

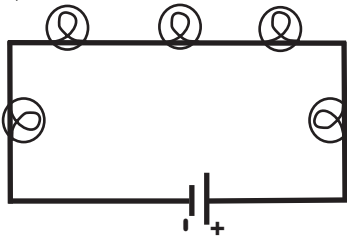


**Grade 7/8 Math Circles**  
**March 21, 2012**  
**Circuits**

**Exercises:**

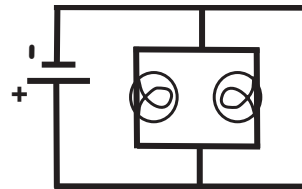
1. For each of the diagrams below, determine if the light bulbs are in series with each other, or in parallel with each other.

a)



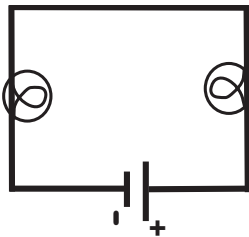
Series

b)



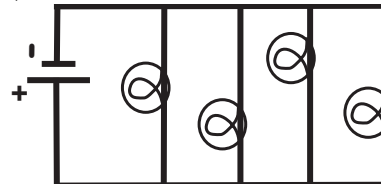
Parallel

c)



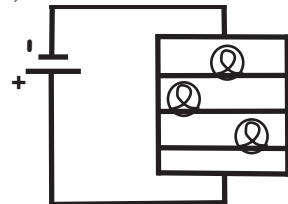
Series

d)



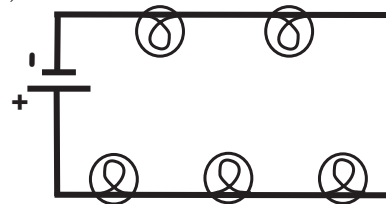
Parallel

e)



Parallel

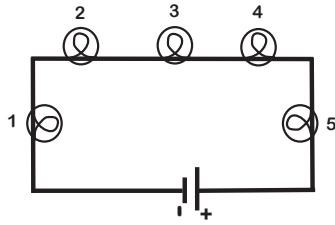
f)



Series

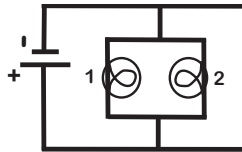
2. For each of the diagrams and corresponding tables below, fill in the missing values in the table using Ohm's Law and circuit properties.

a)



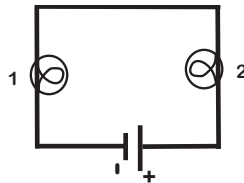
$V_{total} = 40V$	$V_1 = 5V$	$V_2 = 15V$	$V_3 = 10V$	$V_4 = 7.5V$	$V_5 = 2.5V$
$I_{total} = 5A$	$I_1 = 5A$	$I_2 = 5A$	$I_3 = 5A$	$I_4 = 5A$	$I_5 = 5A$
$R_{total} = 8\Omega$	$R_1 = 1\Omega$	$R_2 = 3\Omega$	$R_3 = 2\Omega$	$R_4 = \frac{3}{2}\Omega$	$R_5 = \frac{1}{2}\Omega$

b)



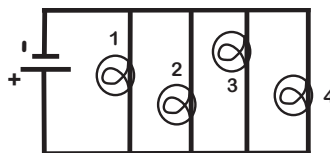
$V_{total} = 4V$	$V_1 = 4V$	$V_2 = 4V$
$I_{total} = 4A$	$I_1 = 2A$	$I_2 = 2A$
$R_{total} = 1\Omega$	$R_1 = 2\Omega$	$R_2 = 2\Omega$

c)



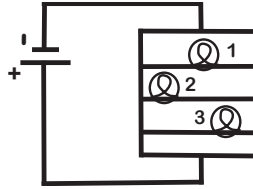
$V_{total} = 18V$	$V_1 = 6V$	$V_2 = 12V$
$I_{total} = 3A$	$I_1 = 3A$	$I_2 = 3A$
$R_{total} = 6\Omega$	$R_1 = 2\Omega$	$R_2 = 4\Omega$

d)



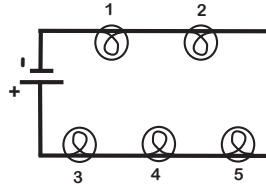
$V_{total} = 12V$	$V_1 = 12V$	$V_2 = 12V$	$V_3 = 12V$	$V_4 = 12V$
$I_{total} = 8A$	$I_1 = 4A$	$I_2 = 6A$	$I_3 = 4A$	$I_4 = 12A$
$R_{total} = \frac{12}{25}\Omega$	$R_1 = 4\Omega$	$R_2 = 2\Omega$	$R_3 = 3\Omega$	$R_4 = 1\Omega$

e)



$V_{total} = 16V$	$V_1 = 16V$	$V_2 = 16V$	$V_3 = 16V$
$I_{total} = 8A$	$I_1 = 4A$	$I_2 = 2A$	$I_3 = 2A$
$R_{total} = 2\Omega$	$R_1 = 4\Omega$	$R_2 = 8\Omega$	$R_3 = 8\Omega$

f)



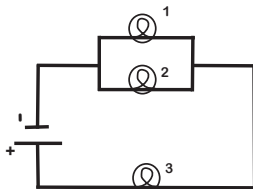
$V_{total} = 100V$	$V_1 = 12V$	$V_2 = 16V$	$V_3 = 20V$	$V_4 = 24V$	$V_5 = 28V$
$I_{total} = 4A$	$I_1 = 4A$	$I_2 = 4A$	$I_3 = 4A$	$I_4 = 4A$	$I_5 = 4A$
$R_{total} = 25\Omega$	$R_1 = 3\Omega$	$R_2 = 4\Omega$	$R_3 = 5\Omega$	$R_4 = 6\Omega$	$R_5 = 7\Omega$

### Challenge Problems:

- For each of the diagrams and corresponding tables below, fill in the missing values in the table using Ohm's Law and circuit properties.

