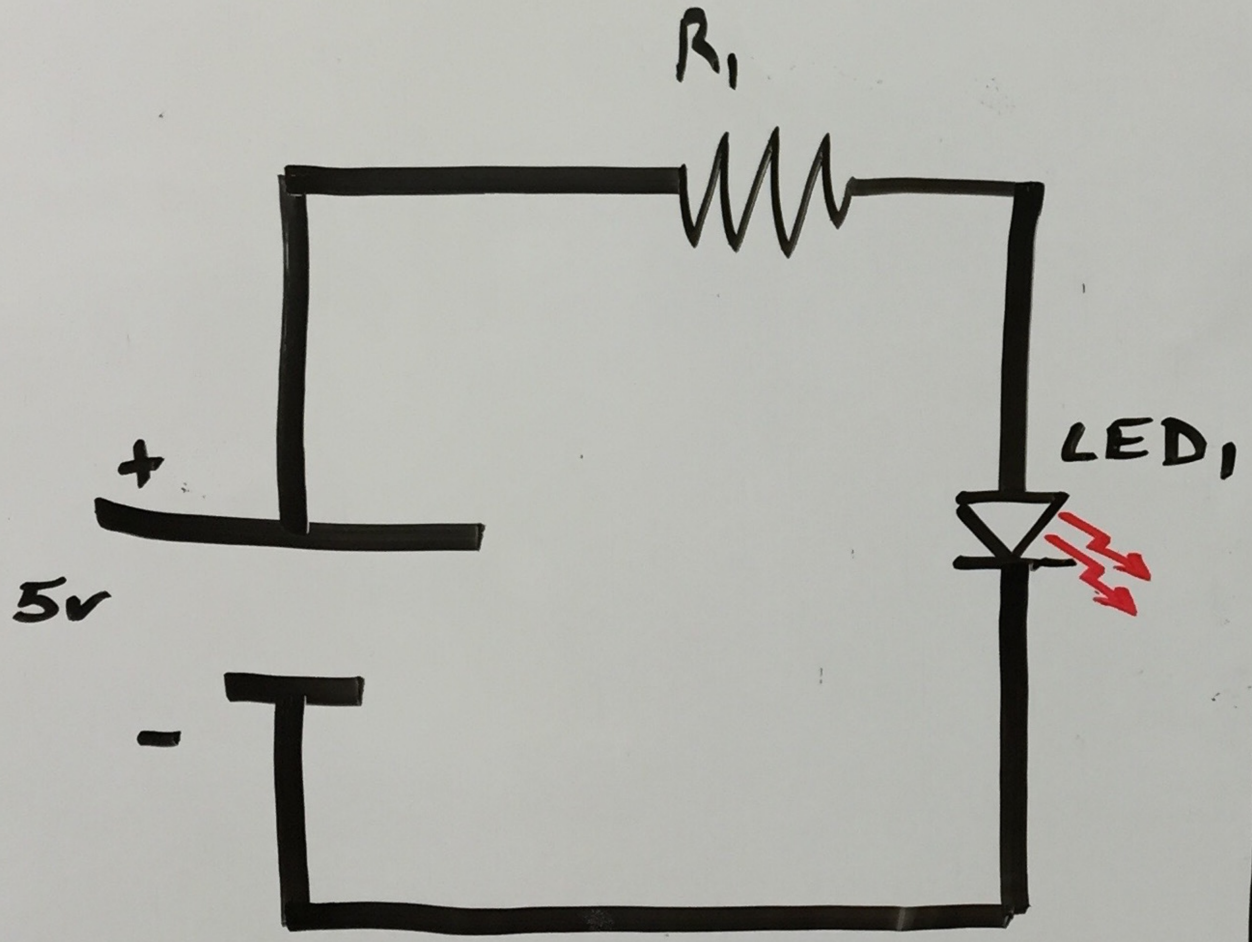
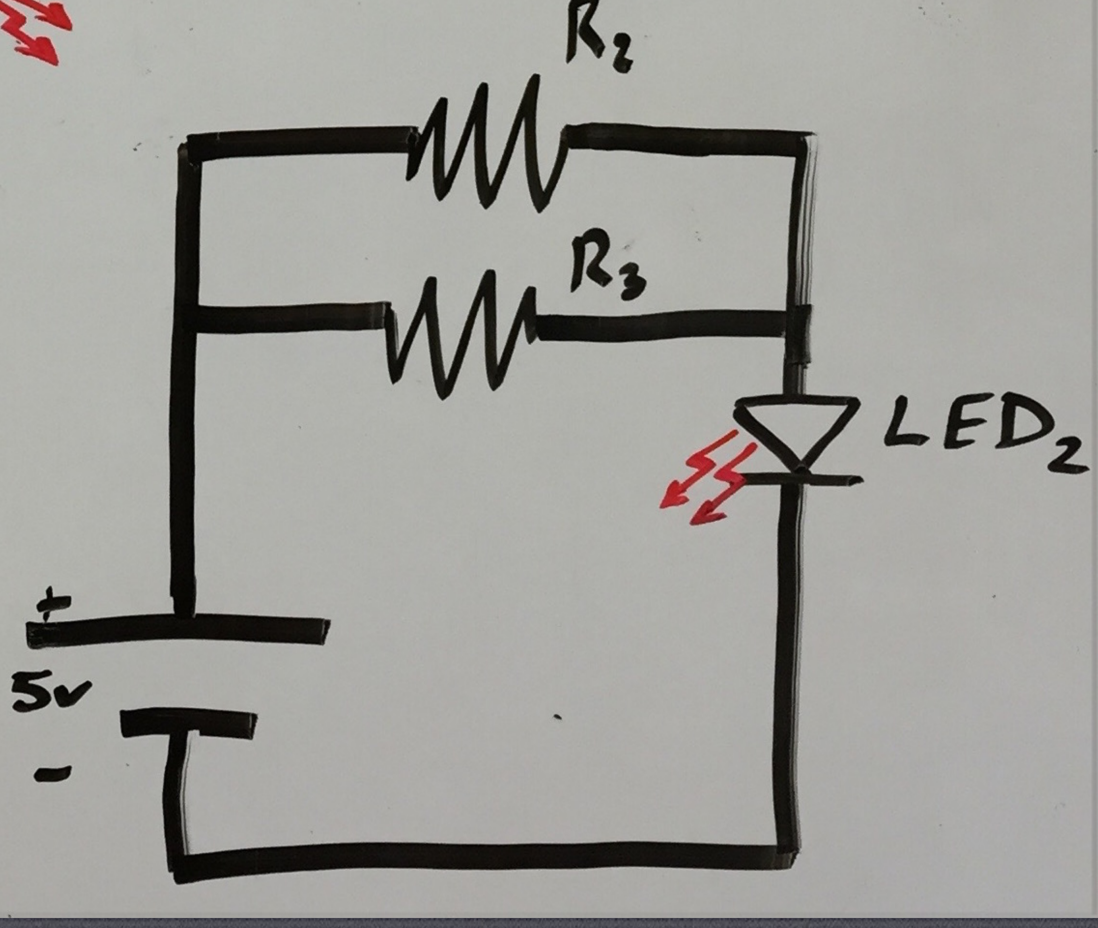
ENAE 100:

Circuits 1

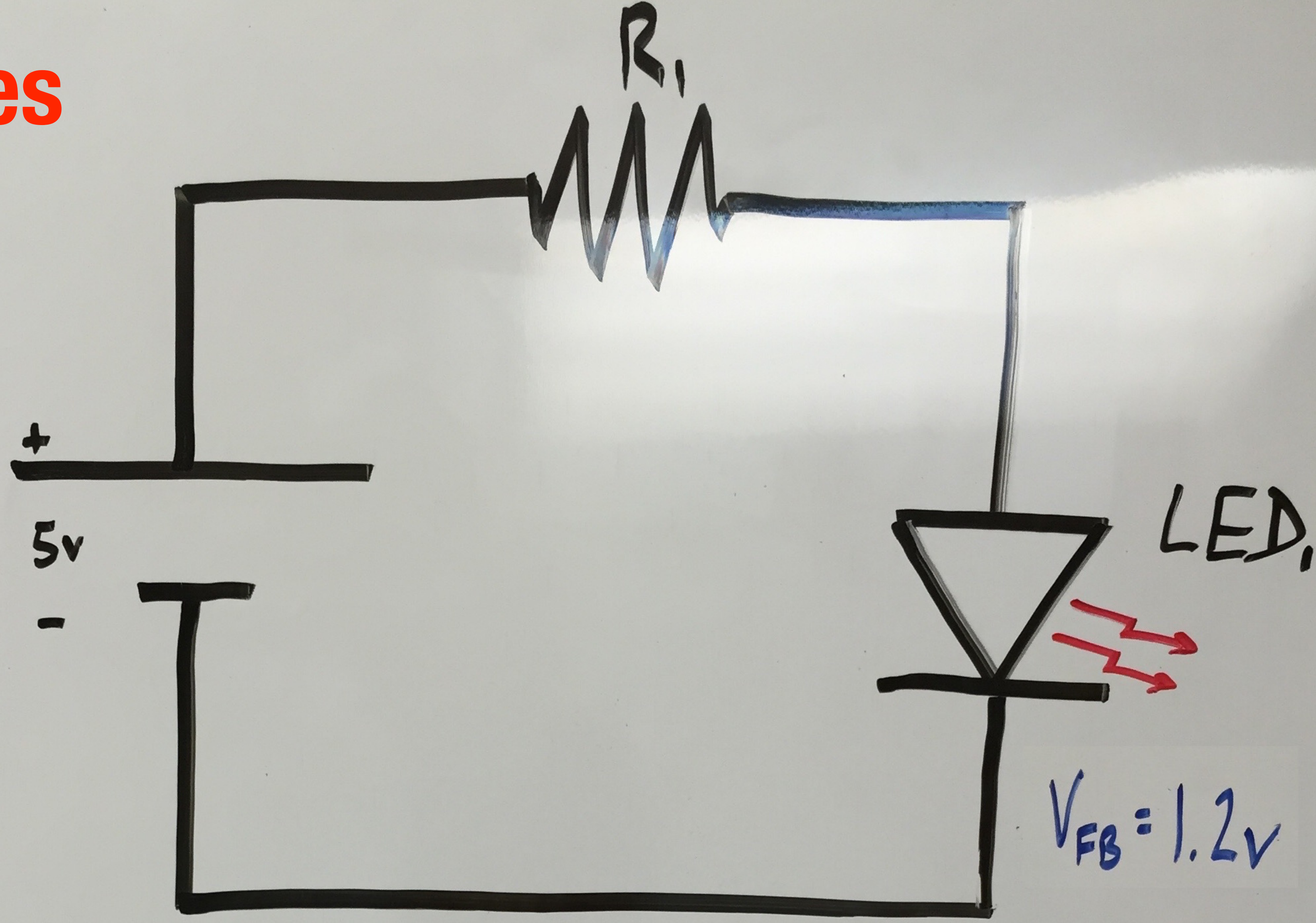
Series



Parallel



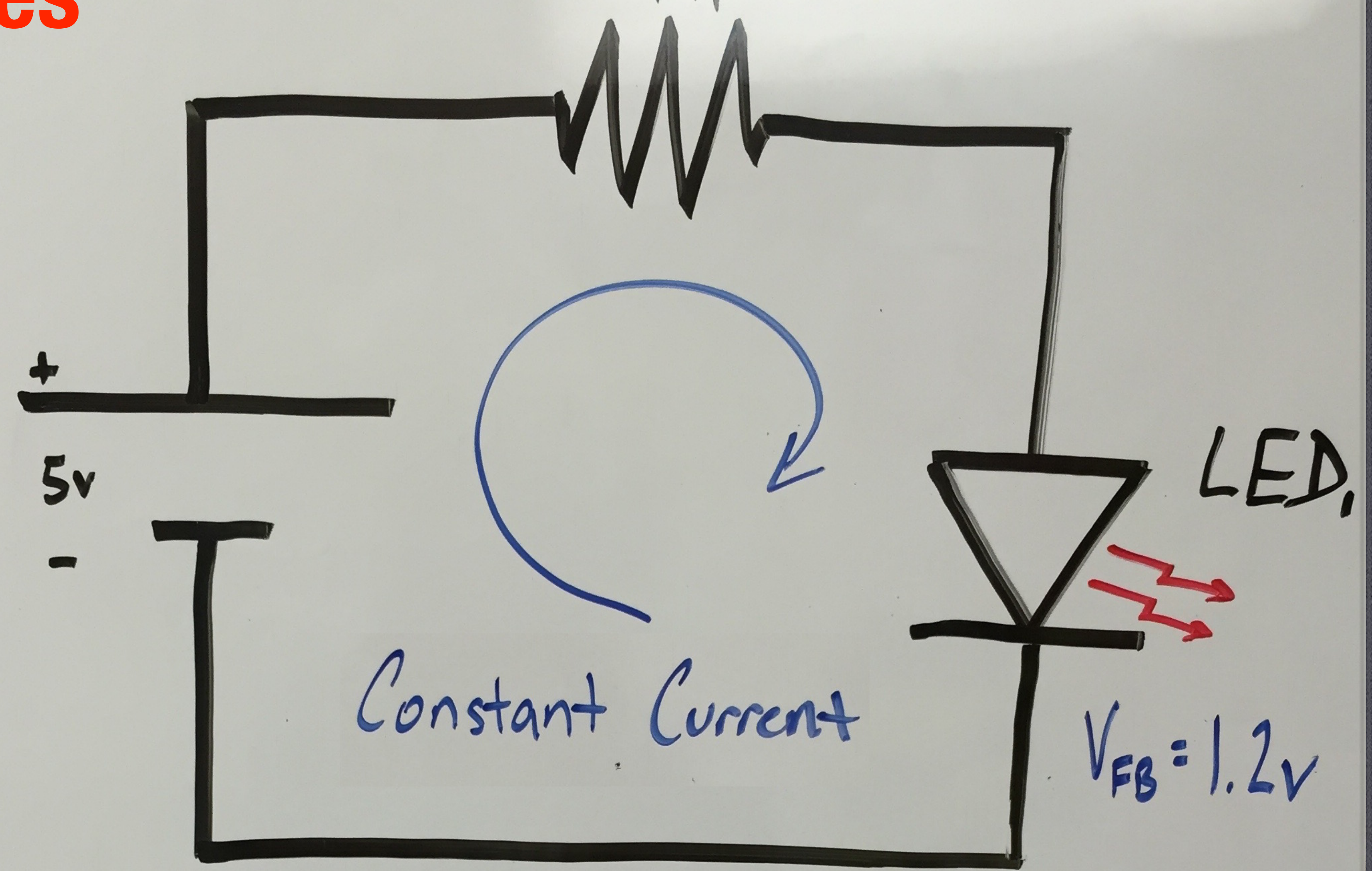
Series



1. What is the purpose of R_1?

2. If $R_1 = 100\Omega$, what is the current going through the LED?

Series



① What is the purpose of R_1?

