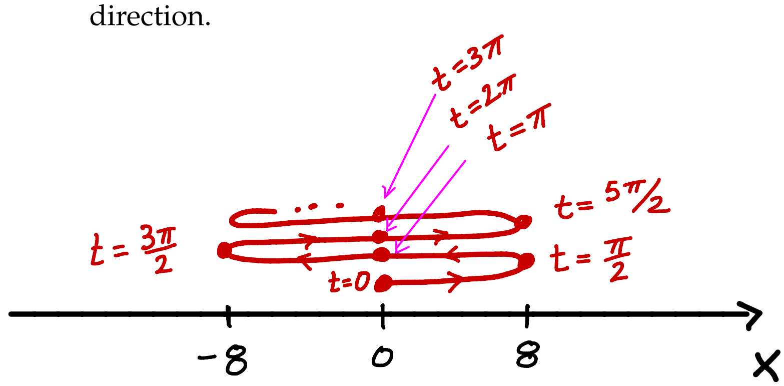
1. (Revisit the spring problem:) A mass on a spring vibrates horizontally on a smooth level surface. Its equation of motion is $x(t) = 8\sin(t)$, where t is in seconds and x is in centimeters.

   (a) We found:
   $v(t) = x'(t) = 8\cos(t)$ and $a(t) = v'(t) = x''(t) = -8\sin(t)$

   (b) We found:
   $x(2\pi/3) = 4\sqrt{3}\ cm$
   $x'(2\pi/3) = -4\ cm/s$
   $x''(2\pi/3) = -4\sqrt{3}\ cm/s^2$
   At $t = 2\pi/3$, the mass is moving to the left and slowing down.

   (c) Draw a picture of the motion of the mass and include the time(s) at which the mass changes direction.



quick check at $t=0$:
$x(0) = 0$ ← initial position
$x'(0) = 8$ ← moving to the right

The mass turns around when $v(t) = x'(t) = 0$ or $8\cos(t) = 0$. We know $\cos(t) = 0$ when $t = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, \ldots$

2. Higher Order Derivatives. For each function below, find $f'(x),\ f''(x),\ f'''(x),\ f^{(4)}(x),\ f^{(82)}(x)$

   (a) $f(x) = x^5 + 2x^2 + 1$

   $f'(x) = 5x^4 + 4x$
   $f''(x) = 20x^3 + 4$
   $f'''(x) = 60x^2$
   $f^{(4)}(x) = 120x$
   $f^{(82)}(x) = 0$

   (b) $f(x) = 2\sin(x)$

   $f'(x) = 2\cos(x)$
   $f''(x) = -2\sin(x)$
   $f'''(x) = -2\cos(x)$
   $f^{(4)}(x) = 2\sin(x) = f(x)$ ← We're back where we started!
   So $f^{(80)}(x) = 2\sin(x)$.
   So $f^{(82)}(x) = f''(x) = -2\sin(x)$

3. Other ways of denoting derivatives.

$$y = f(x)$$

- $f'(x),\ f''(x),\ f'''(x),\ f^{(4)}(x)$

- $y',\ y'',\ y''',\ y^{(4)}$

- $\frac{d}{dx}\left[f(x)\right],\ \frac{d^2}{dx^2}\left[f(x)\right],\ \frac{d^3}{dx^3}\left[f(x)\right]$

- $\frac{df}{dx},\ \frac{d^2f}{dx^2},\ \frac{d^3f}{dx^3},\ \ldots$

- $\frac{dy}{dx},\ \frac{d^2y}{dx^2},\ \frac{d^3y}{dx^2},\ \ldots$