36.6 A pump delivers 200 GPM of water at 130 feet of total dynamic head, operating from 7am-7pm Monday through Friday. The pump is 80% efficient and the motor is 93% efficient. What is the annual cost of operation at $0.13 per kWh?

A. $2670

B. $3490

C. $3750

D. $5030

The cost is a function of electrical power and time, and electrical power is a function of hydraulic horsepower (aka water horsepower i.e. whp) and efficiency. Start by calculating the water horsepower based on volume flow rate and feet of head provided by the pump:

$$whp = \frac{Q\Delta h}{3960} = \frac{(200)(130)}{3960} = 6.566hp$$

Note the volume and head units must be in GPM and ft, respectively, to use this "rule of thumb" equation. Therefore units need not be shown, provided they are confirmed to be correct prior to use.

Recall that brake horsepower, bhp, depends on water horsepower, whp, and the efficiency of the pump, η_p. Similarly, the electrical power, $\dot{W}$,depends on brake horsepower, bhp, and motor efficiency, η_m.

$$bhp = \frac{whp}{\eta_p}$$

$$\dot{W} = \frac{bhp}{\eta_m}$$

Put these together, substitute, solve, and convert to KW:

$$\dot{W} = \frac{whp}{\eta_p \eta_m} = \frac{6.566hp}{(.8)(.93)}\left(\frac{.746KW}{1hp}\right) = 6.58KW$$

To find the annual cost, multiply by time and the unit rate of electricity:

$$Cost = (6.58KW)\left(\frac{12hrs}{day}\right)\left(\frac{5days}{wk}\right)\left(\frac{52wks}{yr}\right)\left(\frac{\$0.13}{KWH}\right) = \$2669\,per\,year$$

Answer A