Current limiting

② If $R_1 = 100\Omega$, what is the current going through the LED?

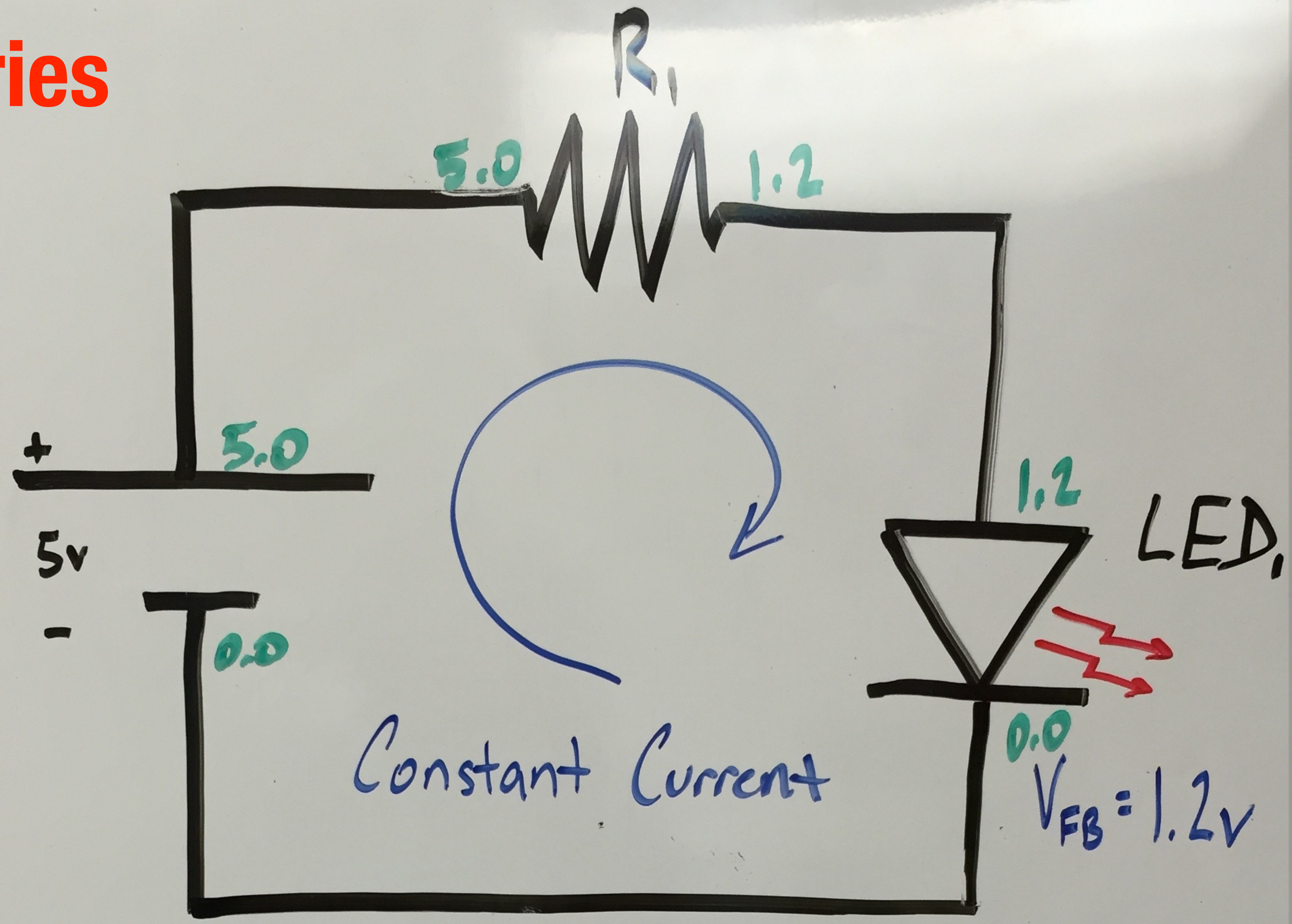
$V = iR$ $\quad (V - V_{FB}) = (i)(100\Omega)$

$(5 - 1.2) = (i)(100\Omega) \Rightarrow \frac{3.8}{100} = i$

$i = 0.038$ Amps

$= 38mA$

Series

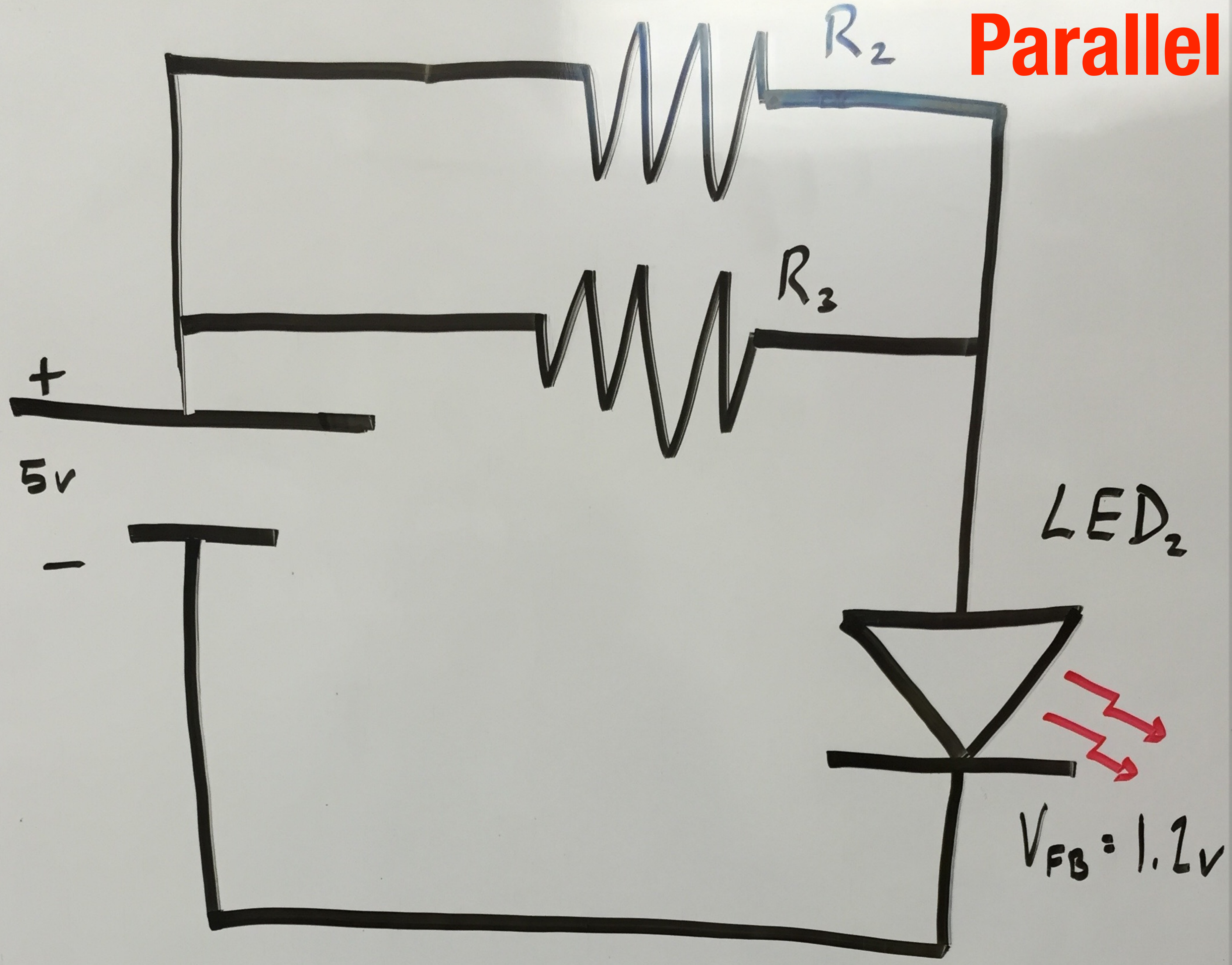


More detail:

- Voltage drop over LED known from specs
- Work backwards to get voltage drop over resistor
- Use Ohm's Law to calculate current in whole circuit

More current = greater intensity

Parallel

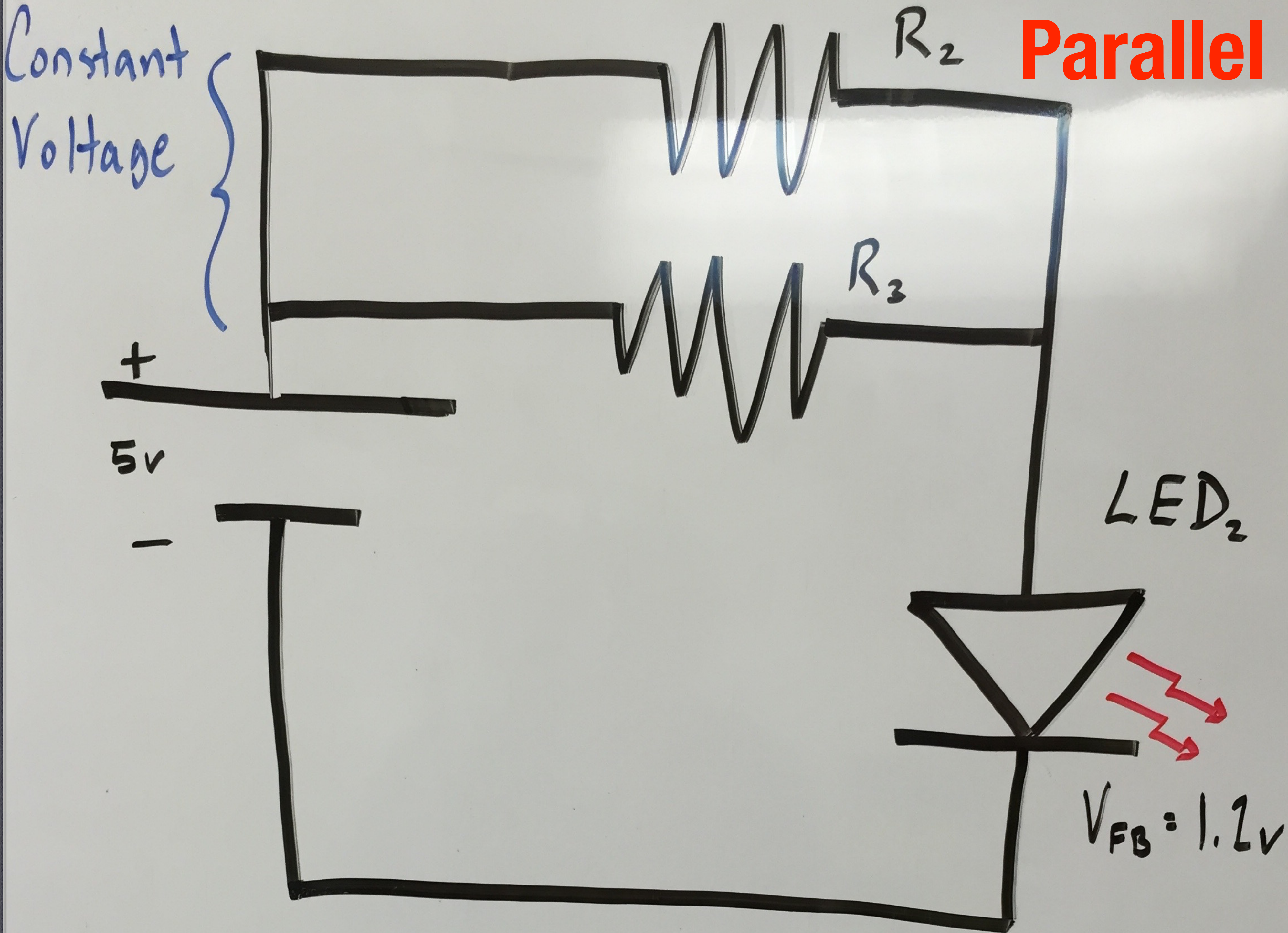


1. What is the purpose of R_2 and R_3 together?

2. If $R_2 = 100\Omega$ and $R_3 = 50\Omega$, what is the total resistance?

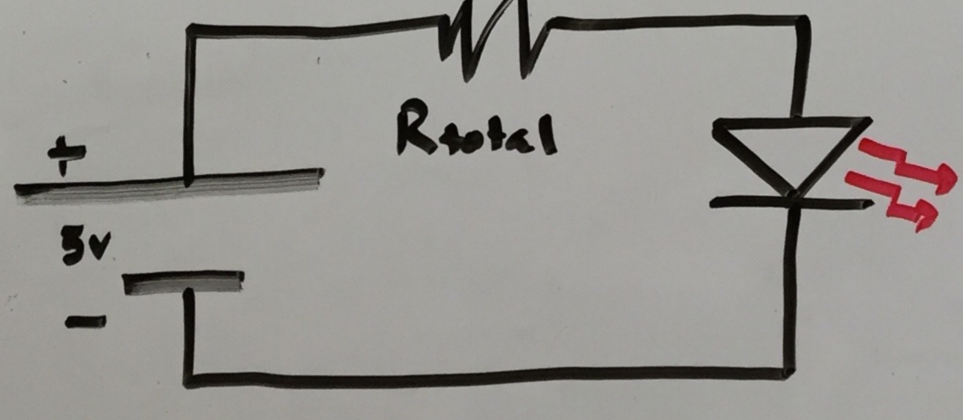
3. If $R_2 = 100\Omega$ and $R_3 = 50\Omega$, what is the current going through the LED?

