PART B - CHEMISTRY

31. **a) 0.94 mole**

$h_g d_g = h_{Hg} d_{Hg}$; $5 \times 2.72 = 13.6\ h_{Hg}$

$h_{Hg} = 1$ m

$P_{gas} = 0.76$ dg + 1 dg = 1760 mm of Hg

$$\frac{1760}{760} \times 10 = n \times R \times 300$$

n = 0.94 mole

32. **b) 124.31 mL**

$$\frac{PV_m}{RT} = \frac{3}{8} \times 2.21;\ V_m = \left(\frac{3}{8} \times 2.21\right) \times \frac{RT}{P};$$

$$V_m = \frac{3}{8} \times 2.21 \times \frac{8.314 \times 300}{8.314}$$

= 248.625 mL;

$$Vo_2 = \frac{16}{32} = 248.625 = 124.31 \text{ mL}$$

33. **c)** $\frac{\pi}{4}(P_2 - P_1)(V_2 - V_1)$

Process direction in V-P diagram is clockwise so process direction in P-V diagram is anti-clockwise.

Net work done by system = Area of the circle = $\pi \times \frac{(P_2 - P_1)}{2} \cdot \frac{(V_2 - V_1)}{2}$

34. **c) 5065.8 J**

$$\int dw = \int -P.dV$$

$$\Rightarrow \quad w = -\int 20 \cdot \frac{dV}{V} = -20 \text{ In } \frac{V_2}{V_1}$$

w = – 46.06 Latm = – 4665.8 J

$\Delta U = q + w \Rightarrow 400 = q - 4665.8$

q = 5065.8 J

35. **d)** $w_3 > w_1 > w_2 > w_4$

36. **c)** $\frac{\Delta H}{T}$

37. **b) 2R**

$$\text{Average } C_v, m = \frac{n_1 Cv, m_1 + n_2 Cv, m_2}{n_1 + n_2}$$

$$= \frac{2 \times \frac{3}{2}R + 2 \times \frac{5}{2}R}{2 + 2} = 2R$$

38. **b) 2.303 R**

$$\Delta S = nCv\ ln\left[\frac{T_2}{T_1}\right] + n\ R\ ln\left[\frac{V_2}{V_1}\right]$$

$$\Delta S = 0 + 1\ R \log\left[\frac{10V}{V}\right] \times 2.303$$

= 2.303R

39. **a) 3.46 kJ**

$$W = -\ nRT\ \ln\left[\frac{P_1}{P_2}\right]$$

40. **b) There is no intermolecular attraction**

41. **b) same as that of a hydrogen molecule**

Average kinetic energy is directly proportional to only absolate temperature.

42. **c) 2N**

at constant temperature and pressure

$v \propto n$

43. **c)** $\sqrt{2/3}$

$$\frac{c_{o_3}}{c_{o_2}} = \sqrt{\frac{3RT}{M}}$$

$\therefore \quad \sqrt{\frac{2}{3}}$

44. **b) 0°C, 2 atm**

$$d = \frac{PM}{RT}$$

$\therefore \quad d \propto p$

$$d \propto \frac{1}{T}$$

$\therefore$ at low temperature and high pressure density is maximum

45. **b)** **20 seconds : O_2**

$$\frac{t_2}{t_1} = \sqrt{\frac{M_2}{M_1}}$$

$$\frac{20}{5} = \sqrt{\frac{32}{2}}$$

46. **a)** **increase in average molecular speed**
Conceptual

47. **c)** **$[p+(a/V^2)]$**

48. **d)** **ammonia**

49. **c)** **NH_3**
Liquification of a gas is easy when 'a' value is maximum.

