Challenge Problem 2

A cylindrical bucket of radius $a$ and height $h$ has a hole in the bottom. The radius of the hole is $r$. How long does it take the bucket to drain? Do not ignore the velocity of the water in the bucket. Assume ideal water in streamline flow.

Use Bernoulli’s equation and the continuity equation. You’ll end up with an equation that looks like:

$$v_b = -\frac{dy}{dt} = f(y)$$

Now use the usual trick of separation of variables:

$$\frac{dy}{dt} = -f(y)$$
$$\frac{dy}{f(y)} = -dt$$
$$\int dt = -\int \frac{dy}{f(y)}$$