Parallel



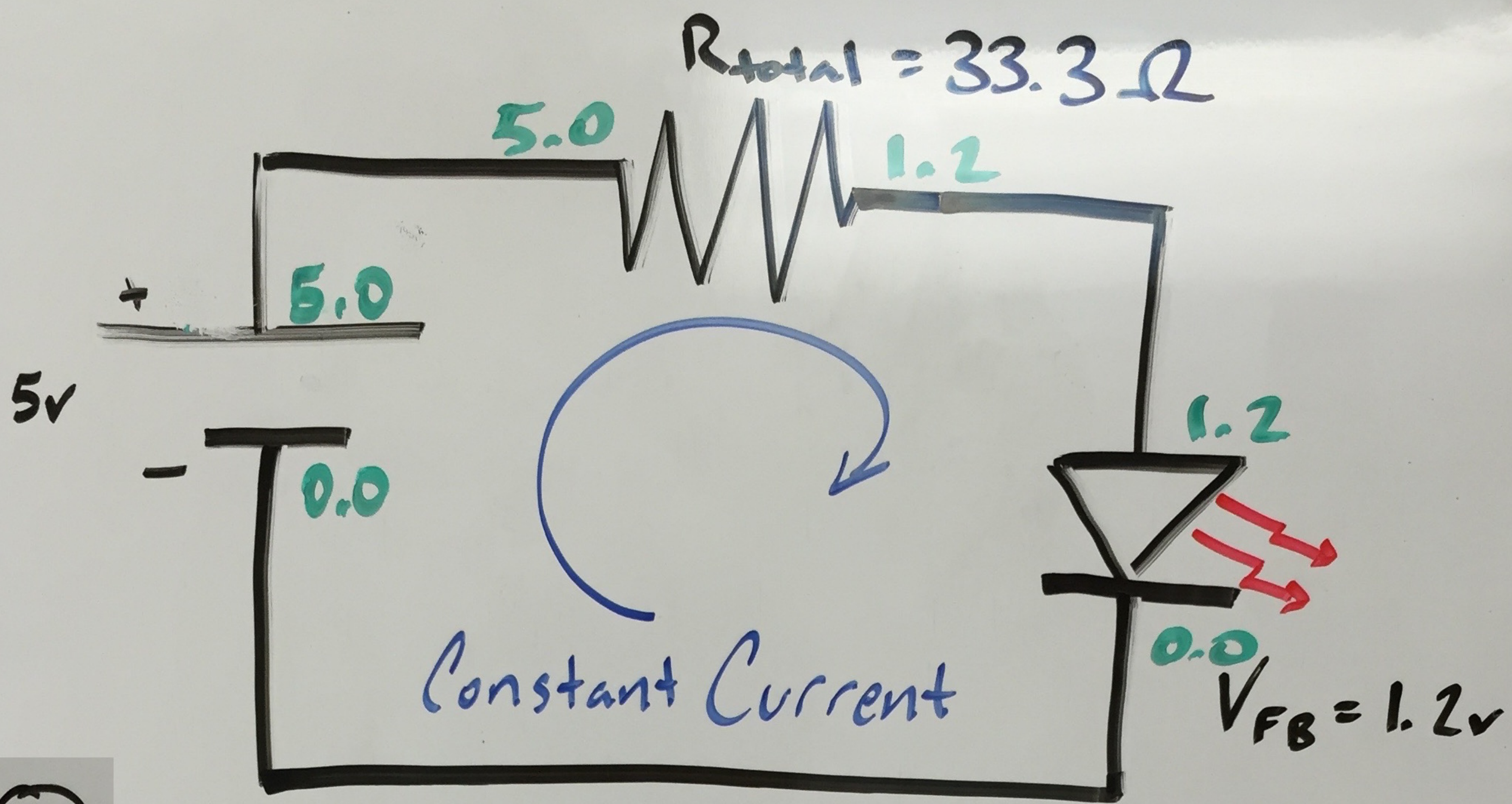
1. Current limiting

2. $$\left(\frac{1}{R_2}+\frac{1}{R_3}\right)^{-1} = \frac{1}{\frac{1}{100}+\frac{1}{50}} = 33.3\,\Omega$$ (R_{total})



Equivalent Circuit

Parallel



3.

