JEE MAIN -9 Full Syllabus Date : 03-01-2024

KEY SHEET

PHYSICS

1)	1	2)	3	3)	1	4)	3	5)	4
6)	1	7)	2	8)	4	9)	4	10)	3
11)	2	12)	3	13)	2	14)	3	15)	4
16)	2	17)	4	18)	3	19)	1	20)	3
21)	5	22)	3	23)	7	24)	54	25)	2

CHEMISTRY

26)	2	27)	4	28)	3	29)	1	30)	4
31)	3	32)	3	33)	2	34)	1	35)	1
36)	3	37)	2	38)	2	39)	1	40)	3
41)	1	42)	4	43)	4	44)	1	45)	2
51)	600	52)	12	53)	2	54)	2	55)	5

MATHEMATICS

51)	1	52)	2	53)	1	54)	1	55)	2
56)	2	57)	3	58)	3	59)	3	60)	3
61)	4	62)	3	63)	2	64)	4	65)	1
66)	1	67)	3	68)	2	69)	3	70)	2
71)	9	72)	2	73)	55	74)	5	75)	300

SOLUTIONS
PHYSICS

1. $[G]=\left[M^{-1}L^{3}T^{-2}\right]$

$[c]=\left[LT^{-1}\right]$

$[h]=\left[ML^{2}T^{-1}\right]$

$\left[M^{o}L^{1}T^{o}\right]=\left[M^{-1}L^{3}T^{-2}\right]^{x}\left[LT^{-1}\right]^{y}\left[ML^{2}T^{-1}\right]^{z}$

$-x+z=0 \qquad 3x+y+2z=1$

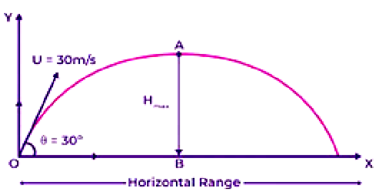
$-2x-y-z=0$

$x=\frac{1}{2},y=-\frac{3}{2},z=\frac{1}{2}$

$\left(\frac{x-y}{z}\right)^{\frac{1}{x}}=16$

2. t is independent of θ

3.



$R_{\max}=\frac{u^{2}}{g/\sqrt{2}} \qquad R_{\min}=\frac{u^{2}}{2g}$

$\frac{R_{\max}}{R_{\min}}=2\sqrt{2}$

4. $L=10\log\frac{l_{0}10^{a}.e^{-kx}}{l_{0}}dB=10[\log10^{a}+\log e^{-kx}]=10\left[a-\frac{kx}{2.3}\right]dB$

7. $a=\frac{20-2t}{2}$

$a=10-t$

$\int_{0}^{v}dv=\int_{0}^{2}(10-t)dt$

$v=\left[10t-\frac{t^{2}}{2}\right]_{0}^{2}$

$=20-2=18m/s$

9. By equation of continuity

$A_{1}V_{A}=A_{2}V_{B}$

$V_{B}=4V_{A}=16\,m/s$

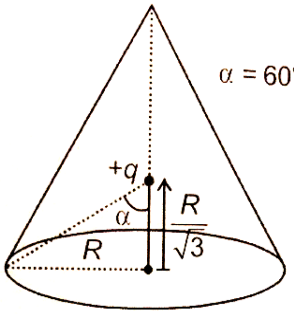
Bernoulli's theorem at point A and B

$P_{A}+\frac{1}{2}\rho V_{A}^{2}=P_{B}+\frac{1}{2}\rho V_{B}^{2}$

$2.8\times10^{5}+\frac{1}{2}\times900\times(4)^{2}=P_{B}+\frac{1}{2}\times900\times(16)^{2}$

$P_B = 172\times10^3\ N/m^2 \quad = 172 kNm^{-2} = (43\times4)kNm^{-2} \quad \Rightarrow K_0 = 4$

10. ϕ Curved surface $= \dfrac{q}{\varepsilon_0} - \dfrac{q}{2\varepsilon_0}(1-\cos\alpha) \quad = \dfrac{3q}{4\varepsilon_0}$



11. At $t=\infty, i = \dfrac{\varepsilon}{2R}$

At $t = 0, i = \dfrac{\varepsilon}{\dfrac{R\frac{R}{2}}{R+\frac{R}{2}} + R} = \dfrac{3\varepsilon}{4R}$

