1. (10 points) Write your guess for the form of the partial fraction decomposition of

$$\frac{1}{x^3 - x}$$

Do *not* solve for the constants. Do *not* integrate.

2. (10 points) Evaluate the improper integral $\int_0^\infty \frac{dx}{(x+1)^2}$

Hint: partial fractions does *not* make sense here.

3. (10 points) Solve the differential equation $y' = xe^y$ for y as a function of x subject to the condition $y(1) = 0$.

4. (20 points) Consider the region in the first quadrant bounded by the x-axis, the y-axis, the line $x = 2$, and the curve $y = 1/(1 + x^2)$. Find the volume of the solid obtained by rotating this region about the y-axis. Simplify your answer.

5. (20 points) A tank holds $20g$ of pure water. A solution containing $3lb/g$ of salt enters the tank at a rate of $2g/m$. The contents of the tank are mixed and drain from the tank at a rate of $3g/m$.
   (a) When will the tank be empty?
   (b) When will the tank be half-empty?
   (c) If $S(t)$ represents the amount of salt in the tank at time t, write the differential equation that S satisfies.
   (d) When the tank is half-empty, how much salt is in the tank? You do *not* need to simplify your answer.

6. (10 points) Suppose that the consumer's demand for some commodity is described by $D(q) = 50 - 3q - q^2$. Suppose that the present market quantity is $q_0 = 3$. Find the consumer surplus for this market. You do *not* need to simplify your answer.

7. (10 points) Evaluate the integral

$$\int \sin^{-1} x \, dx$$

Hint: use the fact that

$$\frac{d}{dx} \sin^{-1} x = \frac{1}{\sqrt{1-x^2}}$$