



# Office Hours!

## Instructor:

Trevor Klar, `trevorklar@math.ucsb.edu`

## Office Hours:

Mondays 2–3PM

Tuesdays 10:30–11:30AM

Thursdays 1–2PM

or by appointment

## Office:

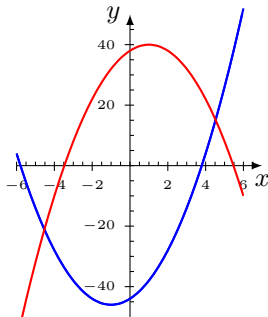
South Hall 6431X (Grad Tower, 6th floor, blue side, first door on the right)

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# Sketching some simple graphs

It's useful to be able to sketch...

## (1) Quadratics



$$y = 2x^2 + 4x - 44$$

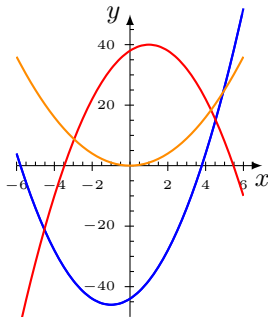
$$y = -2x^2 + 4x + 38$$

- $y = ax^2 + bx + c$
- Bowl-shaped:
  - ★ Opens up if  $a > 0$
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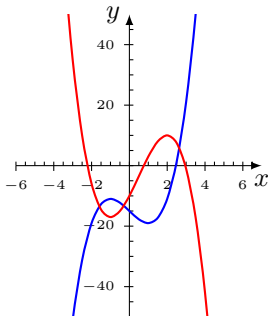
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## (2) Cubics



$$y = 2x^3 - 6x - 15$$

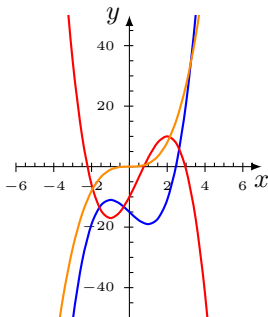
$$y = -2x^3 + 3x^2 + 12x - 10$$

- $y = ax^3 + bx^2 + cx + d$
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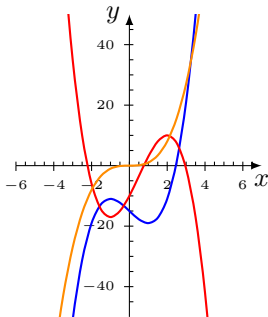
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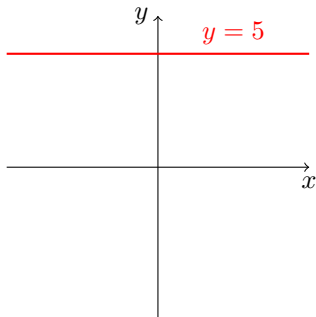
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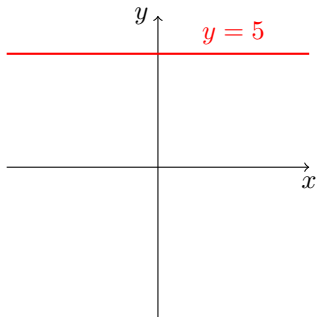
For a polynomial, the **highest power** of  $x$  **dominates** when  $x$  is big

# The Derivatives of Simple Functions

The derivative of a constant is...?



# The Derivatives of Simple Functions

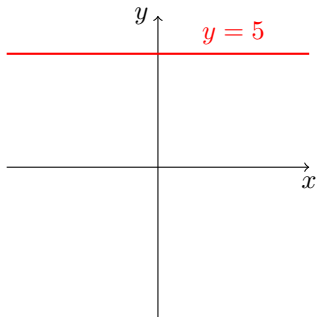


The derivative of a constant is zero because:

- derivative = rate of change
- constants don't change



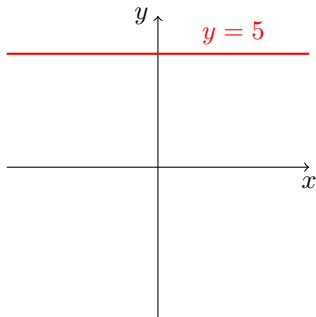
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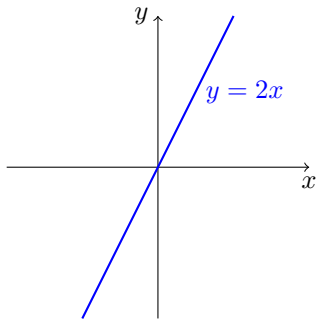


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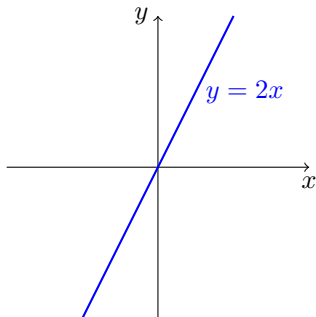
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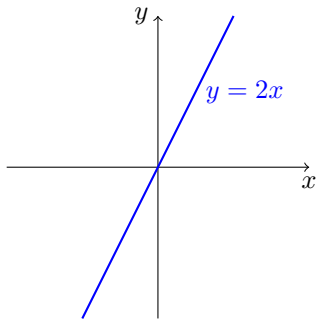
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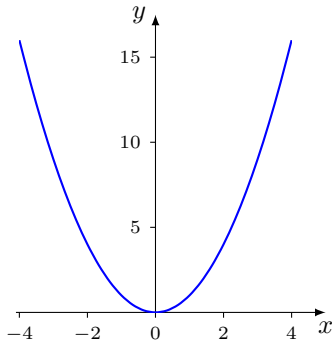
$$\text{So } \frac{d}{dx}(2x) = 2$$

# Meaning of Derivatives

$$\frac{d}{dx}(x^2) = 2x$$

What this means

The **slope** of the graph  
of  $y = x^2$  at  $x = a$  is  $2a$

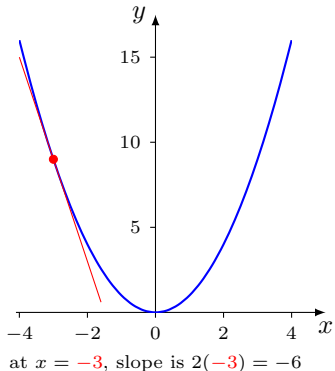


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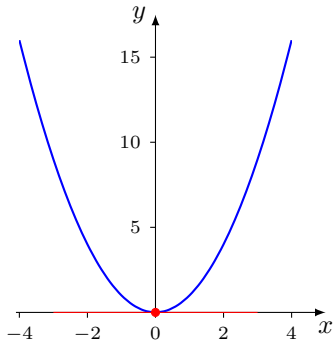


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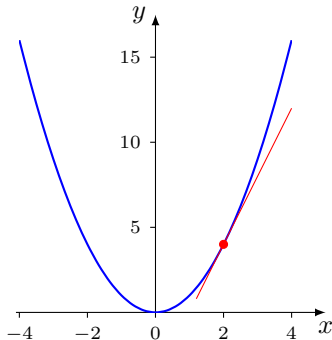


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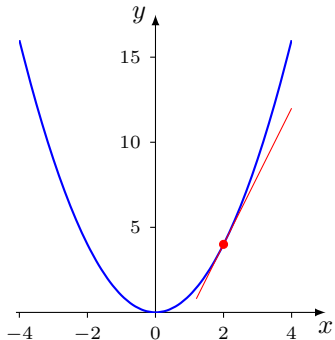
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derivative = rate of change = slope of graph = slope of tangent line

# General Rule:

$$\frac{d}{dx} (x^2) = 2x$$

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**Examples:**

**1.**  $\frac{d}{dx}(x^7) =$

$$A = 7x^7 \quad B = 6x^6 \quad C = 6x^7 \quad D = 7x^6 \quad E = 0$$

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$$A = \frac{1}{2}x^{1/2} \quad B = -\frac{1}{2}x^{-1/2} \quad C = \frac{1}{2}x^{-1/2}$$

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Rule: ALWAYS rewrite the thing you want derivative of as  $x^n$

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A= I have an answer

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**Answer:**  $12x^3 + 27x^2$

A= I got it

B= I nearly got it

C= I want my mommy!

