1. **(125)** Let the stone take time t in reaching the ground

Initial velocity of stone $u = +10\ \mathrm{m/s}$

Acceleration $= -g = -10\ \mathrm{m/s^2}$

Height h $= -75$ m

$$-75 = 10t - \frac{1}{2} \times 10 \times t^2$$

$$\Rightarrow -15 = 2t - t^2$$

$$\Rightarrow t^2 - 5t + 3t - 15 = 0$$

$$\Rightarrow t = 5\mathrm{sec}$$

In this time balloon will move up by $10 \times 5 = 50$ m

Height of balloon from ground $75 + 50 = 125$ m

2. **(b)** $F = A\cos(Bx) + C\sin(Dt)$

Bx and Dt will be dimensionless

So, $[B] = \frac{1}{[x]} = [M^0L^{-1}T^0]$ and $[D] = \frac{1}{[t]} = [M^0L^0T^{-1}]$

As cos and sin function is dimensionless, so A and C will have dimensions of force

$$[A] = [C] = [MLT^{-2}]$$
$$\left[\frac{AD}{B}\right] = \frac{[MLT^{-2}][M^0L^0T^{-1}]}{[M^0L^{-1}T^0]}$$
$$= [ML^2T^{-3}]$$

3. **(b)** Given, $a = \alpha t + \beta t^2$

$$\Rightarrow \frac{dv}{dt} = \alpha t + \beta t^2$$

$$\Rightarrow \int dv = \int \alpha t dt + \int \beta t^2 dt$$

$$\Rightarrow v = \frac{\alpha t^2}{2} + \frac{\beta t^3}{3} + c$$

At $t = 0, v = 0$

$$\Rightarrow 0 = 0 + 0 + c$$

$$\Rightarrow c = 0$$

$$v = \frac{dx}{dt} = \frac{\alpha t^2}{2} + \frac{\beta t^3}{3}$$

$$\int_{x_1}^{x_2} dx = \int_1^2 \frac{\alpha t^2}{2} dt + \int_1^2 \frac{\beta t^3}{3} dt$$

$$x_2 - x_1 = \left[\frac{\alpha t^3}{6}\right]_1^2 + \left[\frac{\beta t^4}{12}\right]_1^2$$

$$\Delta x = \frac{8\alpha}{6} - \frac{\alpha}{6} + \frac{16\beta}{12} - \frac{\beta}{12}$$

$$\Delta x = \frac{7\alpha}{6} + \frac{15\beta}{12}$$

$$\Delta x = \frac{7\alpha}{6} + \frac{5\beta}{4}$$

4. **(c)** Given, $\lambda_{Ph} = \lambda_e$

$$\lambda_e = \frac{h}{mv}$$

Kinetic energy of photon $= \frac{hC}{\lambda_{Ph}} = \frac{hC}{\lambda_e}$ ... (ii)

Kinetic energy of electron $= \frac{(mv)^2}{2m} = \frac{h^2}{\lambda_e^2(2m)}$ ... (iii)

$$\frac{(K.E.)_{Ph}}{(K.E.)_e} = \frac{hC}{\lambda_e} \times \frac{\lambda_e^2(2m)}{h^2}$$

$$= \frac{\lambda_e(2m)C}{h}$$

From eq. (i)

$$= \frac{2mC}{mv} = \frac{2C}{v}$$

$$\Rightarrow \frac{(K.E.)_E}{(K.E.)_{Ph}} = \frac{v}{2C}$$

5. **(d)** Radius of first soap bubble is R_1

Radius of first soap bubble is R_2

Let, $P_1 = \frac{4T}{R_1}, V_1 = \frac{4}{3}\pi R_1^3$, be the excess pressure inside first soap bubble and volume of first soap bubble respectively.

$P_2 = \frac{4T}{R_2}, V_2 = \frac{4}{3}\pi R_2^3$ be the excess pressure inside second soap bubble and volume of second soap bubble respectively.

$P = \frac{4T}{R}, V = \frac{4}{3}\pi R^3$ be the excess pressure inside new soap bubble, volume and radius of new soap bubble respectively.

