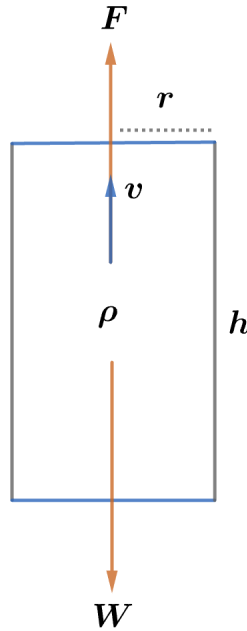# 2012 F=ma Exam: Problem 19

Kevin S. Huang

The motor has to supply a force F on the water in the pipe that balances its weight W since the water is moving at constant speed. Because the pipe is a cylinder, the mass of the water is

$$M = \rho V = \rho(\pi r^2 h)$$

Then

$$F = W = Mg = \pi \rho r^2 hg$$

The power required to pump the water at velocity v is given by

$$P = Fv = \pi \rho r^2 hgv$$

so the radius of the pipe is

$$r = \sqrt{\frac{P}{\pi \rho hgv}} = \sqrt{\frac{1500\,\text{W}}{\pi(1000\,\text{kg/m}^3)(2\,\text{m})(10\,\text{m/s}^2)(2.5\,\text{m/s})}} = 10\,\text{cm}$$

Thus, the answer is $\boxed{\text{D}}$.