Physics 152

Lecture 29

Monday, April 9, 2007

- Kirchhoff's Rules
- RC circuits

[Image of Kirchhoff's Rules]

Announcements

- Help sessions
  - W 9 - 10 pm in NSC 119
- MasteringPhysics
  - Hwk #4 due Wed., Apr. 11
  - WU #18 due Wed., Apr. 11
  - WU #19 due Fri., April 13
- Exam - Thurs., April 12

[Image of Announcements]

Ch. 31: Fundamentals of Circuits

**Junction Rule**

1) The sum of the currents entering a junction must equal the sum of currents leaving a junction. (Conservation of Charge)

**Loop Rule**

2) The sum of potential differences across all the elements on any closed loop in a circuit must be zero. (Conservation of Energy)

[Image of Junction Rule and Loop Rule]

You will only find junction points in parallel circuits. You can use them to identify the parts of a more complicated circuit that are wired in parallel.

[Image of junction points]

This circuit has two junction points. Therefore, we can only use the junction rule ONE time.
For Applying Kirchhoff’s Rules

A) assign a direction to the current in each branch of the circuit. Just GUESS!! If your guess is incorrect, the current will come out as a negative number, but the magnitude will still be correct!

B) when applying the loop rule, you must choose a consistent direction in which to proceed around the loop (either clockwise or counterclockwise, your choice, but stick to it).

When you encounter a resistor in the direction of the current, the voltage drop is $\Delta V = -IR$.

When you encounter a resistor opposite the current, the voltage drop is $\Delta V = +IR$.

When you encounter an emf in the direction you’re going around the loop, the voltage change is $V_1 - V_2$.

When you encounter an emf opposite the direction you’re going, the voltage change is $-V_1$.

You Guessed It!

You Guessed It!

The junction rule can only be applied $n-1$ times in a circuit with $n$ junctions.

Each new equation you write must contain a current that you haven’t yet used.

To solve a system of equations with $k$ unknown quantities, you need $k$ independent equations.

Find the currents in each branch of this circuit.

Worksheet Problem #2
So far we've looked at circuits in which the currents are constant. These circuits have involved only resistors and batteries.

What happens if we put a capacitor into one of these circuits?

Charge begins to build up on the capacitor. The more charge on the capacitor, the more work it takes to bring up the next bit of charge... …the more slowly the capacitor will charge.

When the capacitor is fully charged (i.e., \( Q = CV \)), the current will stop flowing.

\[
q(t) = Q(1 - e^{-t/\tau})
\]

\( \tau = \text{the time constant} = RC \)

Picking the integration constant to satisfy the initial condition \( q(0) = 0 \)
You might be saying to yourself, “I have a hard time believing that $R$ times $C$ gives me units of time!”

$\tau = R \cdot C$

$\tau = [R] \cdot [C]$

Yup! $[\tau] = \text{seconds}$!
Start with a capacitor with charge $Q_0$ on it. What happens when I close the switch now?

The less charge on the capacitor, the smaller the voltage drop, the smaller the current.

So I expect the magnitude of the current to decrease as the capacitor discharges, eventually reaching 0.

Worksheet Problem #5

Worksheet Problem #6