# The Meanings of Derivatives

The derivative of  $f(x) = x^2 + 3x + 1$  is  $f'(x) = \frac{df}{dx} = 2x + 3$ . This means:

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- $f(2 + \Delta x) \approx f(2) + 7\Delta x$ .

# Applications

**7.** What is the slope of the graph  $y = 3x^2 - 7x + 5$  at  $x = 1$ ?

A = -2    B = -1    C = 0    D = 1    E = 2

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- 9.** After  $t$  seconds a hamster on a skate board is  $4t^2 + 2t$  cm from the origin on the  $x$ -axis. What is the exact speed of the hamster (in cm/sec) after 2 seconds?

A = 10    B = 16    C = 18    D = 20    E = 14



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8. What is the instantaneous rate of change of  $f(x) = x^3 - 2x + 3$  at  $x = 1$ ?

A = -2    B = -1    C = 0    D = 1    E = 2    D

9. After  $t$  seconds a hamster on a skate board is  $4t^2 + 2t$  cm from the origin on the  $x$ -axis. What is the exact speed of the hamster (in cm/sec) after 2 seconds?

A = 10    B = 16    C = 18    D = 20    E = 14    C

# Why This Works (§8.9)

$$\frac{d}{dx}(x^{\textcolor{red}{n}}) = \textcolor{red}{n}x^{\textcolor{blue}{n-1}}$$

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$$\frac{d}{dx}(x^n) = nx^{n-1}$$

**Example:**  $n = 3$ : Calculate the average rate of change of  $x^3$  between  $x$  and  $x + \Delta x$  then take limit as  $\Delta x \rightarrow 0$ .

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A similar calculation works for  $x^n$  for any  $n$ .

# More Applications

**10.** What is the equation of the tangent line at  $x = 1$  to the graph of  $y = x^3 - x + 4$ ? The tangent line is  $y = \dots$ ?

A =  $x + 3$     B =  $3x + 1$     C =  $2x - 2$     D =  $2x + 2$     E =  $6x - 2$

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Answer: D

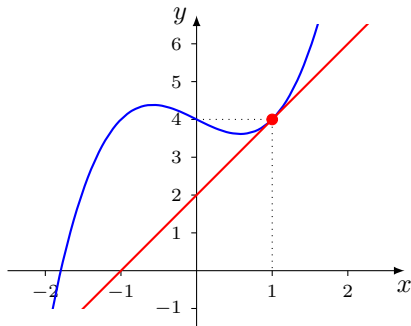
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Here's a picture:



# Another Example

**11.** The temperature in an oven after  $t$  minutes is  $50 + t^3$  °F. How quickly is the temperature rising after 2 minutes?

A= 58    B= 3    C= 12    D= 50    E= 8

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# A Warning!



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**Example:**  $5x^4 = \frac{d}{dx} (x^5) = \frac{d}{dx} (x^2 \cdot x^3) \neq (2x)(3x^2) = 6x^3$



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**12.**  $\frac{d}{dx} ((x^2+1)(x^3+1)) = ?$

A =  $6x^3$     B =  $5x^4 + 3x^2 + 2x$     C =  $x^5 + x^3 + x^2 + 1$     D = Other

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**Answer:** B

# Once upon a time...

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There was a happy math professor and he told his happy students:

“When you work out **derivatives** **ALWAYS** write the  $\frac{d}{dx}$  part so you write something like

$$\frac{d}{dx} (3x^2 + 5x + 2) = 6x + 5$$

and you never-ever-ever write

$$3x^2 + 5x + 2 \quad 6x + 5 \quad \text{or even worse}$$

$$3x^2 + 5x + 2 = 6x + 5.$$

Because if you don't do as I say I will become a sad math professor and you will repeat this class.”