Please read the following instructions carefully:

- There are **five problems** in this exam.
- There is **one bonus** problem.
- You have **80 minutes** to complete the exam
- The point distribution is given in the table below.
- Please write each solution on a separate page.
- You **must have your camera on** during the exam.
- This is a **closed book, closed notes exam**. You must not consult any resource while attempting the exam.
- Upload your work to Gradescope.
- Submitting the exam implies you abide by the honor pledge stated below:

I pledge on my honor that I have not given or received any unauthorized assistance on this quiz/examination

Question:	1	2	3	4	5	6	Total
Points:	10	10	10	10	10	2	52

1. (**Short Questions**) Please answer each of the following five questions:
   (a) (2 points) Solve for x in the following equation:
   $$\frac{x^4 x^2}{x^{10}} = 16$$
   (b) (2 points) Fill in the blanks:
   "If a function has a local minimum at $x = x_0$, then the derivative of $f(x)$, denoted as $f'(x)$, switches from being _____ for $x < x_0$ to being _____ for $x > x_0$."
   (c) (2 points) If the revenue from selling x objects is $R(x)$ (measured in dollars), and we know that $R(20) = 1000$ and $R'(20) = 100$, estimate the value of $R(18)$.
   (d) (2 points) Which of the following functions (there may be more than one) has an inflection point? Choose all the correct answers.

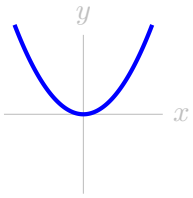


Figure 1: (a)

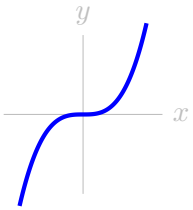


Figure 2: (b)

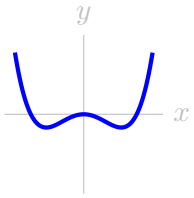


Figure 3: (c)

   (e) (2 points) Mark the following statements as true or false.
   - (True/False) The derivative of a non-vertical, straight line is a constant number.
   - (True/False) The tangent line to a function at a given point always intersects the function at exactly one point.
   - (True/False) A function with a constant rate of change will have a zero derivative everywhere.

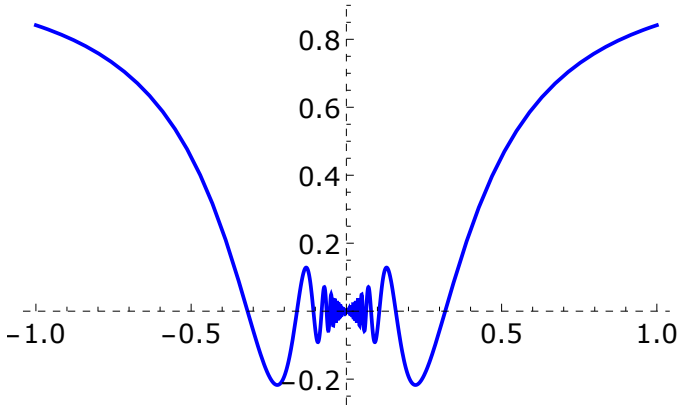
2. (**Derivatives**) Consider the function $f(x) = (x^2 + 1)^4$.
   (a) (5 points) Compute the derivative $f'(x)$. You do not need to simplify your answer.
   (b) (5 points) Determine the equation of the tangent line to $y = f(x)$ at $x = 1$.

3. (**Curve Sketching**) Let $f(x) = x^4 - 4x^3$.
   (a) (5 points) Find the critical points of $f(x)$ and classify them as relative minima/maxima.
   (b) (2 points) Find the inflection points of $f(x)$.
   (c) (3 points) Sketch the graph of $f(x)$.

4. (**Kinematics with Calculus**) We throw a stone in the air, and its height after t seconds is described by the function
   $$h(t) = -16(t^2 - 2t - 3),$$
   measured in feet.
   (a) (5 points) Find the velocity of the ball when the stone hits the ground.
   (b) (5 points) Find the maximum height of the ball.

5. (10 points) (**Optimization with Calculus**) You want to build a closed rectangular box with square base, and with volume 24 cubic feet. The top costs 5 dollars per square foot, and the sides and base cost 1 dollar per square foot. What are the dimensions of the box that you can build for the minimum cost? (Give the length, width, and height as your answer.) Show the work that confirms that your answer is indeed a minimum.

6. (2 points (bonus)) (**ChatGPT vs. MATH 120**) Please answer the following bonus questions:
   (a) (1 point) How valuable do you find learning calculus, particularly in the era of ChatGPT (and AI more generally)? Is it worth the intellectual investment? Feel free to give your honest opinion and get a free point in return.
   (b) (1 point) Let's put your claim and ChatGPT to test. Consider the graph of a function below:



I asked ChatGPT twice to compute $f'(0)$. It answered that $f'(0) = 0$ on the first try and that $f'(0)$ is undefined on the second try. What do you think happened? What do you think is the correct answer? Zero, undefined or something else? Would you be willing to amend your claim to (a) on the basis of this experiment? Why or why not?