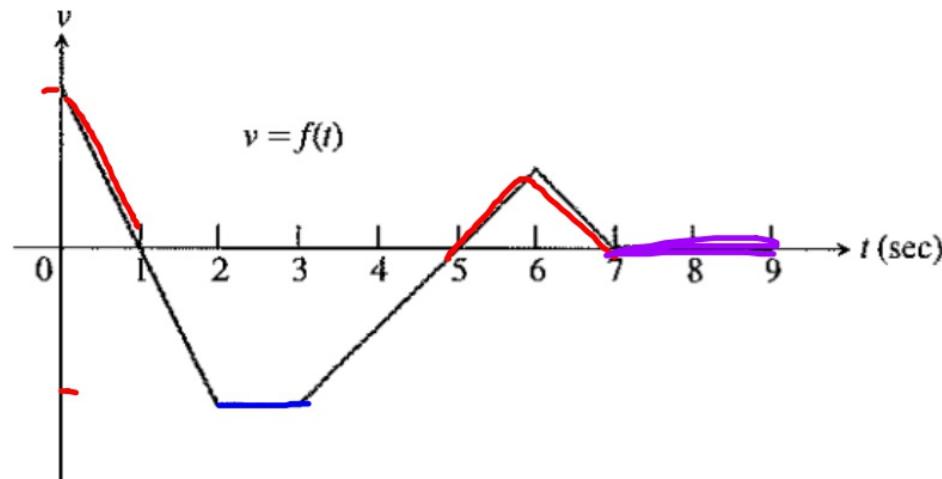


Good afternoon

Warm up: #9 on handout

9. **Particle Motion** The accompanying figure shows the velocity $v = f(t)$ of a particle moving on a coordinate line. See page 10

- (a) When does the particle move forward? move backward?
speed up? slow down?
 $\text{Ans: } (0,1), (5,7), (1,5)$
- (b) When is the particle's acceleration positive? negative?
zero?
 $\text{Ans: } (1,2), (5,6) \xrightarrow{\text{Slope}} (0,1), (3,5), (6,7)$
- (c) When does the particle move at its greatest speed?
 $\text{Ans: } (2,3)$
- (d) When does the particle stand still for more than an instant?



Implicit Differentiation

Explicit vs Implicit

$$y = 3x - 5$$

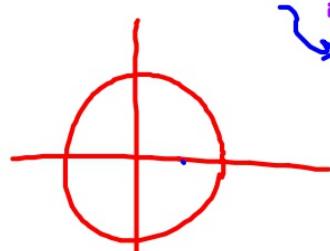
Explicit: solved for
dependent variable

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

I_{Implicit}
dep. ! I_{Indy}
"mixed" J. Ave

My First Implicit Derivative

$$\text{Implicit} \quad x^2 + y^2 = 25$$



$$(x-h)^2 + (y-k)^2 = r^2$$

$$y = \pm \sqrt{25 - x^2} \quad \text{Explicit form}$$

$$\frac{d}{dx} [x^2 + y^2] = [25]$$

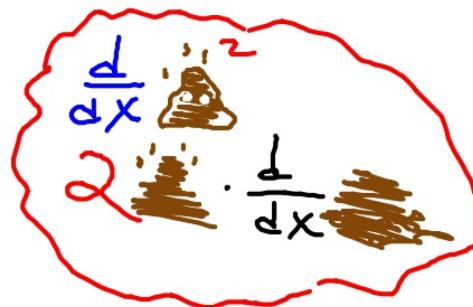
$$\frac{d}{dx} x^2 + \frac{d}{dx} y^2 = 0$$

Derivative
as
operator $\frac{d}{dx}$

$$2x + 2y \cdot \frac{dy}{dx} = 0$$

$$2y \frac{dy}{dx} = -2x$$

$$\frac{dy}{dx} = -\frac{x}{y}$$



Chain rule
"squared" is outer
y is inner
so y^2 becomes
 $2y \frac{dy}{dx}$

Find $\frac{dy}{dx}$

$$\frac{d}{dx} [x^2 + 4y^2] = \frac{d}{dx}(4)$$

$$2x + 8y \frac{dy}{dx} = 0$$

$$8y = -2x$$

$$y = \frac{-2x}{8y} \rightarrow \frac{-x}{4y}$$

implicit

$$\frac{d}{dx} 3 \sin y = \frac{d}{dx} x^2$$
$$3 \cos y \cdot \frac{dy}{dx} = 2x$$
$$\frac{dy}{dx} = \frac{2x}{3 \cos y}$$

explicit

$$\sin y = \frac{1}{3} x^2$$

$$y = \sin^{-1}\left(\frac{1}{3}x^2\right)$$

taking the derivative...
not easy!

$$\frac{1}{x} \left[x^4 + x^2 y^2 - y^2 \right] = \left[1 \right] \frac{d}{dx}$$

$$4x^3 + 2xy^2 + x \cdot 2y \frac{dy}{dx} - 2y \frac{dy}{dx} = 0$$

$f'g + f$

$$x^2 \cdot 2y \frac{dy}{dx} - 2y \frac{dy}{dx} = -4x^3 - 2xy^2$$

$$\frac{dy}{dx} (2xy - 2y) = -4x^3 - 2xy^2$$

$$\boxed{\frac{dy}{dx} = \frac{-4x^3 - 2xy^2}{2xy - 2y}}$$