1. A ball is thrown vertically upward from a cliff 320 feet tall with an initial velocity of 96 feet per second. It's position at any time t is given by $s(t) = -16t^2 + 96t + 320$. Find the maximum height the ball reaches.
2. A ball is thrown vertically downward from a balcony 100 feet high with an initial velocity of 50 feet per second. It's position at time t is given by $s(t) = -16t^2 - 50t + 100$. What is the velocity of the ball when it hits the ground?
3. The position of a particle moving along the x-axis is given by $x(t) = t^3 - 12t^2 + 36t - 20,\ t \geq 0$. For what values of t is the particle moving to the left?
4. The position of a particle moving along the x-axis is given by $x(t) = 2t^3 - 10t^2 + t - 50,\ t \geq 0$. For what values of t is the particle moving to the right?
5. Given $5x^2y + y = x^2 + 3y^2$, find $\dfrac{dy}{dx}$.
6. Given $6xy + y^3 = x^2 + y$, find $\dfrac{dy}{dx}$.
7. Write an equation of a tangent to $2x^3 - x^2y = 1 - y^3$ at $(2, -3)$.
8. Write an equation of a tangent to $xy^2 = 27 - 3y$ at $(2, 3)$.
9. A 20-foot ladder is leaning against a vertical wall. If the bottom of the ladder slides away from the wall at 2 feet per second, how fast is the top of the ladder moving down the wall when the top is 12 feet from the ground?
10. A light is at the top of a 16-foot pole. A 5-foot boy is walking away from the pole at 4 feet per second. At what rate is the length of his shadow increasing?
11. Linearize $f(x) = 3\cos x + \sin x$ at $x = 0$.
12. Linearize $f(x) = \dfrac{2x - 1}{x + 3}$ at an appropriate x-value to approximate $f(1.2)$. Use your linearization to estimate $f(1.2)$.
13. Given $x^2y = \sin(xy)$, find $\dfrac{dy}{dx}$.
14. Given $xy = \tan y$, find $\dfrac{dy}{dx}$.
15. Given $y^2 = x\cos y$, find $\dfrac{dy}{dx}$.
16. Use an appropriate linearization to estimate $\sqrt{81.2}$.
17. Use an appropriate linearization to estimate $\sqrt[3]{8.3}$.

Answers (not complete solutions)

1. 464 feet
2. 94.340 feet per second down (-94.340)
3. $(2, 6)$
4. $(0, .051) \cup (3.283, \infty)$
5. $\dfrac{dy}{dx} = \dfrac{2x - 10xy}{5x^2 + 1 - 6y}$
6. $\dfrac{dy}{dx} = \dfrac{2x - 6y}{6x + 3y^2 - 1}$
7. $y + 3 = -\dfrac{36}{23}(x - 2)$
8. $y - 3 = -\dfrac{3}{5} = (x - 2)$
9. $\dfrac{8}{3}$ feet per second down $\left(-\dfrac{8}{3}\right)$
10. Length increasing at $\dfrac{20}{11}$ feet per second
11. $L(x) = 3 + x$
12. Linearize f at $x = 1$. $L(x) = \dfrac{1}{4} + \dfrac{7}{16}(x - 1) \longrightarrow L(1.2) = .330$
13. $\dfrac{dy}{dx} = \dfrac{-2xy + y\cos xy}{x^2 - x\cos xy}$
14. $\dfrac{dy}{dx} = \dfrac{-y}{x - \sec^2 y}$
15. $\dfrac{dy}{dx} = \dfrac{\cos y}{2y + x\sin y}$
16. Linearize $f(x) = \sqrt{x}$ at $x = 81$. $L(x) = 9 + \dfrac{1}{18}(x - 81) \longrightarrow \sqrt{81.2} \approx L(81.2) = 9.011$
17. Linearize $f(x) = \sqrt[3]{x}$ at $x = 8$. $L(x) = 2 + \dfrac{1}{12}(x - 8) \longrightarrow \sqrt[3]{8.3} \approx L(8.3) = 2.025$