Ratio $= \dfrac{\varepsilon}{2R}\dfrac{4R}{3\varepsilon} = \dfrac{2}{3}$

12. Conceptual

14. Sol. $\dfrac{dl}{dt} = 5000; V = 15 \qquad \dfrac{dl}{dt} = -10000; V = -30$

$L = 3\ mH\ \ for 4-6ms$

$L = \dfrac{V}{\frac{dl}{dt}} = 3\ mH, For\ 0-2ms$

15. $M = iA(-\hat{K}) \quad = -4\pi(0.5)^2\hat{K}$

$\vec{M} = -\pi\hat{K}$

$T = \vec{M}\times\vec{B} = -\left(\pi\hat{K}\right)\times10\hat{i} = -10\pi\hat{J}$

$l = \dfrac{mR^2}{2} = \dfrac{1}{2}2(0.5)^2 = \dfrac{1}{4}$

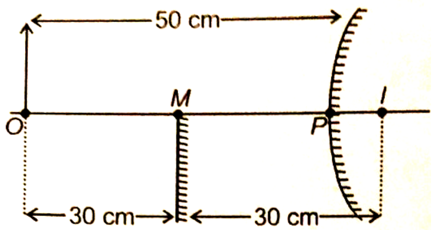
$\alpha = \dfrac{T}{I} = \dfrac{10\pi}{\frac{1}{4}} = 40\pi\ rad/s^2$

16. $x_{cm} = \dfrac{\int_0^L (dm)x}{\int_0^L dm} = \dfrac{\int_0^L\left(a+\frac{bx}{L}\right)dx.x}{\int_a^L\left(a+\frac{bx}{L}\right)dx}$

17. $i = i_z + i_L$

$i_z = i - i_L$

19.



Then for convex mirror, $u = -50$ cm

$v = 10$ cm

$$\Rightarrow \frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$= \frac{1}{10} - \frac{1}{50}$$

$f = 12.5$ cm

$R = 2f = 25$ cm

20. $n = \frac{E\lambda}{hc} = \frac{1\times10^{-7}\times200\times10^{-9}}{6.6\times10^{-34}\times3\times10^{8}} = 1\times10^{11}$

Number of electrons ejected = $\frac{10^{11}}{10^{3}} = 10^{8}$

$$\therefore v = \frac{q}{4\pi\varepsilon_0 r}$$

$$= \frac{\left(10^{8}\times1.6\times10^{-19}\right)\times9\times10^{9}}{4.8\times10^{-2}} = 3V$$

21. If the time of penetration is Δt

Then resistance force

$$F = \frac{mv_0}{\Delta t}$$

For reaction at the end

$$F\times\frac{3a}{4} = Mg\times\frac{a}{2}$$

$$\frac{mv_0}{\Delta t}\times\frac{3a}{4} = \frac{Mga}{2}$$

$$\Delta t = \frac{3}{2}\frac{mv_0}{Mg}$$

22. $V_{ms} = \sqrt{\frac{3RT}{M}} \Rightarrow V = \sqrt{\frac{3R\times373}{M}} \Rightarrow \sqrt{3}V = \sqrt{\frac{3R\times T}{M}}$

$$\Rightarrow \sqrt{3} = \sqrt{\frac{T}{373}} \Rightarrow 3 = \frac{T}{373} \Rightarrow T = 3\times373 = 1119K$$

$$T\left({}^{o}C\right) = 846^{o}C$$

23. By MEC,

$$KE_i + PE_i = KE_f + PE_f$$

$$0 - \frac{GMm}{2R} = 0 - \frac{11}{8}\frac{GMm}{R} + \frac{1}{2}K\left(\frac{R}{2}\right)^2$$