The two bubbles combine isothermally, hence

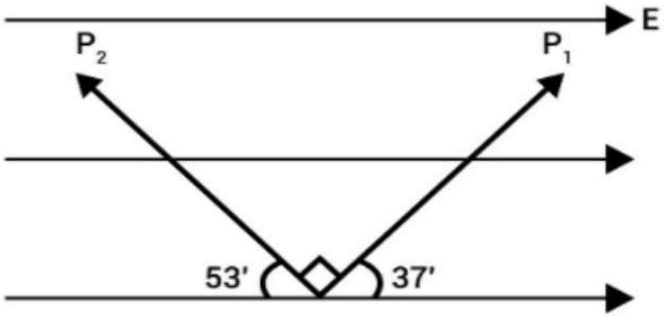
$$PV = P_1V_1 + P_2V_2$$

$$\frac{4T}{R}\left(\frac{4}{3}\pi R^3\right) = \frac{4T}{R_1}\left(\frac{4}{3}\pi R_1^3\right) + \frac{4T}{R_2}\left(\frac{4}{3}\pi R_2^3\right)$$

$$R^2 = R_1^2 + R_2^2$$

$$R = \sqrt{R_1^2 + R_2^2}$$

6. (a)



Torque $= \vec{P} \times \vec{E} = PE\sin\theta$

Torque on dipole one $\tau_1 = P_1 \times E$

$= P_1E\sin 37°$

$= P_1E \times \frac{3}{5}$

Similarly, $\tau_2 = P_2 \times E$

$= P_2E\sin(90 + 37°)$

$= P_2E\cos 37°$

$= P_2E\left(\frac{4}{5}\right)$

$\tau_1 = \tau_2$

$P_1E \times \frac{3}{5} = P_2E\frac{4}{5}$

$\frac{P_1}{P_2} = \frac{4}{3}$

7. (b) $|\vec{X}| = |\vec{Y}| = A$

$|\vec{X} - \vec{Y}| = 10|\vec{X} + \vec{Y}|$

$X^2 + Y^2 - 2XY\cos\theta = 100(X^2 + Y^2 + 2XY\cos\theta)$

$A^2 + A^2 - 2A^2\cos\theta = 100(A^2 + A^2 + 2A^2\cos\theta)$

$2A^2 - 2A^2\cos\theta = 200A^2 + 200A^2\cos\theta$

$198A^2 = -202A^2\cos\theta$

$\cos\theta = \frac{-99}{101}$

$\theta = \cos^{-1}\left(\frac{-99}{101}\right)$

8. **(a)** R = 2 m, mass = M

$w_0 = 200\text{rpm} = 200 \times \frac{\pi}{30} = \frac{20\pi}{3}\text{rad/sec}$

$w = 0$

$t = 10\text{sec}$

$w = w_0 + \alpha t$

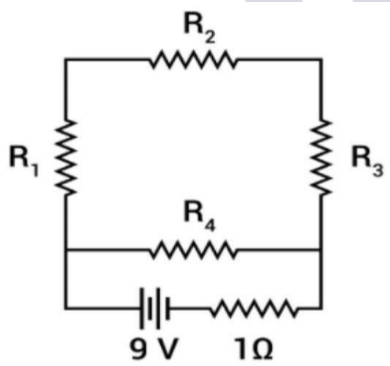
$0 = \frac{20\pi}{3} + \alpha(10)$

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

$\text{Torque}(\tau) = I\alpha; I = \frac{MR^2}{2} = 2M$

$= \frac{4\pi M}{3}$ units

9. **(c)** $R = 16\Omega$



$R_1 = R_2 = R_3 = R_4 = 4\Omega$

$R_{eq} = 3\Omega + 1\Omega = 4\Omega$

$R_{eq} = 4\Omega$

Using ohm's law, V = IR

$9 = I \times 4$

$I = \frac{9}{4}$ A

I is the total current flowing across circuit voltage across internal resistance $= IR'$

$= \frac{9}{4} \times 1 = \frac{9}{4}$ V

Voltage across square diagram $= 9 - \frac{9}{4}$

$= 6.75$ V

10. (b) Formula for refractive index of prism.

$$\mu = \frac{\sin\left(\frac{A + \delta_{\min}}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

11. (b) $\frac{1^{th}}{8}$ of the initial samples is active after 30 days.

