

## Section 3.3: Rates of Change in the Natural and Social Sciences

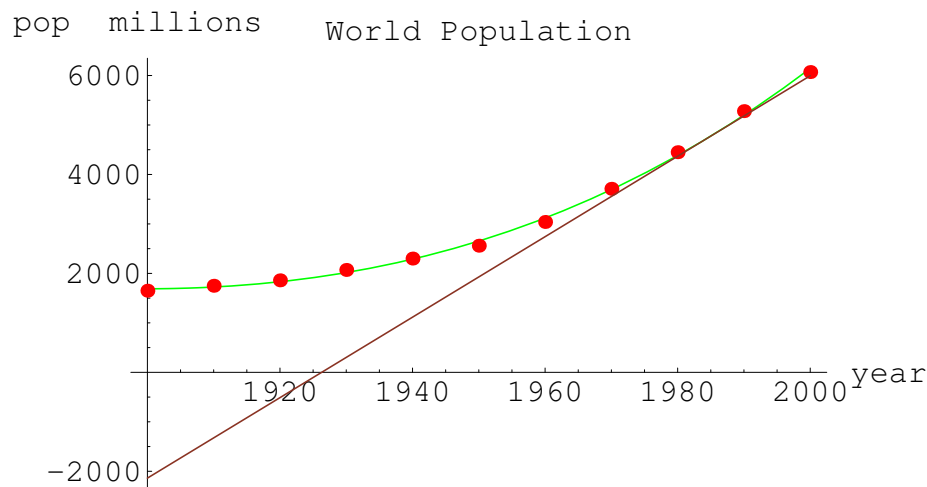
These notes reflect material from our text, *Calculus, Concepts and Contexts, Third Edition*, by James Stewart, published by Brooks/Cole, Pacific Grove, CA, 2005.

*Key points from Stewart, Section 3.3: Rates of change in physics, chemistry, biology, and economics.*

### Applications of the Derivative

The **derivative** is the appropriate notion to consider whenever an instantaneous rate of change arises in the natural and social sciences:

$$f'(a) = \lim_{h \rightarrow 0} \frac{f(a+h) - f(a)}{h}.$$



*Fig. Rate of change of the population of the world in 1985.*

### Albert Einstein on Newton's Contribution

“In order to put his system into mathematical form at all, Newton had to devise the concept of differential quotients and propound the laws of motion in the form of differential equations – perhaps the greatest advance in thought that a single individual was ever privileged to make.”

**Albert Einstein**, from the essay *On the one hundredth anniversary of Maxwell's birth*,  
in “James Clerk Maxwell: A Commemorative Volume.” Quoted by Patrick M. Fitzpatrick,  
in “Advanced Calculus, A Course in Mathematical Analysis.”

### Exercises

*Exercises for Section 3.3, pp 210–213:* 1, 3, 4 (speeding up), 8 (ball), 10 (sodium chlorate crystals),  
14 (spherical cell), 20 (lactonization), 26 (violin string), 30 (sensitivity), 32 (fish farm),  
33 (wolves and caribou)