For each problem, use implicit differentiation to find $\frac{dy}{dx}$ in terms of x and y.

→ always take derivative w/r/t this variable

18) $5y^2 + 2y^3 = 4x^3$

$10y\frac{dy}{dx} + 6y^2 \cdot \frac{dy}{dx} = 12x^2$

$\frac{dy}{dx}(10y + 6y^2) = 12x^2$ $\qquad \frac{dy}{dx} = \frac{12x^2}{10y+6y^2}$

For each problem, use implicit differentiation to find $\frac{d^2y}{dx^2}$ in terms of x and y.

19) $2y^2 + 2 = 3x^3$

$4y\frac{dy}{dx} = 9x^2$

$\frac{d}{dx}\left[\frac{dy}{dx} = \frac{9x^2}{4y}\right]$

A) $\frac{d^2y}{dx^2} = -\frac{3}{x^2}$

B) $\frac{d^2y}{dx^2} = \frac{16y - 72yx}{81x^4}$

C) $\frac{d^2y}{dx^2} = \frac{8y^3 - 18y^2x^2 + 8y - 18x^2}{9x^6}$

D) $\frac{d^2y}{dx^2} = \frac{72xy^2 - 81x^4}{16y^3}$

E) $\frac{d^2y}{dx^2} = \frac{9x^2y^4 + 18x^2y^2 + 9x^2 - 9x^6y}{2y^6 + 6y^4 + 6y^2 + 2}$

$\frac{d^2y}{dx^2} = \frac{4y\,18x - 9x^2\,4\frac{dy}{dx}}{16y^2}$

$\frac{72xy^2 - 81x^4}{16y^3} = \frac{72xy - 36x^2\left(\frac{9x^2}{4y}\right)}{16y^2}$

For each problem, use implicit differentiation to find $\frac{dy}{dx}$ at the given point.

20) $-4y^3 + 5x^2y = 2x^3$ at $(-2, -1)$

$-12y^2\frac{dy}{dx} + 5\left(2xy + x^2\frac{dy}{dx}\right) = 6x^2$

$-12(-1)^2\frac{dy}{dx} + 5\left(2(-2)(-1) + (-2)^2\frac{dy}{dx}\right) = 6(-2)^2$

$-12\frac{dy}{dx} + 5\left(4 + 4\frac{dy}{dx}\right) = 24$

$\frac{dy}{dx} = \frac{4}{8} = \frac{1}{2}$

$-12\frac{dy}{dx} + 20 + 20\frac{dy}{dx} = 24 \longrightarrow 8\frac{dy}{dx} + 20 = 24 \rightarrow 8\frac{dy}{dx} = 4$

A particle moves along a horizontal line. Its position function is $s(t)$ for $t \geq 0$. For each problem, find the velocity function $v(t)$, the acceleration function $a(t)$, the times t when the particle changes directions, the intervals of time when the particle is moving left and moving right, the times t when the acceleration is 0, and the intervals of time when the particle is slowing down and speeding up.

21) $s(t) = t^3 - 22t^2 + 121t$

$v(t)$	$3t^2 - 44t + 121$	Moving right	$(0, \frac{11}{3})$ $(11, \infty)$
$a(t)$	$6t - 44$	Acceleration is 0	$t = \frac{22}{3}$
t when particle changes direction	$t = \frac{11}{3}$ and 11	Speeding up $v(t)$ & $a(t)$ same sign	$(\frac{11}{3}, \frac{22}{3})$ $(11, \infty)$
Moving left	$(\frac{11}{3}, 11)$	Slowing down $v(t)$ & $a(t)$ opposite signs	$(0, \frac{11}{3})$ $(\frac{22}{3}, 11)$

$s'(t) = v(t) = 3t^2 - 44t + 121$

$s''(t) = v'(t) = a(t) = 6t - 44$

$v(t) = 0 = 3t^2 - 44t + 121$

$0 = (3t - 11)(t - 11)$

$t = \frac{11}{3}$ and 11

$6t - 44 = 0$

$6t = 44 \rightarrow t = \frac{44}{6}$

$t = \frac{22}{3}$