So, $\frac{1}{8} = \left(\frac{1}{2}\right)^3$

i.e., it required 3 half-life for this.

3 half life $= 30$ days.

So, 1 half life $= 10$ days

12. (d) Modulation index $= \frac{\text{Peak value of modulating signal}}{\text{Peak value of carrier signal}}$

$= \frac{20}{20} = 1$

% Modulation $= 1 \times 100 = 100\%$

13. (b) $R = \frac{mv}{qB}$ (charges are equal)

$$R_1 = \frac{m_1 v_1}{qB}$$

$$R_2 = \frac{m_2 v_2}{qB}$$

$$\frac{R_1}{R_2} = \frac{m_1}{m_2} \times \frac{v_1}{v_2}$$

$\frac{R_1}{R_2} = \frac{1}{2} \times \frac{3}{2}$ $\left[\because \frac{m_1}{m_2} = \frac{1}{2} \text{ and } \frac{v_1}{v_2} = \frac{3}{2}\right]$

$$\frac{R_1}{R_2} = \frac{3}{4}$$

14. (b) $KE_{\max} = \frac{hc}{\lambda} - \phi$

$KE_{\max 1} = 4.8\text{ev} = \frac{hc}{\lambda} - \phi$..

$KE_{\max 2} = 1.6\text{ev} = \frac{hc}{2\lambda} - \phi$..

Multiply equation (2) by 2

$$1.6 \times 2ev = \frac{hc}{\lambda} - 2\phi \ldots (3)$$

eq (1) - eq (3) we get

$$1.6ev = \phi$$

So,

$$\phi = \frac{hc}{\lambda_0} = 1.6$$

$$\lambda_0 = \frac{1240}{1.6} \text{ nm} = 775 \text{ nm}$$

15. $(\boldsymbol{T_1 = 372}$ **K**$)$

Given,

$$\frac{1}{6} = 1 - \frac{T_{\text{sink}}}{T_{\text{source}}}$$

$$\Rightarrow \frac{T_{\text{sink}}}{T_{\text{source}}} = \frac{5}{6}$$

Also,

$$\frac{2}{6} = 1 - \frac{T_{\text{sink}} - 62}{T_{\text{source}}}$$

$$\Rightarrow \frac{62}{T_{\text{source}}} = \frac{1}{6}$$

$$\therefore T_{\text{source}} = 372 \text{ K}$$

16. (c) $\frac{mV^2}{R} = qVB$

$$\Rightarrow R = \frac{mV}{qB}$$

$$\Rightarrow \frac{R_1}{R_2} = \frac{Q}{2Q} \times \frac{V}{2V} = \frac{1}{4}$$

17. (b) $w \cdot d = \int_0^2 Fy \cdot dy$

$$= \int_0^2 (5y + 4)dy$$

$$= \left[\frac{5y^2}{2} + 4y\right]_0^2$$

$$= 18 \text{ J}$$

18. (a) $V_{rms} = \frac{V_{peak}}{\sqrt{2}}$

$V = V_{\text{peak}} \sin\left(\omega t + \frac{\pi}{2}\right)$

$[\because \text{ at } t = 0\ V = V_{\text{peak}}]$

For V_{rms},

$\Rightarrow \frac{V_{\text{peak}}}{\sqrt{2}} = V_{\text{peak}} \cos \omega t$

$\Rightarrow \cos \omega t = \frac{1}{\sqrt{2}}$

$\omega t = \frac{\pi}{4}$

$\Rightarrow (2\pi f)t = \frac{\pi}{4}$

$\Rightarrow t = \frac{1}{8f} = 2.5$ ms.

19. (b) For left circuit,

$P = 20 \times \frac{20}{5} = 80w,$

For right circuit,

$P = 20 \times \frac{20}{Z} \times \frac{R}{Z}$

$z = \sqrt{R^2 + (X_L - X_C)^2}$

Equating

$80 = \frac{400R}{z^2}$

$z^2 = \frac{400 \times 5}{80}$

$\Rightarrow Z = 5$

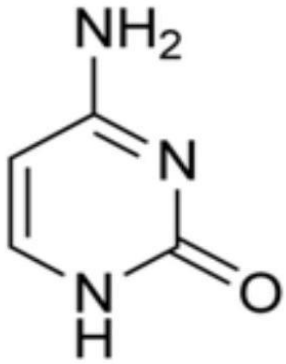
$R = Z$ (Resonance)

$\Rightarrow w = \frac{1}{\sqrt{LC}}$

$= \frac{1}{\sqrt{0.1 \times 40 \times 10^{-6}}}$

$= 500\text{rad/s}$

20.