$$K = \frac{7GMm}{R^3}$$

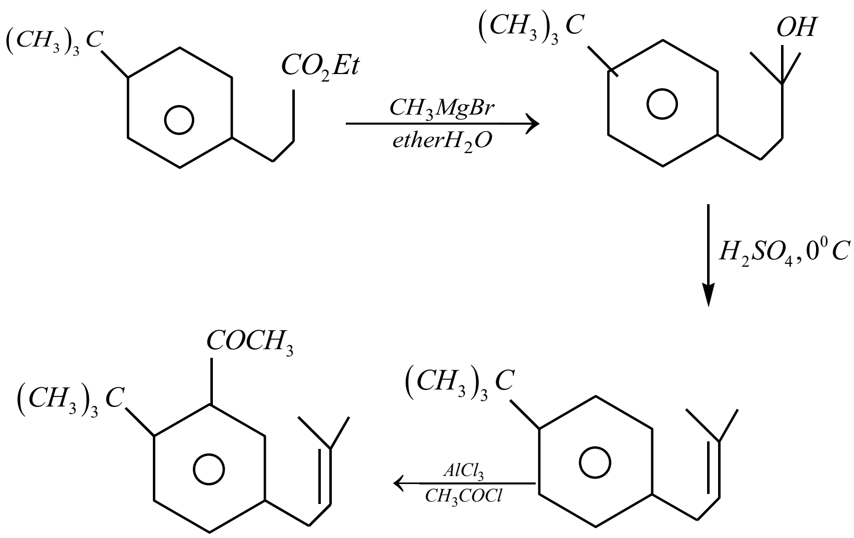
24. $K_1 + K_2 = 5.5MeV$

And $P_1 = P_2$

25. $I_A = I_{cm} + md^2$

CHEMISTRY

26.

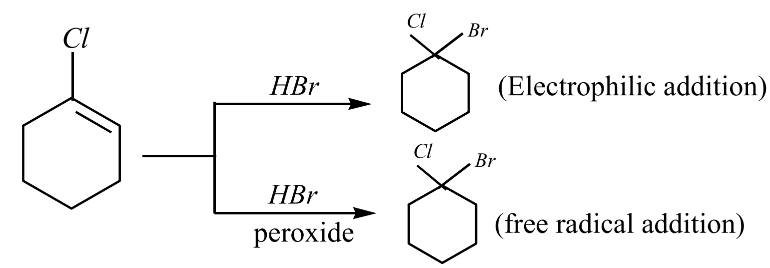


27. Glucose, Fructose and Mannose produces same osazone.

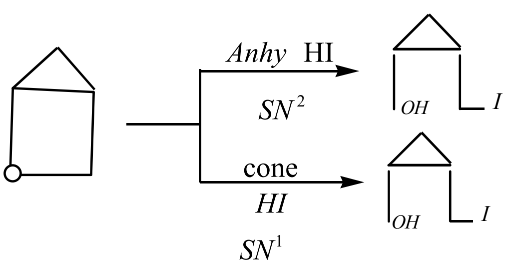
28. At C_1 and C_3 carbon dotted line species must be on the same side and opposite to C_2 carbon species.

29.

A)



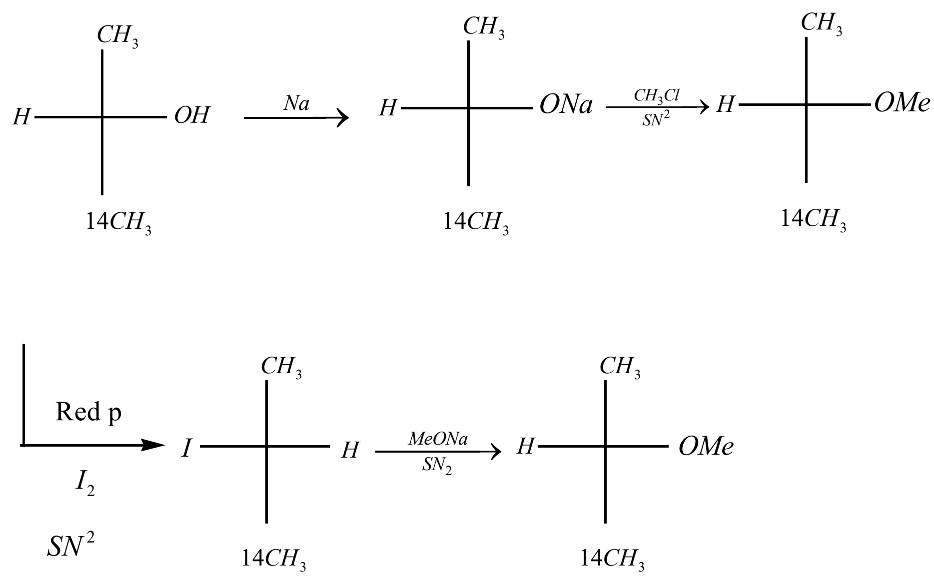
B)



C) $CH_3-\overset{O}{\overset{||}{C}}-OH$ → ($SOCl_2$) $CH_3-CO-Cl$

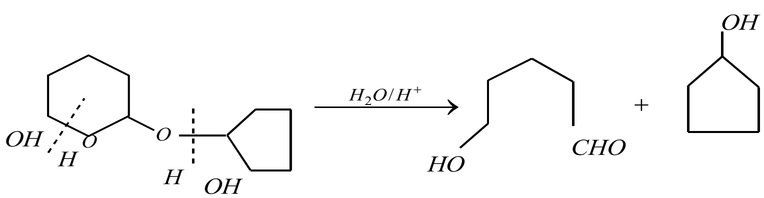
→ (Redp, Cl_2) $Cl-CH_2-CO-OH$

D)



30. cyclohexanol is more soluble in water. 1-hexanol can form inter molecular H-bond with water

31.



