Please show all your work and circle your answer when appropriate. You do not need to simplify answers unless the problem specifies to do so.

1) Find \( \frac{1}{\sqrt{x}} \cdot \frac{d}{dx} \left( \frac{1}{\sqrt{x}} \right) \). (6 points)

2) Below are graphs of 6 functions. Some of them are continuous functions on the real line. Some of them are not. Circle those that are continuous. For those that are not continuous, draw a single arrow pointing to a feature of the graph that makes you think it's not continuous. (4 points)
3) Calculate \( \lim_{x \to 1} \frac{5x^2 + 6x + 1}{8x - 4} \) (4 points)

4) Calculate \( \lim_{x \to 1^+} \frac{x - 2}{(x - 1)^3} \) (4 points)

5) Calculate \( \lim_{x \to -2} \frac{x^3 - 5x^2 + 6x}{x^4 - 4x^2} \) (4 points)

6) Calculate \( \lim_{x \to -b} \frac{(x + b)^7 + (x + b)^{10}}{4(x + b)} \) (4 points)
7) Given the graph to the right, estimate the average rate of change between the points given by $x = 1$ and $x = 4$. (2 points)

8) Given the graph to the right, estimate the instantaneous rate of change at point given by $x = 1$. (2 points)

9) Find $\lim_{x \to \infty} x^6$ (4 points)

10) Find $\lim_{x \to -\infty} 2^x$ (4 points)

11) Find $\lim_{x \to \infty} \frac{x^2 + 5}{x^2 - 3}$ (4 points)

12) Find $\lim_{x \to -\infty} \frac{-x^3 + 2x + 4}{x^2 - 2x^3}$ (4 points)
13) Find the derivative of each of the functions below.

(a) $f(x) = 3x^5 - 2x^3$  (4 points)

(b) $f(x) = 7$  (4 points)

(c) $f(x) = \frac{x^2}{\sin(x)}$  (4 points)
14) Find the derivative of each of the functions below.

\[(d) \ f(x) = 2^x \cdot 3^x \quad (4 \text{ points})\]

\[(e) \ln(x^{34}) \quad (4 \text{ points})\]

15) Given \( f(x) = x^5 \), which of the following expressions correctly give \( f'(x) \)? Circle all that apply. (3.5 points)

\[(a) \ f'(x) = 5x^4\]

\[(b) \ f'(x) = 5x^4 \frac{dy}{dx}\]

\[(c) \ f'(x) = \lim_{h \to 0} \frac{(x + h)^5 - x^5}{h}\]

\[(d) \ f'(x) = \lim_{x \to 0} \frac{(x + h)^5 - x^5}{h}\]

\[(e) \ f'(x) = \lim_{h \to 0} \frac{(x + h)^5 - h^5}{h}\]

\[(f) \ f'(x) = \lim_{x \to 0} \frac{(x + h)^5 - h^5}{h}\]

\[(g) \ f'(x) = \lim_{b \to x} \frac{(x)^5 - b^5}{x - b}\]
16) Find \( \frac{dy}{dx} \), given that \( xy^2 + \sin(y) = x^4 + 2 \)  (6 points)

17) The distance of a train from a station is given by \( s(t) = \frac{1}{2} t^2 \). How fast is the train traveling after 60 seconds? The function \( s \) is given in feet, while \( t \) is given in seconds. (6 points)
18) Use the graph of \( y = f(x) \) below to find each of the following. (1 point each)

(a) \( \lim_{x \to -4^-} f(x) \)

(b) \( \lim_{x \to -4^+} f(x) \)

(c) \( \lim_{x \to -4} f(x) \)

(d) \( \lim_{x \to -2^-} f(x) \)

(e) \( \lim_{x \to -2^+} f(x) \)

(f) \( \lim_{x \to -2} f(x) \)

(g) \( \lim_{x \to 1^-} f(x) \)

(h) \( \lim_{x \to 1^+} f(x) \)

(i) \( \lim_{x \to 1} f(x) \)

(j) \( \lim_{x \to 2^-} f(x) \)

(k) \( \lim_{x \to 2^+} f(x) \)

(l) \( \lim_{x \to 2} f(x) \)
19) This problem is intended to test your conceptual understanding of the formal definition of a limit. We covered this in class using what we called the “\(\varepsilon - \delta\)” game. Below is a graph of a function. At \(x = 2\), we think that the limit is \(\lim_{x \to 2} f(x) = 3\). Today, our notion of closeness on the \(y\)-axis will be \(\varepsilon = \frac{1}{2}\), so we must force \(f(x)\) to be within \(\frac{1}{2}\) units of 3. This is illustrated using the dotted lines on the graph below. Find the corresponding notion of closeness on the \(x\)-axis that is required, and illustrate it on the graph. (6.5 points)