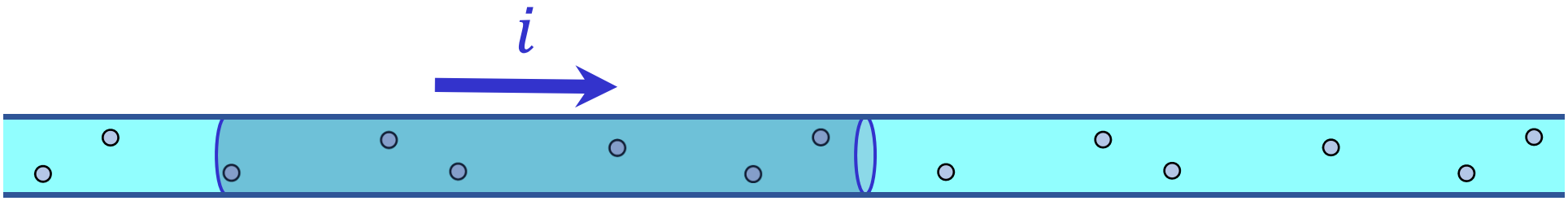
Basic Introduction to Electronics

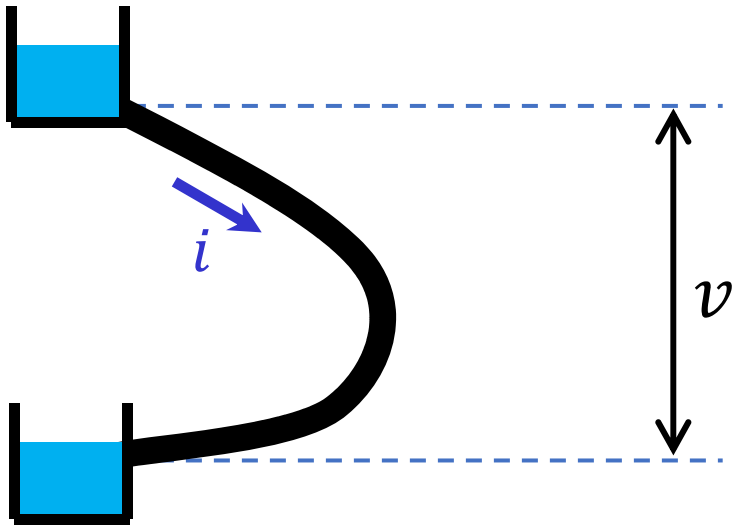


Electrical current

Symbol: i

Unit: Ampere (A)

For example: 1 mA = 0.001 Amperes

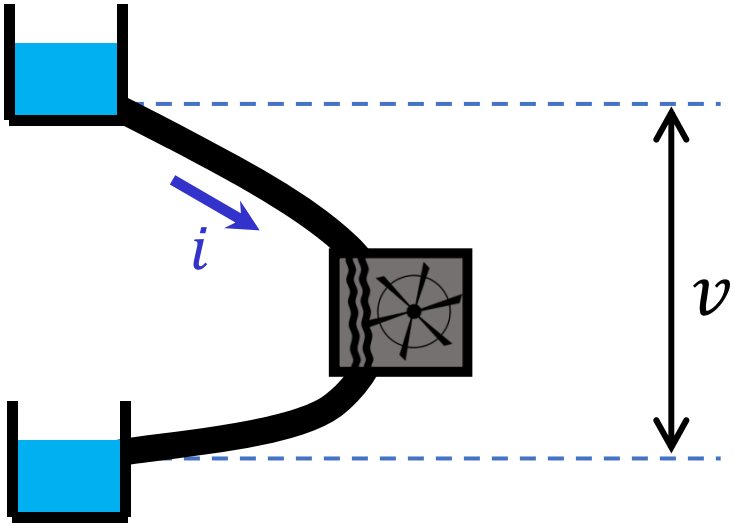


Voltage

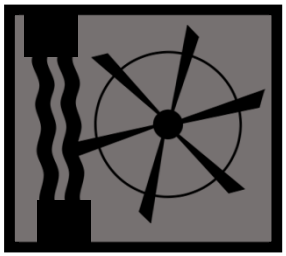
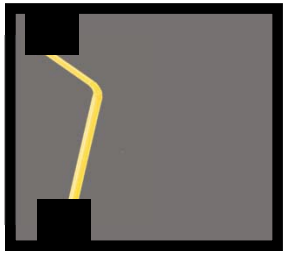
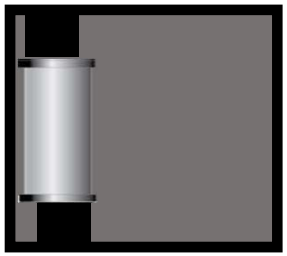
Symbol: v

Unit: Volt (V)

