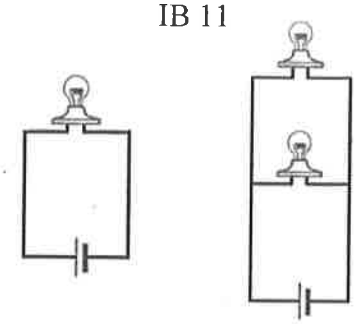
Combining Light Bulbs in Parallel



1. Build a circuit with one light bulb and observe its brightness

2. Add a second bulb in parallel. Observe or infer what happens to the:

	PREDICTION	RESULT
Power of an individual bulb		same
Total power of the circuit		↑
Resistance of an individual bulb		same
Total resistance of the circuit		↓
Total potential difference across the circuit		same
Potential difference across an individual bulb		same
Total current in the circuit		↑
Current through an individual bulb		same

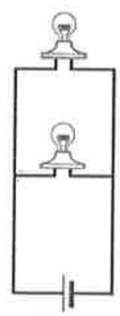
3. Unscrew one light bulb from its base (but leave the base in the circuit). What happens to the other light bulb? Why?

4. Assume each light bulb has a constant resistance of 10 Ω. Analyze each circuit.

3 V

R	10Ω
V	3V
I	.3A
P	.9W

$V = IR$
$P = IV$

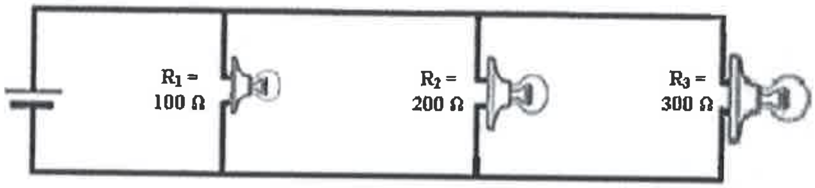


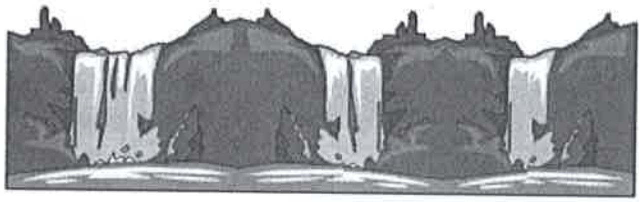
	Bulb #1	Bulb #2	Circuit Total
R	10Ω	10Ω	5Ω
V	3V	3V	3V
I	.3A	.3A	.6A
P	.9W	.9W	1.8W

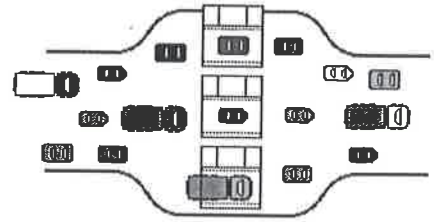
$V = IR$
$P = IV$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{10\Omega} + \frac{1}{10\Omega} = \frac{1}{5\Omega}$$

Analyzing Parallel Circuits







Three Resistors Placed in Parallel

SAME 1. **Voltage:** The increase in potential provided by the battery is equal to the potential drop across each resistor.

$$V_T = V_1 = V_2 = V_3$$

SUM 2. **Current:** The total current coming out of (and going back into) the battery is equal to the sum of the individual currents going through each resistor.

$$I_T = I_1 + I_2 + I_3$$

NOTE: conservation of electric charge

SUM 3. **Power:** The total power used in the circuit is the sum of the power used by the individual resistors.

$$P_T = P_1 + P_2 + P_3$$

SUM of R^{-1} 4. **Resistance:** The reciprocal of the total resistance is equal to the sum of the reciprocals of the individual resistances.

