36.7 **A $7.5hp$ single phase $230V$ motor drawing $40A$ at full load is located $50\,meters$ from the voltage source. The motor is wired with $8AWG$ wire which has a cross sectional area of $16,509\,circular\,mils$ ($1\,circular\,mil = 5.066 \times 10^{-10} m^2$) and a resistivity of $1.724 \times 10^{-8} \Omega \cdot m$. What is the percent voltage drop for the wiring in the circuit?**

A. 1%

B. 2%

C. 3%

D. 4%

The electrical resistance attributable to the wiring is the result of copper's resistivity, which is an intrinsic material property, and the length and gauge of the wire. The formula for resistivity can be rearranged to solve for the total resistance.

$$\rho = \frac{RA}{L}$$

$$R = \frac{\rho L}{A}$$

Since the motor is $50ft$ from the voltage source, a sufficient length of wire must be provided to make a round trip from the source to the load and back. Therefore, the total length is given by:

$$L = 2(50m) = 100m$$

Determine the resistance.

$$R = \frac{\rho L}{A} = \frac{\left(1.724 \times 10^{-8} \Omega \cdot m\right)(100m)}{(16,509 cmil)\left(5.066 \times 10^{-10} \frac{m^2}{cmil}\right)} = 0.206\Omega$$

Find the voltage drop due to the wire by applying Ohm's Law.

$$V_{drop} = IR = (40A)(0.206\Omega) = 8.25V$$

Determine the percentage voltage drop by dividing by the nominal voltage of the source.

$$\frac{V_{drop}}{V_{source}} = \frac{8.25V}{230V} = 0.036 = 3.6\%$$

Answer D