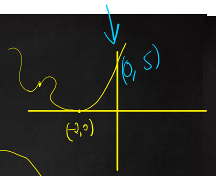
COMP AND INTEGER

The curve $y = ax^3 + bx^2 + cx + 5$ touches the x-axis at $P(-2, 0)$ and cuts the y-axis at Q, where its gradient is 3. Then

1. The value of a is
   (a) $-1/2$ (b) $-1/4$
   (c) $-3/4$ (d) $-5/4$
2. The value of b is
   (a) $-1/2$ (b) $-1/4$
   (c) $-3/4$ (d) $-5/4$
3. The value of $2a + 4b + c$ is
   (a) -1 (b) -2
   (c) -3 (d) -4.



$x=0, y=5$

① $(-2,0)$

② $\left.\frac{dy}{dx}\right|_{(-2,0)} = 0$

$y = ax^3 + bx^2 + cx + 5$

$0 = -8a + 4b - 2c + 5$ — ①

$\frac{dy}{dx} = 3ax^2 + 2bx + c = 0$

$(-2,0)$ $12a - 4b + c = 0$ — ②

$\left.\frac{dy}{dx}\right|_{(0,5)} = 3 = c$

$\boxed{c=3}$

③

$a = -\frac{1}{2}, b = -\frac{3}{4}$

The number of values of c such that the straight line $3x + 4y = c$ touches the curve $\frac{x^4}{2} = x + y$.

$c = \frac{7}{8}$

$m = -3/4$ $\boxed{01}$

$\frac{x^4}{2} = x + y \Rightarrow \frac{4x^3}{2} - 1 = \frac{dy}{dx} = -3/4$

$\frac{4x^3}{2} = \frac{1}{4}$ $x^3 = 1/8$

$3x + 4y = c$

$x = \frac{1}{2}, \frac{\omega}{2}, \frac{\omega^2}{2}$

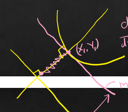
$y = \frac{5}{32}$

$3x + 4y = c$

$3 \times \frac{1}{2} + 4 \times \frac{5}{32} = \boxed{c = 7/8}$

The shortest (largest) distance between two non-intersecting curves is found along the common normal to the two curves.

1. The shortest distance between the line $y = x - 2$ and the parabola $y = x^2 + 3x + 2$ is
   (a) $\frac{3}{\sqrt{2}}$ ✓ (b) $\frac{5}{\sqrt{2}}$
   (c) $\frac{7}{\sqrt{2}}$ (d) $\frac{1}{\sqrt{2}}$
2. The minimum distance between the curves $y^2 = 4x$ and $x^2 + y^2 - 12x + 31 = 0$ is
   (a) $\sqrt{21}$ (b) $\sqrt{21} - \sqrt{5}$ $\sqrt{20} - \sqrt{5}$
   (c) $\sqrt{26} - \sqrt{5}$ (d) $\sqrt{26} + \sqrt{5}$
3. The point on the curve $x^2 + y^2 = 6$ whose distance from the line $x + y = 7$ is minimum is
   (a) (1, 2) (b) (2, 1)
   (c) (1, 3) (d) (3, 1).



