1.) Use any method to differentiate the following functions. You need not simplify answers.

   a.) \( y = \sqrt{x^2 - 3x - 4} \)  
   b.) \( f(x) = (x^3 + (x^2 + 1)^3)^4 \)  
   c.) \( f(x) = \frac{(x + 5)^3}{(2 - x)^4} \)

   d.) \( g(x) = \left(\frac{x + 1}{x^2 + 1}\right)^{20} \)  
   e.) \( f(x) = \sqrt{1 + \sqrt{2 + \sqrt{3 + x}}} \)  
   f.) \( y = x^3(4 - x^2)^4 \)

2.) Solve \( f'(x) = 0 \) for \( x \) and solve \( f''(x) = 0 \) for \( x \).

   a.) \( f(x) = x(x - 5)^4 \)  
   b.) \( f(x) = \frac{4x^2}{x^2 + 4} \)  
   c.) \( f(x) = x^2 - 32\sqrt{x} \)

3.) Assume that a pomegranate is projected directly upward from the ground with an initial velocity of 112 ft./sec. It can be shown that the pomegranate’s height above the ground at time \( t \) seconds is given by \( s(t) = -16t^2 + 112t \) feet.

   a.) What is the height of the pomegranate after \( t = 1 \) sec., \( t = 2 \) sec., and \( t = 5 \) sec.?
   b.) What is the velocity of the pomegranate after \( t = 1 \) sec., \( t = 2 \) sec., and \( t = 5 \) sec.?
   c.) At what time does the pomegranate reach its maximum height? What is the pomegranate’s maximum height?
   d.) How long is the pomegranate in the air? What is the pomegranate’s velocity as it strikes the ground?
   e.) What is the pomegranate’s acceleration when \( t = 1 \) sec., \( t = 2 \) sec., \( t = 5 \) sec.?

4.) Assume that \( y \) is a function of \( x \). Compute \( y' = \frac{dy}{dx} \) and \( y'' = \frac{d^2y}{dx^2} \) (You need not simplify \( y'' \)) for each equation. Write all answers in terms of \( x \) and \( y \) only.

   a.) \( y = x^2 + x \)  
   b.) \( x = y^2 - y \)  
   c.) \( x^2 + y^3 = xy \)

   d.) \( x - y^{1/3} = (x + y)^5 \)  
   e.) \( \frac{x}{2x - y} = 3 + y \)
5.) Use implicit differentiation to find the largest $y$-value in the "loop" of the Folium of Descartes, which is given by the equation $x^3 + y^3 - 3xy = 0$ (See diagram below.).

![Folium of Descartes](image)

6.) Find the slope of the graph of $xy^2 + y = 2$ at $x = 0$ and at $x = 1$. Sketch the graph near $x = 0$ and $x = 1$.

7.) The volume $V$ of a sphere is changing at the rate of $\pi$ ft.$^3$/min. At what rate is the sphere’s surface area $S$ changing when
   
   a.) $S = 4\pi$ ft.$^2$ ?  
   b.) $S = 36\pi$ ft.$^2$ ?

(RECALL: For a sphere volume $V = (4/3)\pi r^3$ and surface area $S = 4\pi r^2$.)

8.) Car B is 30 miles directly east of car A and begins moving west at 90 mph. At the same moment car A begins moving north at 60 mph. At what rate is the distance between the cars changing after $t = \frac{1}{5}$ hr.? $t = \frac{1}{3}$ hr.? 

9.) A conical tank (point down) has height 10 ft. and base radius 8 ft. Water begins flowing into the tank at the rate of $\pi$ ft.$^3$/sec. At what rate is the depth $h$ of the water changing
   
   a.) when $h = 1$ ft. ?  
   b.) when $h = 9$ ft. ?

(RECALL: For a cone volume $V = (1/3)\pi r^2h$.)

The following problem is for recreational purposes only.

10.) Find all points $(x, y)$ which are equidistant from the three given points $(0, 0)$, $(4, 0)$, and $(3, 2)$. 

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