Day 3

Capacitors
You have a 9V battery that you would like to use to power a device that needs 4.5V. What value of R should you use to avoid dissipating more than 10 mW?

A. 1 kΩ  
B. 10 kΩ  
C. 100 kΩ  
D. 1 MΩ
Review

You have a 9V battery that you would like to use to power a device that needs 4.5 V.

What value of R should you use to avoid dissipating more than 10 mW?

A. 1 kΩ
B. 10 kΩ
C. 100 kΩ
D. 1 MΩ

\[ P = IV = \frac{V^2}{R_{\text{tot}}} \]
Review

If you attach a microprocessor that requires a supply voltage $4 < V < 6$, how much effective resistance can this device have?

What value of $R_{\text{load}}$ will keep $V_{\text{load}}$ over 4V?

A. 1 kΩ  
B. 10 kΩ  
C. 100 kΩ  
D. 1 MΩ
Review

If you attach a microprocessor that requires a supply voltage $4 < V < 6$, how much effective resistance can this device have?

$V_{source} = 4.5V$

$R_{source} = 5k$

$R_{load}$

$V_{load}$

What value of $R_{load}$ will keep $V_{load}$ over $4V$?

A. 1 kΩ
B. 10 kΩ
C. 100 kΩ
D. 1 MΩ

Loading: $V_{load} \sim \left( \frac{R_{source}}{R_{load}} \right) V_{source}$
Review

If you attach a microprocessor that requires a supply voltage $4 < V < 6$, how much effective resistance can this device have?

$V_{source} = 4.5\text{V}$

$R_{source} = 5k$

$R_{load}$

Loading: $V_{load} \sim (R_{source} / R_{load}) V_{source}$

What value of $R_{load}$ will keep $V_{load}$ over $4\text{V}$?

A. 1 kΩ
B. 10 kΩ
C. 100 kΩ
D. 1 MΩ
Capacitor Zoo
Capacitor Zoo

- **1000 µF**
- **10x10^4 pF**
  
  \[= 0.1 \text{ µF}\]

- **22x10^2 pF**
  
  \[= 2.2 \text{ nF}\]
Question

Sketch $V_c$ vs. $t$ and $I$ vs. $t$ for the following circuit after the switch closes

Qualitative is fine...
Ammeter

Old School: fundamentally measures current
**Multimeter**

Fundamentally measures voltage.

- **Function Select** (autoranging)
- **Current Measurement**
- **Common** (local ground)
- **Voltage Measurement**
Multimeter

- Function Select (non-autoranging)
- Current Measurements
- Common (local ground)
- Voltage Measurement
Protoboards

Aka ‘Breadboards’
Protoboards

Bus strips, or “Rails” are connected (although not necessarily across the full board)

Connect these to your supply voltages
Protoboards

Terminal strips are connected on each side of the gutter
Use these for your components
Our Equipment

Banana Terminals
(connect to power supply)
Run wires from terminals to rails

Ground (Earth)

Fixed voltage
Adjustable voltage
Protoboards
Resistors

- Size generally correlated to power capability
- Colors specify nominal resistance
How to Read Resistor Color Codes

6-Band

2 7 4 \times 10^0 \pm 2

= 274 \, \Omega \pm 2\%, \, 250 \, \text{ppm/K}

<table>
<thead>
<tr>
<th>Color</th>
<th>1st Digit</th>
<th>2nd Digit</th>
<th>3rd Digit</th>
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<td>0</td>
<td>0</td>
</tr>
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</tr>
<tr>
<td>Silver</td>
<td>9</td>
<td>9</td>
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</tr>
</tbody>
</table>

Multiplier: 1 \, \Omega \quad 10 \, \Omega \quad 100 \, \Omega \quad 1k \, \Omega \quad 10k \, \Omega \quad 100k \, \Omega \quad 1M \, \Omega

Tolerance: ± 1% \quad ± 2% \quad ± 2% \quad ± 0.5% \quad ± 0.25% \quad ± 0.1% \quad ± 5% \quad ± 10%

Temperature Coefficient: 250 \, \text{ppm/K} \quad 100 \, \text{ppm/K} \quad 50 \, \text{ppm/K} \quad 15 \, \text{ppm/K} \quad 25 \, \text{ppm/K} \quad 20 \, \text{ppm/K} \quad 10 \, \text{ppm/K} \quad 5 \, \text{ppm/K} \quad 1 \, \text{ppm/K}

4-Band

12 \times 10^5 \pm 5%

= 1,200 \, \text{k\Omega} \pm 5%

5-Band

100 \times 10^2 \pm 1%

= 10,000 \, \Omega \pm 1%
Resistor Fun

What resistance is this?
Resistor Fun

What resistance is this?

Green 5
Blue 6
Orange 3
Resistor Fun

What resistance is this?

Green 5  
Blue 6  
Orange 3

\[ R = 56 \times 10^3 = 56 \text{ k}\Omega \]

(5% accuracy)
Resistor Fun

How about these?
Resistor Fun

How about these?

Yellow 4
Purple 7
Brown 1

\[ R = 47 \times 10^1 = 470 \, \Omega \]