32. Reaction is Benzoin condensation.

33. In case of NI_3, the lone pair moment adds on the resultant of the $N-I$ moments but in case of NF_3, the lone pair moment on N partly cancels the resultant $N-F$ moments.

34. $NaCl$ reacts with conc. H_2SO_4 to give colourless fumes of HCl which on treatment with MnO_2 get oxidized to yellowish green coloured Cl_2 gas.

35. Only 1^0 aliphatic amines are prepared. 3, 4 cannot be prepared because of steric hinderence.

36.

37. N_2H_4 is not a chelating and ambident ligand.

38. Total 3 isomers 2 are cis and 1 are trans

39. $2MnO_2 + 2K_2CO_3 + O_2 \rightarrow 2K_2MnO_4 + CO_2$

$(X) \qquad\qquad (Y)$

$2KMnO_4 + Cl_2 \rightarrow 2K_2MnO_4 + 2KCl$

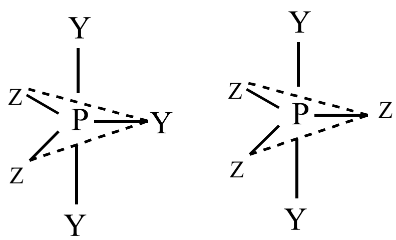
(Z)

40. $2CuSO_4 + 4KI \rightarrow Cu_2I_2 + I_2 + 2K_2SO_4$

$KI + I_2 \rightarrow KI_3$

41. Both NO_2^- and NO_3^- gives brown gas with H_2SO_4.

42.



Non zero   zero

43. The $\delta - bonding$ molecular orbital possess two nodal palnes.

44. V.P ↑ with↑ in temperature. $\Delta T_f = i.K_f.m = 1\times 2\times \frac{34.5}{46\times 500}\times 1000 = 3$

45.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Initial: 1 3 0

Af eq $1-x$ $3-3x$ $2x$

Out of 4 moles 2 moles are reacted

$\therefore 1-x+3-3x = 2 \Rightarrow x = 0.5$

46. Total moles at $eq = (1-x)(3-3x)+2x = 3$ $P_{NH_3} = \frac{1}{3}\times p = \frac{p}{3}$

$\frac{Q_1}{Q_2} = \frac{T_1}{T_2}$ $\eta = 1-\frac{Q_2}{Q_1} = 1-\frac{T_2}{T_1} \Rightarrow \frac{Q_1-Q_2}{Q_1} = \frac{T_1-T_2}{T_1}$

$\Rightarrow \frac{w}{Q_1} = \frac{T_1-T_2}{T_1} \Rightarrow \frac{w}{3000} = \frac{1000-800}{1000}$ $\therefore w = 600J$

47. When $t = t_{114}$, $a = a_0/4$ $t_{1/4} = \frac{2.303}{K}\log\frac{a_0}{a_0/4}$

When $t = t_{1/10}$, $a = a_0/10$ then

$t_{1/10} = \frac{2.303}{K}\log\frac{a_0}{a_0/10}$ $\frac{t_{1/4}}{t_{1/10}}\times 20 = \frac{2.303}{K}\log 4\times\frac{K}{2.303\times\log 10}\times 20$

$= \frac{\log 4}{\log 10}\times 20 = \frac{2\log 2}{\log 10}\times 20$ $= \frac{2\times 0.3\times 20}{1} = 12$

48. conductivity (K) $= \frac{cell\text{ constant}}{\text{Resistance}} = \frac{1.15}{230} = 5\times 10^{-3} s\text{ cm}^{-1}$

$Equivalent\ \ conductivity(\wedge_{eq}) = \frac{K\times 1000}{normality} = \frac{5\times 10^{-3}\times 10^3}{2.5}$ $= 2\ ohm^{-1}cm^2eq^{-1}$

49. $E = E^0 - \frac{0.059}{n}\log\frac{[Fe^{+2}]^2}{[H^+]^4[P_{O_2}]}$ $= 1.67 - \frac{0.059}{4}\log\frac{(10^{-3})^2}{(10^{-3})^4\times(0.1)}$

