Directions: Closed book, closed notes, no calculators. Put all phones, etc., away. You will need only a pencil or pen.

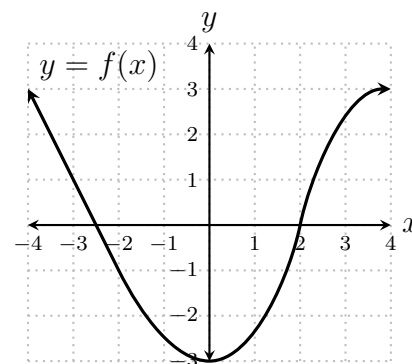1. (10 points) Answer the questions about the function f graphed below.

   (a) $\lim\limits_{h \to 0} \dfrac{f(-3+h) - f(-3)}{h} =$

   (b) $\lim\limits_{x \to \infty} f\left(\dfrac{1}{x}\right) =$

   (c) $\lim\limits_{x \to 0} \dfrac{1}{3 + f(x)} =$

   (d) $\lim\limits_{x \to 2} \dfrac{\sin\left(f(x)\right)}{f(x) + 1} =$

   (e) $\lim\limits_{x \to 2} \dfrac{\sin\left(f(x)\right)}{f(x)} =$

$y = f(x)$

2. (20 points) Find the limits

   (a) $\lim\limits_{x \to 0^+} \sin^{-1}(x - 1) =$

   (b) $\lim\limits_{x \to e} 5 \ln\left(x^3\right) =$

   (c) $\lim\limits_{x \to 3} \dfrac{x - 3}{x^2 - 7x + 12} =$

   (d) $\lim\limits_{x \to 1} \dfrac{\dfrac{1}{x} - 1}{x - 1} =$

3. (7 points) Use a **limit definition** of the derivative to find the derivative of $f(x) = \sqrt{1-x}$.

4. (7 points) An object moving on a straight line is $s(t) = t^3 - 3t^2$ feet from its starting point at time t seconds. Find its acceleration when its velocity is -3 feet per second.

5. (7 points) Suppose $f(x) = x^2 + 2x^3$ and $g(x) = x^2 - 2x^3 + 48x$. Find all x for which the tangent to $y = f(x)$ at $(x, f(x))$ is parallel to the tangent to $y = g(x)$ at $(x, g(x))$.

6. (35 points) Find the derivatives of these functions. You do **not** need to simplify your answers.

(a) $f(x) = \dfrac{\sqrt{2}}{x} + \pi x$

(b) $f(x) = \cos(x)\sin(x)$

(c) $f(x) = \cos\left(\sin(x)\right)$

(d) $f(x) = \tan^{-1}(-x)$

(e) $f(x) = \ln\left(e^{x^2-3x} + x\right)$

(f) $f(x) = \dfrac{1}{x^2 + 5x - 7}$

(g) $f(x) = \sqrt{\dfrac{x+1}{x-1}}^{\,3}$

7. (7 points) Given the equation $\dfrac{x}{y} = y^5 + x$, find y'.

8. (7 points) Find the derivative of $f(x) = x^{\ln(x)}$.