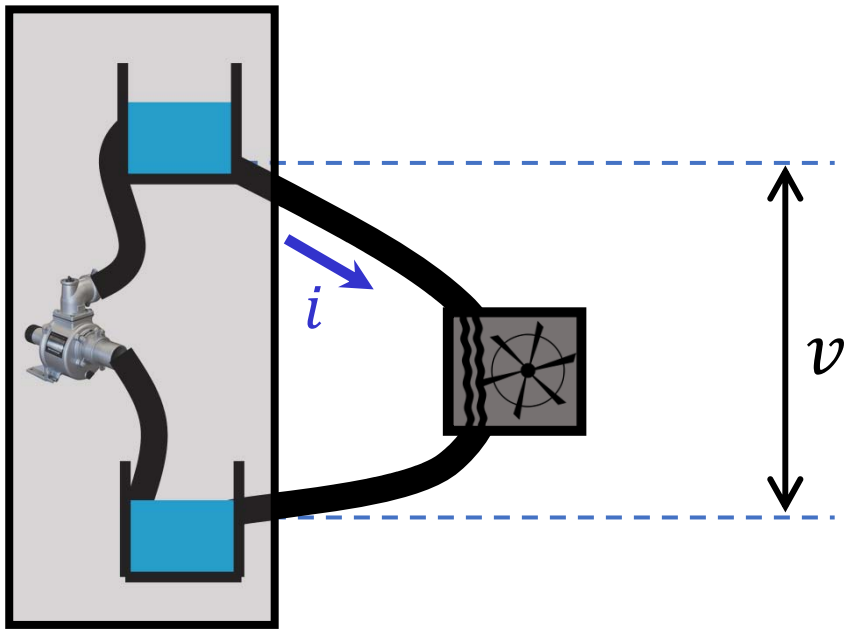
For example: 5 V

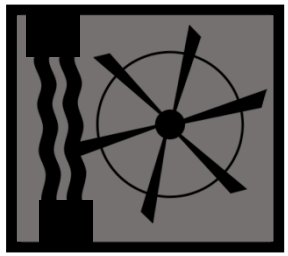


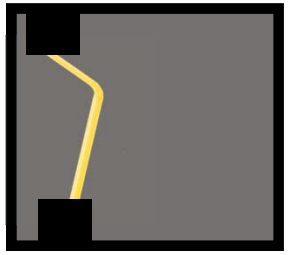
Circuit elements

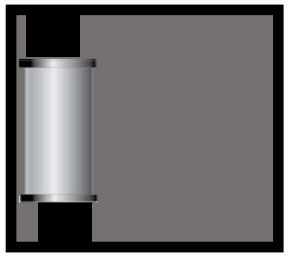




Same v Different i

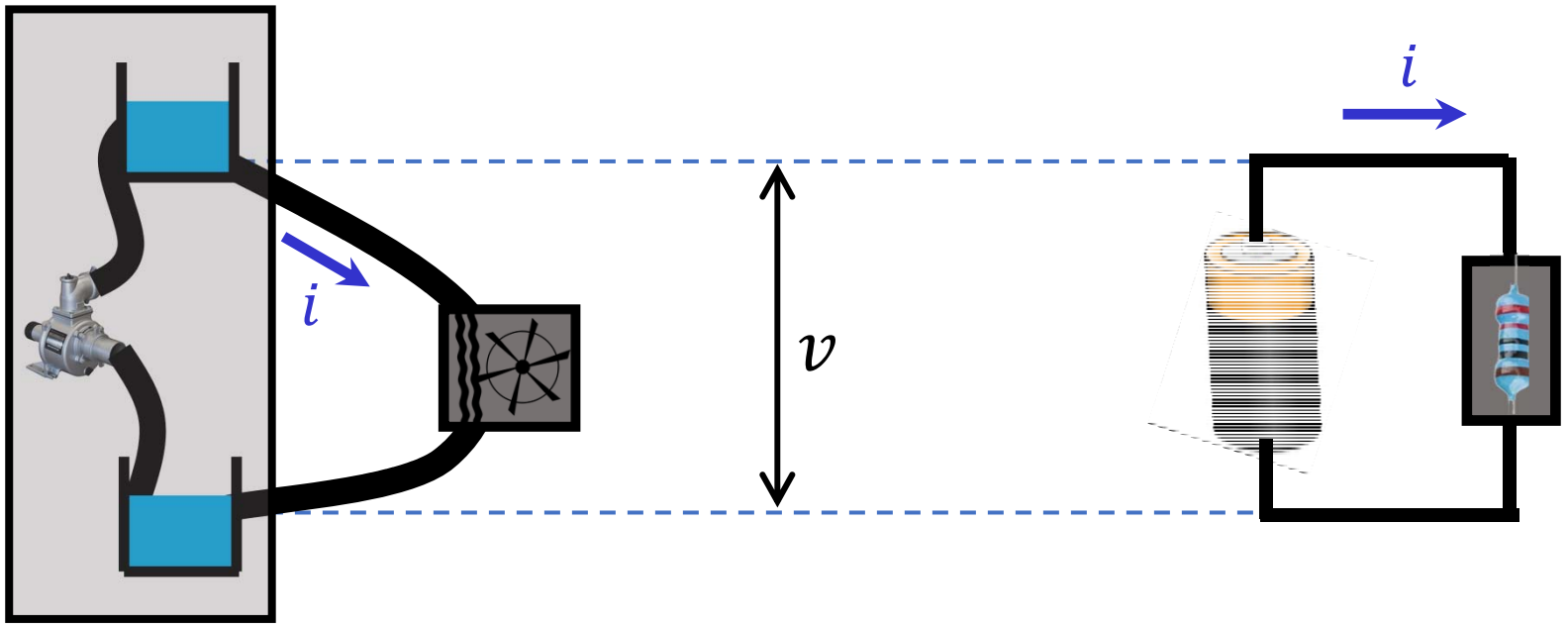






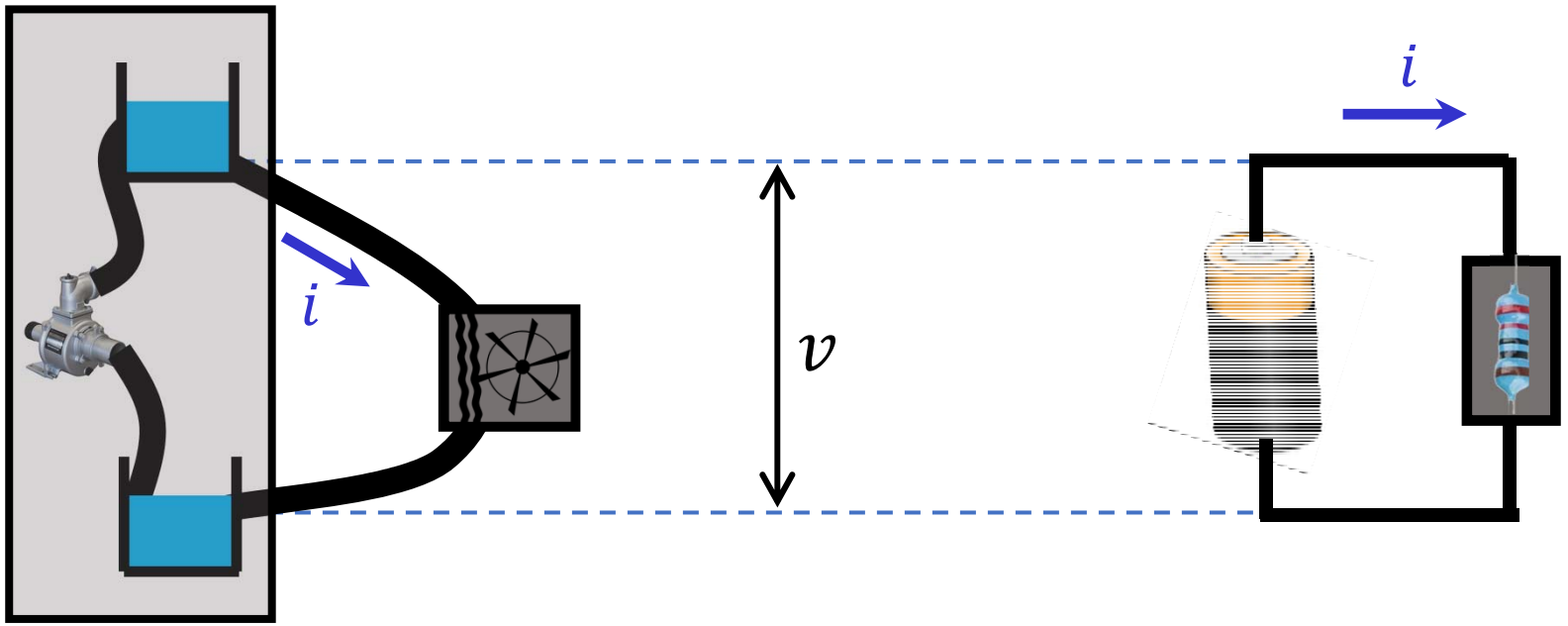


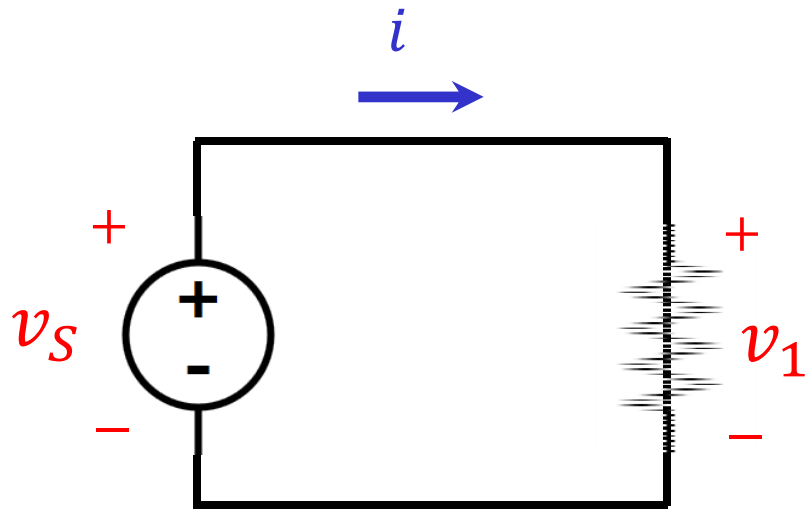
Same v Different i

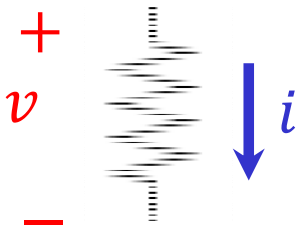


Circuit elements

Same v Different i


i
i
v


i
+
v_S
-
+
v_1
-



$$v = i \cdot R$$

$$i = \frac{v}{R}$$

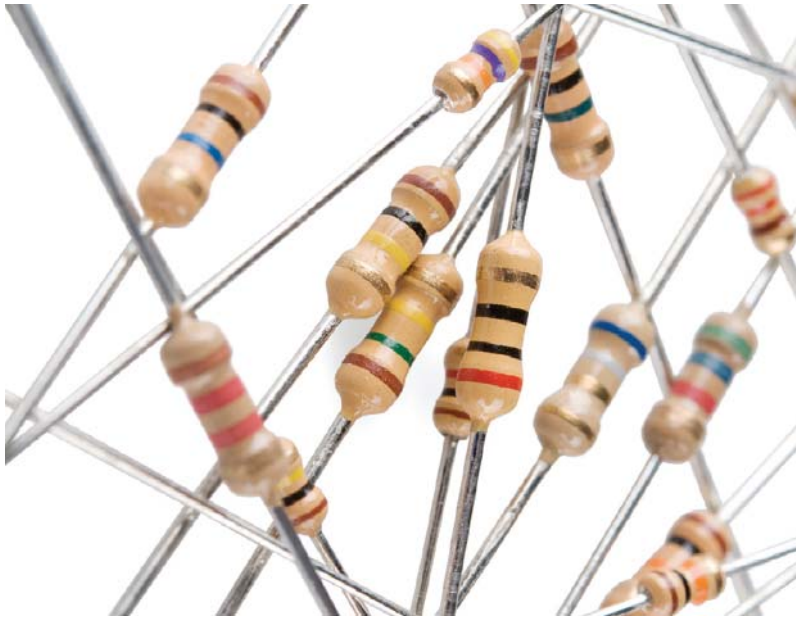
Ohm's Law

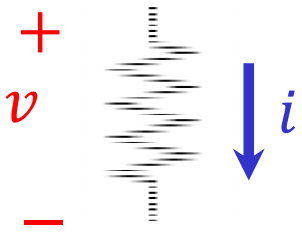
Resistor

Symbol: R

Unit: ohm (Ω)

For example: 1 kΩ

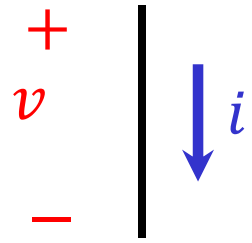




$$v = i \cdot R$$

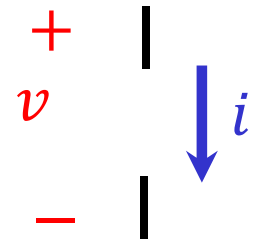
$$i = \frac{v}{R}$$

Ohm's Law



$$v = 0$$

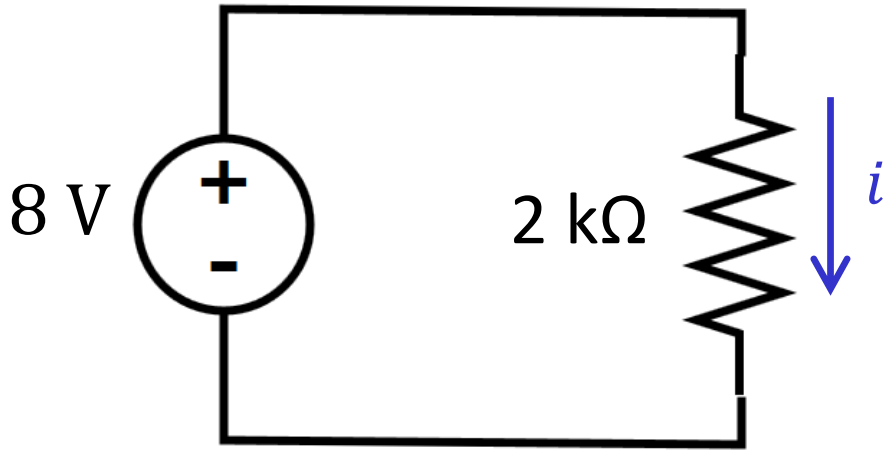
$$R = 0$$



$$i = 0$$

$$R = \infty$$

If the resistance R is 2 kΩ, the current i is:



[A] 0 mA

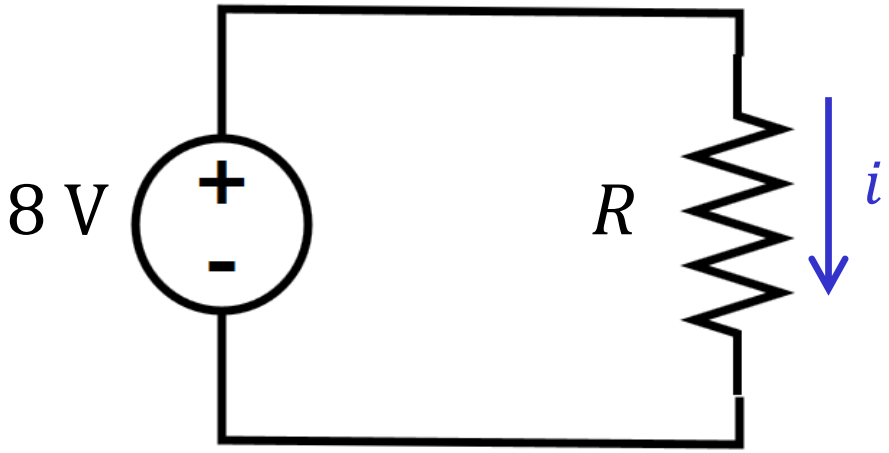
[B] 2 mA

[C] 4 mA

[D] 16 mA

[E] I don't know

What happens when the resistance *R* is lowered?



