Theme Music: Fleetwood Mac
Silver Springs
Cartoon: Pat Brady
Rose is Rose
### Quiz 6

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**Avg. = 5.6**

![Bar chart showing quiz results](image)
Foothold ideas: Kirchhoff’s principles

1. **Flow rule**: The total amount of current flowing into any volume in an electrical network equals the amount flowing out.

2. **Ohm’s law**: in a resistor, \( \Delta V = IR \)

3. **Loop rule**: Following around any loop in an electrical network the potential has to come back to the same value (sum of drops = sum of rises).

   - The Constant Potential Corollary: Along any part of a circuit with 0 resistance, \( \Delta V = 0 \), i.e., \( V \) is constant.
Foothold ideas: Harmonic oscillation

- There is an equilibrium (balance) point where the mass can stay without moving.
- Whichever way the mass moves, the force is in the direction of pushing it back to its equilibrium position.
- When it gets back to its equilibrium, it’s still moving so it overshoots.
Model system: Mass on a Spring

- Consider a cart of mass $m$ attached to a light (mass of spring $<< m$) spring.
- Choose the coordinate system so that when the cart is at 0 the spring is at its rest length.
- Recall the properties of a (nice) spring.
  - When it is pulled or pushed on both ends it changes its length.

$$T = k\Delta l$$
Analyzing the forces: cart & spring

**FBD:**
What are the forces acting on the cart?

- $N_{t\rightarrow c}$
- $T_{s\rightarrow c}$
- $W_{e\rightarrow c}$
Doing the Math: The Equation of Motion

- The N2 equation for the cart is

\[ a = \frac{F_{\text{net}}}{m} = -kx/m = -\left(\frac{k}{m}\right)x \]

- What kind of a quantity is k/m?

\[
\begin{bmatrix}
k \\
m
\end{bmatrix} =
\]
Mathematical structure

- Express \( a = \frac{F_{\text{net}}}{m} \) in terms of derivatives.

\[
\frac{d^2x}{dt^2} = -\omega_0^2 x
\]

- Except for the constant, this is like having a functions that is its own second derivative.

\[
\frac{d^2f}{dt^2} = -f
\]

- In calculus, we learn that \( \sin(t) \) and \( \cos(t) \) work like this. How about: \( x = \cos t \)?