50. **d)** **44800 ml**

$$v = \frac{nRT}{p}$$

$$= \frac{2 \times 0.0821 \times 273}{1}$$

= 44.8 lit or 44,800 ml

51. **b)** **30 ml**
in 100 ml ozonised oxyen
40 ml O_2 and 60 ml O_3 is present
$60\ O_3 \xrightarrow{\Delta} 60 0_2 + 60(0)$ or $30\ O_2$
∴ increase in volume is 30ml

52. **c)** **Heat (q)**
Heat and work on path functions

53. **c)** **Adiabatic process**
Conceptual

54. **d)** **All**

55. **c)** **$\Delta E_1 + \Delta E_2 = 0$**
ΔE is a state function

56. **d)** **In all the above equilibrium**
Conceptual

57. **c)** **pressure of gas can not be measured during process except initial and final states accurately**
Conceptual

58. **c)** **4.01 kJ**

$$w = -2.3.3 \times nRT \log \frac{P_1}{P_2}$$

59. **c)** **800 K**
$\Delta u = q + w$
$nc_v\Delta T = nc_p\Delta T + (-8.314\ kJ)$

$$\Delta T = \frac{C_p}{C_v}\Delta T = \frac{8.314}{nC_v}$$

$$\Delta T\ (r-1) = \frac{8.314}{nC_v}$$

$$\Delta T\ (r-1) = \frac{8.314}{n \times \frac{R}{r-1}}$$

$$\Delta T\ (r-1) = \frac{8.314(r-1)}{nR}$$

$$T_2 - T_1 = \frac{8.314}{n \times R}$$

$$T_2 = T_1 + \frac{8.314}{nR}$$

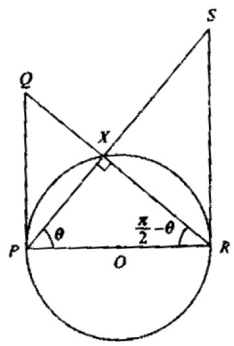
$$= 300 + \frac{8.314 \times 1000}{2 \times 8.314}$$

= 300 + 500
= 800 k

60. **a)** **202 J**
$w = \Delta pv$
= 2 lit atm
= 2 × 101
= 202 J

PART C - MATHS

61. **a)** $\sqrt{\mathbf{PQ} \times \mathbf{RS}}$



From the figure, we have

$\frac{PQ}{PR} = \tan(\pi/2 - \theta) = \cot\theta.$

and $\frac{RS}{PR} = \tan\theta$

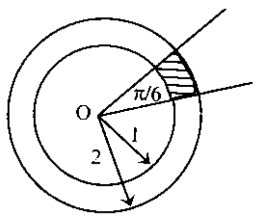
⇒ $\frac{PQ}{PR} \cdot \frac{RS}{PR} = 1$

⇒ $(PR)^2 = PQ.RS$

⇒ $(2r)^2 = PQ.RS$

⇒ $2r = \sqrt{PQ \times RS}$

62. **d)** $\frac{\pi}{4}$



The angle θ between the lines represented by $\sqrt{3}x^2 - 4xy + \sqrt{3}y^2 = 0$ is

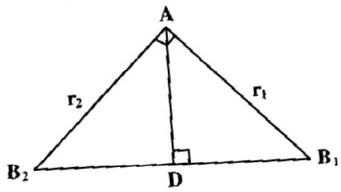
$$\theta = \tan^{-1}\frac{2\sqrt{h^2 - ab}}{|a+b|}$$

$$= \tan^{-1}\frac{2\sqrt{2^2 - 3}}{\sqrt{3}+\sqrt{3}} = \frac{1}{\sqrt{3}}$$

gives $\theta = \frac{\pi}{6}$

Hence, the shaded area $= \frac{\pi/6}{2\pi} \times \pi\left(2^2 - 1^2\right) = \frac{\pi}{4}$

