$f(x)$	$f'(x)$
x^7	$7x^6$
$6x^7$	$42x^6$
x	1
$9x$	9
9	0

23.5 Derivatives of Polynomials Cont'd

Ex: Find the derivative

a) $f = \pi r + 7r^{10}$

f' or $\frac{df}{dr} = \pi + 70r^9$

b) $V = 12m^3 - 8m^2$

V' or $\frac{dV}{dm} = 36m^2 - 16m$

Ex: Find $\frac{d}{dt}\left[t^6 + t^5 + \underset{\#}{\sqrt{r}}\,t^4 + \underset{\#}{r}t + \underset{\#}{r^5}\right]$

r is constant

$= 6t^5 + 5t^4 + \sqrt{r}(4t^3) + r + 0$

$= 6t^5 + 5t^4 + 4\sqrt{r}t^3 + r$

23.4 Instantaneous Rate of Change and 23.9 Higher Derivatives

Def

Suppose an object moves in a straight line (e.g. car in a driveway).

$s(t)$: displacement after t seconds (m)

$v(t)$: velocity " (m/s)

$a(t)$: acceleration " (m/s^2)

$$v(t) = s'(t)$$
$$a(t) = v'(t)$$

Ex: $s(t) = t^2 + 5t$

s: in m t: in s

a) Find velocity at $t = 1$s

$$v(t) = s'(t)$$
$$= 2t + 5$$

$$v(1) = 7 \ \frac{m}{s}$$

b) Find the time when Velocity $= 6 \ \frac{m}{s}$.

$$v(t) = 2t + 5$$

Set $v = 6$: $\quad 6 = 2t + 5$

$$1 = 2t$$
$$0.5 = t$$
$$t = 0.5 \text{ s}$$

c) Find acceleration at $t = 1$ s

$$a(t) = v'(t)$$
$$= 2$$

$$a(1) = 2 \ \frac{m}{s^2}$$

Ex: Find all derivatives of $f(x) = x^4 + 7x^2$

$f'(x) = 4x^3 + 14x$ $\quad$ 1st derivative

$f''(x) = 12x^2 + 14$ 2nd derivative

$f'''(x) = 24x$ 3rd derivative

$f^{(4)}(x) = 24$ 4th derivative

$f^{(5)}(x) = 0$

$\vdots$

$$v(t) = s'(t)$$

$$a(t) = v'(t)$$

or

$$a(t) = s''(t)$$

Ex: $s(t) = 8t^3 - 12t^2 + 5$

Find velocity and acceleration.

$v(t) = 24t^2 - 24t$ $\left(\frac{m}{s}\right)$

$a(t) = 48t - 24$ $\left(\frac{m}{s^2}\right)$