[A] The current i increases

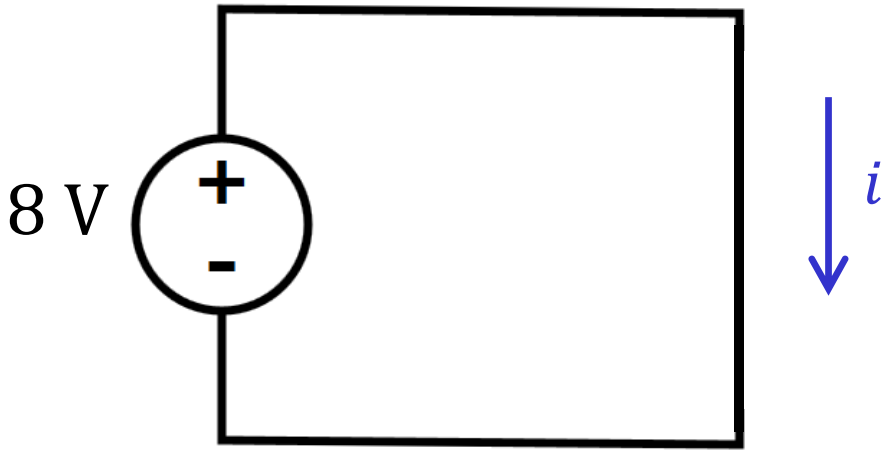
[B] The current i decreases

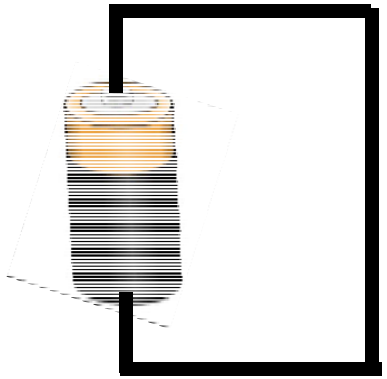
[C] The current i stays the same

[D] The current i cannot be calculated

[E] I don't know

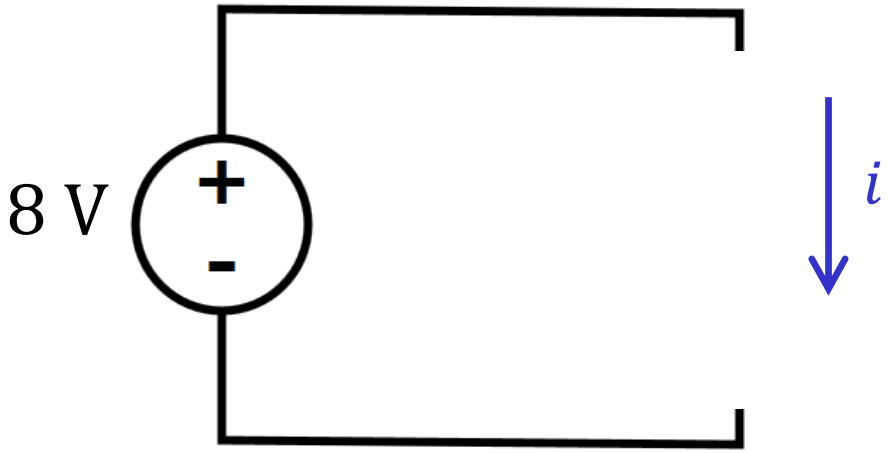
What happens when the resistance *R* is lowered?





Very bad!

What is the current i ?



[A] 0 mA

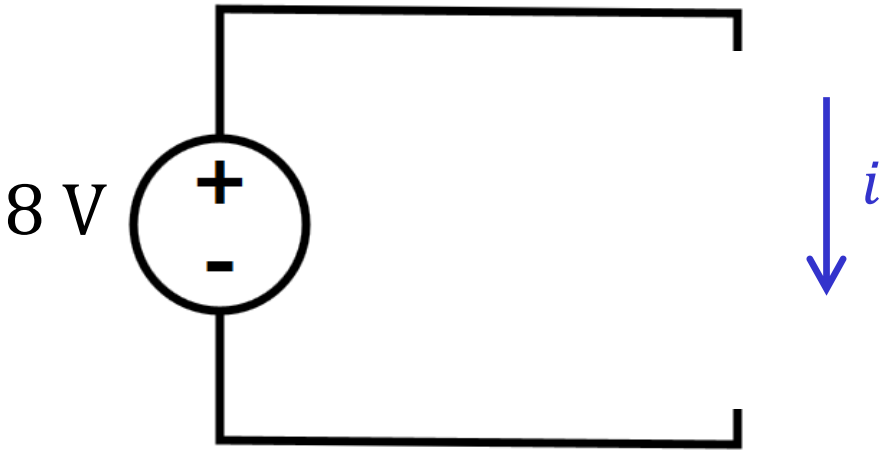
[B] 8 mA

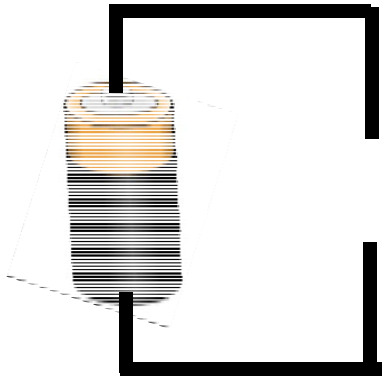
[C] 8 A

[D] $\propto$

[E] I don't know

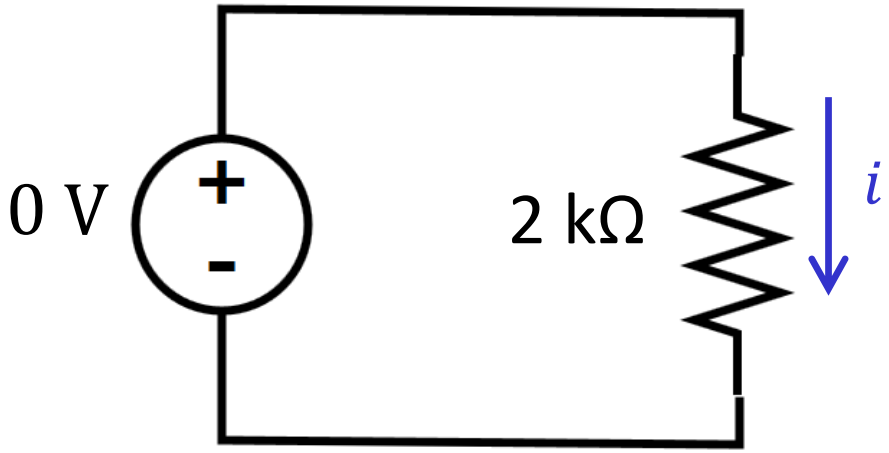
What is the current i ?





No current

If the resistance *R* is 2 kΩ, the current i is:



[A] 0 mA

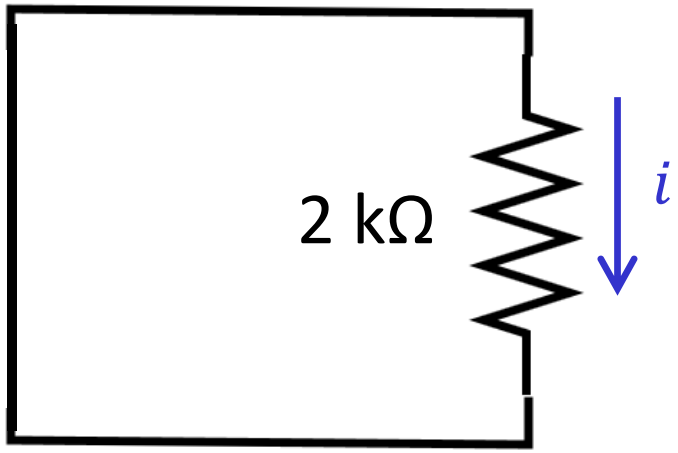
[B] 2 mA

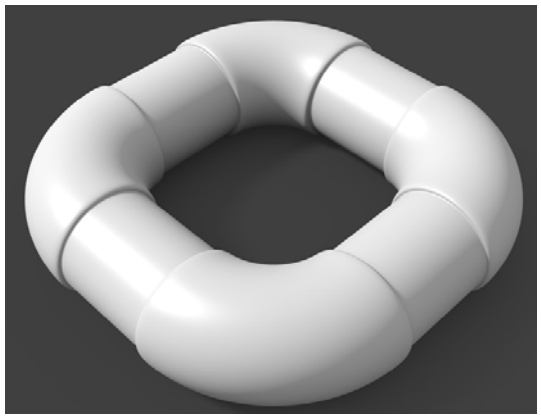
[C] 4 mA

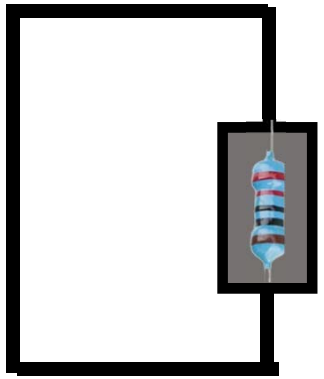
[D] 16 mA

[E] I don't know

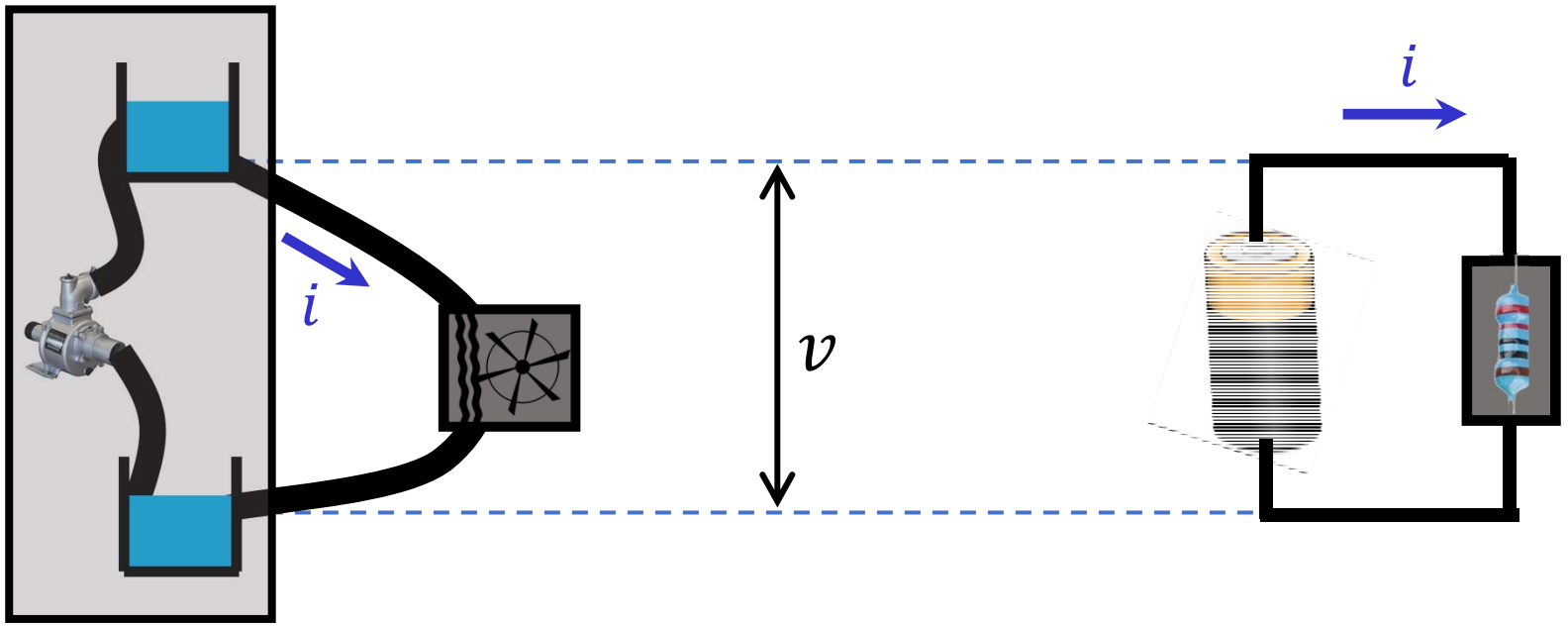
If the resistance R is 2 kΩ, the current i is:

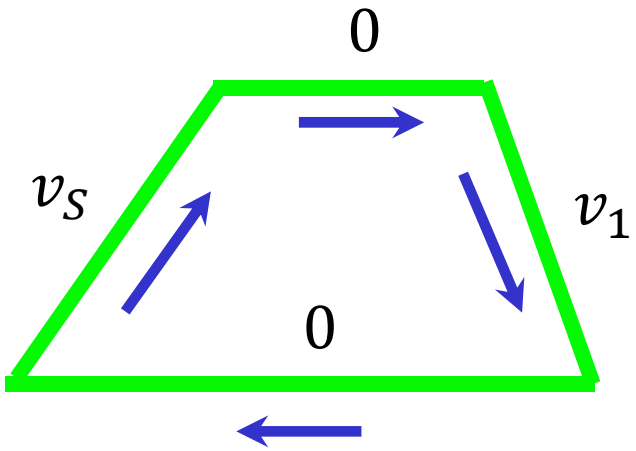


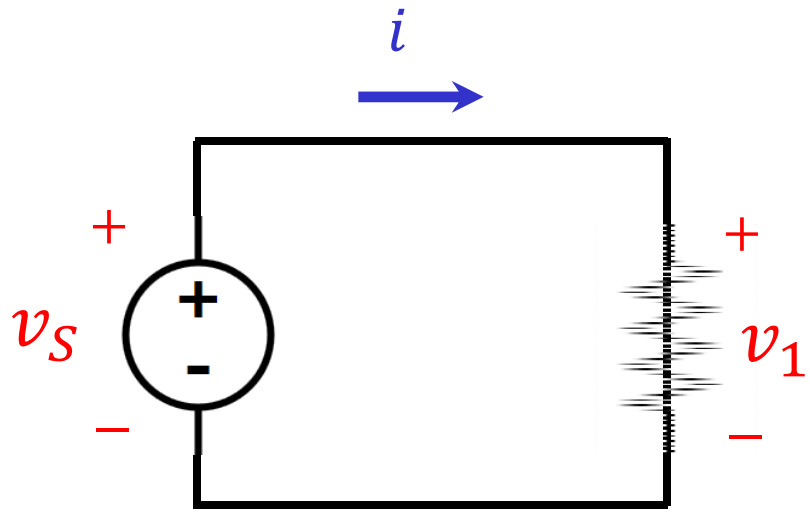




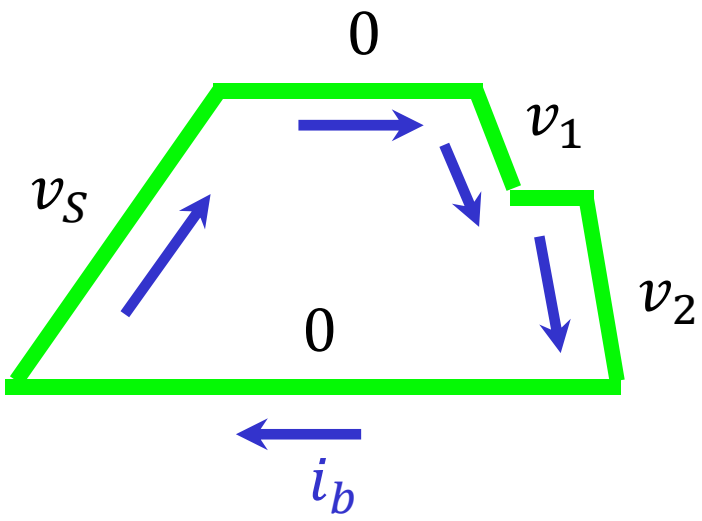
No current

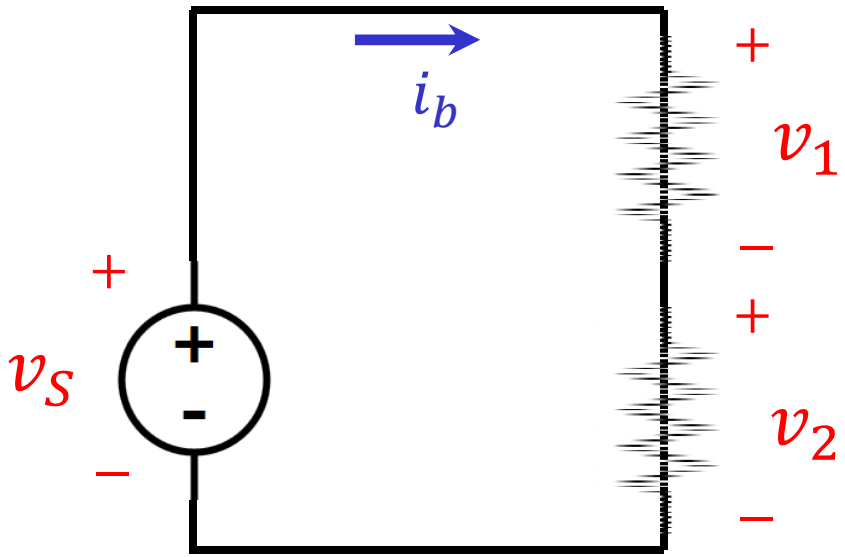

i
i
v

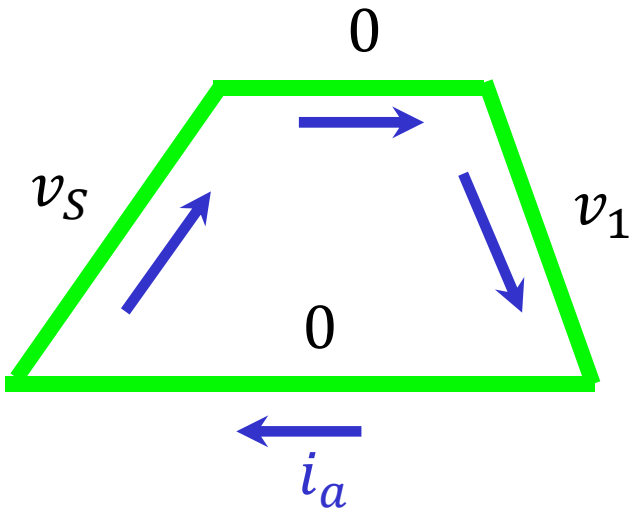

0
v_S
v_1
0

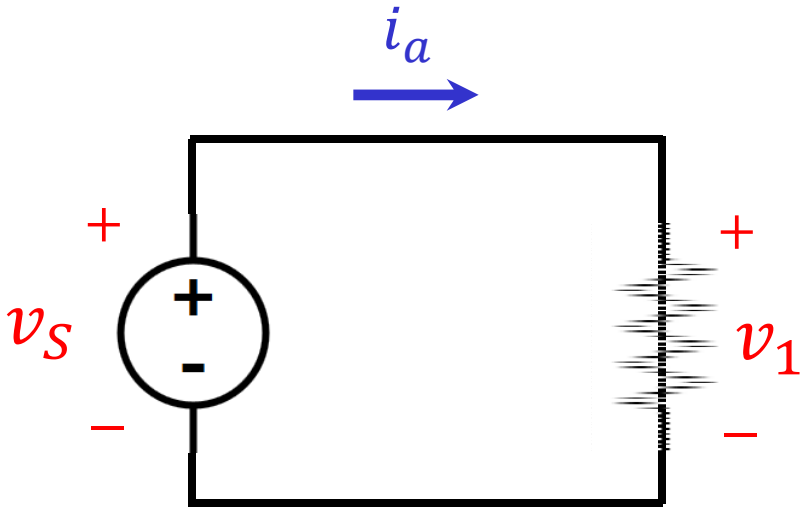

i
+
v_S
-
−
+
v_1
−

$v_S = v_1 + v_2$

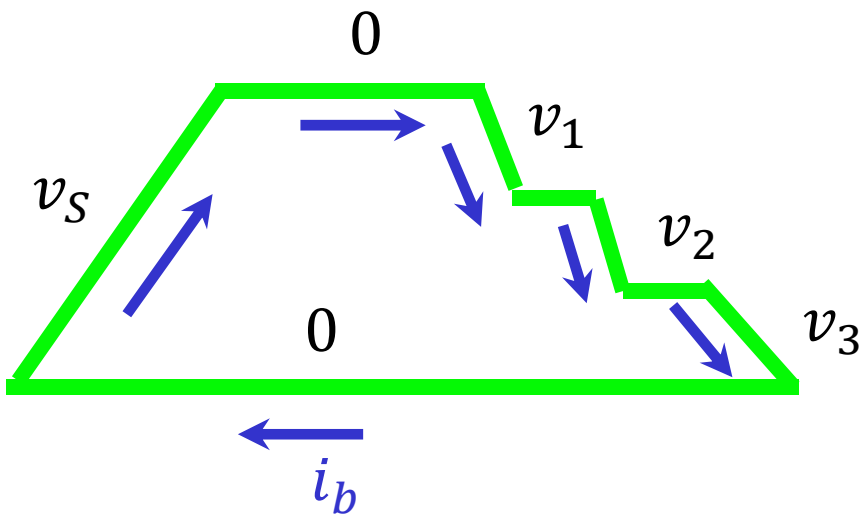








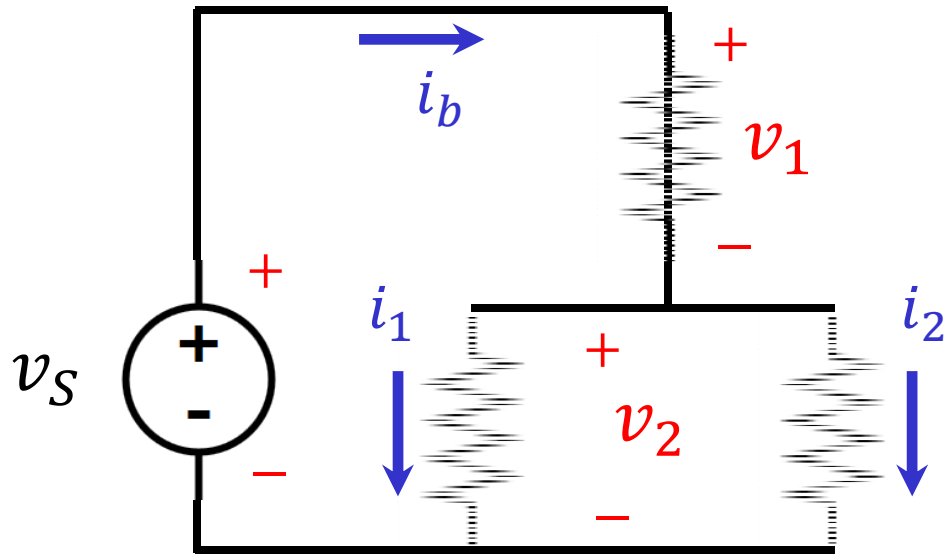
$v_S = v_1$



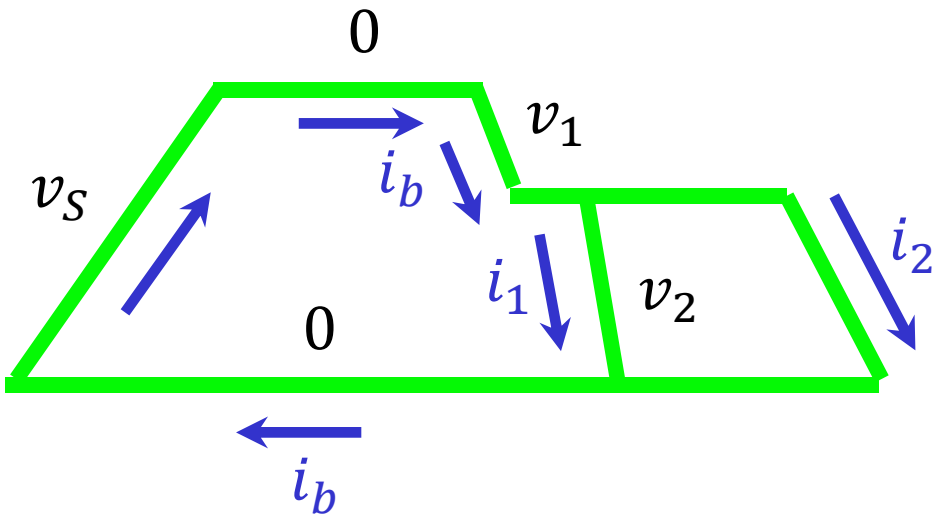