63. **d)** $\frac{2r_1r_2}{\sqrt{r_1^2 + r_2^2}}$



Let $\angle AB_1S_2 = \theta$

⇒ $AD = r_1 \sin\theta$ and $AD = r_2 \cos\theta$

⇒ $AD^2\left(\frac{1}{R_1^2} + \frac{1}{R_2^2}\right)$

⇒ $AD = \frac{r_1r_2}{\sqrt{r_1^2 + r_2^2}}$

Thus, length of common chord

$= \frac{2r_1r_2}{\sqrt{r_1^2 + r_2^2}}$

64. **b)** **1**

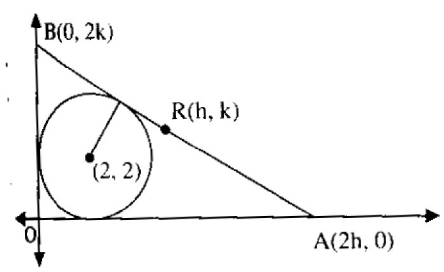
Let mid-point of AB be R(h,k)

Then coordinates of A and B are $(2h, 0)$ and $(0, 2k)$ respectively.

Equation of line AB is $\frac{x}{2h} + \frac{y}{2k} = 1$

Since this line touches given circle

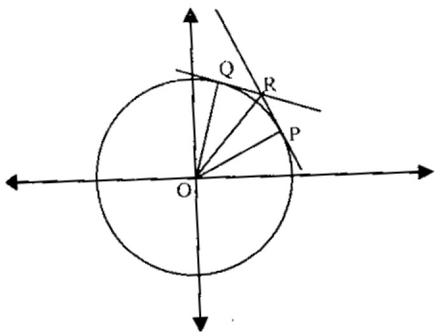
We have $\frac{\left|\frac{2}{2h} + \frac{2}{2k} - 1\right|}{\sqrt{\frac{1}{h^2} + \frac{1}{k^2}}} = 2$



On simplifying, we get locus $x + y - xy + \sqrt{x^2 + y^2} = 0$

65. **c)** $\mathbf{3(x^2 + y^2) = 4a^2}$

Let the parametric angles of two points on the circle $x^2 + y^2 = a^2$ be θ and $\pi/3 + \theta$.
Then the two points are P $(a \cos \theta, a \sin \theta)$ and Q $(a \cos (\pi/3 + \theta), a \sin (\pi/3 + \theta))$
In the figure, $\angle POQ = \pi/3$ and $\angle POR = \pi/6$



In ΔOPR, OP = OR cos 30^0

$\Rightarrow$ $a = \sqrt{h^2 + k^2}\,\frac{\sqrt{3}}{2}$

$\Rightarrow$ Locus of R(h,k) is $3(x^2 + y^2) = 4a^2$

66. **d)** $\mathbf{y^2 - 10x - 6y + 14 = 0}$

Let the centre of the circle be (h,k). Since the circle touches the axis of y, therefore radius = h. The radius of the circle $x^2 + y^2 - 6x - 6y + 14 = 0$ is 2 and it has its centre at (3,3).Since the two circles touch each other externally therefore. Distance between the centres = sum of the radii

$\Rightarrow$ $\sqrt{(h-3)^2 + (k-3)^2} = h + 2$

$\Rightarrow$ $k^2 - 10h - 6k + 14 = 0$

Hence, the locus of (h,k) is $y^2 - 10x - 6y + 14 = 0$

67. **c)** $\mathbf{xy = 0}$

Let the coordinates of P be (h,k). Let the equation of a tangent from P(h,k) to the circle $x^2 + y^2 = a^2$ be $y = mx + a\sqrt{1+m^2}$.