$V = IR$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$R_T = R_{eq}$

$$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$$

NOTE: total resistance of the system is less than any individual resistance

5. A 3.0 Ω and a 6.0 Ω resistor are connected in parallel. What is their equivalent resistance?

$$\left(\frac{1}{3.0\Omega} + \frac{1}{6.0\Omega}\right)^{-1} = R_{eq} = 2\Omega = R_T$$

Parallel relationships

$$\frac{R_1}{R_2} = \frac{I_2}{I_1} = \frac{P_2}{P_1}$$

6. In a parallel circuit, which resistor, if any, will . . .

   a) have the greatest potential difference across it?
   same

   b) have the most current running through it?
   smallest resistor

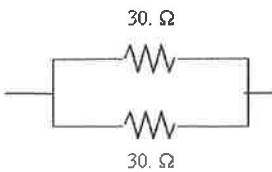
   c) dissipate the most power?
   smallest resistor

   d) shine brightest (if it is a light bulb)?
   smallest resistor

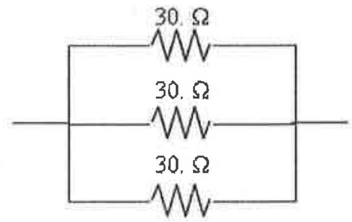
7. Calculate the equivalent resistance of each resistor segment below.

Shortcut for identical parallel resistors:

Equivalent resistors = resistance of one ÷ # of resistors in circuit



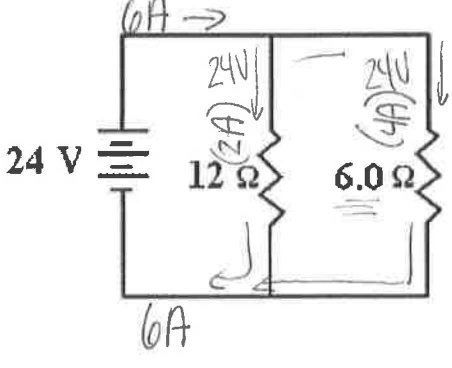
$R_{eq} = 15\Omega$



$R_{eq} = 10\Omega$

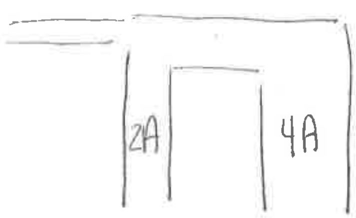
$\frac{1}{30\Omega} + \frac{1}{30\Omega} = \frac{1}{15\Omega} \left(\frac{1}{R_T}\right)$ $\quad \frac{1}{30\Omega} + \frac{1}{30\Omega} + \frac{1}{30\Omega} = \frac{1}{10\Omega}$

8. Calculate the voltage drop across each resistor and the current through each resistor. Calculate the total current in the circuit and the equivalent resistance of the circuit.



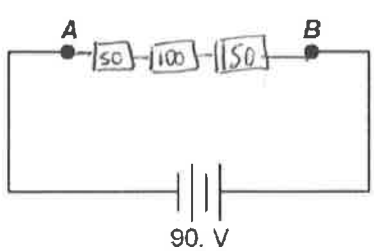
$\frac{1}{12\Omega} + \frac{1}{6\Omega} = \frac{1}{4\Omega}$ $\quad R_{eq} = 4\Omega$

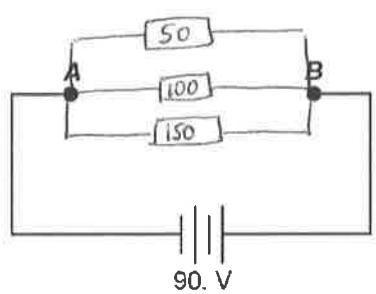
$I_T = \frac{V_T}{R_T} = 6A$



$I_{12\Omega} = \frac{24V}{12\Omega} = 2A$ $\quad I_{6\Omega} = \frac{24V}{6\Omega} = 4A$

9. A 50. Ω, a 100. Ω and a 150. Ω resistor are to be connected in the circuit below between A and B. What type of connection will have the highest resistance? The lowest resistance? Complete each circuit and calculate each current.





$R_T = 300\Omega$

$I_T = \frac{V_T}{R_T} = \frac{90V}{300\Omega} = .3A$

$\left(\frac{1}{50\Omega} + \frac{1}{100\Omega} + \frac{1}{150\Omega}\right)^{-1} = R_T = 27\Omega$

$R_T = 27\Omega$

$I_T = \frac{90V}{27\Omega} = 3.3A$