$$\sum_{up} v = \sum_{down} v$$

KVL

Kirchhoff's Voltage Law

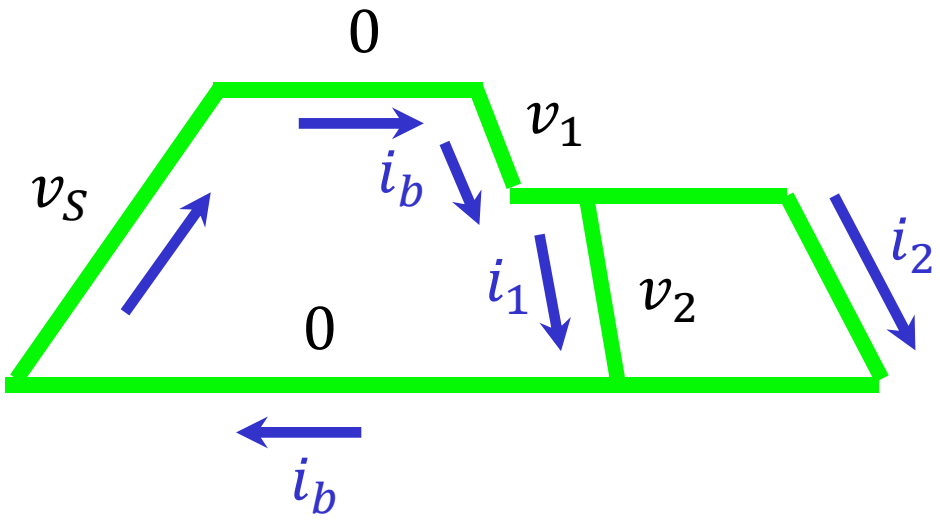


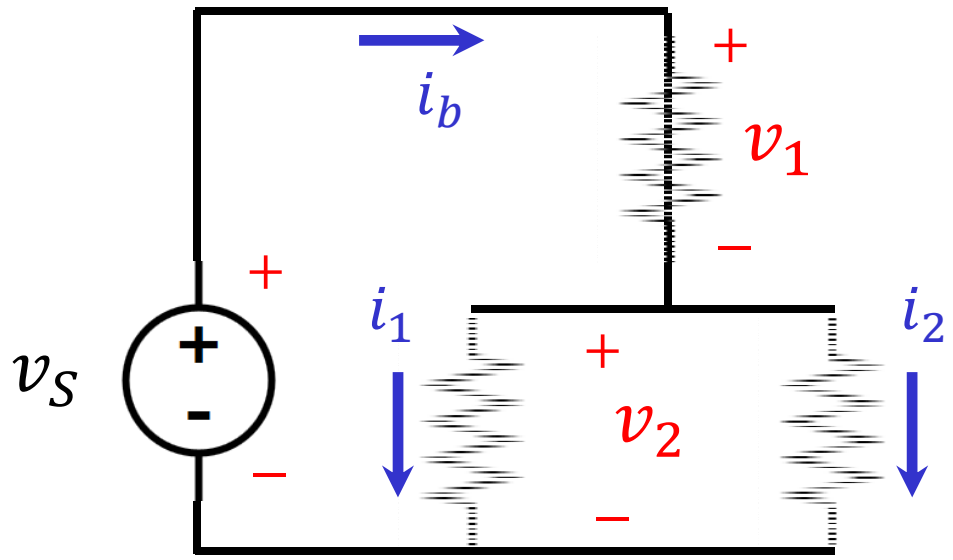
$$i_b = i_1 + i_2$$



$$\sum_{in} i = \sum_{out} i$$

KCL
Kirchhoff's Current Law

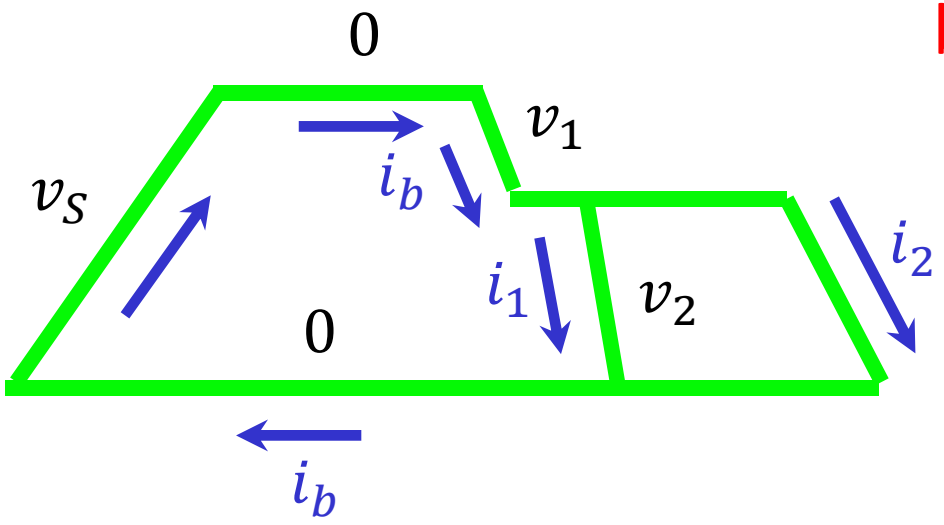




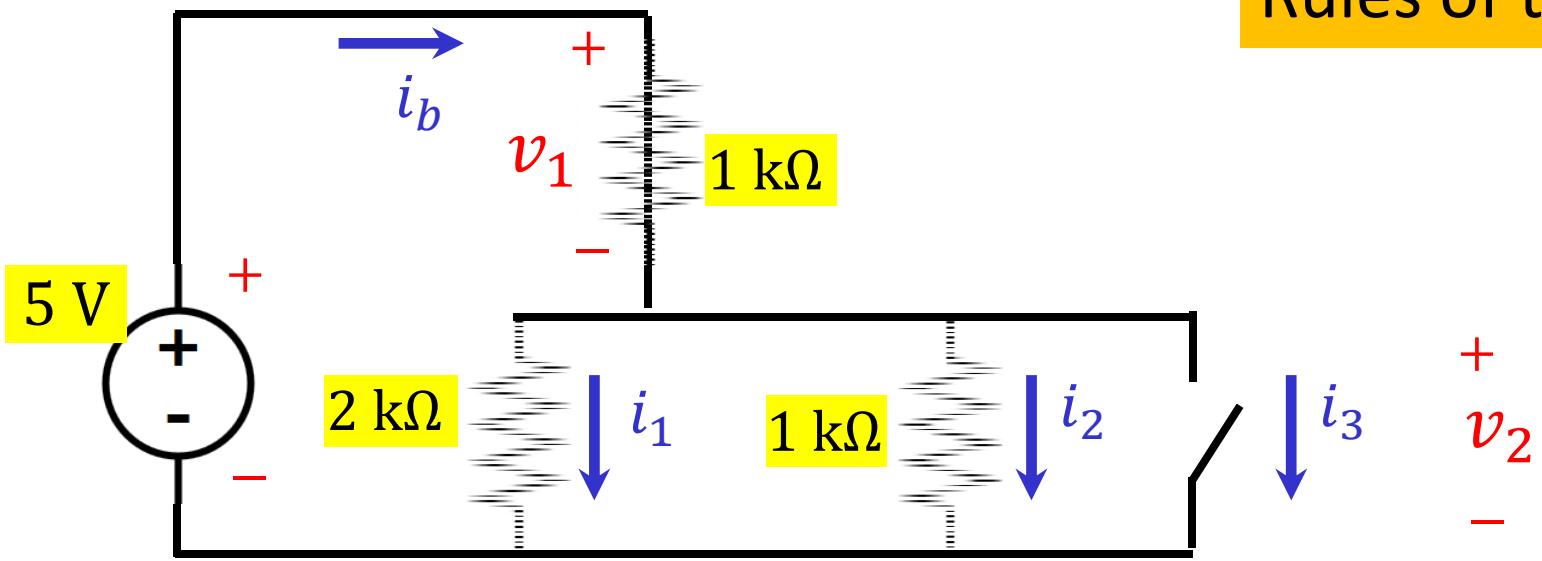
$$v_S = v_1 + v_2$$

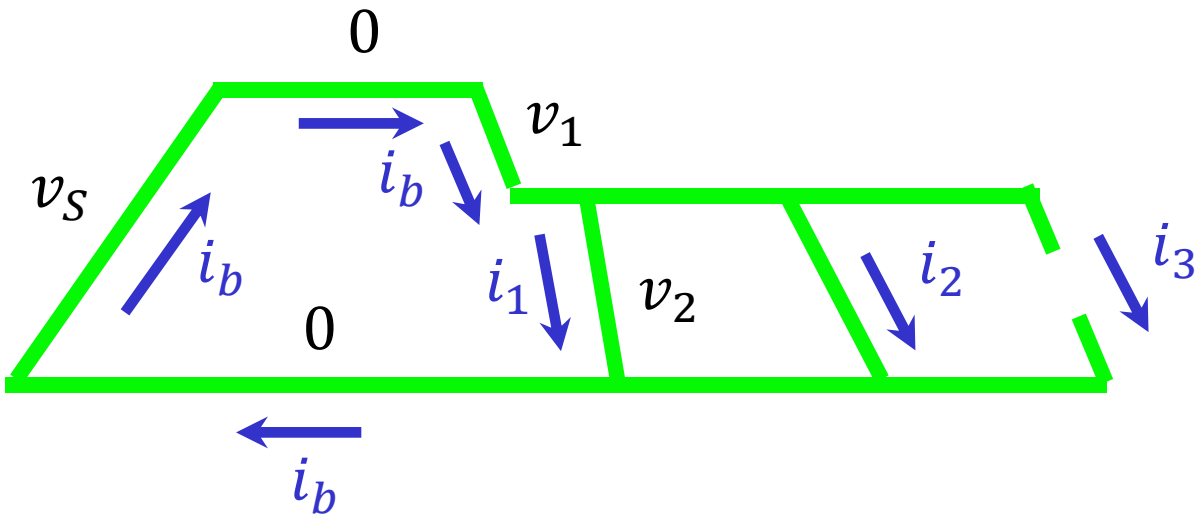
$$i_b = i_1 + i_2$$

Relationship between *i* an *v* ?