These are formed by many d-block and f-block elements. However, the metals of group 7, 8 and 9 do not form hydride.

Even from group 6, only chromium forms CrH.

21. (a)

Column I	Column II
(i) Clouds	(Q) Aerosols
(ii) Pumice stone	(R) Solid foam
(iii) Cheese	(P) Gel
(iv) Shaving cream	(S) Emulsion

22. (a) Bond order

$O_2^+ \quad O_2 \quad O_2^- \quad O_2^{2-}$

No. of electron 15 16 17 18

2.5 2 1.5 1

Bond order $O_2^+ > O_2 > O_2^- > O_2^{2-}$

23. (b) $W = -200\ J$

$q = +150\ J$

$\Delta U = q + w$

$\Delta U = 150 - 200 = -50\ J$

24. (a) $HO = 4f^{11}\ 6\ s^2$

$HO^{3+} = 4f^{10}$

25. (a)

26. (d) S_1 CFC $+ UV \rightarrow Cl^\circ$

$S_2\ O_3 + NO \rightarrow NO_2 + O_2$

S_1 wrong

S_2 wrong

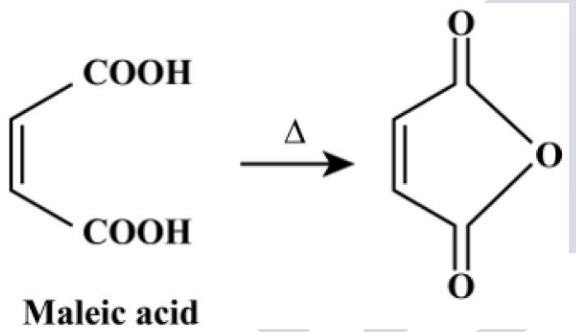
27. (a) Nylon 2-nylon 6

It is an alternating polyamide copolymer of glycine ($H_2\ N - CH_2\ ^-COOH$) and amino caproic acid $[H_2\ N(CH_2)_5COOH]$ and is biodegradable

28. (c)

Column I	Column II
(i) Froth floatation method	P. Sulphide ore
(ii) Reverberatory furnace	S. Blister Copper
(iii) Blast furnace	Q. Pig iron
(iv) Leaching	R. Ag

29. (d)



30. (0.4) Rate $= \frac{\Delta C}{\Delta t} = \frac{0.2}{0.5}$

$\Delta t = \frac{30}{60} = 0.5$

$= 0.4\ \mathrm{mol/lit^{-1}, Hr^{-1}}$

31. (a) $[OH^-] = 2 \times 5 \times 10^{-3}$

$[\mathrm{OH^-}] = 10^{-2}\mathrm{M}$

$[\mathrm{H^+}][\mathrm{OH^-}] = 10^{-14}$

$[H^+] = \frac{10^{-14}}{10^{-2}}$

$[H^+] = 10^{-12}$

32. (b) $\underset{+7}{\mathrm{MnO_4^-}} \rightarrow \underset{+2}{\mathrm{Mn^{+2}}}$

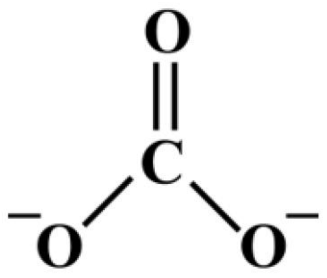
Change by 5

33. (c) $Sc^{3+} \Rightarrow d^\circ, \mu = 0 B.M$

$V^{2+} \Rightarrow d^3, \mu \approx 3.9 B.M$

$Ti^{2+} \Rightarrow d^2, \mu = 2.8B.M$

34. (a)



