33.1 A 10 hp pump with 90% efficiency transports water to an elevation of $200ft$ above the pump. What volume of water is transported in a 1 hour period?

A. $300\,gallons$

B. $1400\,gallons$

C. $10,700\,gallons$

D. $11,900\,gallons$

Start by considering the relationship between power, work, and energy. Note that work and energy have common units. Work is typically represented as a force exerted over a distance. For a mass of water being raised by a certain distance, it must experience an increase in Potential Energy.

$$PE = \frac{mgh}{g_c}$$

Use $m = \rho V$.

$$PE = \frac{mgh}{g_c} = \frac{\rho V g h}{g_c}$$

Equate the potential energy added to the water to the amount of work done, which is a function of the power and the time.

$$P = \frac{W}{t} \rightarrow W = Pt$$

Since the pump has a stated efficiency, apply a multiplier with the pump horsepower rating.

$$W = \eta P t$$

Equate the work and potential energy.

$$\eta P t = \frac{\rho V g h}{g_c}$$

Solve for volume, then substitute values and solve.

$$V = \frac{\eta P t g_c}{\rho g h} = \frac{(0.9)\,(10hp)\left(550\frac{ft-lb_f}{sec-hp}\right)(3600sec)\left(32.2\frac{lb_m-ft}{lb_f-sec^2}\right)\left(7.48\frac{gallons}{ft^3}\right)}{\left(62.4\frac{lb_m}{ft^3}\right)\left(32.2\frac{ft}{sec^2}\right)(200ft)} = 10,680gallons$$

Answer C