$\frac{dy}{dx} = 2x + 3 = 1$

$2x = -2$

$m = 1$ $\boxed{x = -1}$

$y = x - 2$

$y = x^2 + 3x + 2$

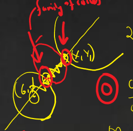
$y_1 = 1 - 3 + 2 = 0$

$(-1, 0)$

$y = x - 2$

$\left|\frac{-1-2}{\sqrt{1^2+1^2}}\right| = \frac{3}{\sqrt{2}}$

family of circles



$2y\frac{dy}{dx} = 4.$

⓪ $\frac{dy}{dx} = \frac{2}{y_1}$ $y^2 = 4x.$

$m_{normal} = -\frac{y_1}{2}.$

① $\frac{y - y_1}{x - x_1} = -\frac{y_1}{2}$ $(6,0)$

$\frac{-\cancel{y_1}}{6 - x_1} = \frac{-\cancel{y_1}}{2}$

$2 = 6 - x_1$

$\boxed{x_1 = 4}$ $y = \pm 4$

$\boxed{y_1 = 0}$ $(x_1 = 0)$

② $r = \sqrt{36 - 31}$
$= \sqrt{5}$

③ $(0,0), (4,4), (4,-4)$
$(6,0)$ $(6,0)$ $(6,0)$
6 $\sqrt{20}$ $\sqrt{20}.$

$\boxed{\sqrt{20} - \sqrt{5}}$

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

If m is the length of the subnormal to the curve $y^2 = x^3$ at the point (4, 8), then find the value of $\sqrt{m} + 1$.

The curve $(x + y) - \ln(x + y) = 2x + 5$ has a vertical tangent at the point (α, β), then the value of $(|\alpha + \beta| + 4)$.

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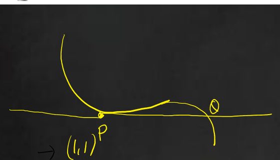
1.

If the tangent at $P(1, 1)$ to the curve $y^2 = x(2-x)^2$ meets the curve again at Q, then find the co-ordinates of Q.



$y^2 = x(2-x)^2$

$2y\frac{dy}{dx} = (2-x)^2 + x\,2(2-x)(-1)$

$(1,1)$ $\quad 2m = 1 + 2(1)(-1) = 1-2$

$\boxed{m = -1/2}$

$y - 1 = -\frac{1}{2}(x-1)$

$2y - 2 = -x + 1$

$x + 2y = 3$ — (1)

$y^2 = x(2-x)^2$ — (2)

(1) & (2)

$x = 3 - 2y$

$y^2 = (3-2y)(2-(3-2y))^2$

$y^2 = (3-2y)(2y-1)^2$

$\Rightarrow 8y^3 - 19y^2 + 14y - 3 = 0$

$y = 1 \Rightarrow (y-1)$

$y-1)\ 8y^3 - 19y^2 + 14y - 3\ ($

$R = 0$

$8y^3 - 8y^2 - 11y^2 + 11y + 3y - 3 = 0$

$\Rightarrow (y-1)(8y^2 - 11y + 3) = 0$

$(y-1)(y-1)(8y-3) = 0$

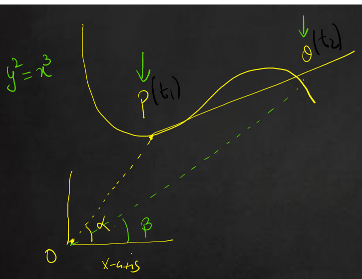
$y = 1$ (P) $\qquad y = 3/8$ (Q)

$x = 3 - 2\times\frac{3}{8}$

$x = 9/4$

$Q(9/4, 3/8)$

If the tangent at P to the curve $y^2 = x^3$ intersects the curve again at Q and the straight line OP, OQ makes angles α, β with the x-axis, where O is origin, then find the value of $\left(\frac{\tan\alpha}{\tan\beta} + 2013\right)$.



$y^2 = x^3$

$\boxed{P(t_1^2, t_1^3)}$ $\quad Q(t_2^2, t_2^3)$

$\tan\alpha = \frac{t_1^3 - 0}{t_1^2 - 0} = t_1$

$\tan\beta = t_2$

$2y\frac{dy}{dx} = 3x^2$

$m = \frac{3}{2}\frac{x^2}{y} = \frac{3}{2}\times\frac{t_1^4}{t_1^3} = \frac{3}{2}t_1$

Eqn of tangent at P:

$y - t_1^3 = \frac{3}{2}t_1(x - t_1^2)$

$Q(t_2^2, t_2^3)$

$2(t_2^3 - t_1^3) = 3t_1(t_2^2 - t_1^2)$

$\Rightarrow 2(t_2^2 + t_1^2 + t_1t_2) = 3t_1(t_1 + t_2)$

$\Rightarrow 2t_2^2 + 2t_1^2 + 2t_1t_2 = 3t_1^2 + 3t_1t_2$

$\Rightarrow t_1^2 - 2t_2^2 + t_1t_2 = 0$

Divide 't_2^2'