$E = 1.67 - \frac{0.059}{4}\log 10^7$ $= 1.67 - 0.103 = 1.567 \approx 2$

50. $(NH)_2S + Fe^{+3} \rightarrow FeS + S + NH_4^+$

$HI + Fe^{+3} \rightarrow FeI_2 + I_2$ $Sn^{+2} + Fe^{+3} \rightarrow Fe^{+2} + Sn^{+4}$

$CN^- + Fe^{+3} \rightarrow Fe(CN)_3 \downarrow \xrightarrow[CN^-]{excess} \left[Fe(CN)_6\right]^{-3}$

yellow ppt

$NaNO_2 + Fe^{+3} \rightarrow NO$ reaction $\quad SO_2 + Fe^{+3} \rightarrow Fe^{+2} + SO_4^{-2}$

$S_2O_3^{-2} + Fe^{+3} \rightarrow Fe^{+2} + S_4O_6^{-2}$ $\quad SCN^- + Fe^{+3} \rightarrow \underset{\text{Blood red}}{Fe(SCN)_3}$

$NaIO_3 + Fe^{+3} + H^+ \rightarrow No$ reaction

MATHEMATICS

51. $f(x)$ has minimum value at $x=1$

52. $x^2 = v \Rightarrow 2xdx = dv$

$$f(t)=\frac{1}{2}\int \frac{e^v v^2}{\left(v^2+2v+2\right)^2}dv$$

$$=\frac{1}{2}\int e^v\left[\frac{1}{v^2+2v+2}-\frac{2v+2}{\left(v^2+2v+2\right)^2}dv \qquad =\frac{1}{2}\ \frac{e^v}{v^2+2v+2}\right.$$

$$\therefore\ \mathrm{f}(t)=\frac{1}{2}\left[\frac{e^{x^2}}{x^4+2x^2+2}\right]_0^t=\frac{1}{2}\left[\frac{e^{t^2}}{t^4+2t^2+2}-\frac{1}{2}\right]$$

$$f(1)=\frac{e}{10}-\frac{1}{4} \qquad f^1(t)=\frac{e^{t^2 t^5}}{\left(t^4+2t^2+2\right)^2}\Rightarrow f^1(1)=\frac{e}{25}\ \therefore f(1)+f^1(1)=\frac{7e}{50}-\frac{1}{4}$$

53. $\frac{x^2}{9}-\frac{y^2}{4}=1,\ x^2+y^2-8x=0$

$\frac{x^2}{9}+\frac{x^2-8x}{4}=1 \qquad \Rightarrow 13x^2-72x-36=0\ \Rightarrow x=6,\frac{-6}{13}$

But $x=6$ is acceptable

$A\left(6,2\sqrt{3}\right)\ \mathrm{B}\left(6,-2\sqrt{3}\right)$

Equation of circle is $x^2+y^2-12x+24=0$

54. $\frac{dy}{dx}=\frac{(x-2)+(y-2)}{(x-2)-(y-2)}$

Put $x-2=h,$ y-2=k

$\frac{dk}{dh}=\frac{h+k}{h-k}met\ \mathrm{k=vh}\rightarrow \mathrm{v+h}\frac{dv}{dh}=\frac{1+v}{1-v}$

$\Rightarrow \int\frac{1-V}{1+V^2}dv=\int\frac{1}{h}dh$

$\Rightarrow \tan^{-1}(v)=\frac{1}{2}\log\left(1+v^2\right)+\log h+c$

$\tan^{-1}\left(\frac{y-2}{x-2}\right)=\frac{1}{2}\log\left(1+\frac{(y-2)^2}{(x-2)^2}\right)+\log(x-2)+c$ ______ (1)

$(3,2)\Rightarrow 0=0+c\Rightarrow c=0$

Also (1) passes through $(P+2,3)$

$\tan^{-1}\left(\frac{1}{p}\right)=\frac{1}{2}\log\left(1+\frac{1}{p^2}\right)+\log p \qquad 2\tan^{-1}\left(\frac{1}{p}\right)=\log\left(1+p^2\right)$

55. The equation of the circle is $(x-h)^2+(y-k)^2=k^2$

If passes through $(-1,1)$ then $(-1-h)^2+(1-k)^2=k^2$

$h^2+2h-2k+2=0 \quad \Rightarrow \Delta \geq 0 \Rightarrow 4-4(-2k+2) \geq 0 \quad \Rightarrow k \geq \frac{1}{2}$

56. $e=\sqrt{\frac{\alpha^2-\beta^2}{\alpha^2}}$

57. $|A|=x+y+z=12, \quad x \geq 1, \quad y \geq 1, \quad z \geq 1 \qquad 11C_2=55$