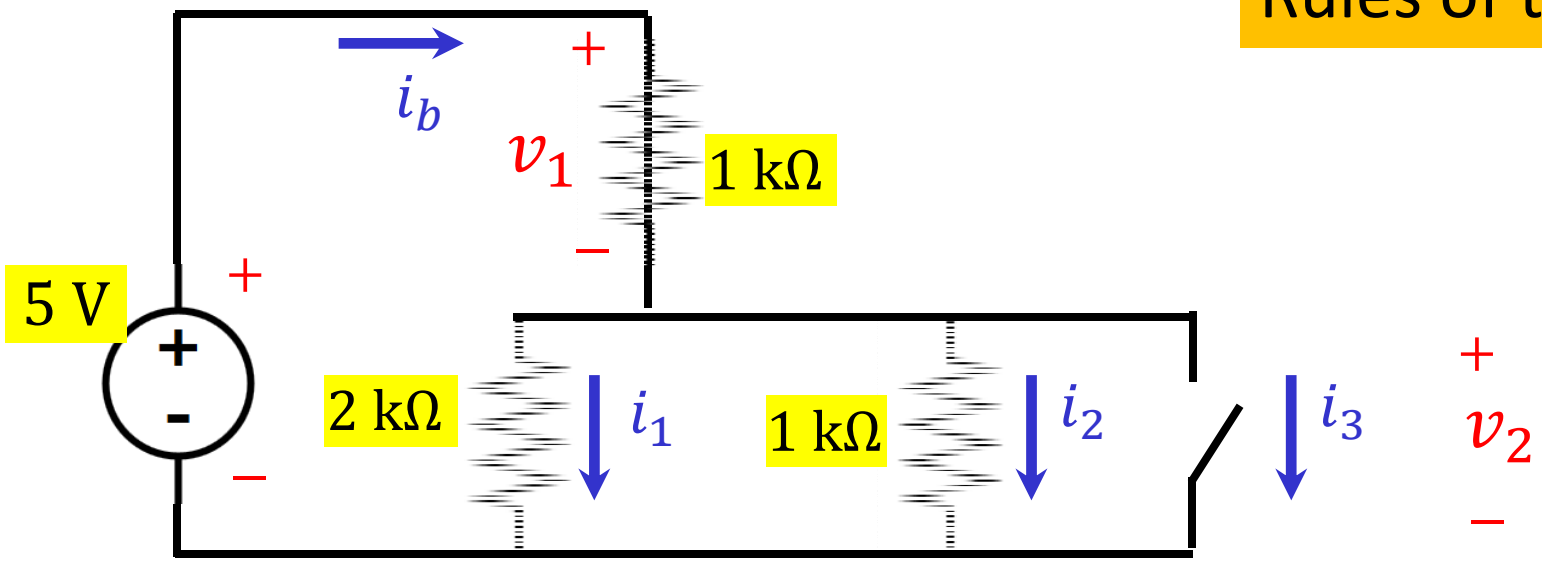


Rules of the game





Rules of the game



KCL

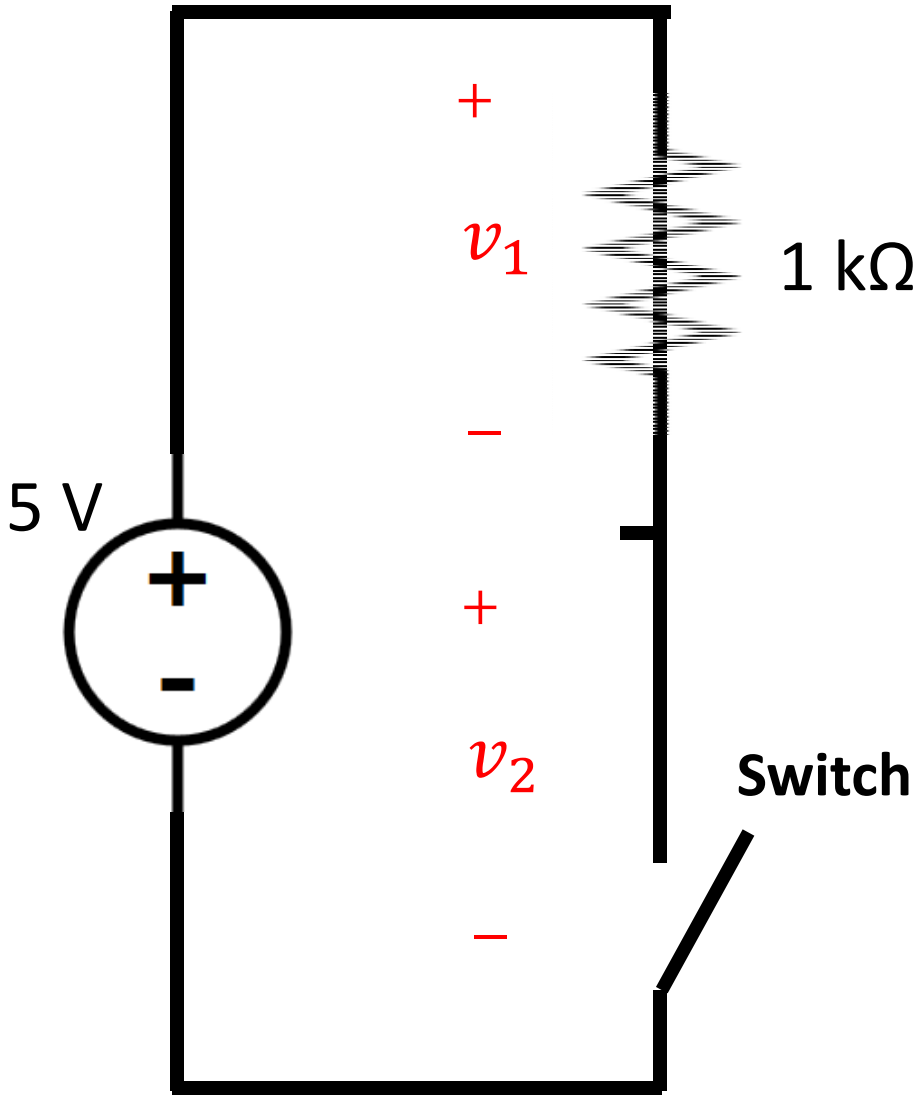
$$\sum_{in} i = \sum_{out} i$$

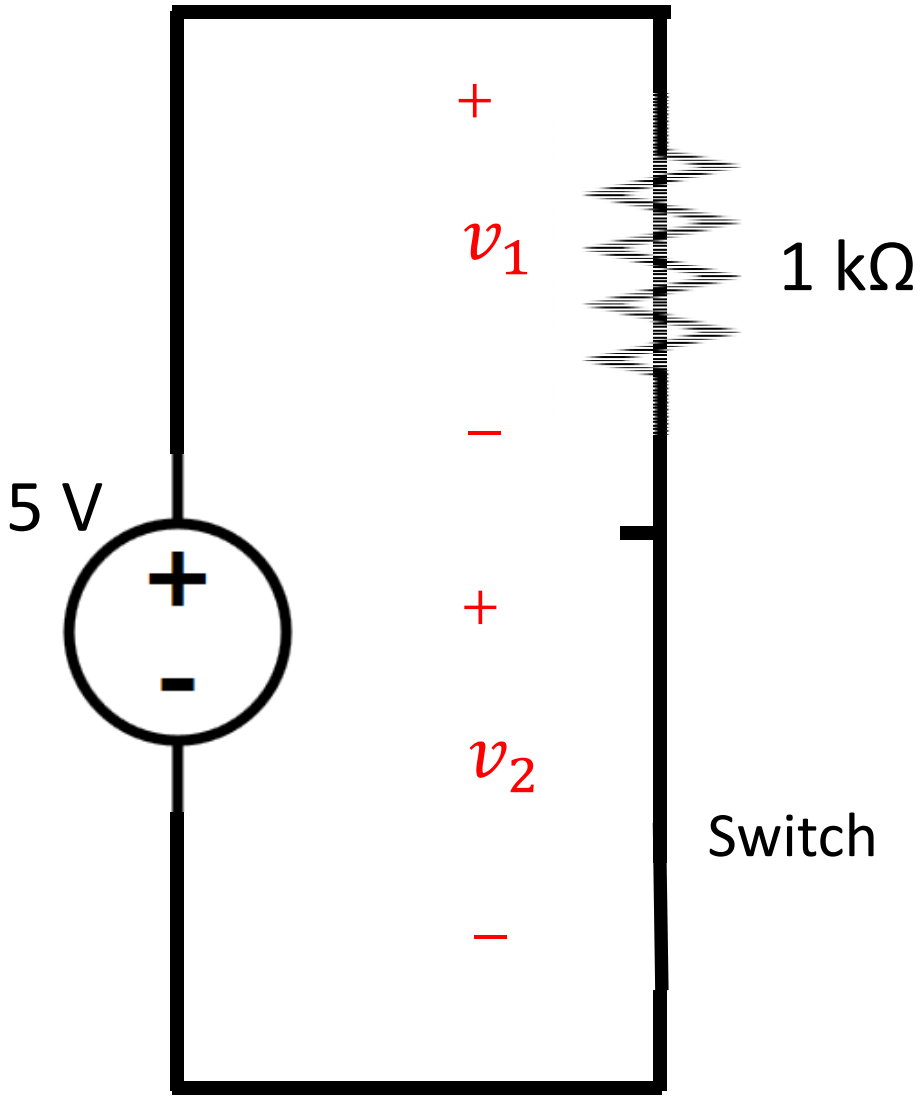
KVL

$$\sum_{up} v = \sum_{down} v$$

Ohm's Law

$$v = i \cdot R$$


+
v_1
1 kΩ
−
5 V
+
-
+
v_2
Switch
−



When the switch is <u>closed</u>, the voltage v_2 is:

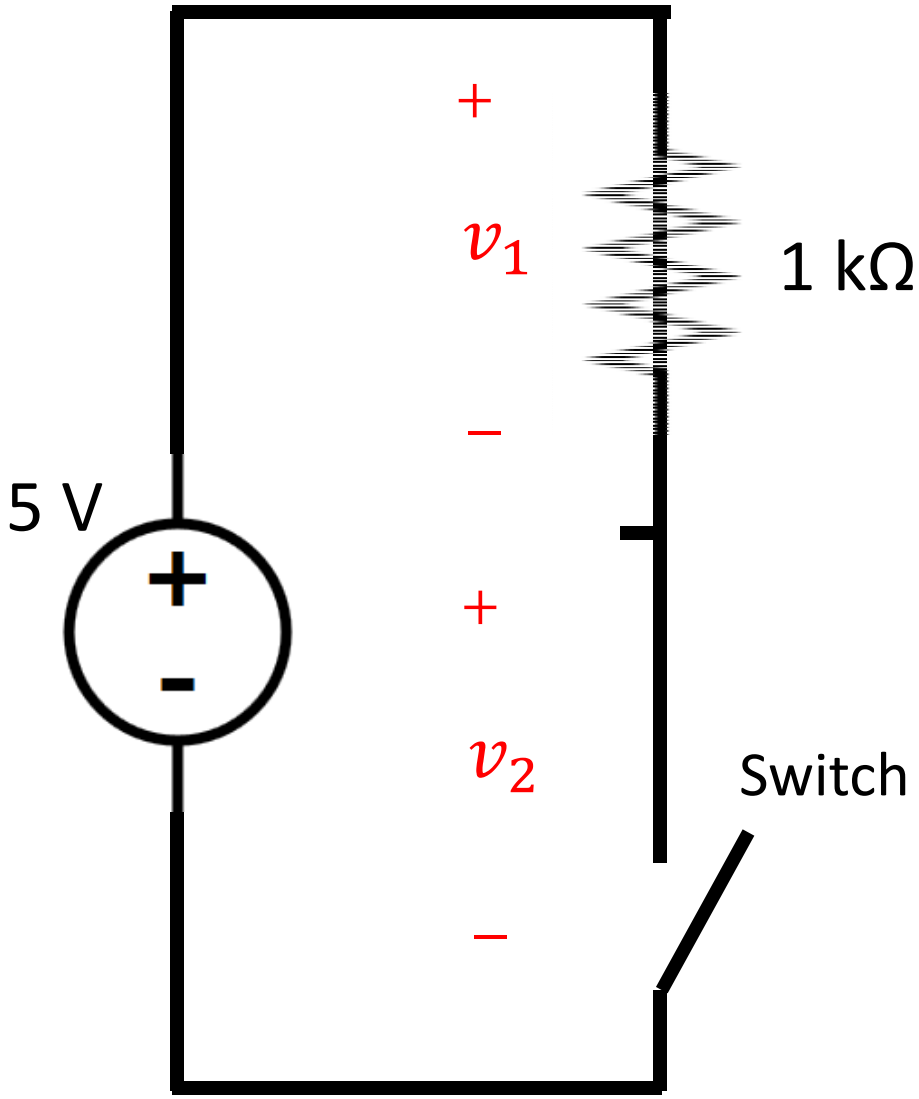
[A] 0 V

[B] 1 mV

[C] 1 V

[D] 4 V

[E] 5 V



When the switch is <u>open</u>, the voltage v_2 is:

