

**Instructions:** Show all work. Use exact answers unless otherwise asked to round.

1. Find the Jacobian for the transformation given by  $x = uv, y = \frac{u}{v}$ .
2. Determine the change of variables needed for the region bounded by  $y = 2x - 1, y = 2x + 1, y = 1 - x, y = 3 - x$ . Sketch the region in the plane before  $(xy)$  and after  $(uv)$ .
3. Evaluate the integral  $\iint_R xy dA$  over the region  $R$  bounded by the curves  $y = x, y = 3x, xy = 1, xy = 3$  using the transformations  $x = \sqrt{\frac{v}{u}}, y = \sqrt{uv}$ . Sketch the region before the transformation.
4. A ball is thrown eastward into the air from the origin (positive x-axis). The initial velocity is  $\langle 50, 0, 80 \rangle$ , with speed measured in feet per second. The spin of the ball results in a southward acceleration of  $4 \text{ ft/sec}^2$ , so the acceleration vector is  $\vec{a} = \langle 0, -4, -32 \rangle$ . Where does the ball land, and with what speed?