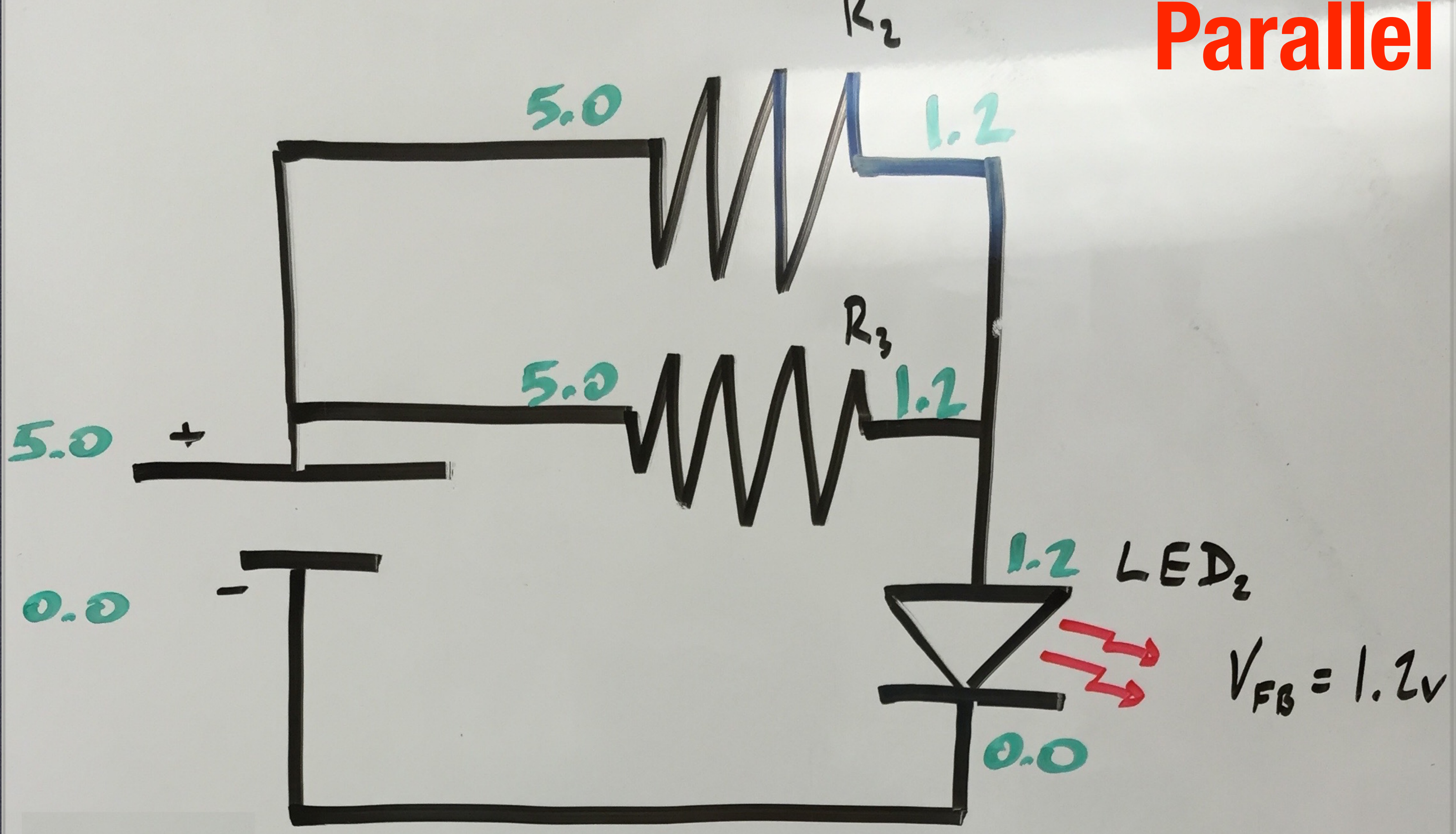
$$(V - V_{FB}) = (i)(R_{total})$$

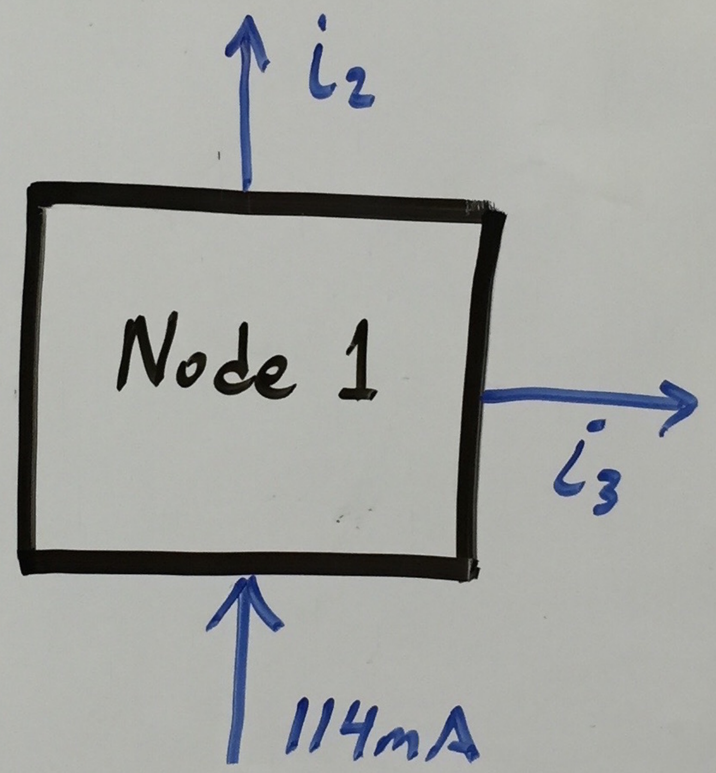
$$(5 - 1.2) = (i)(33.3\,\Omega)$$

$$i = \frac{3.8v}{33.3\,\Omega} = 0.114 \text{ Amps}$$

$$i = 114\text{mA}$$

Parallel





Input = Output

$114mA = i_2 + i_3$

$114mA - i_2 = i_3$

$114mA - 38mA = i_3$

$i_3 = 76mA$

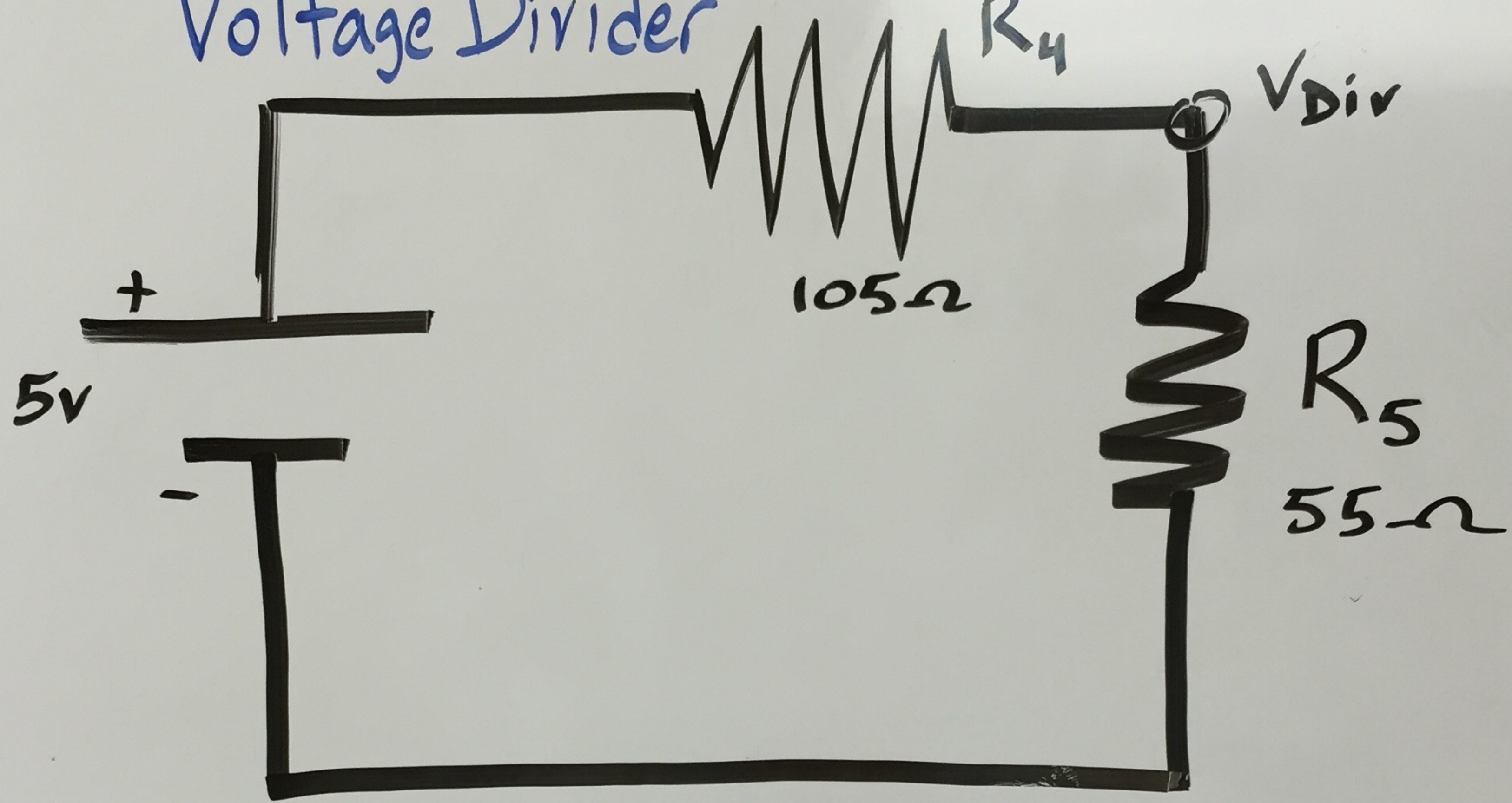
$(V - V_{FB}) = (i_2)(R_2)$

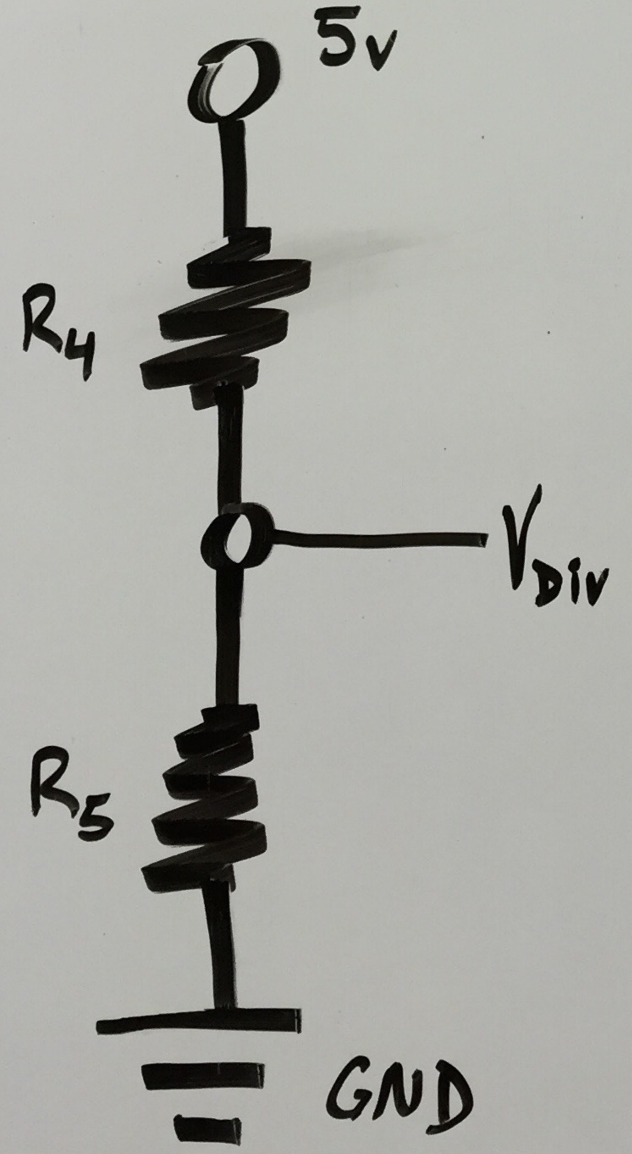
$(5-1.2) = (i_2)(100\Omega)$

$\frac{3.8}{100} = i_2 = 38mA$

Special Series Circuits

Voltage Divider





$$V_{total} = I_{constant} R_{total}$$

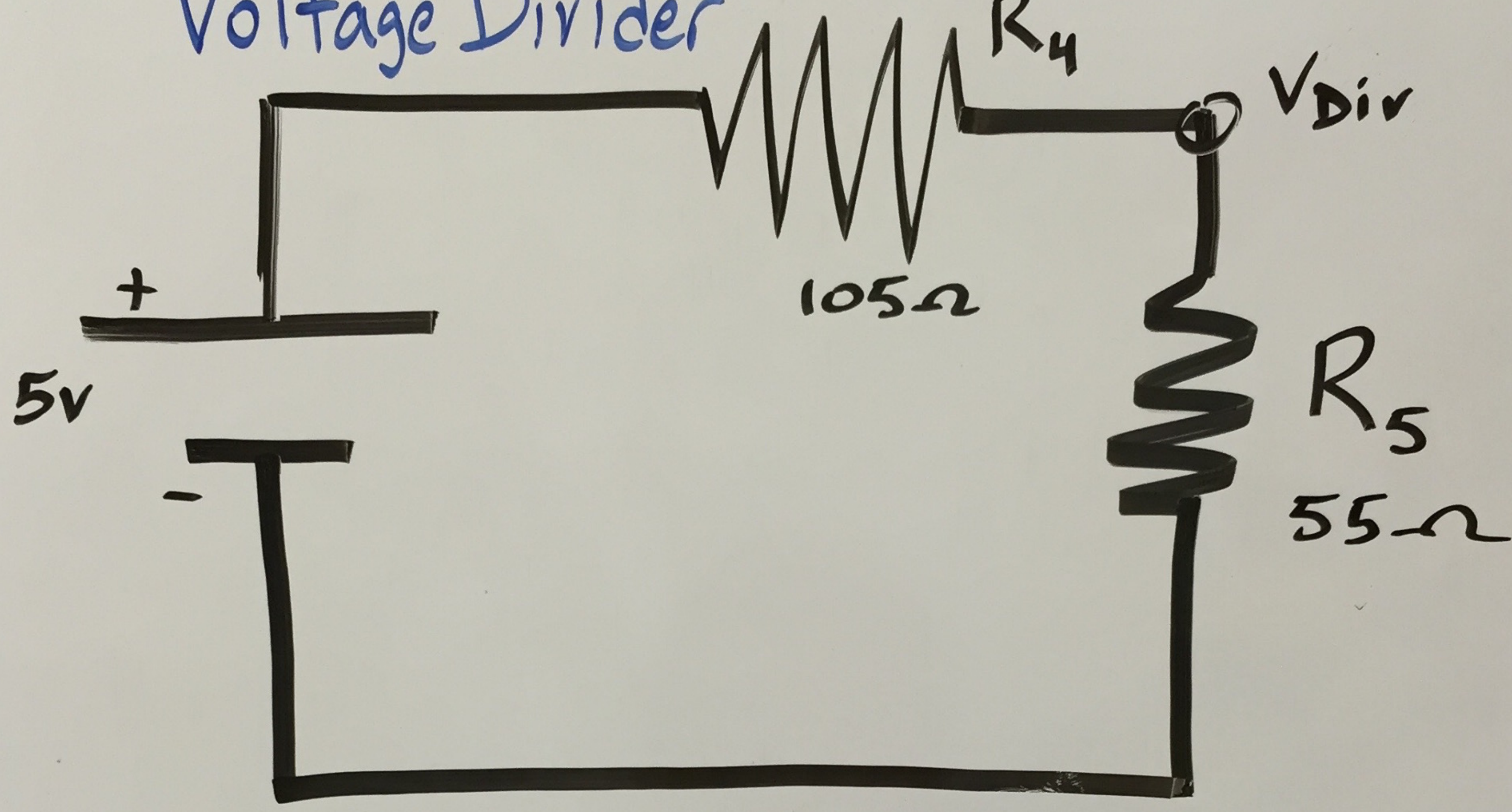
$$R_{total} = 55\Omega + 105\Omega$$
$$= 160\Omega$$