Since P(h,k) lies on $y = mx + a\sqrt{1+m^2}$

Therefore, $k = mh + a\sqrt{1+m^2}$

$\Rightarrow$ $(k - mh)^2 = \left(a\sqrt{(1+m^2)}\right)^2$

$\Rightarrow$ $m^2(h^2 - a^2) - 2mkh + k^2 - a^2 = 0$

This is quadratic equation in m. Let the two roots be m_1 and m_2. Then

$m_1 + m_2 = \frac{2hk}{k^2 - a^2}$

But $\tan \alpha = m_1$, $\tan \beta = m_2$ and it is given that $\cot \alpha + \cot \beta = 0$

$\therefore$ $\frac{1}{m_1} + \frac{1}{m_2} = 0$

$\Rightarrow$ $m_1 + m_2 = 0$

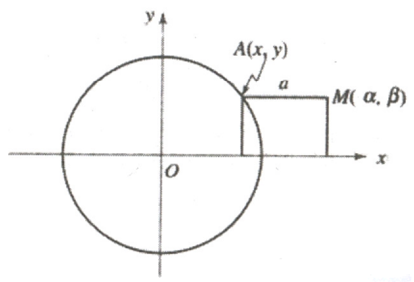
$\Rightarrow$ $\frac{2hk}{k^2 - a^2} = 0$

$\Rightarrow$ $hk = 0$

Hence the locus of (h,k) is $xy = 0$

68. **b)** $\mathbf{x^2 + y^2 = 2ax}$

Let the coordinates of A be (x,y) and M be $(\alpha,\beta$. Since AM is parallel to OX



$\alpha = x + a$ and $\beta = y \Rightarrow x = \alpha - a$ and $y = \beta$

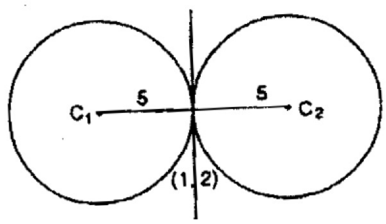
As A (x, y) lies on the circle $x^2 + y^2 = a^2$, we have $(\alpha - a)^2 + \beta^2 = a^2$

$\Rightarrow$ $a^2 - 2a\alpha + \beta^2 = 0$

$\Rightarrow$ locus of M (α,β) is $x^2 + y^2 = 2ax$.

69. **b)** **(4/5, 7/5)**

The given circle is $x^2 + y^2 - 4x - 6y - 12 = 0$ whose centre is $C_1(2,3)$ and radius $r_1 = C_1A = 5$



If $C_2(h,k)$ is the centre of the circle of radius 3 which touches the circle (1) internally at the point A (–1,–1), then $C_2A = 3$ and $C_1C_2 = C_1A - C_2A = 5 - 3 = 2$
Thus, $C_2(h,k)$ divide C_1A in the ratio 2 : 3 internally,

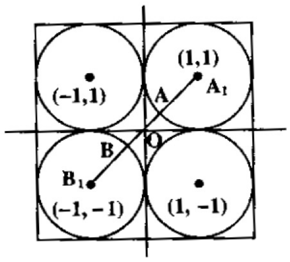
$\therefore \quad h = \dfrac{2(-1)+3.2}{2+3} = \dfrac{4}{5}$ and

$\therefore \quad k = \dfrac{2(-1)+3.3}{2+3} = \dfrac{7}{5}$

70. **a)** $\boldsymbol{x^2 + y^2 = 3 - \sqrt{2}}$

$A_1B_1 = \sqrt{4+4} = 2\sqrt{2}$

$\Rightarrow \quad AB = 2\sqrt{2} - 2 = 2\left(\sqrt{2}-1\right)$



Thus, equation of the required circle is

$x^2 + y^2 = \left(\sqrt{2}-1\right)^2 = 3 - 2\sqrt{2}$

71. **c)** **3**

The two circles are
$x^2 + y^2 - 4x - 6y - 3 = 0$ and $x^2 + y^2 + 2x + 2y + 1 = 0$
Centres : $C_1(2,3)$ $\quad C_2(-1, 1)$
radii : $r_1 = 4$ $\quad r_2 = 1$
We have, $C_1C_2 = 5 = r_1 + r_2$, therefore there are 3 common tangents to the given circles.

