1. (4 pts. each) Two cars start from rest at a traffic light and accelerate for several minutes. The figure below shows their velocities (in feet per minute) as a function of time (in minutes).

(a) Which car is accelerating faster after one minute?

(b) Which car is ahead after one minute?

(c) Which car is ahead after two minutes?
2. (4 pts. each) Let \( f(x) = 2x^3 - 13x^2 + 22x - 8 \).

(a) Explain why the function \( f \) must have a root in the interval \((0, 1)\).

(b) Explain why the function \( f \) must have a root in the interval \((1, 3)\).

(c) Using parts (a) and (b), explain why there must be a stationary point in the interval \([0, 3]\).

(d) Explain why \( f \) must attain a maximum value on the interval \([0, 3]\), and find this value.
3. (5 pts each) For each of the following problems, find the equation of the line tangent to the graph at the given point.

(a) \( y \sin 2x = x \cos 2y \) at the point \((\pi/2, \pi/4)\).

(b) \( y = \arctan(x^2) \) at the point \((1, \pi/4)\).

(c) \( y = \int_0^x \frac{3t^2}{1 + t^3} dt \) at the point \((1, \ln 2)\).
4. (4 pts each) Evaluate the following limits.

(a) \( \lim_{x \to \infty} \frac{\ln \sqrt{x}}{x^2} \)

(b) \( \lim_{x \to 0} \frac{\sec x}{1 - \sin x} \)

5. (5 pts. each) Evaluate the following integrals:

(a) \( \int_{1}^{2} (8x^3 + 3x^2) \, dx \)

(b) \( \int_{0}^{1} \sin(3\pi x) \, dx \)
6. (4 pts each) Consider the function \( h(x) = x^2 - x \) on the interval \([0, 2]\). Below is the graph of \( h \).

(a) Partition the interval into four equal subintervals and use left approximating sums to compute an estimate of \( \int_{0}^{2} h(x) \, dx \). Make sure you draw the rectangles in the picture above.

(b) Use the Fundamental Theorem of Calculus to calculate the exact value of the integral \( \int_{0}^{2} h(x) \, dx \).

(c) How do the quantities in (a) and (b) compare to each other? Explain the limit definition of the integral using this example.
7. (3 pts each) Let \( G(x) = \int_0^x g(t) \, dt \) where \( g(t) \) is the function shown in the figure. Answer the following questions about \( G \). (You may use estimates if you’re not sure of the exact values.)

(a) What is \( G(-2) \)? \( G(1) \)? \( G(3) \)?

(b) What is \( G'(1) \)? What is \( G''(1) \)?

(c) Where are the stationary points of \( G \)?

(d) On what intervals is \( G \) increasing? On what intervals is \( G \) decreasing?

(e) What are the inflection points of \( G \)?

(f) On what intervals is \( G \) concave up? On what intervals is \( G \) concave down?
8. (9 pts) A balloon is rising at a constant speed of 5 ft/s. A boy is cycling along a straight road at a speed of 15 ft/sec. When he passes under the balloon, it is 45 ft above him. How fast is the distance between the boy and the balloon increasing 3 seconds later?