35. (b) $\%N = \frac{1.4 \times N \times V}{w}$

$$46 = \frac{1.4 \times 2 \times V}{0.8}$$

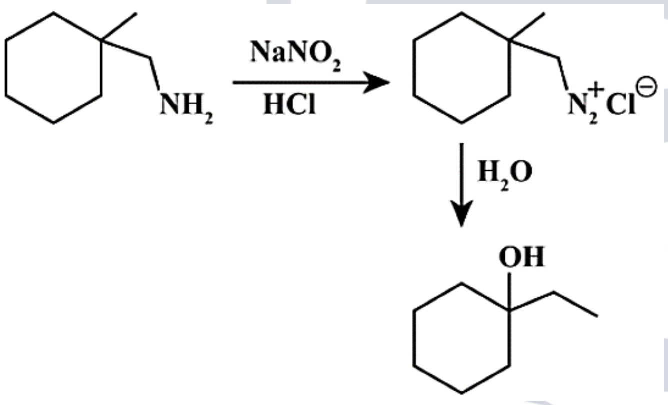
$V = 13.14mL$

36. (d) Density $\propto$ mass

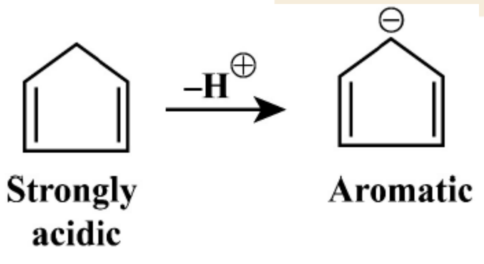
Benzene < chlorobenzene < 1,3 dichlorobenzene < 1 Bromo 3 chlorobenzene

37. (c) $[Co(en)_3]Cl_2$ chelation Ligands form more stable complexes.

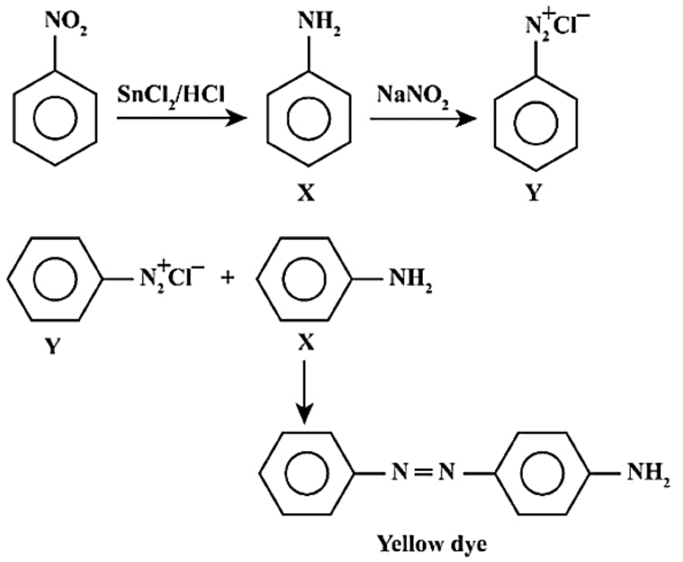
38. (c)



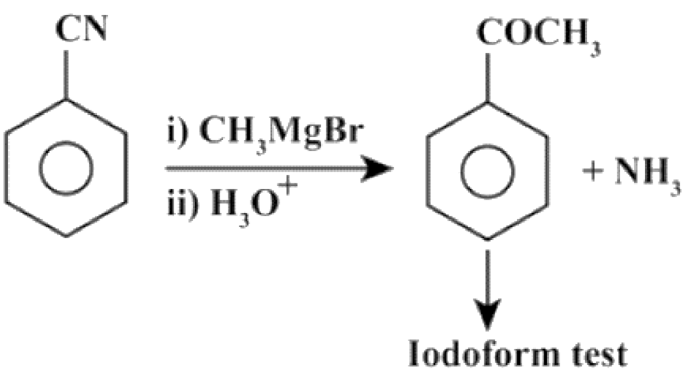
39. (d)



40. (c)



41. (b)



42. (b)

Column I	Column II
(i) Li	R. Bicarbonate used in Fire extinguisher
(ii) Cs	S. element in fluid of cell
(iii) Na	P. Carbonate that disintegrate
(iv) K	Q. Forma unstable compound with I^-