72. **b)** $\boldsymbol{\dfrac{192}{25}}$ **sq.units**

The equation of the chord of contact of tangents drawn from P(4,3) to $x^2 + y^2 = 9$ is $4x + 3y = 9$.

The equation of PQ is $y = \dfrac{3}{4}x$.

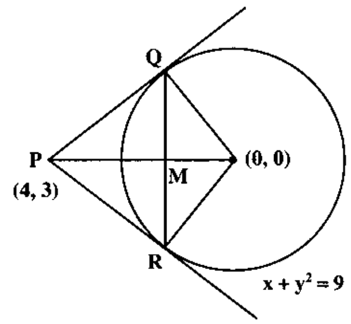
Now OM = (length of the ⊥ from (0,0) on

$4x + 3y - 9 = 0 = \dfrac{9}{5}$)

$QR = 2 \times QM = 2\sqrt{OQ^2 - OM^2}$

$= 2\sqrt{9 - \dfrac{81}{25}} = \dfrac{24}{5}$

Now, $PM = OP - OM = 5 - \dfrac{9}{5} = \dfrac{16}{5}$

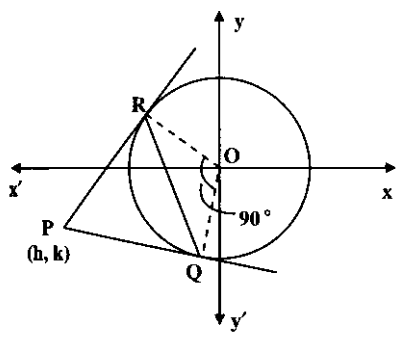


So, area of $\Delta PQR = \dfrac{1}{2}\left(\dfrac{24}{5}\right)\left(\dfrac{16}{5}\right)$

$= \dfrac{192}{25}$ sq.units

73. **d)** $\boldsymbol{h^2 + k^2 = 2a^2}$

As shown in the diagram $\angle ROQ = \pi/2$ also $\angle PRO = \angle PQO = \pi/2$
Then the quadrilateral PROQ is square and hence PR = RO



$\Rightarrow \quad \sqrt{h^2 + k^2 - a^2} = a$

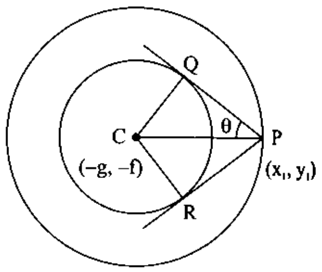
$\Rightarrow \quad h^2 + k^2 = 2a^2$

74. **c)** α

In ΔCPQ, $\sin\theta = \dfrac{CQ}{CP}$

$$= \frac{\sqrt{g^2 + f^2 - c\sin^2\alpha - (g^2 + f^2)\cos^2\alpha}}{\sqrt{g^2 + f^2 - c}}$$

$$= \frac{CQ}{CP} = \frac{\sqrt{g^2 + f^2 - c}\,\sin\alpha}{\sqrt{g^2 + f^2 - c}} = \sin\alpha$$



Then the angle between the tangents is 2α.

75. **a)** $-1 < \alpha < 1$

The given circle

$S(x,y) \equiv x^2 + y^2 - x - y - 6 = 0$

has centre at $C \equiv \left(\dfrac{1}{2}, \dfrac{1}{2}\right)$

According to the required conditions, the given point $P(\alpha - 1, \alpha + 1)$ must lie inside the given circle

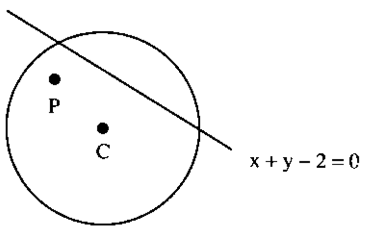
i.e $S(\alpha - 1, \alpha + 1) < 0$

$\Rightarrow \quad (\alpha - 1)^2 + (\alpha + 1)^2 - (\alpha - 1) - (\alpha + 1) - 6 < 0$ ...(i)

$\Rightarrow \quad \alpha^2 - \alpha - 2 < 0$ i.e $(\alpha - 2)(\alpha + 1) < 0$

$\Rightarrow \quad -1 < \alpha < 2$

[using sign scheme from algebra]...(ii)



and also P and C must lie on the same side of the line (see fig)

$L(x,y) \equiv x + y - 2 = 0$ ...(iii)

i.e $L\left(\dfrac{1}{2}, \dfrac{1}{2}\right)$ and $L(\alpha - 1, \alpha + 1)$ must have the same sign.

