1. Find all values for p for which the integral $\int_1^\infty \frac{1}{x^p}\,dx$ converges. Note: The parameter p can be any real number: positive or negative, rational or irrational. Also be careful to check for special cases.

2. (Modified from the 2007 AP Calculus AB exam) Let R be the region in the first and second quadrants that is bounded above by the graph of $y = \frac{20}{1+x^2}$ and below by the horizontal line $y = 2$. Let S be the region in the first quadrant bounded above by $y = \frac{20}{1+x^2}$ and below by the x-axis. (This problem continues on the following pages.)

   (a) Evaluate $\int \frac{1}{(1+x^2)^2}\,dx$

(b) Evaluate $\int_0^3 \frac{1}{(1+x^2)^2}\,dx$.

(c) Evaluate $\int_0^\infty \frac{1}{(1+x^2)^2}\,dx$.

(d) Find the volume of the solid generated when R is rotated about the x-axis.

(e) Find the volume of the solid generated when R is rotated about the y-axis.

(f) Find the volume of the solid generated when S is rotated about the x-axis.

(g) Find the volume of the solid generated when S is rotated about the y-axis.

(h) Setup, but do not evaluate, an integral expression that gives the length of the boundary curve for the region R.

(i) Setup, but do not evaluate, an integral expression that gives the surface area of the solid that is formed when the region R is rotated about the line $y = 2$.

(j) The region R is the base of a solid. For this solid, the cross-sections perpendicular to the x-axis are semicircles. Find the volume of this solid.