58. No. of ways of getting one correct $=7C_1 6!\left(1-\frac{1}{1!}+\frac{1}{2!}-\frac{1}{3!}+\frac{1}{4!}-\frac{1}{5!}+\frac{1}{6!}\right)=7C_1(265)$

No. of ways of getting two correct $=7C_2 5!\left(1-\frac{1}{1!}+\frac{1}{2!}-\frac{1}{3!}+\frac{1}{4!}-\frac{1}{5!}\right)=7C_2(44)$

No. of ways of getting three correct $=7C_2 4!\left(1-\frac{1}{1!}+\frac{1}{2!}-\frac{1}{3!}+\frac{1}{4!}\right)=7C_3(9)$

Required no. of ways $=7C_1(265)+7C_2(44)+7C_3(9)$

59. $\underset{x\to 0}{Lt}\frac{e^{x^2}-\cos x}{x^2}=\underset{x\to 0}{Lt}\left(\frac{e^{x^2}-1}{x^2}\right)+\left(\frac{1-\cos x}{x^2}\right) \quad =1+\frac{1}{2}=\frac{3}{2}$

61. $n(S)=5^5 \qquad n(A)=5C_2\left((1+1+3)\,or\,(1+2+2)\right)=1500$

$p=\frac{1500}{55}=\frac{12}{25} \qquad \left[\frac{1}{p}\right]=2$

62. $\bar{x}=\frac{n_1\bar{x}_1+n_2\bar{x}_2}{n_1+n_2}=\frac{200\times 25+300\times 10}{500}=16$

$d_1=\bar{x}_1-\bar{x}=9, \quad d_2=\bar{x}_2-\bar{x}=-6 \qquad \sigma^2=\frac{n_1\left(\sigma_1^2+d_1^2\right)+n_2\left(\sigma_2^2+d_2^2\right)}{n_1+n_2}=67.2$

64. $\underset{x\to 0}{Lt} f(x)=f(0)$

$5-a=10 \Rightarrow a=-5$

65. Total non empty subsets – Subsets with product is odd.

66. Area $=\frac{1}{2}\left|\overline{PR}\times\overline{QS}\right|$

67. Let $f(x)=3 \Rightarrow \frac{x^2+4x+30}{x^2-8x+18}=3 \Rightarrow x=7\pm\sqrt{37}$

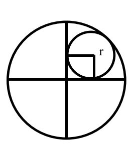
$f(x_1)=f(x_2)=3$, but $x_1 \neq x_2$

$\therefore$ f is not one-one

68. $\tan 60^0=\left|\frac{m+\sqrt{3}}{1-\sqrt{3}m}\right| \Rightarrow m=0$ or $\sqrt{3}$

$y+2=\sqrt{3}(x-3) \Rightarrow y-\sqrt{3}x+2+3\sqrt{3}=0$

69.



$C_1C_2=\sqrt{2}r$

$2-r=\sqrt{2}r \Rightarrow r^2+4r-4=0$

70. $f(x)=\tan^{-1}(2x+3)-\tan^{-1}(2x+2)+\tan^{-1}(2x+4)-\tan^{-1}(2x+3)$

$+\tan^{-1}(2x+5)-\tan^{-1}(2x+4)+\tan^{-1}(2x+6)-\tan^{-1}(2x+5)$

$= \tan^{-1}(2x+6) - \tan^{-1}(2x+2)$

72. $e^{\lim_{x\to 0} \frac{\left(2-2\cos x\sqrt{\cos 2x}\right)(x+3)}{x^2}} = e^{(3)(3)} = e^9$

73. $e^{2x} + 4e^x - 58 + \frac{4}{e^x} + \frac{1}{e^{2x}} = 0$ $\quad\left(e^{2x} + \frac{1}{e^{2x}}\right) + 4\left(e^x + \frac{1}{e^x}\right) - 58 = 0$

$\left(e^x + \frac{1}{e^x} = p\right) \therefore\ p^2 - 2 + 4p - 58 = 0 \quad p^2 + 4p - 60 = 0 \quad (p+10)(p-6) = 0$

74. $PA + PB$ is minimum when R lies on AB $\quad \therefore PA + PB = AB = 5$

75. $a\left(1+r+r^2\right) = 70$

$4a, 5ar, 4ar^2 \to A.P$

$5r = 2 + 2r^2 \Rightarrow r = 2, \frac{1}{2}$

If $r = 2,\ a = 10$