Now since $L\left(\dfrac{1}{2}, \dfrac{1}{2}\right) = \dfrac{1}{2} + \dfrac{1}{2} - 2 < 0$

therefore, we have

$L(\alpha - 1, \alpha + 1) = (\alpha - 1) + (\alpha + 1)$

$-2 < 0$ i.e $\alpha < 1$

Inequalities (ii) and (iv) together give the permissible values of α as $-1 < \alpha < 1$

76. **a)** $\sqrt{5}$

The centre and the radius of the given circle are P(6,0) and $\sqrt{5}$, respectively. Now the minimum distance between the two curves always occurs along a line which is normal to both the curves. The equation of the normal for $y^2 = 4x$ at $(t^2, 2t)$ is $y = -tx + 2t + t^3$.

If it is normal to the circle also then it must pass though (6,0). So

$0 = t^3 - 4t \quad \Rightarrow t = 0$ or $t = \pm 2$

$\Rightarrow \quad A(4,4)$ and $C(4,-4)$

$\Rightarrow \quad PA = PC = \sqrt{20} = 2\sqrt{5}$

The required minimum distance is

$2\sqrt{5} - \sqrt{5} = \sqrt{5}$

77. **a)** $y^2 = a(x - 3a)$

The point of intersection of the normals at $P(at_1^2, 2at_1)$ and $Q(at_2^2, 2at_2)$ is

$R \equiv [2a + a(t_1^2 + t_2^2 + t_1t_2), -at_1t_2(t_1 + t_2)]$

$= (h,k)$

Also PQ is the focal chord then $t_1t_2 = -1$.

So $k = a(t_1 + t_2)$ ...(i)

and $h = 2a + a[(t_1 + t_2)^2 - t_1t_2]$

$= 2a + a[(t_1 + t_2)^2 + 1]$ ...(ii)

Eliminating $t_1 + t_2$ from (i) and (ii), we have $h = 2a + a\left(\dfrac{k^2}{a^2} + 1\right)$

$\Rightarrow \quad y^2 = a(x - 3a)$

78. **d) $12a$**

The ends of the latus rectum are P(a, $2a$) and P′(a, $-2a$). The point P has parameter $t_1 = 1$ and the point the P′ has parameter $t_2 = -1$. The normal at P meets the curve again at Q′, whose parameter $t'_1 = -t - \frac{2}{t_1} = -3$

The normal at P′ meets the curve again at Q′, whose parameter $t'_2 = -t - \frac{2}{t_2} = 3$

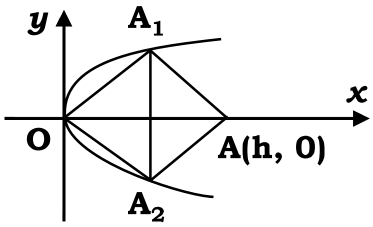
Hence, Q and Q′ have coordinates($9a$, $-6a$) and ($9a$, $6a$), respectively.

Hence, QQ′ = $12a$

79. **c) 28**

Let $A_1 \equiv (2at_1^2, 4t_1)$, $A_2 \equiv (2t_1^2, -4t_1)$.