43. (b) $(|x|-4)(|x|+3)=0 \Rightarrow |x|=4 \Rightarrow x=\pm 4$

Number of real solution is 2

44. (b) ${}^{n}P_r = {}^{n}P_{r+1} \Rightarrow \frac{n!}{(n-r)!} = \frac{n!}{(n-r-1)!} \Rightarrow n-r=1$

$${}^{n}C_r = {}^{n}C_{r-1} \Rightarrow \frac{n!}{r!\cdot(n-r)!} = \frac{n!}{(r-1)!\cdot(n-r+1)!}$$

$$r = n-r+1 \Rightarrow 2r = 1+1+r \Rightarrow r=2$$

45. $(\boldsymbol{x^2+3xy-y^2=0})$

Equation of angle bisector is $\frac{x^2-y^2}{xy}=\frac{a-b}{h}$

$$\Rightarrow \frac{x^2-y^2}{xy}=\frac{6}{-2}=-3$$
$$\Rightarrow x^2+3xy-y^2=0$$

46. (b)

$$f(x)=\begin{cases} 5x+1, & x<2 \\ \int_0^n (5+|1-t|)dt, & x\geq 2 \end{cases}$$

$$f(2^+)=\int_0^1 (6-t)dt+\int_1^x (t+4)dt$$

$$f(2^+)=\frac{11}{2}+\left(\frac{t^2}{2}+4t\right)_1^x=\frac{11}{2}+\frac{x^2}{2}+4x-\frac{1}{2}-4$$

$$f(2^+)=\frac{x^2}{2}+4x+1$$

$f(2^-)=f(2^+)=11$ (continuous)

$f'(2^-)=5, f'(2^+)=6$(not differentiable)

47. (0.00)

$$I=\int_{-1}^{1}\log\left(x+\sqrt{x^2+1}\right)dx=\int_{-1}^{1}\log\left(-x+\sqrt{x^2+1}\right)dx$$
$$2I=\int_{-1}^{1}\log 1 dx$$
$$\Rightarrow I=0$$

48. $\begin{bmatrix} \mathbf{1} & \mathbf{0} \\ \mathbf{25} & \mathbf{1} \end{bmatrix}$

$$P=\begin{bmatrix} 1 & 0 \\ \frac{1}{2} & 1 \end{bmatrix}$$

$$P^2=\begin{bmatrix} 1 & 0 \\ \frac{1}{2} & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 \\ \frac{1}{2} & 1 \end{bmatrix}=\begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$$

$$P^3=\begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 \\ \frac{1}{2} & 1 \end{bmatrix}=\begin{bmatrix} 1 & 0 \\ \frac{3}{2} & 1 \end{bmatrix}$$

$$\therefore P^n=\begin{bmatrix} 1 & 0 \\ \frac{n}{2} & 1 \end{bmatrix}\Rightarrow P^{50}=\begin{bmatrix} 1 & 0 \\ 25 & 1 \end{bmatrix}$$

49. (6.00)

$|\bar{a}\times\bar{b}| = |\bar{a}||\bar{b}|\sin\theta$

$\Rightarrow \sin\theta = \frac{4}{5} \Rightarrow \cos\theta = \frac{3}{5}$

$\therefore |\bar{a}\cdot\bar{b}| = |\bar{a}||\bar{b}|\cos\theta = 6$

50. (1.00)

$$\begin{vmatrix} \sin x & \cos x & \cos x \\ \cos x & \sin x & \cos x \\ \cos x & \cos x & \sin x \end{vmatrix} = 0$$

$R_1 \to R_1 + R_2 + R_3$

$$(\sin x + 2\cos x)\begin{vmatrix} 1 & 1 & 1 \\ \cos x & \sin x & \cos x \\ \cos x & \cos x & \sin x \end{vmatrix} = 0$$

$C_2 \to C_2 - C_1; C_3 \to C_3 - C_1$

$$(\sin x + 2\cos x)\begin{vmatrix} 1 & 0 & 0 \\ \cos x & \sin x - \cos x & 0 \\ \cos x & 0 & \sin x - \cos x \end{vmatrix} = 0$$

