1. (32 points) The following problems are not related.

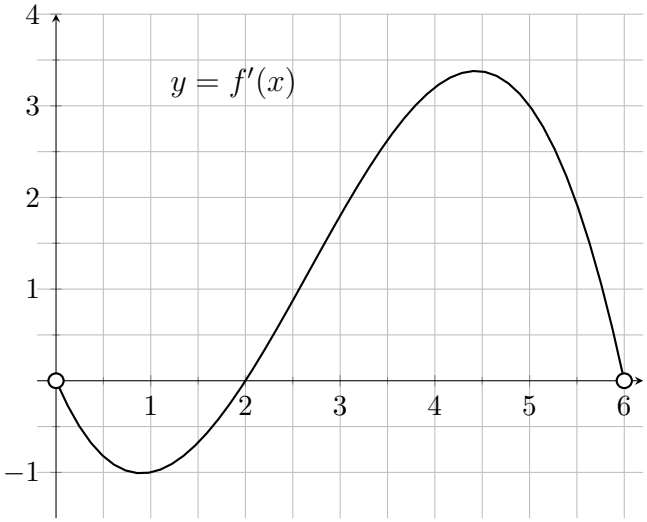
   (a) Find the derivative of $y = \dfrac{x^2 - 4x + 8\sqrt{x}}{\sqrt{x}}$. (Simplify your final answer.)

   (b) Find $g'(x)$ where $g(x) = \dfrac{(5x - \tan(x))^4}{9x^2 - 4}$. (Please do **NOT** simplify your final answer.)

   (c) Find the slope of the tangent line at the point $(3, 2)$ of $xy^2 + y^3 = 20$.

2. (12 points) Rumi is driving east **towards** an intersection at the same time Jinu is driving south **away** from the intersection. At the moment Rumi is 4 miles away from the intersection and driving at a speed of 50 miles per hour, Jinu is 6 miles away and driving at a speed of 30 miles per hour. At what rate is the distance between Rumi and Jinu changing at that moment?

3. (12 points) Answer the following questions about the function $f(x)$, whose domain is $(0, 6)$. The graph of its derivative, $f'(x)$, is shown below. The derivative $f'(x)$ has a minimum value at $(1, -1)$ and a maximum value at $(4.4, 3.4)$. No justification is necessary for your answers.



   (a) For what value(s) of x does $y = f(x)$ have horizontal tangents?

   (b) On what open interval(s) does $y = f(x)$ have negative slope?

   (c) On what open interval(s) is $f(x)$ continuous?

   (d) Find an equation for the line tangent to $y = f(x)$ at $x = 5$ given $f(5) = -4$.

   (e) Find the value of $\lim\limits_{h \to 0} \dfrac{f(1+h) - f(1)}{h}$.

   (f) On what open interval(s) is the second derivative, $f''(x)$, positive?

4. (22 points) Consider $g(x) = 4\cos x - 2\cos(2x)$.

   (a) Determine all critical numbers of $g(x)$ in the interval $[0, \pi]$.

   (b) Find the absolute maximum and absolute minimum values of $g(x)$ over the interval $[0, \pi]$. Clearly indicate the x-coordinates where these occur.

   (c) Use the Intermediate Value Theorem to show that $g(x) = 2.5$ has at least one solution. First state the hypotheses of the intermediate value theorem and confirm that they are satisfied. Then determine an interval $[a, b]$ where the solution can be found.

5. (22 points) Consider the function $f(x) = (x - 9)^{2/3}$.

   (a) i. Determine the linear approximation of $f(x)$ at $x = 17$.
   ii. Use the linear approximation from (i) to approximate $f(17.2)$.

   (b) Use the definition of the derivative to show that $f(x)$ is not differentiable at $x = 9$.