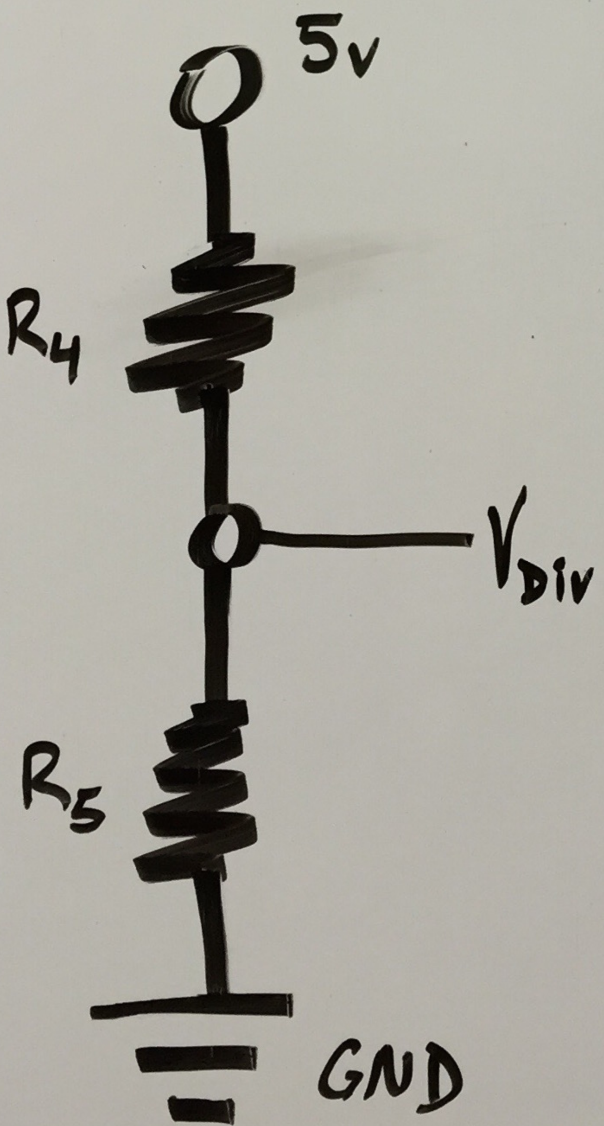
$$5v = (I)(160\Omega)$$

$$\frac{5}{160} = I = 0.03125 \text{ Amps}$$
$$= 31.25 \text{ mA}$$

Special Series Circuits

Voltage Divider





$$V_{Drop} = I_{Constant} R_4$$

$$V_{Drop} = (0.03125)(105)$$
$$= 3.28125v$$

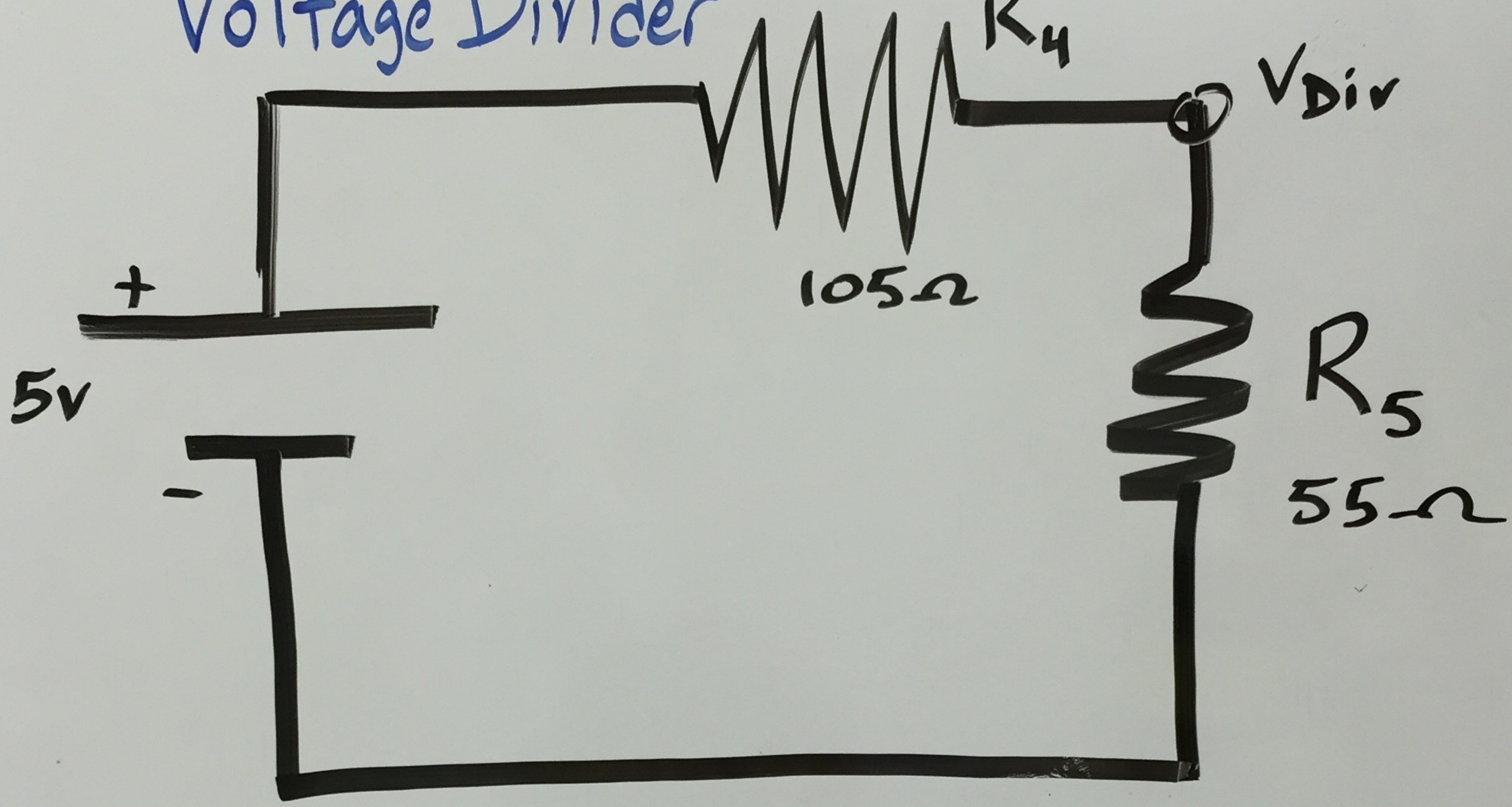
$$V - V_{Drop} = V_{Div}$$

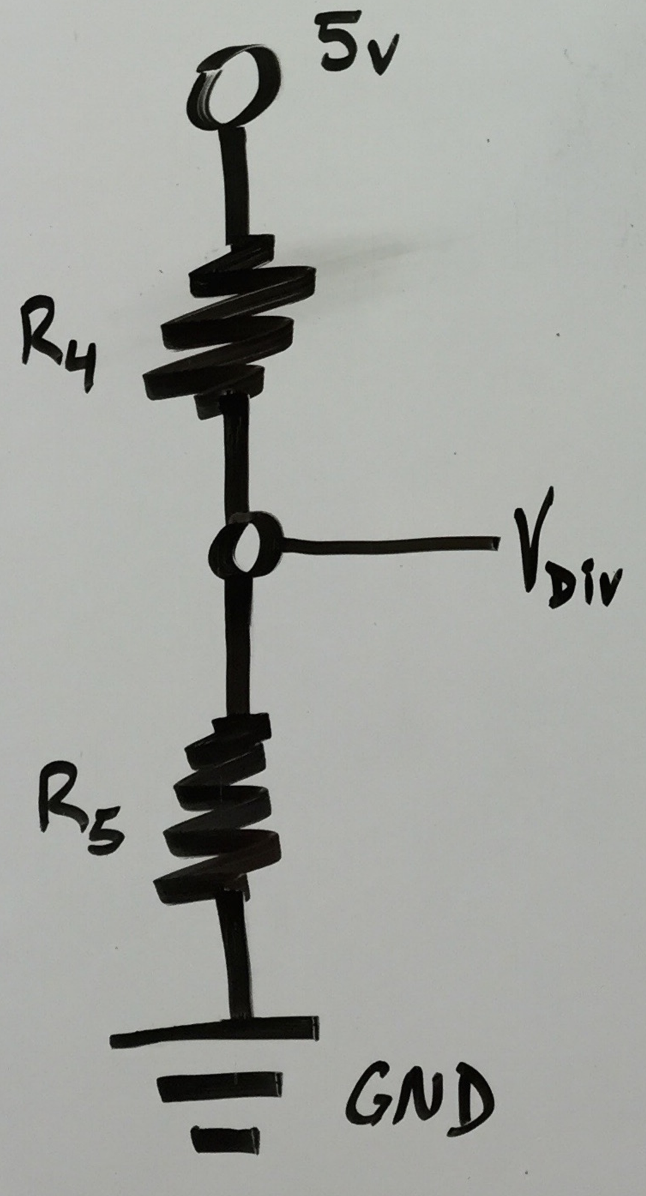
$$5 - 3.28125 = V_{Div}$$

$$V_{Div} = 1.71875v$$

Special Series Circuits

Voltage Divider





$$5 = (R_4 + R_5)(i)$$

$$\boxed{\frac{5}{(R_4 + R_5)} = i}$$

$$5 - V_{Div} = (R_4)(i)$$

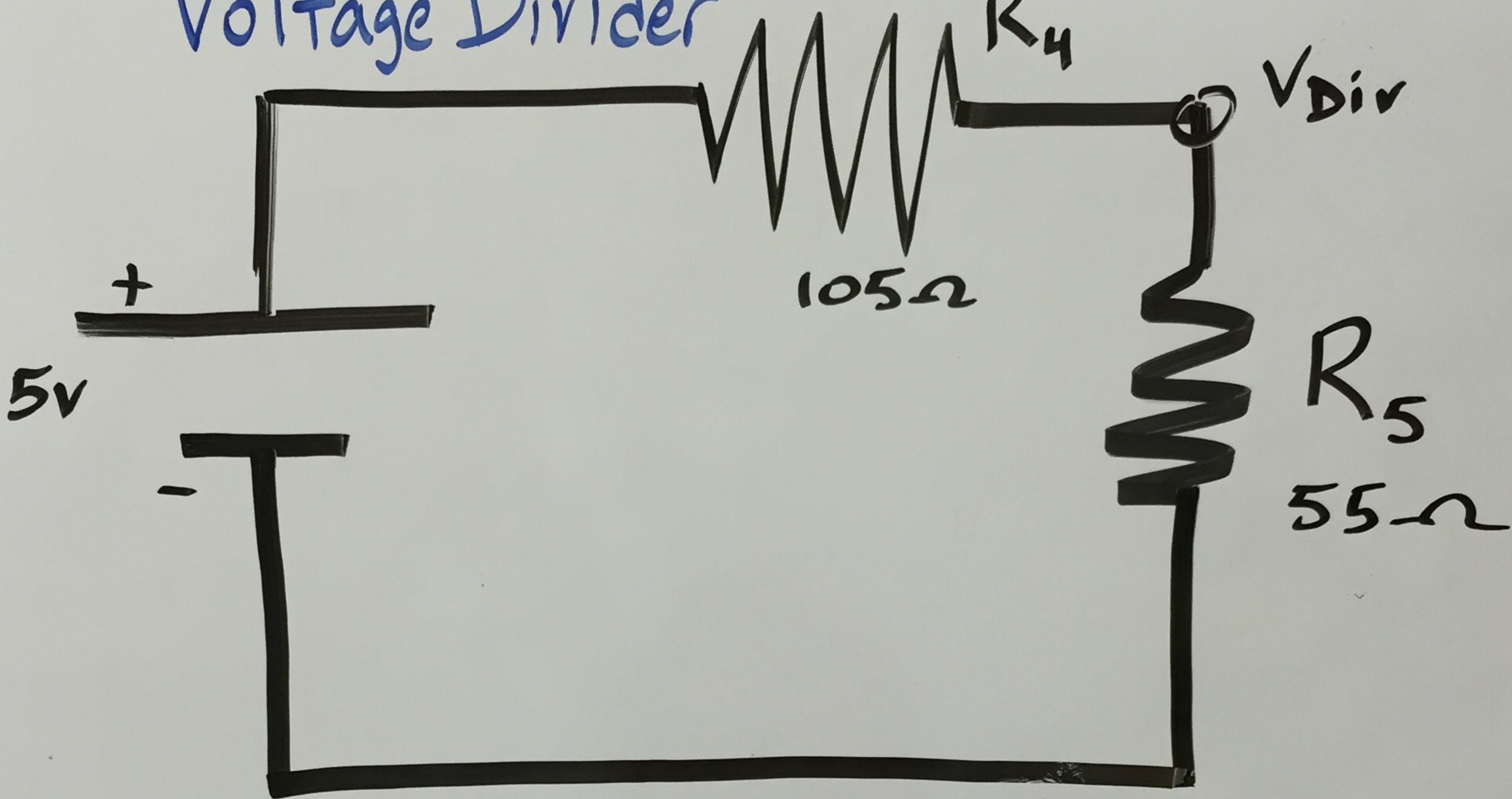
$$5 - V_{Div} = \frac{(5)(R_4)}{(R_4 + R_5)}$$

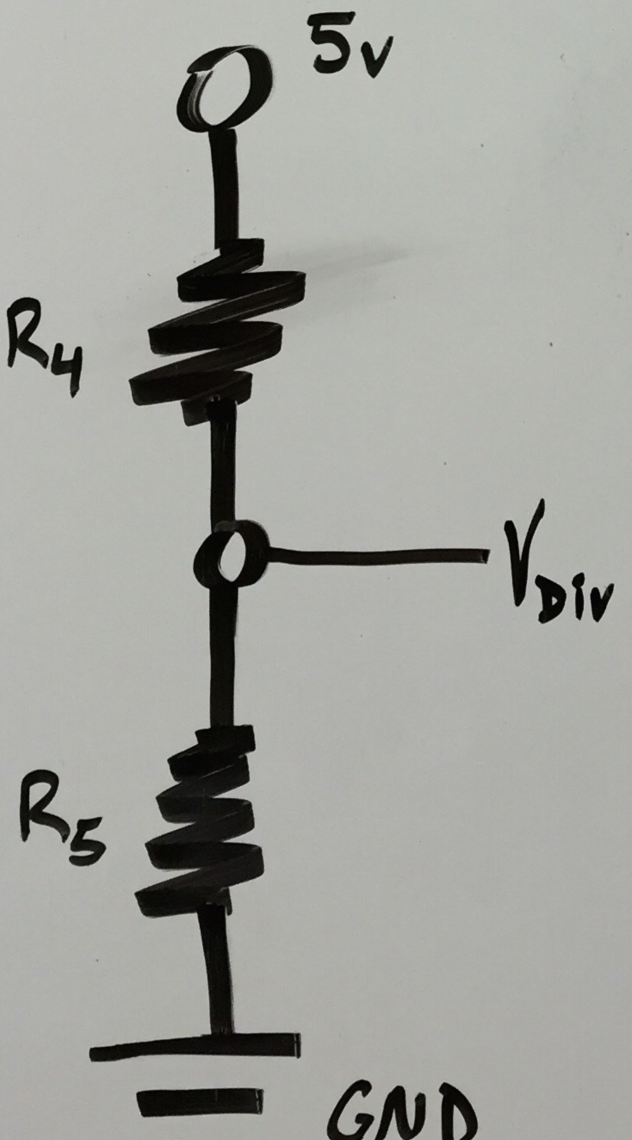
$$V_{Div} = 5 - \frac{5(R_4)}{R_4 + R_5}$$

$$= 5\left(1 - \frac{R_4}{R_4 + R_5}\right)$$

Special Series Circuits

Voltage Divider





$$V_{Div} = 5\left(\frac{R_4 + R_5}{R_4 + R_5} - \frac{R_4}{R_4 + R_5}\right)$$

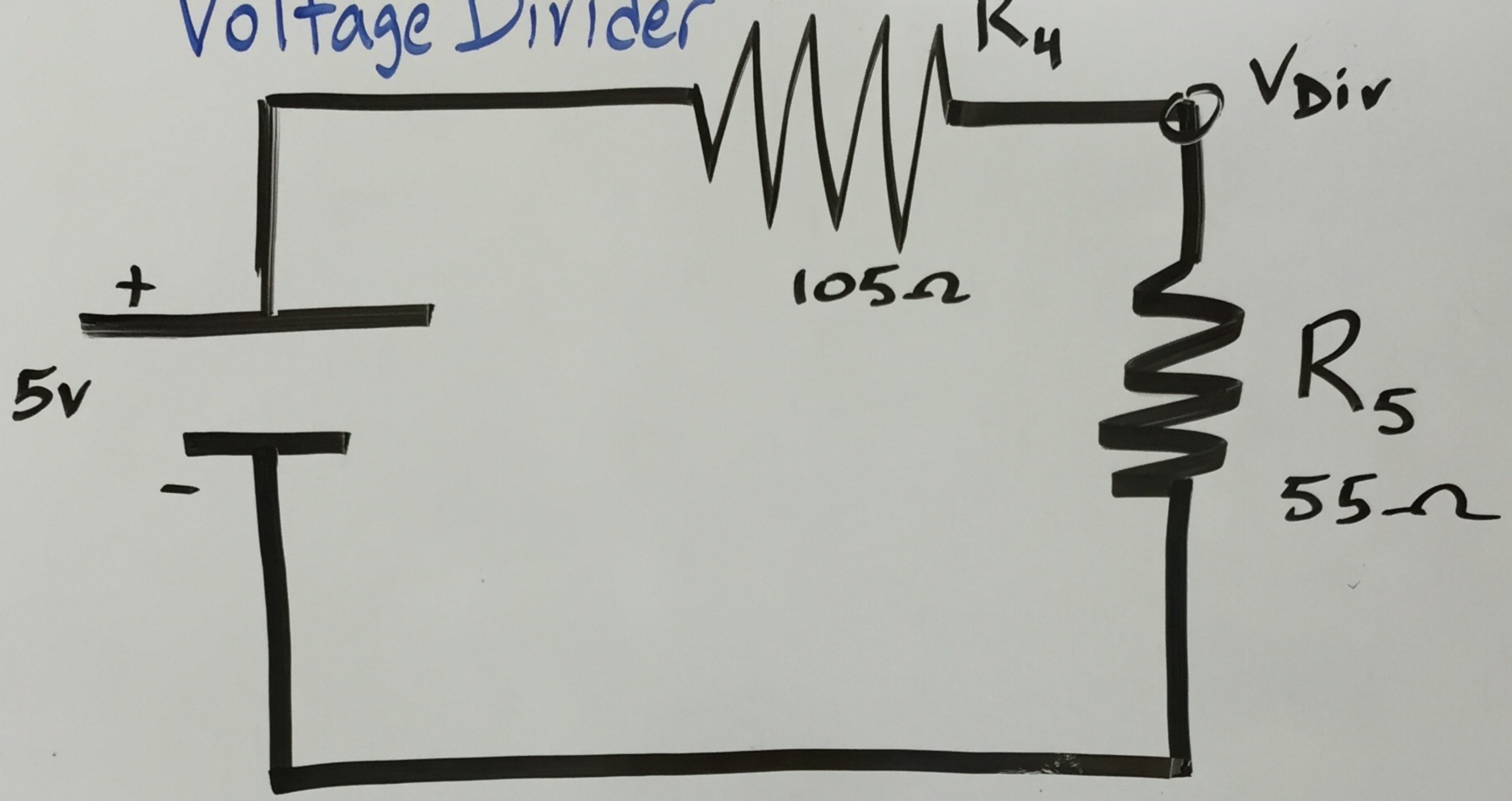
$$= 5\left(\frac{R_5}{R_4 + R_5}\right)$$

