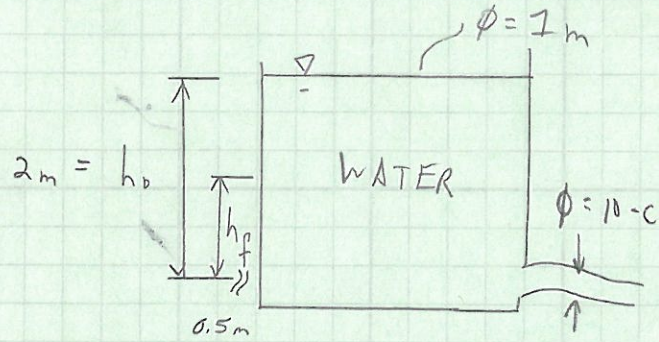
A 10-cm ϕ jet of water issues from a 1-m ϕ tank, as shown. Assume the velocity in the jet is $\sqrt{2gh}$ m/sec.

How long will it take for the water surface in the tank to drop from $h_0 = 2m$ to $h_f = 0.5m$



Since γ is constant we'll use

Q instead of γQ

↑ volume per time

↑ mass per time

$$Vel_{out} = \sqrt{2gh}$$

$$Q_{out} = V_{out} A = \sqrt{2gh}\,\pi(.05m)^2 = .035\,h^{1/2}$$

$$Q_{out} = .035h^{1/2} \qquad (Q \text{ is a function of ht.})$$

$$\text{Discharge Rate of tank} = \frac{dh}{dt}A = \pi(0.5m)^2\frac{dh}{dt} = 0.785\frac{dh}{dt}$$

(Vol/time; Area-constant)

Q_{out} = Discharge Rate of Tank

$$0.035\,h^{1/2} = 0.785\frac{dh}{dt}$$

$$\int_0^t dt = 22.43\int_{h_f}^{h_0} h^{-1/2}\,dh \qquad t = 0 \text{ when } h = h_0$$

$$t = \frac{22.43\,h^{1/2}}{0.5}\Bigg|_{0.5}^{2}$$

$$t = 44.8\left(\sqrt{2} - \sqrt{0.5}\right)$$

$$\boxed{t = 31.7 \text{ sec}}$$