a-1}$

64. D

Sol. $\frac{3^{200}}{8} = \frac{81^{50}}{8} = \frac{(80+1)^{50}}{8} = \frac{\left({}^{50}C_0 80^{50} + {}^{50}C_1 80^{49} + {}^{50}C_1 80^{48} + ... + {}^{50}C_{49} 80\right) + {}^{50}C_{50}}{8}$

$= \frac{80k+1}{8} = 10k + \frac{1}{8}$; $(k \in \text{integers})$

65. B

Sol. Family of planes containing line of intersection

$x + y + z + 1 = 0 = 2x - y + z + 3$ is given by

$x + y + z + 1 + \lambda(2x - y + z + 3) = 0$

If this plane is parallel to line $\frac{x-1}{0} = \frac{y+1}{-1} = \frac{z-0}{1}$

then, $(2\lambda + 1)(0) + (1 - \lambda)(-1) + (1 + \lambda)(1) = 0 \Rightarrow \lambda = 0$

$\Rightarrow$ Plane parallel to given line is $x + y + z + 1 = 0$

$\Rightarrow$ Distance of $(1,-1,0)$ from $x+y+z+1=0$ is $\frac{|1-1+0+1|}{\sqrt{1^2+1^2+1^2}}=\frac{1}{\sqrt{3}}$

66. B

Sol. $p\vee(\sim p\wedge q)=(p\vee\sim p)\wedge(p\vee q)=p\vee q$

$\sim(p\vee(\sim p\wedge q))=\sim(p\vee\sim q)\wedge(p\vee q)=p\vee q$

$\sim(p\vee(\sim p\wedge q))=\sim(p\vee q)=\sim p\wedge\sim q$

67. B

Sol. Let A_i, B_i, C_i be the family members of families A, B, C respectively

$(A_1A_2A_3)(B_1B_2B_3)(C_1C_2C_3C_4)$

Required arrangement $=3!\times3!\times3!\times4!=(3!)^3(4!)$

68. B

Sol. $\begin{vmatrix}\cos^2x & 1+\sin^2x & \sin2x\\ 1+\cos^2x & \sin^2x & \sin2x\\ \cos^2x & \sin^2x & 1+\sin2x\end{vmatrix}$

$=\begin{vmatrix}\cos^2x & 1+\sin^2x & \sin2x\\ 1 & -1 & 0\\ 0 & -1 & 1\end{vmatrix}$ $\quad (R_2\to R_2-R_1; R_3\to R_3-R_1)$

$=-2-\sin2x$

$m=-3; M=-1\Rightarrow(m,M)\equiv(-3,-1)$

69. B

Sol. $(a^2+b^2+c^2)p^2-2(ab+bc+cd)p+(b^2+c^2+d^2)=0$

$(a^2p^2-2abp+b^2)+(b^2p^2-2bp+c^2)+(c^2p^2-2cdp+d^2)=0$

$\Rightarrow(ap-b)^2+(bp-c)^2+(cp-d)^2=0$

$\Rightarrow p=\frac{b}{a}=\frac{c}{b}=\frac{d}{c}$

$\Rightarrow$a, b, c, d are in G.P.

70. C

Sol. $\Delta=\begin{vmatrix}1&1&1\\1&2&3\\1&3&\lambda\end{vmatrix}=\lambda-5;\ \Delta_x=\begin{vmatrix}2&1&1\\5&2&3\\\mu&3&\lambda\end{vmatrix}=-\lambda+\mu-3$

$\Delta_y=\begin{vmatrix}1&2&1\\1&5&3\\1&\mu&\lambda\end{vmatrix}=3\lambda-2\mu+1;\ \Delta_z=\begin{vmatrix}1&1&2\\1&2&5\\1&3&\mu\end{vmatrix}=\mu-8$

For $\lambda=5;\mu=8$

$\Delta_x = \Delta_y = \Delta_z = \Delta = 0$

71. 28

Sol. $2^m - 2^n = 112$

$m = 7; n = 4$ (By Hit and Trial)

m . n = 28

72. 05

Sol. $$f'(x) = \begin{cases} 20x^3 \sin\left(\frac{1}{x}\right) - 5x^2 \cos\left(\frac{1}{x}\right) - 3x^2 \cos\left(\frac{1}{x}\right) - x\sin\left(\frac{1}{x}\right) + 10 & x < 0 \\ 0 & x = 0 \\ 20x^3 \cos\left(\frac{1}{x}\right) + 5x^2 \sin\left(\frac{1}{x}\right) + 3x^2 \sin\left(\frac{1}{x}\right) - x\cos\left(\frac{1}{x}\right) + 2\lambda & x > 0 \end{cases}$$

$f''_-(0) = f''_+(0)$

$\Rightarrow 10 = 2\lambda$

$\Rightarrow \lambda = 5$

73. 04

Sol. $\sqrt{3}\left|\vec{a}+\vec{b}\right| + \left|\vec{a}-\vec{b}\right|$

$= \sqrt{3}\sqrt{1+1+2\vec{a}.\vec{b}} + \sqrt{1+1-2\vec{a}.\vec{b}}$

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

$= \sqrt{3}.2\cos\frac{\theta}{2} + 2\sin\frac{\theta}{2}$

$= 2\left(\sqrt{3}\cos\frac{\theta}{2} + \sin\frac{\theta}{2}\right)$

$\leq 2\sqrt{\left(\sqrt{3}\right)^2 + 1}$

$= 2\sqrt{3+1}$

= 4

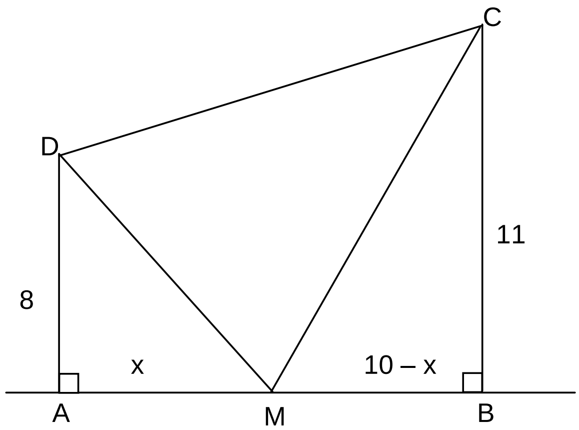
74. 05

Sol. $MD^2 + MC^2 = 64 + x^2 + 121 + (10-x)^2$

$= 2x^2 - 20x + 285$

$= 2(x-5)^2 + 235$

$MD^2 + MC^2$ is minimum when x = 5



75. 80

Sol. $x + z = h$

$x = 80\cos 30^{o} = 40\sqrt{3}$

$y = 80\sin 30^{o} = 40$

$\Rightarrow 40\sqrt{3} + z = h$

$\tan 75^{o} = \dfrac{h-y}{z}$

$2+\sqrt{3} = \dfrac{h-40}{h-40\sqrt{3}}$

$h - 40\sqrt{3} = (h-40)\left(2-\sqrt{3}\right)$

$h - 40\sqrt{3} = 2h - \sqrt{3}h - 80 + 40\sqrt{3}$

$\left(\sqrt{3}-1\right)h = 80\left(\sqrt{3}-1\right)$

$h = 80$