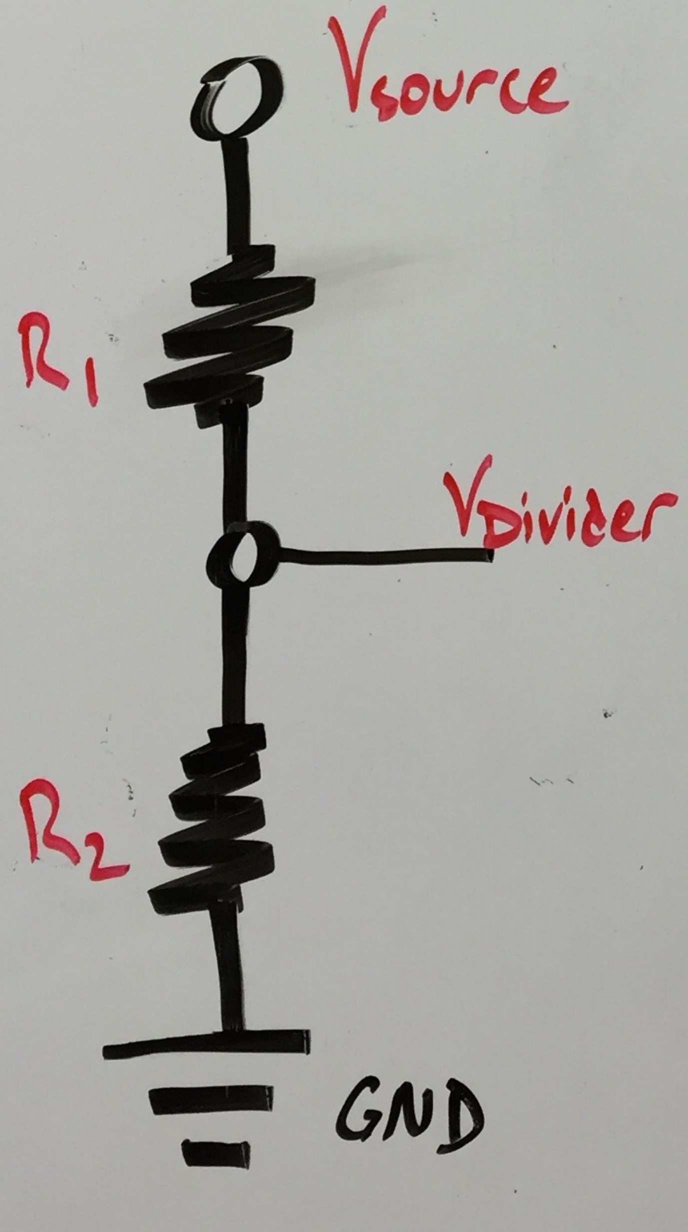
$$= 5\left(\frac{55}{105 + 55}\right)$$

$$= 1.71875v$$

Special Series Circuits

Voltage Divider

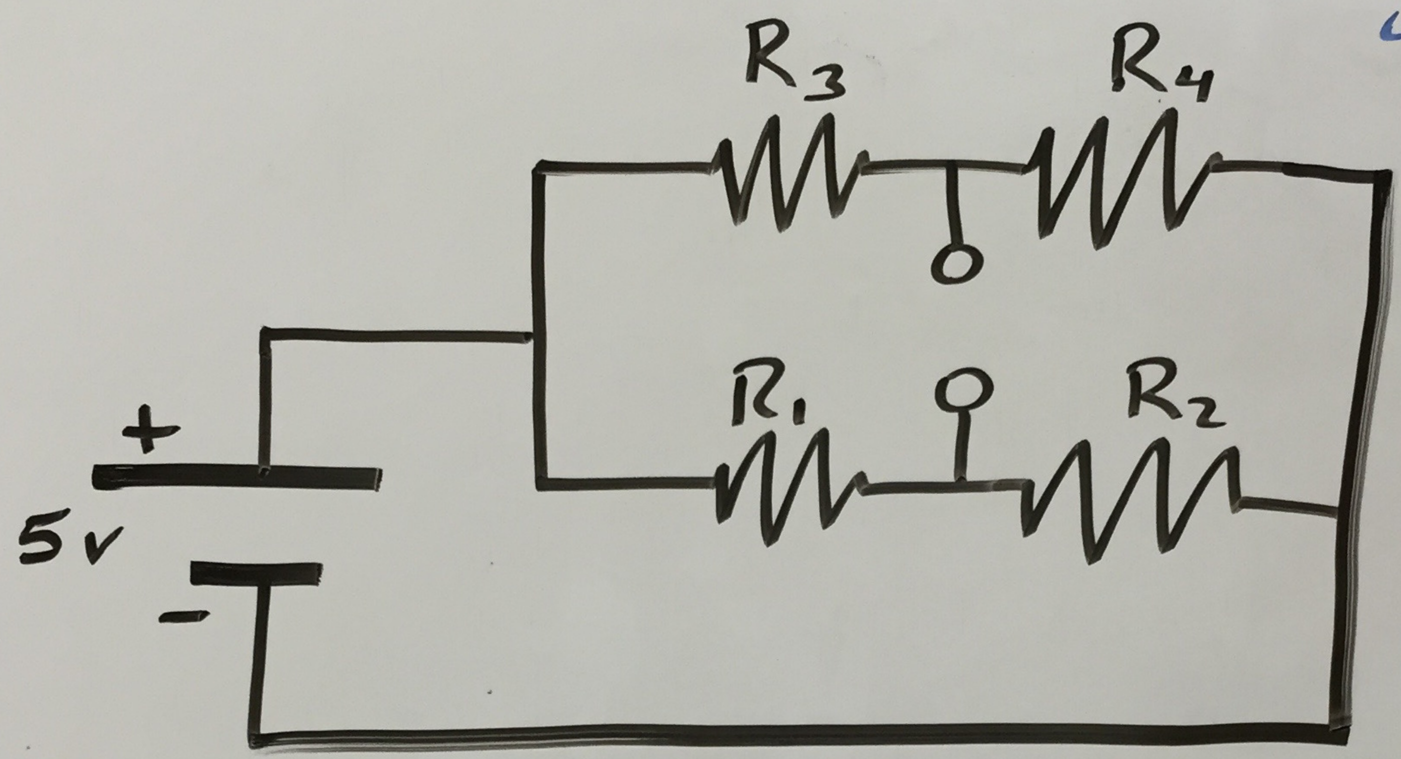


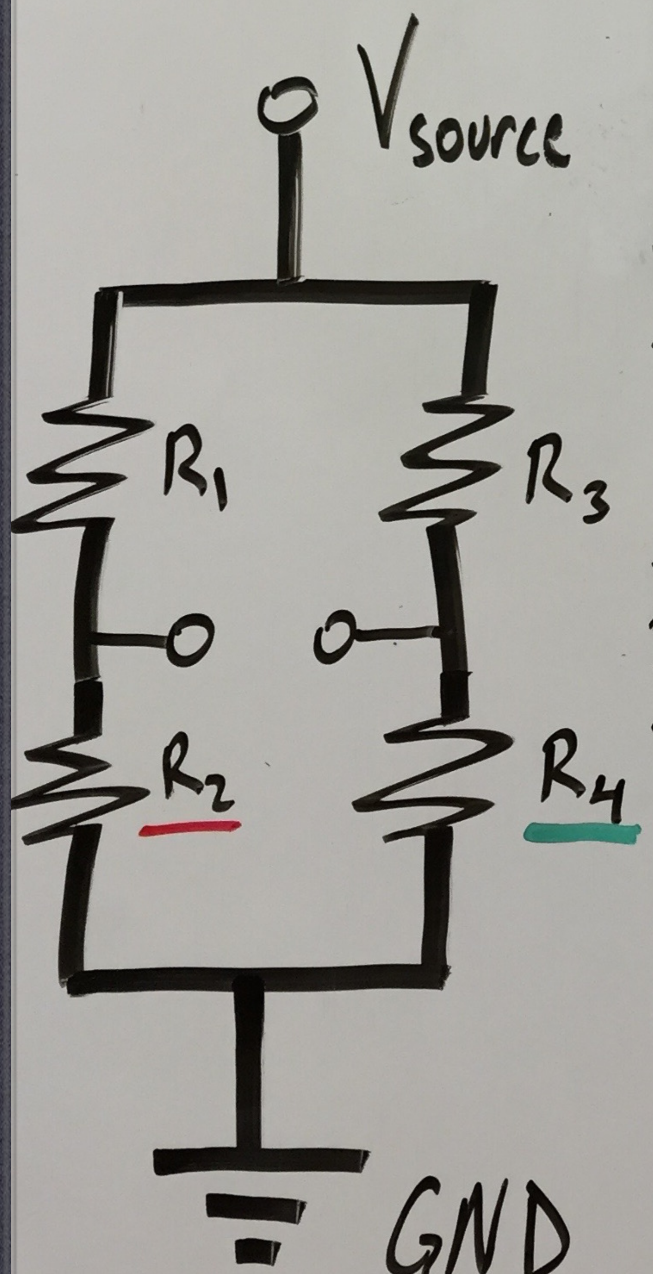


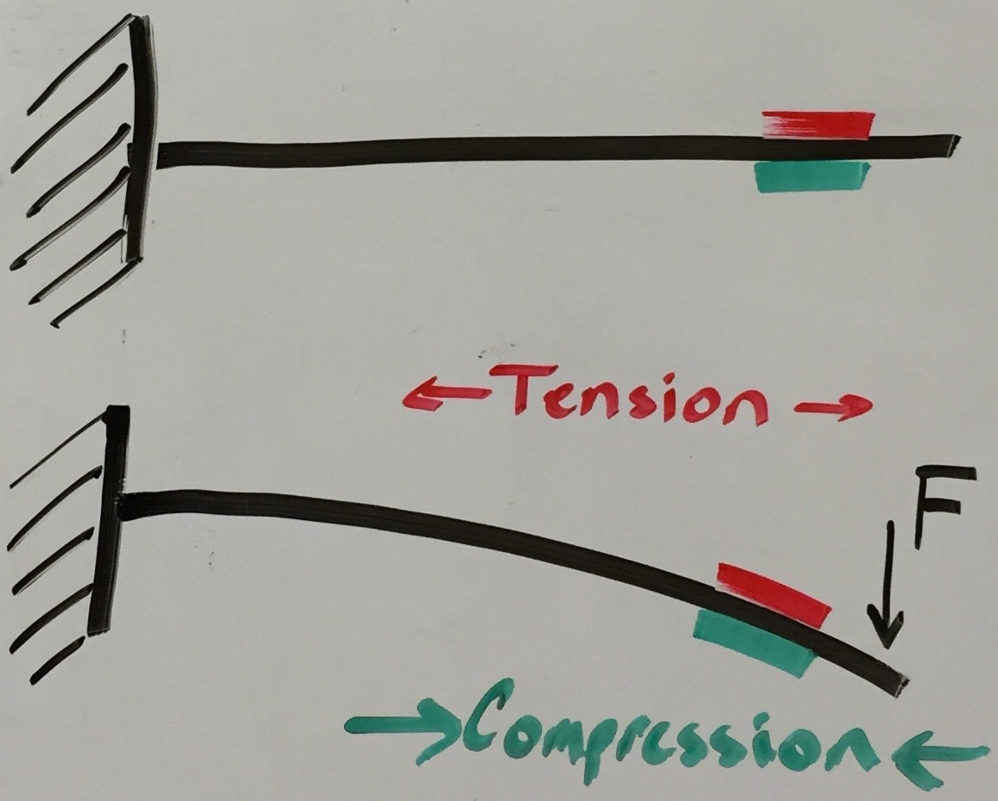
$$V_{Divider} = V_{source}\left(\frac{R_2}{R_1 + R_2}\right)$$