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

$\Rightarrow \tan x = 1 \Rightarrow 1$ solution

$\Rightarrow \tan x = -2 \Rightarrow 0$ solution

Total 1 solution

51. (7.59)

$$\cot\left(\frac{\pi}{24}\right) = \cot(7.5) = \cot\left(\frac{15}{2}\right)$$

$$1 + \cos(15) = 1 + \cos(45 - 30) = 1 + \left(\frac{1}{\sqrt{2}}\right)\left(\frac{\sqrt{3}}{2}\right) + \left(\frac{1}{\sqrt{2}}\right)\left(\frac{1}{2}\right) = \frac{\sqrt{3} + 1 + 2\sqrt{2}}{2\sqrt{2}}$$

$$\sin^2 15 = \sin^2(45 - 30) = \left(\frac{\sqrt{3} - 1}{2\sqrt{2}}\right)^2 = \frac{4 - 2\sqrt{3}}{8} = \frac{2 - \sqrt{3}}{4}$$

$$\cot^2\left(\frac{15}{2}\right) = \frac{1 + \cos 15}{1 - \cos 15} = \frac{(1 + \cos 15)^2}{\sin^2 15} = \frac{(2\sqrt{2} + \sqrt{3} + 1)^2}{8\left(\frac{2 - \sqrt{3}}{4}\right)} = \frac{(2\sqrt{2} + \sqrt{3} + 1)^2}{4 - 2\sqrt{3}}$$

$$\cot\left(\frac{15}{2}\right) = \frac{(2\sqrt{2} + \sqrt{3} + 1)}{\sqrt{4 - 2\sqrt{3}}} = \frac{(2\sqrt{2} + \sqrt{3} + 1)}{\sqrt{3} - 1} = \frac{(2\sqrt{2} + \sqrt{3} + 1)(\sqrt{3} + 1)}{2} = \sqrt{6} + \sqrt{2} + \sqrt{3} + \sqrt{4}$$

52. (-1) Equation of circle is $x^2 - y^2 + 2y^2 + 2x = 0$

$\Rightarrow x^2 + y^2 + 2x = 0$

$\Rightarrow$ centre $(-1,0)$

Also, $(x - 3)^2 = -y - 13 + 9 = -(y + 4) \Rightarrow$ vertex$(3, -4)$

$\therefore$ Equation of line passing through $(-1,0)\&(3,-4)$ is

$y = \frac{-4}{4}(x + 1) \Rightarrow x + y = -1$

$\therefore$ y-intercept of line $= -1$

53. (39.00)

$$f(x) = \frac{P(x)}{\sin(x-2)}$$

$P''(x) = c \Rightarrow P(x) = ax^2 + bx + c$

$P(2) = 0 \Rightarrow 4a + 2b + c = 0$

$P'(2) = 7 \Rightarrow 4a + b = 7$

$P(3) = 9 \Rightarrow 9a + 3b + c = 9$

$a = 2, b = -1, c = -6$

$\therefore P(x) = 2x^2 - x - 6$

$\Rightarrow P(5) = 39$

54. (55.00)

$$^nC_7(2)^{n-7}\left(\frac{1}{3}\right)^7 = {}^nC_8(2)^{n-8}\left(\frac{1}{3}\right)^8$$

$$\frac{^nC_8}{^nC_7} = 3 \cdot 2 = 6 = \frac{n-7}{8} \Rightarrow n = 55$$

55. (4.00)

$S = 4 - 5 + 5 - 6 + 6 \ldots - 50 + 50 = 4$

56. ($\sqrt{ab}$)

$$\begin{vmatrix} a & a & c \\ 1 & 0 & 1 \\ c & c & b \end{vmatrix} = 0$$

$\Rightarrow -ac - a(b-c) + c^2 = 0$

$c^2 = ab$

$x = \sqrt{ab}$

57. (11.00)

$$T_{r+1} = {}^{12}C_r \cdot (2)^{\frac{r}{3}} \cdot (3)^{\frac{12-r}{4}} = {}^{12}C_r \cdot (3)^3 \cdot (2)^{\frac{r}{3}} \cdot (3)^{\frac{-r}{4}}$$

$\therefore$ Number of rational terms $= 2(r = 0,1,2)$

$\therefore$ Number of irrational term $= 13 - 2 = 11$