Circuits

I. Combining Resistors in Parallel and Series

A. Series – Placing resistors in series makes a __________________________ resistor.

\[ R_{eq} = R_1 + R_2 \]

Analogous to making the length __________________!!!
B. Parallel -

Placing resistors in parallel creates a __________ resistor.

Analogous to making the area ______________!!!
C. Special Cases - Short Cuts

1. For TWO resistors in parallel, we have

2. For N identical resistors in parallel, we have
EXAMPLE 1: What is the resistance between the terminals A and D in the following circuit?

SOLUTION:

The two 4 kΩ resistors are in ____________________________.

Thus, we have

These three resistors are now in ____________________________.

Thus, we have
**EXAMPLE 2:** What is the resistance between terminals A and B in the following circuit?

**SOLUTION:**
EXAMPLE 3: What is the resistance between terminals A and B in the following circuit?

SOLUTION:
II. Short and Open Circuits

A. Definition of a Short Circuit:

A short circuit is when __________  ___________________

is dropped across a circuit element.

B. Special Case (Resistor):

For a resistive element, a short circuit also implies by ohm’s

law that there is ________  ___________________.

EXAMPLE:

\[ V = I \times R \]
C. **Definition of an Open Circuit:**

An open circuit is when ___________  _________________

flows through a circuit element.

D. **Special Case (Resistor):**

For a resistive element, an open circuit also implies by ohm’s law that there is _________________  ________________.

**EXAMPLE:**

\[
I = \frac{V_{AB}}{R}
\]

\[
\begin{array}{c}
& + & V_{AB} & - \\
& A & & B \\
\end{array}
\]
III. **Voltage and Current Divider Circuits**

Knowledge of the voltage divider and current divider circuits can be extremely useful both in designing and analyzing electronic circuits because:

1) They often allow us to use a single voltage or current supply to all the necessary voltages and currents required;

2) These circuits are so common that knowledge of their formulas can greatly improve both our understanding and speed in analyzing electric circuits.

A. **Voltage Divider Circuit (Series)**

![Voltage Divider Circuit (Series)](image-url)
B. Current Divider Circuit (Parallel)
IV. Battery or Power Supply – Source of EMF

A. A battery is a ________________ of ______________ ______________. It is a __________ with its own energy supply.

B. Schematic Symbol for Ideal Battery

C. Schematic Symbol for a Real Battery
NOTE: Any circuit (no matter how complex) can be reduced to a single voltage source in series with a resistor as long as we generalize resistance to include complex numbers (called impedance). This is known as the Thevinen’s equivalent circuit and is extremely powerful in solving more complicated circuits and in design.

D. Effect of Internal Resistance – $R_{\text{int}}$

In an electrical circuit, it is important for the internal resistance of a battery to be much smaller than the load resistance connected to the battery. This is to ensure that most of the energy is supplied to the load and not wasted as heat inside the battery. The following example should demonstrate this point.
EXAMPLE: For a 13 volt battery with an internal resistance of 1 \( \Omega \), what voltage will you measure at the battery terminals when a) the battery terminals are left open; b) a 12 \( \Omega \) resistor is connected between the terminals.

SOLUTION:

a)

b)