Special Parallel Circuits

Wheatstone Bridge





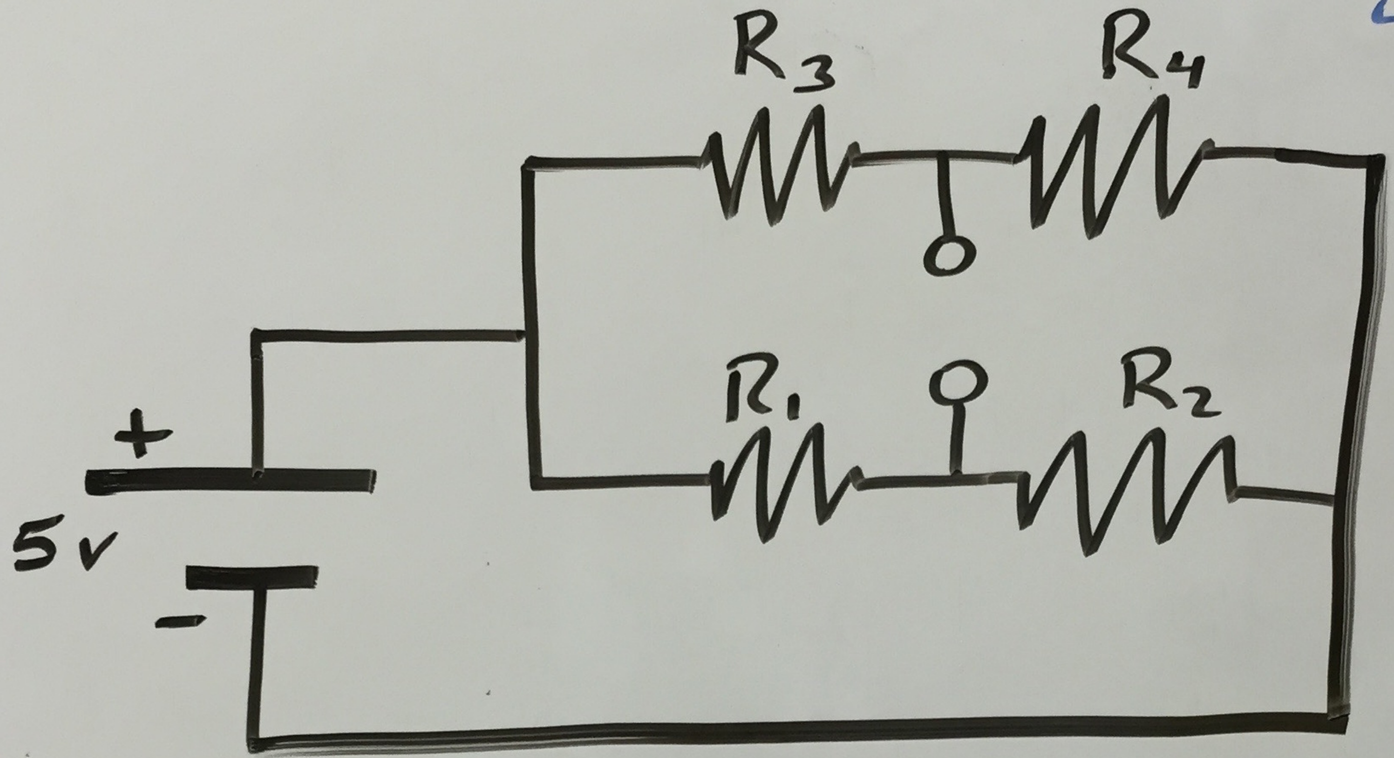


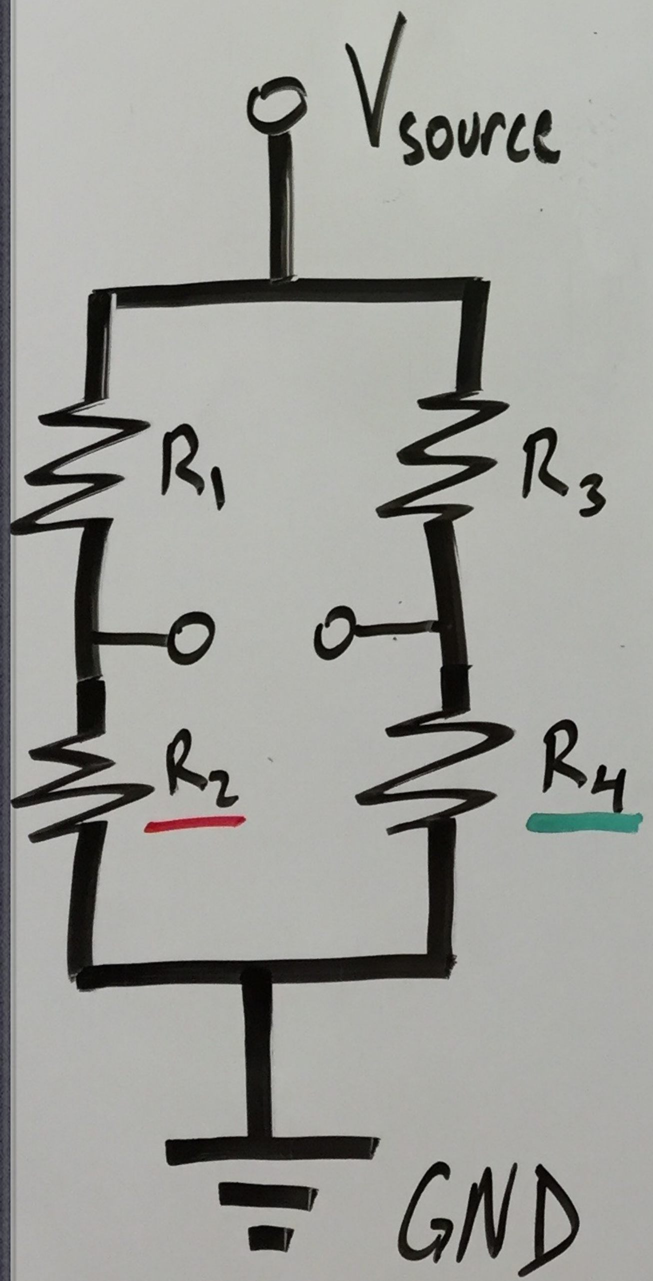
Tension stretches, increases resistance

Compression shrinks, decreases resistance

Special Parallel Circuits

Wheatstone Bridge





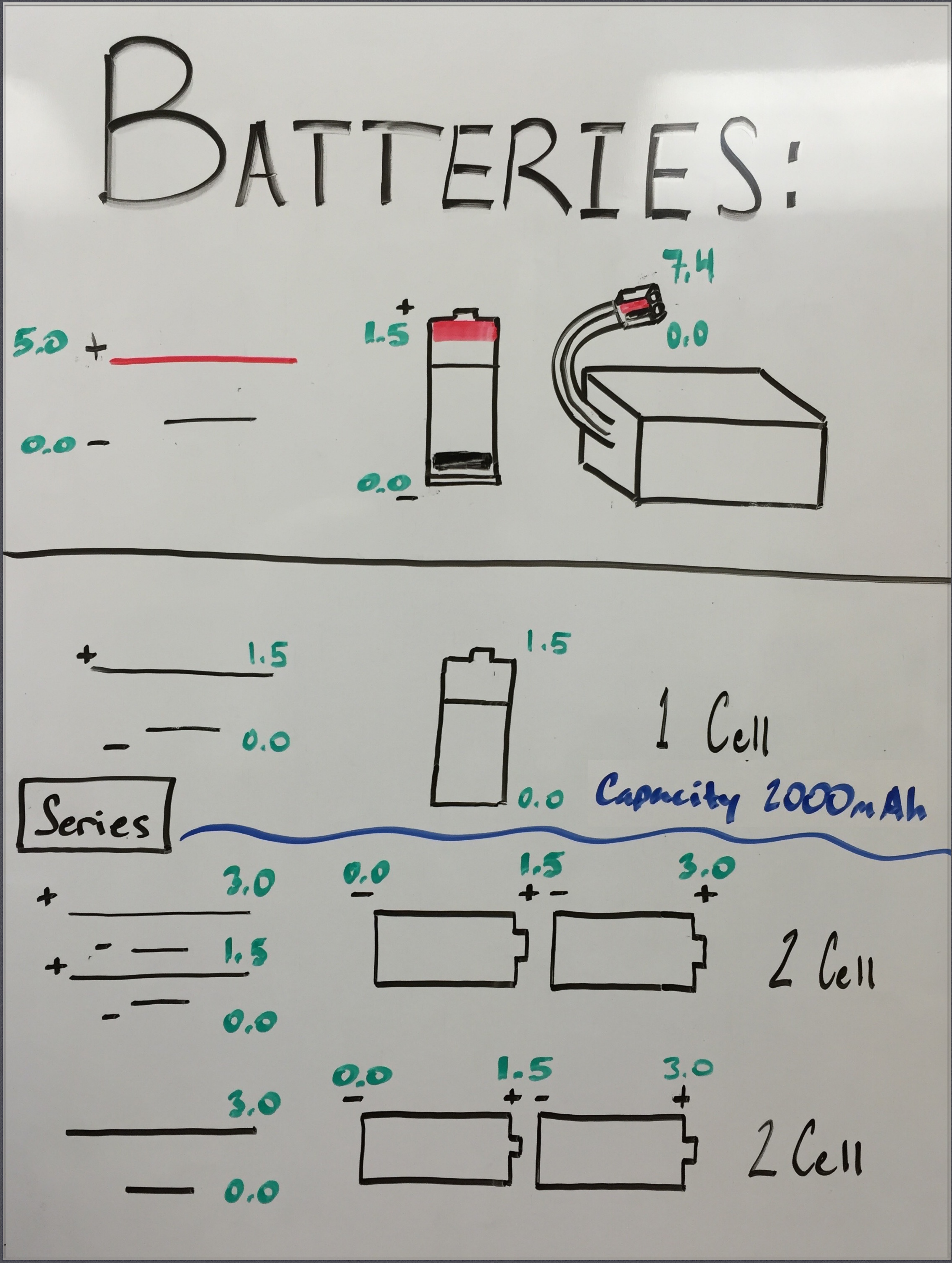
$$V_{source}\left(\frac{R_2}{R_1+R_2}\right)$$

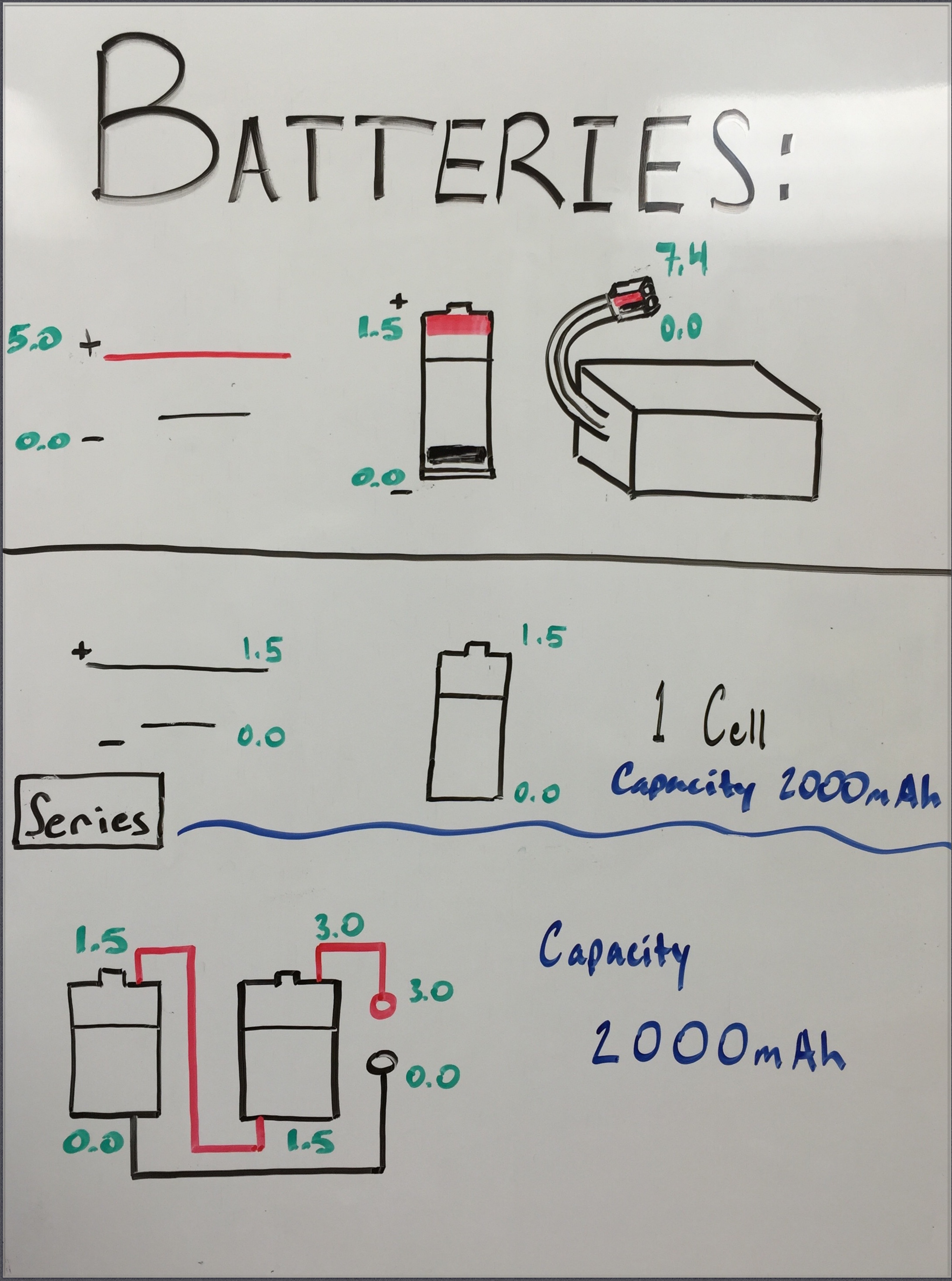
$$5\left(\frac{98}{100+98}\right) = 2.475v = V_1$$

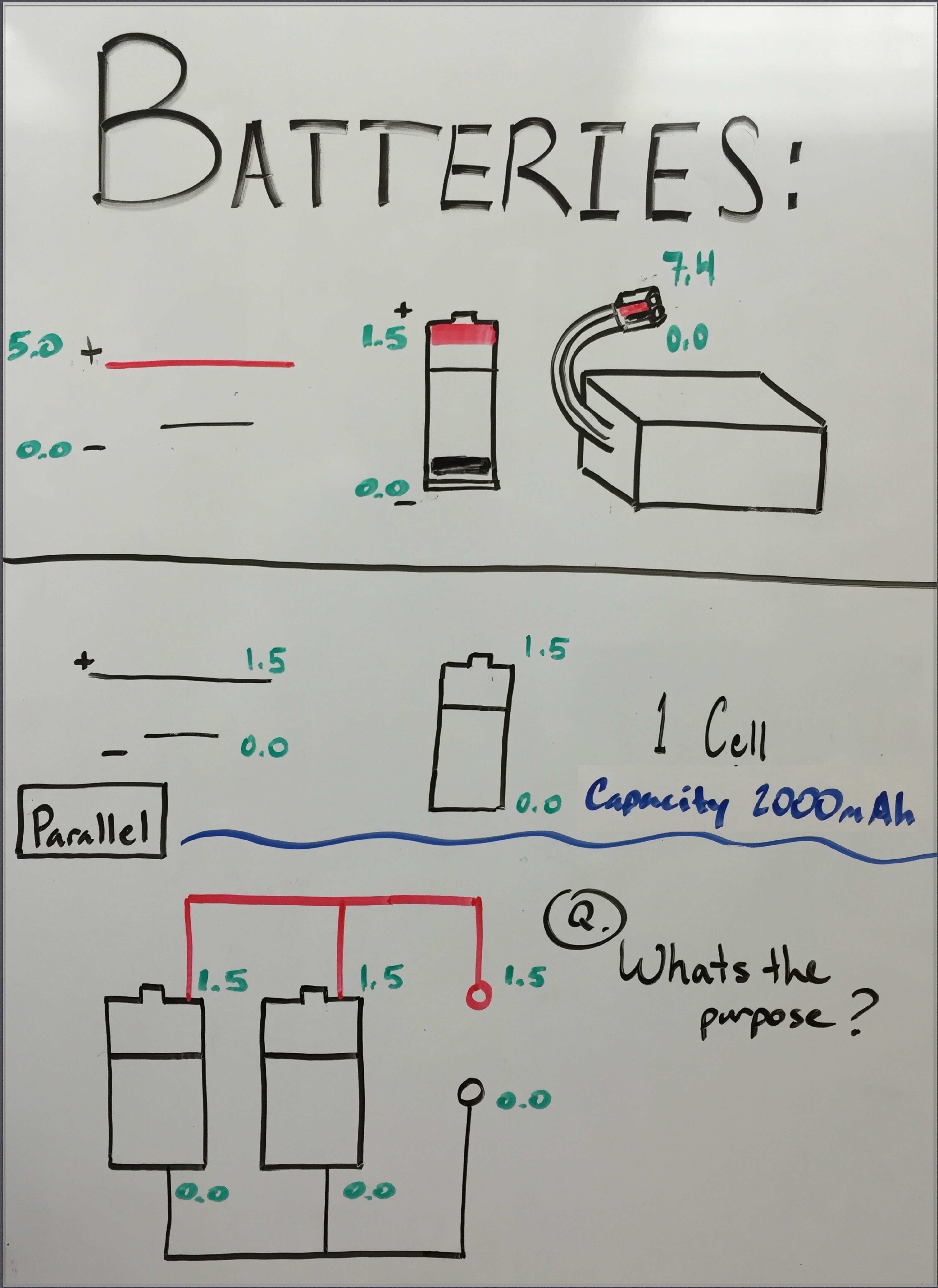
$$V_{source}\left(\frac{R_3}{R_3+R_4}\right)$$

