1. (10 points) If \( f(x) = \ln\left(\frac{x - 2}{2x + 1}\right) \) then find a formula for the inverse function \( f^{-1}(x) \).

2. (5 points) Sketch the graph of \( y = \arctan(x) \). Indicate on your graph both coordinates of the points of intersection with the vertical lines \( x = 1 \) and \( x = -1 \).

3. (20 points) Compute each of the following integrals:
   (a) \( \int 2x + 1 \, dx \)
   (b) \( \int \sec(\theta) \tan(\theta) \, d\theta \)
   (c) \( \int x \sin(x) \, dx \)
   (d) \( \int x^2 \, dx \)
   (e) \( \int x \, dx \)
   (f) \( \int_{\ln(3/8)}^{\ln(\pi/\sqrt{2})} \cos(2e^x) \, dx \)

4. (15 points) (a) Find the actual partial fractions decomposition for \( f(x) = \frac{x}{x^2 - 3x - 18} \).
   (b) Use your answer to (a) to work the integral \( \int f(x) \, dx \).
   (c) Find the actual partial fractions decomposition for \( g(x) = \frac{x^2 - 26x - 54}{x^2 - 3x - 18} \).

5. (8 points) Determine the limits:
   (a) \( \lim_{x \to \infty} \frac{\ln(x + 1)}{x^2 + 1} \)
   (b) \( \lim_{x \to \infty} g(x) \) where \( g(x) = (x + 1)^{1/(x^2 + 1)} \) (Hint: the two limits are related.)

6. (8 points) Let \( f(x) = e^{-x^2 + x - 1} \). (a) Use calculus to show that \( f(x) \) has exactly one local extreme, and find its value. (b) Use your answer to (a) to describe the range of \( f \).

7. (12 points) Work the integral \( \int \frac{1}{x^2 + 1} \, dx \). Use this problem to illustrate the technique of trig substitution, and the use of half-angle formulas and right triangle analysis.

8. (10 points) Find the area inside the ellipse with equation \( \frac{y^2}{2} + \frac{x^2}{4} = 1 \). [picture drawn on board.]

9. (12 points) Let \( R \) be the region in the \( xy \)-plane bounded by the curves \( y = 1/x, \, y = 1, \, x = 1 \) and \( x = 2 \). Let \( S \) be the solid obtained by rotating \( R \) around the \( x \)-axis.
   (a) Sketch the region \( R \) (b) Express the area of \( R \) as a definite integral.
   (c) Express the volume of \( S \) as a definite integral using the washer method.
   (d) Express the volume of \( S \) as a definite integral using the shell method.