1 $y = 2x^2$ at $(1,2)$

$dy/dx = 4x$ $\quad \frac{dy}{dx}\Big|_{x=1} = 4$; $m = 4$ (gradient of the tangent)

Tangent passes through $(\overset{x_1}{1}, \overset{y_1}{2})$

$y - y_1 = m(x - x_1)$

$y - 2 = 4(x - 1)$

$y - 2 = 4x - 4$

a $y = 4x - 2$ (gradient of the tangent)

Gradient of the normal $= \frac{-1}{\text{gradient of the tangent}} = \frac{-1}{4}$

b Equation of normal $y - 2 = \frac{-x}{4} + \frac{1}{4}$

$4y - 8 = -x + 1$

$4y + x = 9$

2 $y = 3x^2 - 2x$ at $(2,8)$

$dy/dx = 6x - 2$

for tangent $dy/dx\Big|_{x=2}$ $m = 12 - 2 = 10$

$(\overset{x_1}{2}, \overset{y_1}{8})$

$y - y_1 = m(x - x_1)$

$y - 8 = 10(x - 2)$

$y - 8 = 10x - 20$

a $y = 10x - 12$

$m_2 = \frac{-1}{m_1} = \frac{-1}{10}$ for normal

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b ~~$10(y-8) = -x+2$~~

$y-8 = \frac{-1}{10}(x-2)$

$10(y-8) = -x+2$

$10y - 80 = -x + 2$

$10y = -x + 82$

$10y + x = 82$

3 $y = \frac{x^3}{2}$ at $(-1, -0.5)$

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

for tangent $\left.\frac{dy}{dx}\right|_{x=-1}$ $m = 1.5(-1)^2 = 1.5$

$(\overset{x_1}{-1}, \overset{y_1}{-0.5})$

$y - y_1 = m(x - x_1)$

$y - (-0.5) = 1.5(x - (-1))$

$y + 0.5 = 1.5(x+1)$

$y = 1.5x + 1.5 - 0.5$

$y = 1.5x + 1$

4 $2y = 3x + 2$

$m_2 = \frac{-1}{m_1} = \frac{-1}{1.5}$ for normal

$y + 0.5 = \frac{-1}{1.5}(x+1)$

$y + 0.5 = \frac{-2}{3}(x+1)$

$3(y+0.5) = -2(x+1$

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$3y + 15 = -2x - 2$

$3y + 2x = -2 - 5$

$3y + 2x = -35$

b ~~$b + 6y + 4x = -7$~~ $6y + 4x = -7$

4 $y = 1 + x - x^2$ at $(-2, -5)$

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

for tangent $\left.\frac{dy}{dx}\right|_{x=-2} = m = -2(-2) + 1 = 5$

$(\frac{x_1}{-2}, \frac{y_1}{-5})$

$y - y_1 = m(x - x_1)$

$y - (-5) = 5(x - (-2))$

$y + 5 = 5(x + 2)$

$y + 5 = 5x + 10$

$y = 5x + 10 - 5$

a $y = 5x + 5$

Gradient of normal $= \frac{-1}{\text{gradient of tangent}} = \frac{-1}{5}$

for normal

$y + 5 = \frac{-1}{5}(x + 2)$

$5(y + 5) = -1(x + 2)$

$5y + 25 = -x - 2$

$5y + x = -2 - 25$

b $5y + x = -27$

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5 $y = x^{-1}$ at $(3, 1/3)$

$dy/dx = -1x^{-2} = \frac{-1}{x^2}$

$\left.\frac{dy}{dx}\right|_{x=3} = m = \frac{-1}{9}$

$(\underset{x}{3}, \underset{y}{\frac{1}{3}})$

$y - y_1 = m(x - x_1)$

$y - 1/3 = -1/9\,(x - 3)$

$9(y - \frac{1}{3}) = -1(x - 3)$

$9y - 3 = -x + 3$

4 $9y + x = 6$

~~Find~~ $m_2 = \frac{-1}{m_1} = \frac{-1}{\frac{-1}{9}} = 9$

for normal:

$y - 1/3 = 9(x - 3)$

$y - 1/3 = 9x - 27$

$y = 9x - 27 + \frac{1}{3}$

$y = 9x - \frac{80}{3}$

b $3y = 27x - 80$