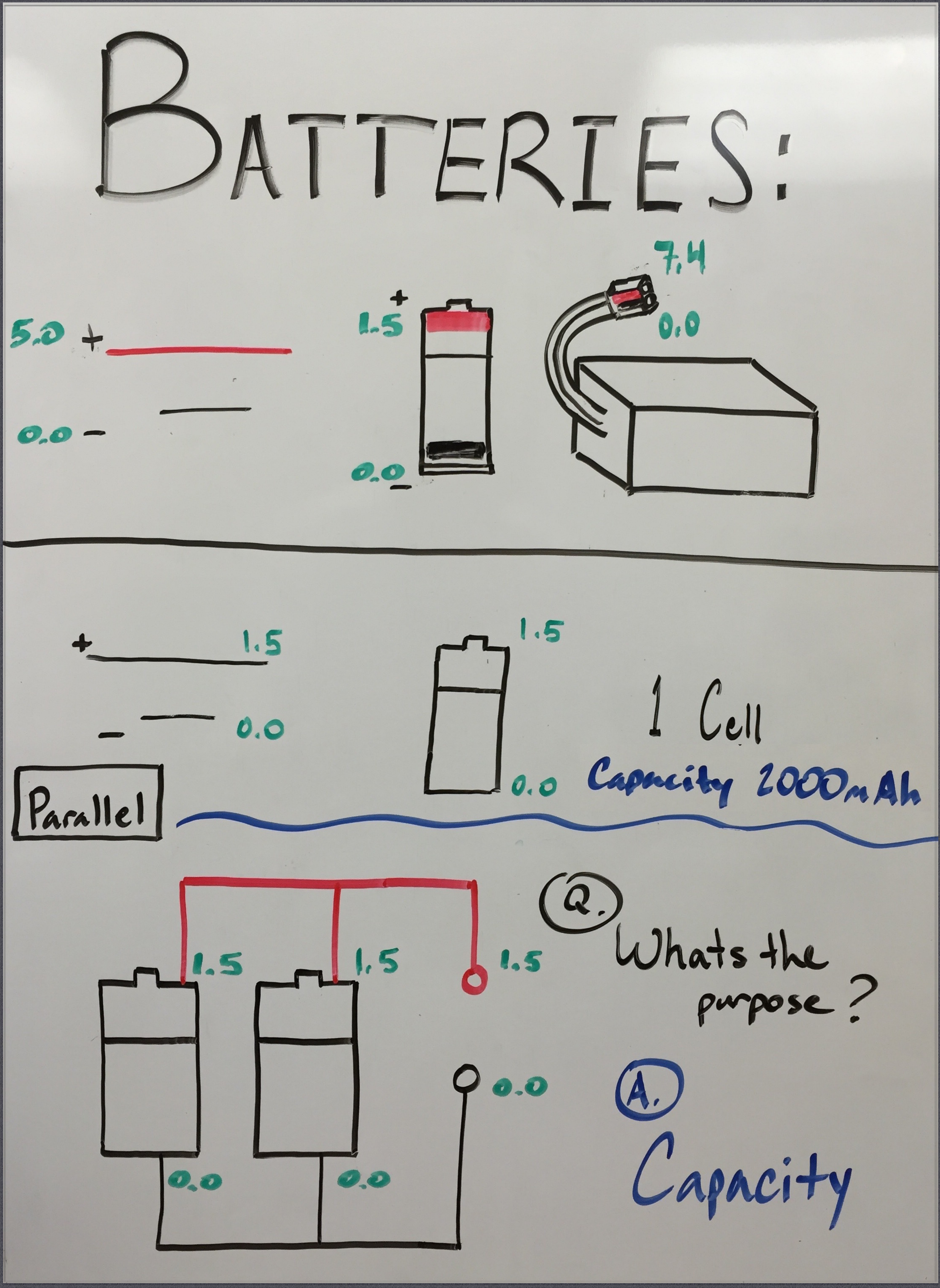
$$5\left(\frac{102}{100+102}\right) = 2.525v = V_2$$

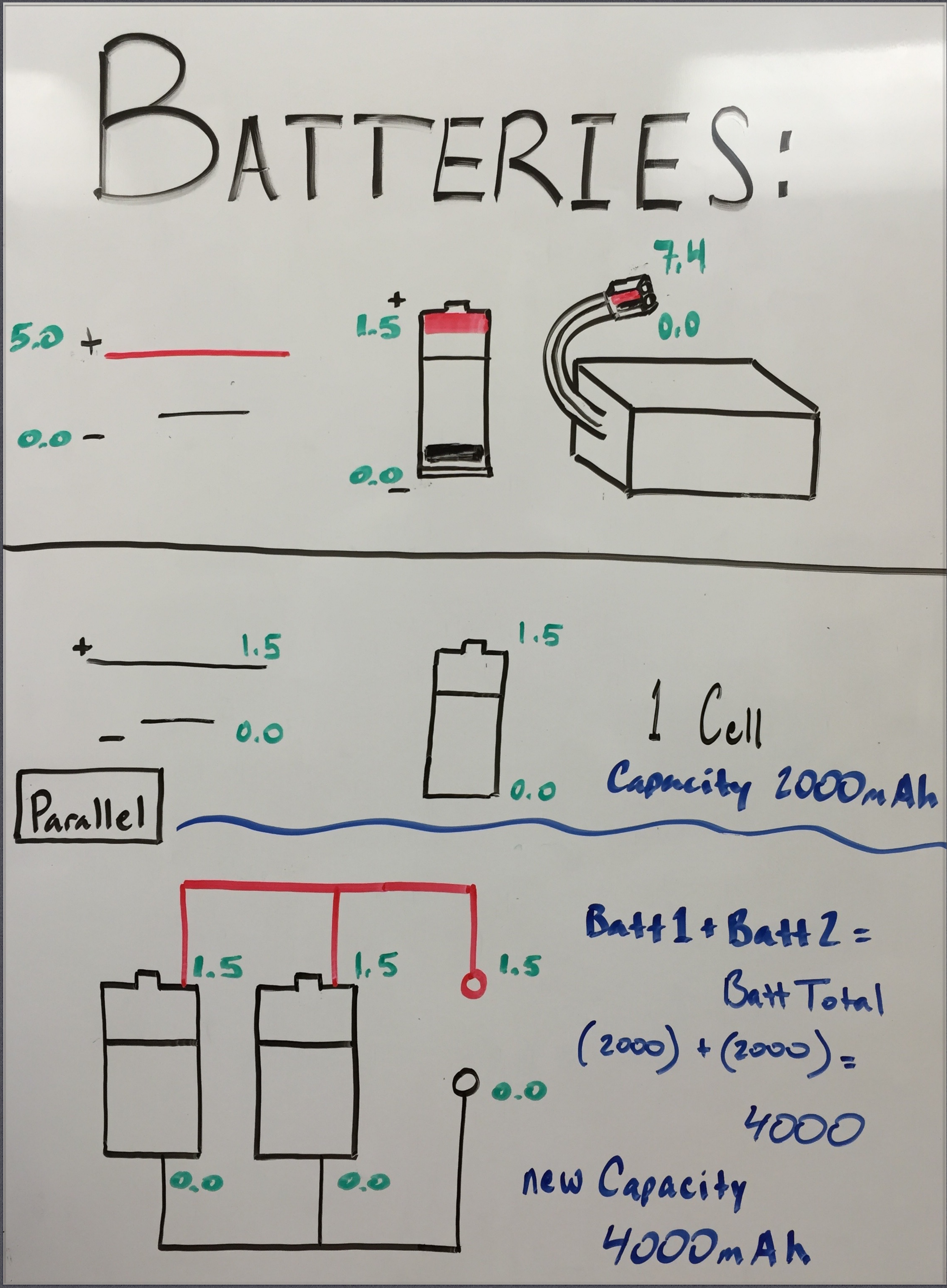
$$V_2 - V_1 = 0.05 \text{ volts}$$


BATTERIES:
5.0 +
0.0 −
+
1.5
0.0
7.4
0.0
+
1.5
−
0.0
1.5
0.0
1.5
0.0
1 Cell
Capacity 2000mAh
Series
+
3.0
− 1.5
+
− 0.0
0.0
1.5
3.0
− + − +
2 Cell
3.0
0.0
0.0
1.5
3.0
− + − +
2 Cell


BATTERIES:
7.4
0.0
5.0 +
0.0 –
1.5 +
0.0 –
+ 1.5
– 0.0
1.5
0.0
1 Cell
Capacity 2000mAh
Series
1.5
3.0
3.0
0.0
0.0
1.5
Capacity
2000mAh

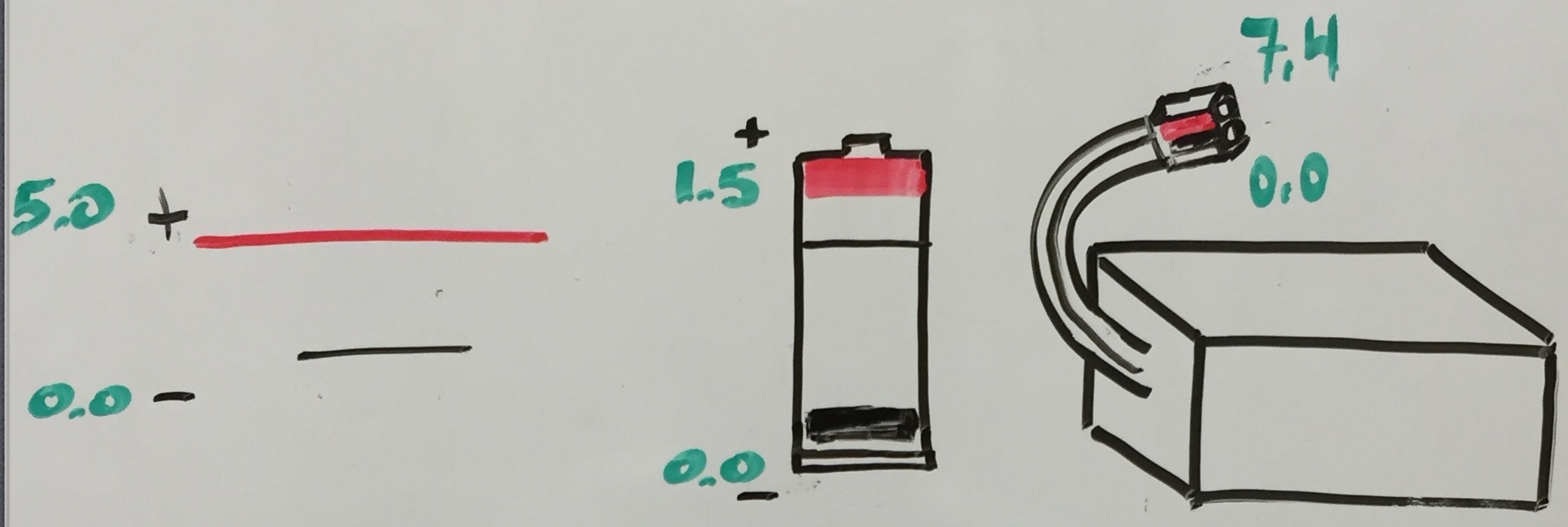

BATTERIES:
7.4
+
5.0 +
1.5
0.0
0.0 –
0.0
+ 1.5
1.5
– 0.0
1 Cell
0.0
Capacity 2000mAh
Parallel
Q.
Whats the purpose?
1.5
1.5
1.5
0.0
0.0
0.0


BATTERIES:
5.0 +
0.0 −
+
1.5
0.0
7.4
0.0
+
1.5
−
0.0
1.5
0.0
1 Cell
Capacity 2000mAh
Parallel
1.5
1.5
1.5
0.0
0.0
0.0
Q.
Whats the purpose?
A.
Capacity



BATTERIES:
5.0 +
0.0 −
+
1.5
0.0
7.4
0.0
+
1.5
− 0.0
1.5
1 Cell
0.0
Capacity 2000mAh
Parallel
1.5
1.5
1.5
0.0
0.0
0.0
Batt 1 + Batt 2 =
Batt Total
(2000) + (2000) =
4000
new Capacity
4000mAh

BATTERIES:



Summary

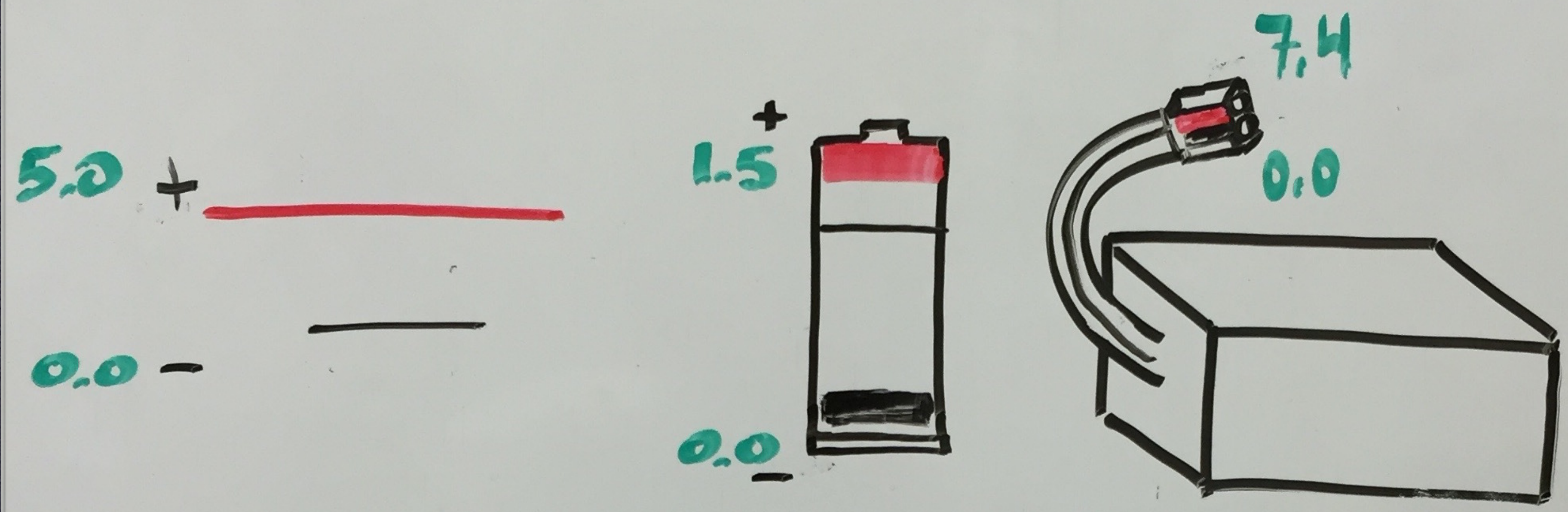
Batteries in Series →

- Increases voltage (addition)
- Capacity remains constant

Batteries in Parallel →

- Voltage remains constant
- Capacity increases (addition)

BATTERIES:



Notes:

- Never mix battery chemistries
- Never mix battery voltages
- Never mix battery capacities