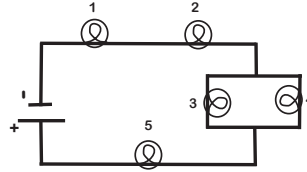
**Note:** All of the circuits below contain both parallel and series components. To solve for the missing values, you will need to solve for the total values in the parallel component. Then you can simplify the circuit by treating the parallel component as a single light bulb in series with the rest of the circuit. The values for current, voltage, and resistance of the simplified light bulb will be the total values of the parallel component.

a)



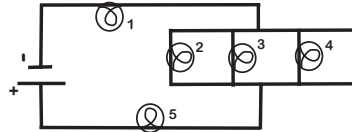
$V_{total} = 14V$	$V_1 = 6V$	$V_2 = 6V$	$V_3 = 8V$
$I_{total} = 2A$	$I_1 = \frac{1}{2}A$	$I_2 = \frac{3}{2}A$	$I_3 = 2A$
$R_{total} = 7\Omega$	$R_1 = 12\Omega$	$R_2 = 4\Omega$	$R_3 = 4\Omega$

b)



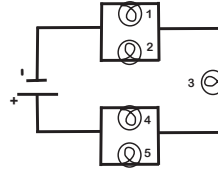
$V_{total} = 18V$	$V_1 = 6V$	$V_2 = 3V$	$V_3 = 6V$	$V_4 = 6V$	$V_5 = 3V$
$I_{total} = \frac{3}{2}A$	$I_1 = \frac{3}{2}A$	$I_2 = \frac{3}{2}A$	$I_3 = 1A$	$I_4 = \frac{1}{2}A$	$I_5 = \frac{3}{2}A$
$R_{total} = 12\Omega$	$R_1 = 4\Omega$	$R_2 = 2\Omega$	$R_3 = 6\Omega$	$R_4 = 12\Omega$	$R_5 = 2\Omega$

c)



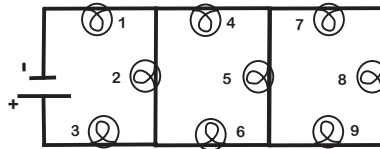
$V_{total} = 30V$	$V_1 = 25V$	$V_2 = \frac{60}{13}V$	$V_3 = \frac{60}{13}V$	$V_4 = \frac{60}{13}V$	$V_5 = \frac{5}{13}V$
$I_{total} = 5A$	$I_1 = 5A$	$I_2 = \frac{30}{13}A$	$I_3 = \frac{20}{13}A$	$I_4 = \frac{15}{13}A$	$I_5 = 5A$
$R_{total} = 6\Omega$	$R_1 = 5\Omega$	$R_2 = 2\Omega$	$R_3 = 3\Omega$	$R_4 = 4\Omega$	$R_5 = \frac{1}{13}\Omega$

d)



$V_{total} = 25V$	$V_1 = \frac{180}{17}V$	$V_2 = \frac{180}{17}V$	$V_3 = \frac{189}{17}V$	$V_4 = \frac{56}{17}V$	$V_5 = \frac{56}{17}V$
$I_{total} = \frac{63}{17}A$	$I_1 = \frac{18}{17}A$	$I_2 = \frac{45}{17}A$	$I_3 = \frac{63}{17}A$	$I_4 = \frac{7}{17}A$	$I_5 = \frac{56}{17}A$
$R_{total} = \frac{425}{63}\Omega$	$R_1 = 10\Omega$	$R_2 = 4\Omega$	$R_3 = 3\Omega$	$R_4 = 8\Omega$	$R_5 = 1\Omega$

2. a) Each light bulb in the diagram has resistance  $R$ . Determine the total resistance of the circuit in terms of  $R$ .



- b) Given that  $R = 15\Omega$  and  $I_T = 2A$ , use the total resistance found in part (a) to fill in all the missing values in the table below.

$V_{total} = 82V$	$V_1 = 30V$	$V_2 = 22V$	$V_3 = 30V$	$V_4 = 8V$	$V_5 = 6V$
$I_{total} = 2A$	$I_1 = 2A$	$I_2 = \frac{22}{15}A$	$I_3 = 2A$	$I_4 = \frac{8}{15}A$	$I_5 = \frac{2}{5}A$
$R_{total} = 41\Omega$	$R_1 = 15\Omega$	$R_2 = 15\Omega$	$R_3 = 15\Omega$	$R_4 = 15\Omega$	$R_5 = 15\Omega$
	$V_6 = 8V$	$V_7 = 2V$	$V_8 = 2V$	$V_9 = 2V$	
	$I_6 = \frac{8}{15}A$	$I_7 = \frac{2}{15}A$	$I_8 = \frac{2}{15}A$	$I_9 = \frac{2}{15}A$	
	$R_6 = 15\Omega$	$R_7 = 15\Omega$	$R_8 = 15\Omega$	$R_9 = 15\Omega$	