- On the front of your blue book print (1) your name, (2) your student ID number, (3) your discussion section number, and (4) a grading table.
- Show all work in your blue book and BOX IN YOUR FINAL ANSWERS where appropriate.
- Please start each problem on a new page. There are a total of **eight** problems on both sides of this paper and a total of **150** points.
- NO books, notes, crib sheets, calculators or any other electronic devices are allowed.

Show your reasoning clearly for problems 1—7. A correct answer with no supporting work may receive no credit while an incorrect answer with some correct work may receive partial credit.

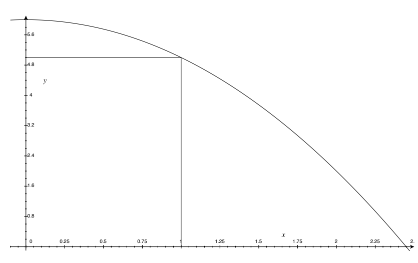
1. Solve the following unrelated problems.
   (a) (7 pts) Evaluate $\displaystyle\int \frac{xe^x - x + 1}{x}\,dx$.
   (b) (4 pts) The world population is 6.07 billions in year 2000, and it is increasing at a rate of $r(t)$ billions per year t years after 2000. Write down an expression for what the world population will be in 2010.
   (c) (9 pts) Calculate the exact area between the x–axis and the curve $y = \sin^2(x)\cos(x)$ between $x = 0$ and $x = \dfrac{\pi}{2}$.

2. (20 pts: 2, 3, 5, 10) Find the following limits if they exist. If they do not, explain why not.
   (a) $\displaystyle\lim_{x\to 0} \frac{1}{x-2}$ (b) $\displaystyle\lim_{x\to 0^-} \frac{1+x}{x}$ (d) $\displaystyle\lim_{x\to 0} \frac{2x^2+6x}{3x}$ (d) $\displaystyle\lim_{x\to 0} \left(\frac{1}{\sin(x)} - \frac{1}{x}\right)$

3. Solve the following unrelated problems.
   (a) (8 pts) Find the tangent line approximation to the function $y = \sqrt{1+x}$ at $x = 3$.
   (b) (7 pts) Evaluate $\displaystyle\frac{\mathrm{d}}{\mathrm{d}x}\int_{\cos(x)}^{3} e^{-t^2}\,\mathrm{d}t$.

4. (15 pts) A stone thrown upward from the top of a 320–foot cliff at 64 ft/sec eventually falls to the beach below. Recall that $g = 32$ ft/sec^2 on the surface of the earth. (If you quote physics formula(s), prove those formula(s) first using calculus.)
   (a) What is the maximum height the stone reaches?
   (b) What is the velocity of the stone when it hits the beach?

5. (15 points) A rectangle has one side on the x–axis, one side on the y–axis, one vertex at the origin and one on the parabola $y = 6 - x^2$. Find the maximum possible area.



6. (10 pts) The radius of a spherical balloon is increasing by 2 cm/sec. At what rate is air being blown into the balloon at the moment when the radius is 10 cm? Give units in your answer.

7. (25 points total) Consider the function

$$f(x) = \frac{x-1}{x^2}.$$

   (a) What is the domain of $f(x)$?

   (b) Is f even, odd, or neither? Why?

   (c) Find all intercepts.

   (d) On what interval(s) is f increasing? decreasing? Find the coordinates (both x and y) of the local max/min of $f(x)$ if there exist any.

   (e) On what interval(s) is f concave up? concave down? Find the coordinates (both x and y) of the inflection points of $f(x)$ if there exist any.

   (f) Find all asymptotes, both vertical and horizontal ones, if there exist any.

   (g) Sketch the graph of $f(x)$. Make sure that it reflects your answers to all previous parts.

Only the final answer will be graded for problems 8. No justification is needed.

8. (30 pts: 3 each) Determine the following statements are true or false. **Write out the whole word "TRUE" or "FALSE" for each problem.**

   (a) An antiderivative of e^{-x^2} is $e^{-x^2}/2x$.

   (b) Every continuous function has an antiderivative.

   (c) The units for a definite integral of a function $f(x)$ are the same as the units for $f(x)$.

   (d) If $\int_0^2 f(x)\,\mathrm{d}x = 6$, then $\int_0^4 f(x)\,\mathrm{d}x = 12$.

   (e) If $f'(p) = 0$, then $f(x)$ has either a local maximum or a local minimum at $x = p$.

   (f) If $f(1) > 0$ and $f(3) < 0$, then there exists a number c between 1 and 3 such that $f(c) = 0$.

   (g) If $F(x)$ and $G(x)$ are both antiderivatives of $f(x)$ on an interval then $F(x) - G(x)$ is a constant function.

   (h) If $f(x) > 0$ for all x then every solution of the differential equation $\frac{\mathrm{d}y}{\mathrm{d}x} = f(x)$ is an increasing function.

   (i) $y = xe^{-x} - 3$ is a solution of the initial value problem

$$\frac{\mathrm{d}y}{\mathrm{d}x} = (1-x)e^{-x}, \qquad y(0) = -3.$$

   (j) If a function is not differentiable, then it is not continuous.