Clearly, $\angle A_1OA = \frac{\pi}{6}$



$\Rightarrow \frac{2}{t_1} = \frac{1}{\sqrt{3}}$

$\Rightarrow t_1 = 2\sqrt{3}$

The equation of thenormal at A_1 is

$y = -t_1 x + 4t_1 + 2t_1^3$

$\Rightarrow h = 4 + 2t_1^2 = 4 + 2 \times 12 = 28.$

80. **c) $t_2^2 \geq 8$**

A normal at t_1 cuts the parabola again at t_2, then $t_2 = -t_1 - \frac{2}{t_1}$

$\Rightarrow t_1^2 + t_1t_2 + 2 = 0$

Since, t_1 is real, discriminant ≥ 0

$\Rightarrow t_2^2 - 8 \geq 0$

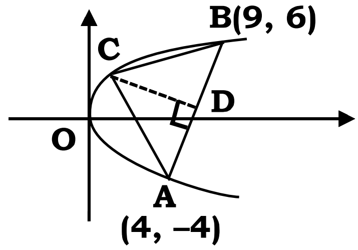
$\Rightarrow t_2^2 \geq 8$

81. **a)** $\left(\frac{1}{4}, 1\right)$

The area of the triangle ABC is maximum if CD is maximum, because AB is fixed.

That means the tangent drawn to the parabola at c should be parallel to AB.

Slope of AB = $\frac{6+4}{9-4} = 2$



For $y^2 = 4x$, $\frac{dy}{dx} = \frac{2}{y} = 2$

$\Rightarrow y = 1$

$\Rightarrow x = \frac{1}{4}$

82. **c) $(x + 1)^2 = 4(y - 1)$**

Any point on the given parabola is (t^2, $2t$).

The equation of the tangent at (1, 2) is $x - y + 1 = 0$.

The image(h, k) of the point (t^2, $2t$) in $x - y + 1 = 0$ is $\frac{h - t^2}{1} = \frac{k - 2t^2}{-1} = -\frac{2(t^2 - 2t + 1)}{1 + 1}$

$\therefore h = t^2 - t^2 + 2t - 1 = 2t - 1$ and

$k = 2t + t^2 - 2t + 1 = t^2 + 1$ Eliminating t from $h = 2t - 1$and $k = t^2 + 1$, we get $(h + 1)^2 = 4(k - 1)$

The required equation of the reflection is $(x + 1)^2 = 4(y - 1)$.

83. **b)** **The line through Q parallel to *y*–axis**

Let the coordinates of P, Q and R be $(at_i^2, 2at_i)$ where $i = 1, 2, 3$ having ordinates in GP

So that t_1, t_2, t_3 are also in GP, i.e. $t_1t_3 = t_2^2$.

The equation of the tangents ar P and R are $t_1y = x + at_1^2$ and $t_3\, y = x + at_3^2$, which intersect at the point$(at_1t_3, a(t_1 + t_3)) \equiv (at_2^2, a(t_1 + t_3))$ which lies on the line through Q parallel to the y-axis

84. **b)** GP

Let P$(at_1^2, 2at_1)$ and Q $at_2^2, 2at_2)$ be two points on the parabola $y^2 = 4ax$ ...(*i*)

The equation of tangents at P and Q on (i) are $t_1y = x + at_1^2$ and $t_2y = x + at_2^2$.

The point of intersection of these tangents is T$[at_1t_2, a(t_1 + t_2)]$

The coordinates of the focus S are $(a, 0)$. Thus,

$(ST)^2 = (at_1t_2 - a)^2 + [a(t_1 + t_2)]^2$

$= a^2(1 + t_1^2)(1 + t_2^2)$

$= (a + at_1^2)(a + at_2^2)$

= SP.SQ.

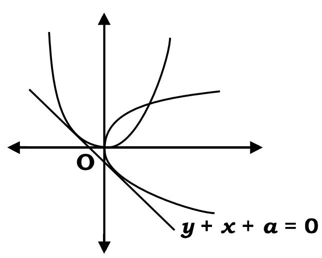
85. **d)** $x + y + a = 0$

The equation of the tangent to $y^2 = 4ax$ having slope m is $y = mx + \dfrac{a}{m}$

It will touch $x^2 = 4ay$ if $x^2 = 4a\left(mx + \dfrac{a}{m}\right)$ has equal roots.

