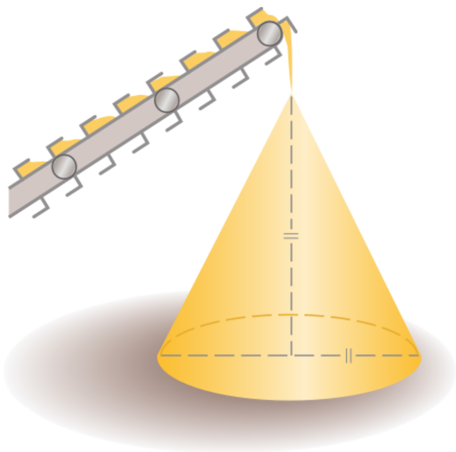
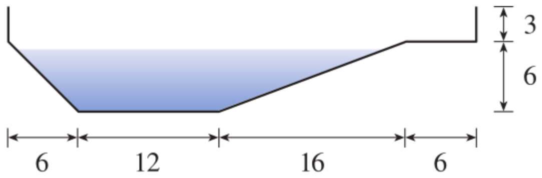
3.9.23 Use the fact that the distance (in meters) a dropped stone falls after t seconds is $d = 4.9t^2$. A woman stands near the edge of a cliff and drops a stone over the edge. Exactly one second later she drops another stone. One second after that, how fast is the distance between the two stones changing?

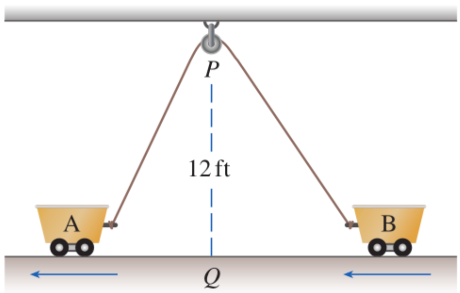
3.9.29 Gravel is being dumped from a conveyor belt at a rate of 30 ft^3/min, and its coarseness is such that it forms a pile in the shape of a cone whose base diameter and height are always equal. How fast is the height of the pile increasing when the pile is 10 ft hight?



3.9.30 A swimming pool is 20 ft wide, 40 ft long, 3 ft deep at the shallow end, and 9 ft deep at its deepest point. A cross-section is shown in the figure. If the pool is being filled at a rate of 0.8 ft^3/min, how fast is the water level rising when the depth at the deepest point is 5 ft?



3.9.44 Two carts, A and B, are connected by a rope 39 ft long that passes over a pulley P. The point Q is on the floor 12 ft directly beneath P and between the carts. Cart A is being pulled away from Q at a speed of 2 ft/s. How fast is cart B moving toward Q at the instant when cart A is 5 ft from Q?



3.9.53 Suppose that the volume V of a rolling snowball increases so that $\frac{dV}{dt}$ is proportional to the surface area of the snowball at time t. Show that the radius r increases at a constant rate, that is $\frac{dr}{dt}$ is constant.

3.10.48 When blood flows along a blood vessel, the flux F (the volume of blood per unit time that flows past a given point) is proportional to the fourth power of the radius R of the blood vessel:

$$F = kR^4$$

(This is known as Poiseuilles's Law) A partially clogged artery can be expanded by an operation called angioplasty, in which a balloon-tipped catheter is inflated inside the artery in order to widen it and restore normal blood flow.

Show that the relative change in F is about four times the relative change in R. How will a 5% increase in the radius affect the flow of blood?

3.10.50 In physics textbooks, the period T of a pendulum of length L is often given at $T \approx 2\pi\sqrt{L/g}$, provided that the pendulum swings through a relatively small arc. In the course of deriving this formula, the equation $a_T = -g\sin\theta$ for the tangential acceleration of the bob of the pendulum is obtained, and then $\sin\theta$ is replaced by θ with the remark that for small angles, θ(in radians) is very close to $\sin(\theta)$.

(a) Verify the linear approximation at 0 for the sine function: $\sin\theta \approx \theta$

(b) If $\theta = \pi/18$(equivalent to $10°$) and we approximate $\sin\theta$ by θ, what is the percentage error?

(c) Use a graph to determine the values of θ for which $\sin\theta$ and θ differ by less than 2%. What are the values in degrees?

3.10.52 Suppose that we don't have a formula $g(x)$ but we know that $g(2) = -4$ and $g'(x) = \sqrt{x^2+5}$ for all x.

(a) Use a linear approximation to estimate $g(1.95)$ and $g(2.05)$.

(b) Are your estimates in part (a) too large or too small? Explain.

4.1.45 Find the critical numbers of the function: $f(\theta) = 2\cos(\theta) + \sin^2(\theta)$.

4.1.50 A formula for the *derivative* of a function f is given. How many critical numbers does f have?

$$f'(x) = \frac{100\cos^2 x}{10 + x^2} - 1$$

4.1.60 Find the absolute maximum/minimum values of f on the given interval.

$$f(x) = \frac{e^x}{1 + x^2}, \ [0, 3]$$

4.1.63 Find the absolute maximum/minimum values of f on the given interval.

$$f(x) = x^{-2} \ln x, \quad \left[\frac{1}{2}, 4\right]$$

4.1.66 Find the absolute maximum/minimum values of f on the given interval.

$$f(x) = x - 2\tan^{-1} x, \; [0, 4]$$