Wire gauge is the resistance per unit length in decibels, where 10 AWG wire has 1 ohm per thousand feet resistance. Therefore, every increase of 3 AWG ($\approx 10 \times \log_{10} 2$) increases the resistance per unit length by a factor of two. The general formula for the gauge of wire given the resistance per thousand feet R is

$$\text{AWG} = 10 \times \log_{10} R + 10$$

or

$$R = 10^{\frac{\text{AWG}-10}{10}}$$

ohms per thousand feet.

Wire of length L, cross-sectional area A and conductivity σ has resistance $L/\sigma A$, or resisitance per unit length $R = 1/\sigma A$. Using the formula above gives

$$A \propto 10^{-\frac{\text{AWG}-10}{10}} \qquad \text{or} \qquad D \propto 10^{-\frac{\text{AWG}-10}{20}}$$

where D is the diameter of the wire. Using the fact that 10 AWG wire has a diameter of 0.10 inches gives

$$D = 10^{-\frac{\text{AWG}+10}{20}}.$$

Solving this equation for wire gauge given diameter

$$\text{AWG} = -20 \times \log_{10} D - 10.$$

A reasonable value for the current carrying capacity of a wire can be estimated from the rule that the cross-sectional area should be 700 "circular mils" per amp. The (rather perverse) definition of a circular area measured in "circular mils" is that it is the area of the square whose side has the same length as the diameter of the circle, i.e. just the diameter (in mils or 0.001 inch) squared. The current carrying capacity in amps is therefore (with D measured in inches)

$$I = \frac{10^6 \times D^2}{700}$$

or in terms of AWG

$$I = \frac{1}{700} \times 10^{\frac{50-\text{AWG}}{10}}$$

solving for AWG in terms of current

$$\text{AWG} = 50 - 10 \times \log_{10}(700 \times I)$$

The power dissipated in the wire per foot is

$$P = I^2 R.$$

Substituting I and R given by the formulas above gives

$$P = \left(\frac{1}{700}\right)^2 \times 10^{\frac{90-\text{AWG}}{10}}$$

Watts per thousand feet.