# CALCULUS
## Derivatives and rates of change
## OLD

WARNING: In this homework, derivatives must be computed from the defintion, *i.e.*, as the limit of the difference quotient. Do NOT use product, quotient or chain rules, or any other technique coming from a later topic.

0270-1. Let $C$ be the curve $y = x^2 - 3x + 5$.
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Let $L$ be the tangent line to $C$ at the point $(2, 3)$.

a. Find the slope of $L$, by computing a limit of slopes of secant lines.

b. Find an equation of $L$.

c. Graph $C$ and $L$ in the rectangle
$$-1 \leq x \leq 4, \qquad -1 \leq y \leq 6.$$

d. Graph $C$ and $L$ in the rectangle
$$1 \leq x \leq 3, \qquad 2 \leq y \leq 6.$$

e. Graph $C$ and $L$ in the rectangle
$$1.9 \leq x \leq 2.1, \qquad 2.8 \leq y \leq 3.2.$$

In c, d and e, note that, as you "zoom in", the tangent line looks more and more like the curve.

0270-2. OLD a. Compute $\lim_{h\to 0} \dfrac{\sqrt{4+h}-2}{h}$.

b. Find the slope of the secant line to $y = \sqrt{x+1}$ through the points $(3,2)$ and $(3+h, \sqrt{4+h})$.

c. Find an equation of the tangent line to $y = \sqrt{x+1}$ at the point $(3,2)$.

0270-3. OLD A particle moves on a number line. Its position at any time $t$ is $\sqrt{t+1}$.

a. Find the average velocity between time $t = 3$ and time $t = 3+h$.

b. Find the instantaneous velocity at time $t = 3$.

0270-4. A heavy object is taken to the top of a
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building 100 feet high. At time $t = 0$, it is thrown upward at 35 feet/second. We engage the services of two Nobel prize-winning physicists who confer (*i.e.*, yell and scream at one another). After several hours of scholarly study, followed by minor medical treatment for blunt trauma, lacerations and contusions, they hold a joint press conference, and inform their public that, $t$ seconds after release, the object will be located

$$100 + 35t - 16t^2 \qquad \text{feet}$$

above the ground. Based on this, find the the velocity of the object 0.5 seconds after release. Give your answer in feet per second.

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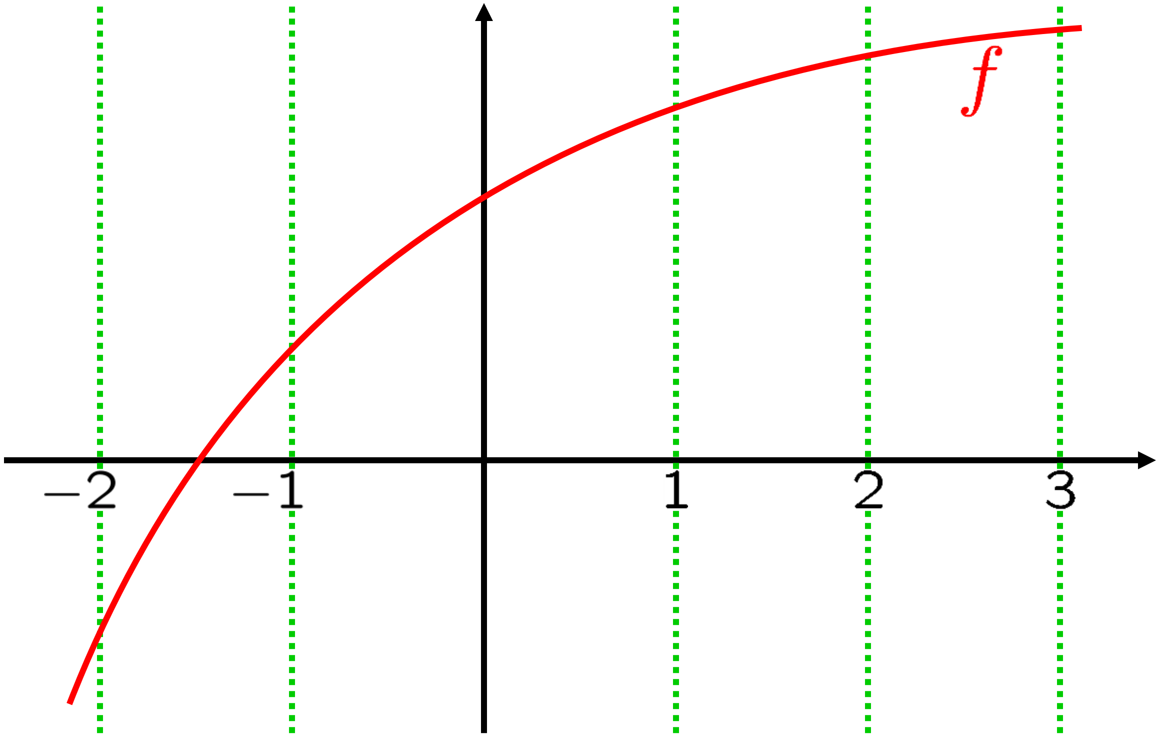


Order these numbers, from smallest to largest:

$$f'(-2),\ f'(-1),\ f'(0),\ f'(1),\ f'(2),\ f'(3)$$

Note that we are asking about $f'$, not $f$.

0270-6. Let $f(x) = \dfrac{2x+3}{5x-1}$.

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Do NOT use the quotient rule. Use only the definition of the derivative as the limit of the difference quotient.

a. Compute $f'(2)$.

b. Compute $f'(3)$.

c. Compute $f'(4)$.

d. Compute $f'(a)$, for an arbitrary number $a$.

0270-7. Find a function $f$ and a number $a$ s.t.

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$$f'(a) = \lim_{h\to 0} \frac{[\cos(2+h)] - [\cos 2]}{h}.$$