Thus, $16a^2m^2 = -16\dfrac{a^2}{m} \Rightarrow m = -1$

Thus, the common tangent is $y + x + a = 0$.

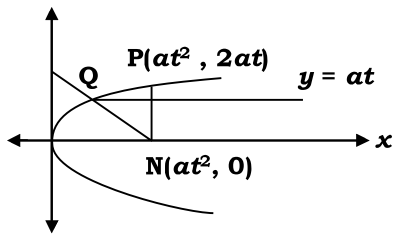


86. **a)** $(0, (4/3)\, at)$

The equation of line parallel to the axis and bisecting the ordinates PN of the point P$(at^2, 2at)$ is $y = at$, which meets the parabola $y^2 = 4ax$ at the point Q$((1/4)at^2, at)$. Coordinates of N are $(at^2, 0)$. Equation of NQ is

$$y = \frac{0 - at}{at^2 - (1/4)\,at^2}\,(x - at^2)$$

which meets the tangent at the vertex, $x = 0$, at the point $y = (4/3)at$.



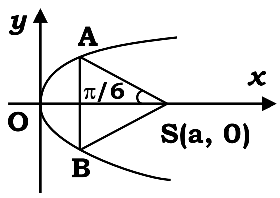
87. **b)** $4a\left(2 - \sqrt{3}\right)$

Let A $(at_1^2, 2at_1)$, B $\equiv (at_2^2, -2at_1)$

$m_{As} = \tan\left(\dfrac{5\pi}{6}\right)$

$\Rightarrow \dfrac{2at_1}{at_1^2 - a} = -\dfrac{1}{\sqrt{3}}$

$\Rightarrow t_1^2 + 2\sqrt{3}\, t_1 - 1 = 0$



$\Rightarrow t_1 = -\sqrt{3} \pm 2$

Clearly, $t_1 = -\sqrt{3} - 2$ is rejected.

Thus, $t_1 = (2 - \sqrt{3})$

Hence, AB $= 4at_1 = 4a(2 - \sqrt{3})$.

88. **c)** 4

The parabola is $y^2 = k(x - 8/k)$

or $Y^2 = 4AX$, where $4A = k$, $Y = y$, $X = x - 8/k$

It directrix is $X = -A$ or $x - 8/k = -k/4$

or $x = \dfrac{8}{k} - \dfrac{k}{4}$

Comparing with $x = 1$, we get

$1 = \dfrac{32 - k^2}{4k}$

$\Rightarrow k^2 + 4k - 32 = 0$

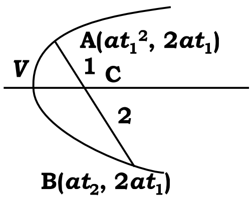
$\Rightarrow (k + 8)(k - 4) = 0$

89. **b)** $t_2 + 2t_1 = 0$

Here, $C = \left(\dfrac{2at_1^2 + at_2^2}{3}, \dfrac{4at_1 + 2at_2}{3}\right)$

It lies on y = 0. So, $\dfrac{4at_1 + 2at_2}{3} = 0$

$\Rightarrow t_2 + 2t_1 = 0$



90. **b)** $0 < a < 4$

$(a, 2a)$ is interior point of $y^2 - 16x = 0$

if $(2a)^2 - 16a < 0 \Rightarrow a^2 - 4a < 0 \Rightarrow 0 < a < 4 \ldots(i)$

V(0, 0) and $(a, 2a)$ are on the same side

of $x - 4 = 0$. So $a - 4 < 0 \Rightarrow a < 4$ $\ldots(iii)$

From (i) and (ii), we have $0 < a < 4$.