$\left(\frac{t_1}{t_2}\right)^2 + \left(\frac{t_1}{t_2}\right) - 2 = 0$

$u = \frac{t_1}{t_2}$

$u^2 + u - 2 = 0$

$(u+2)(u-1) = 0$

$u = -2, \ u = 1$

$\boxed{\frac{t_1}{t_2} = -2}$, $\quad \frac{t_1}{t_2} = 1$

$\frac{\tan\alpha}{\tan\beta} + 2013 = -2 + 2013 = \boxed{2011}$

$\frac{\tan\alpha}{\tan\beta} = \frac{t_1}{t_2} = -2$

Q

Find the equation of the straight line which is a tangent at one point and normal at another point to the curve $y = 8t^3 - 1$, $x = 4t^2 + 3$.

If the tangent at a variable point P on the curve $y = x^2 - x^3$ meets it again at Q, then prove that the locus of the middle point of PQ is
$y = 1 - 9x + 28x^2 - 28x^3$.

A curve is given by the equations $x = \sec^2\theta$ and $y = \cot\theta$. If the tangent at P where $\theta = \frac{\pi}{4}$ meets the curve again at Q. Find PQ.

Find the value of c such that the line joining the points $A(0, 3)$ & $B(5, -2)$ becomes tangent to the curve $y = \frac{c}{x+1}$.

$\frac{y-3}{x-0} = \frac{5}{-5} = -1$

$y - 3 = -x$

$\boxed{x+y=3}$

$y = \frac{c}{x+1}$

$y = 3-x$

$(3-x)(x+1) = c$

$x^2 - 2x + (c-3) = 0$

$D = 0$

$4 - 4(c-3) = 0$

$1 - c + 3 = 0$

$\boxed{c=4}$

If the tangent at any point $P(4m^2, 8m^3)$ of $x^3 - y^2 = 0$ is a normal also the curve $x^3 - y^2 = 0$ then find the value of $(9m^2 + 2)$.

$x^3 = y^2$ $\quad P(4m^2, 8m^3)$

$2y\frac{dy}{dx} = 3x^2$

$\boxed{x = 4m^2}$

$\boxed{\frac{dy}{dx} = \frac{3x^2}{2y} = \frac{3 \times 16m^4}{2 \times 8m^3} = 3m}$

$y - 8m^3 = (3m)(x - 4m^2)$

$y - 8m^3 = 3mx - 12m^3$

$y = \boxed{3mx - 4m^3}$

$x^3 = (3mx - 4m^3)^2$

$x^3 = 9m^2x^2 + 16m^6 - 24xm^4$

$\Rightarrow x^3 - 9m^2x^2 + 24m^4x - 16m^6 = 0$

$(x - 4m^2)$ $\quad \boxed{m^2}$

$(x - m^2)$

$(x^3 - m^2x^2) + (-8m^2x^2 + 8m^4x) + 16m^4x - 16m^6 = 0$

$\Rightarrow (x - m^2)(x^2 - 8m^2x + 16m^4) = 0$

$(x - m^2)(x - 4m^2)^2 = 0$

Q $\quad P$

$x = m^2,$

$x^3 = y^2$ $\quad m^6 = y^2$

$\boxed{y = \pm m^3}$

$Q(m^2, m^3)$, $\quad Q(m^2, -m^3)$

$\frac{dy}{dx} = \frac{3x^2}{2y}$ $\quad m_{normal} = -\frac{2y}{3x^2}$

$= -\frac{2}{3} \times \frac{m^3}{m^4}$

$\boxed{m_{normal} = -\frac{2}{3m}}$

$3m = \frac{-2}{3m}$

$9m^2 = -2$

$\boxed{9m^2 = 2}$

$9m^2 + 2 = 2 + 2 = 4$

If the curves $ay + x^2 = 7$ and $y = x^3$ cut each other orthogonally at a point, find a.

If the curves $y = 1 - ax^2$ and $y = x^2$ are orthogonal,