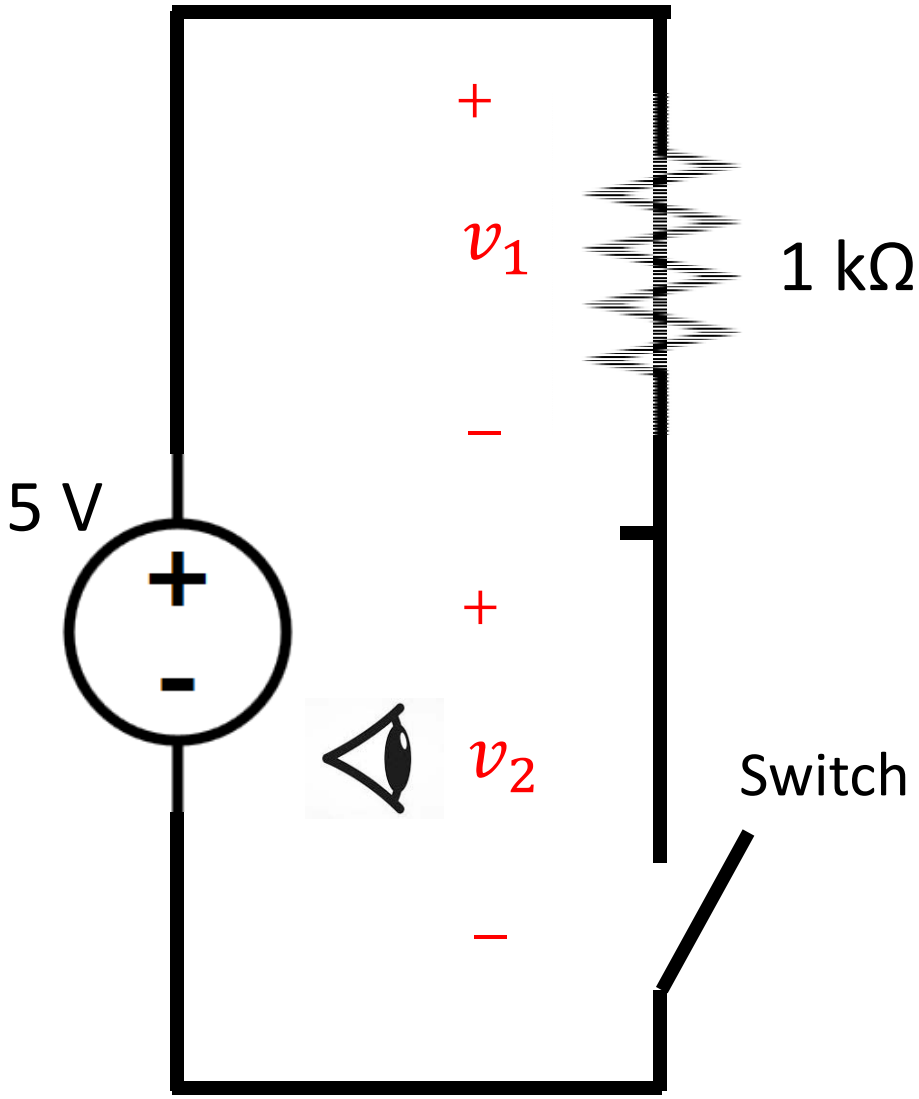
[A] 0 V

[B] 1 mV

[C] 1 V

[D] 4 V

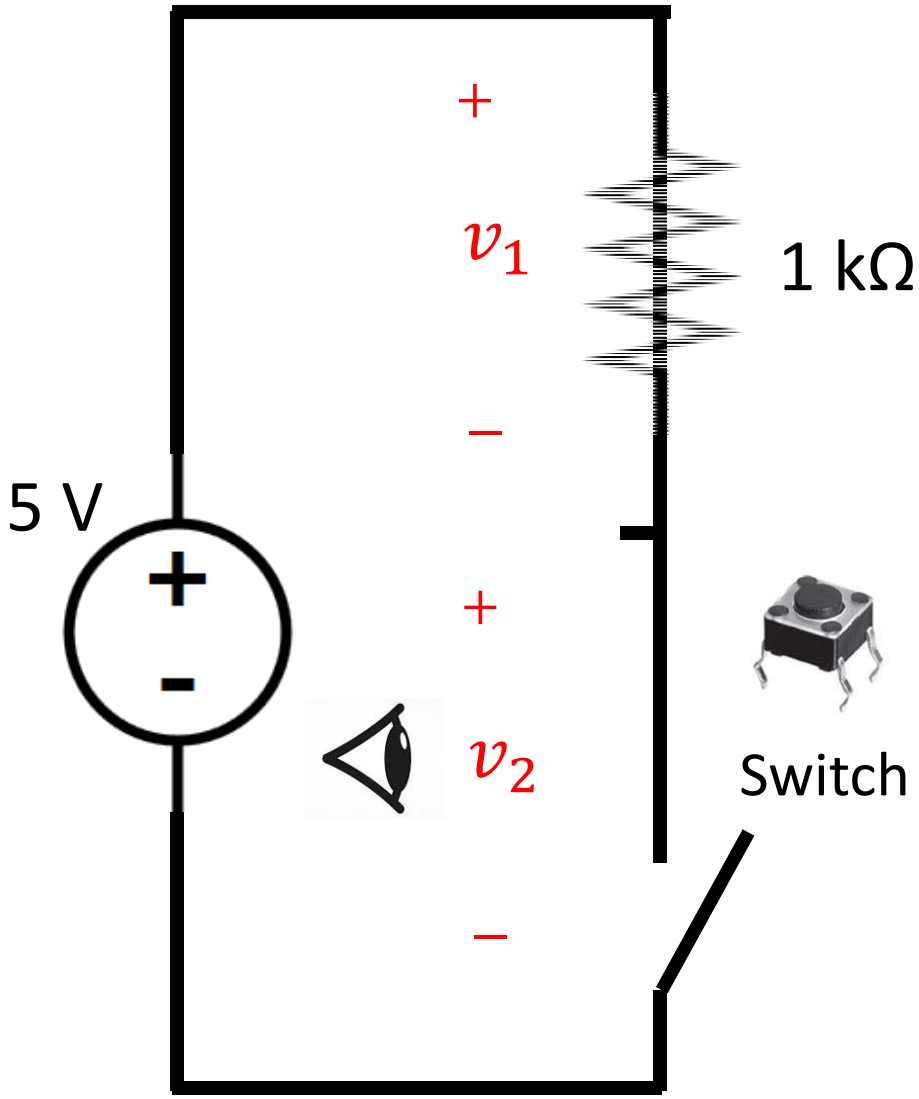
[E] 5 V



Observe v_2

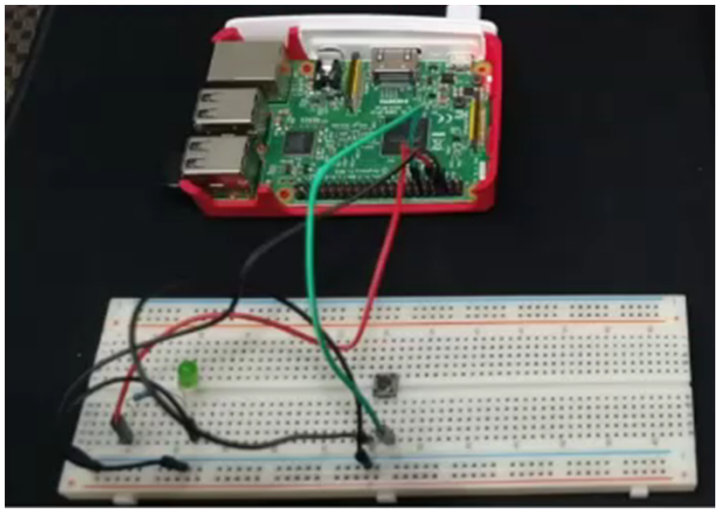
HIGH: switch is open

LOW: switch is closed

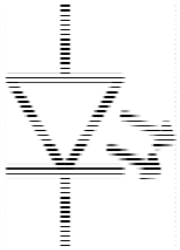


Observe v_2

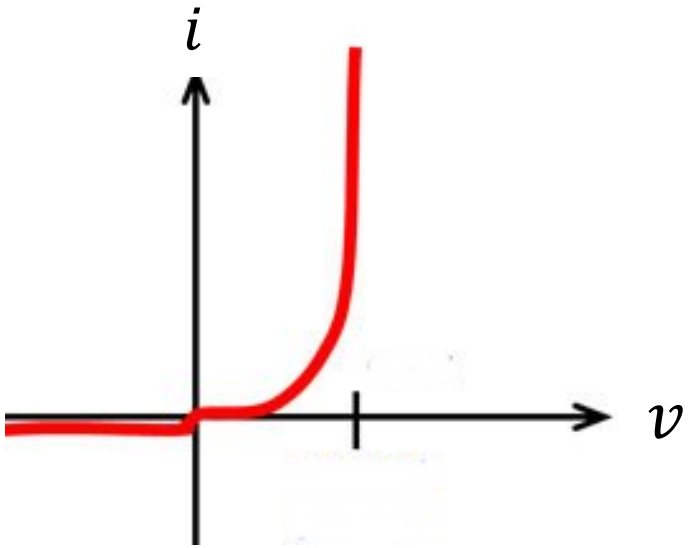
HIGH: switch is open
LOW: switch is closed



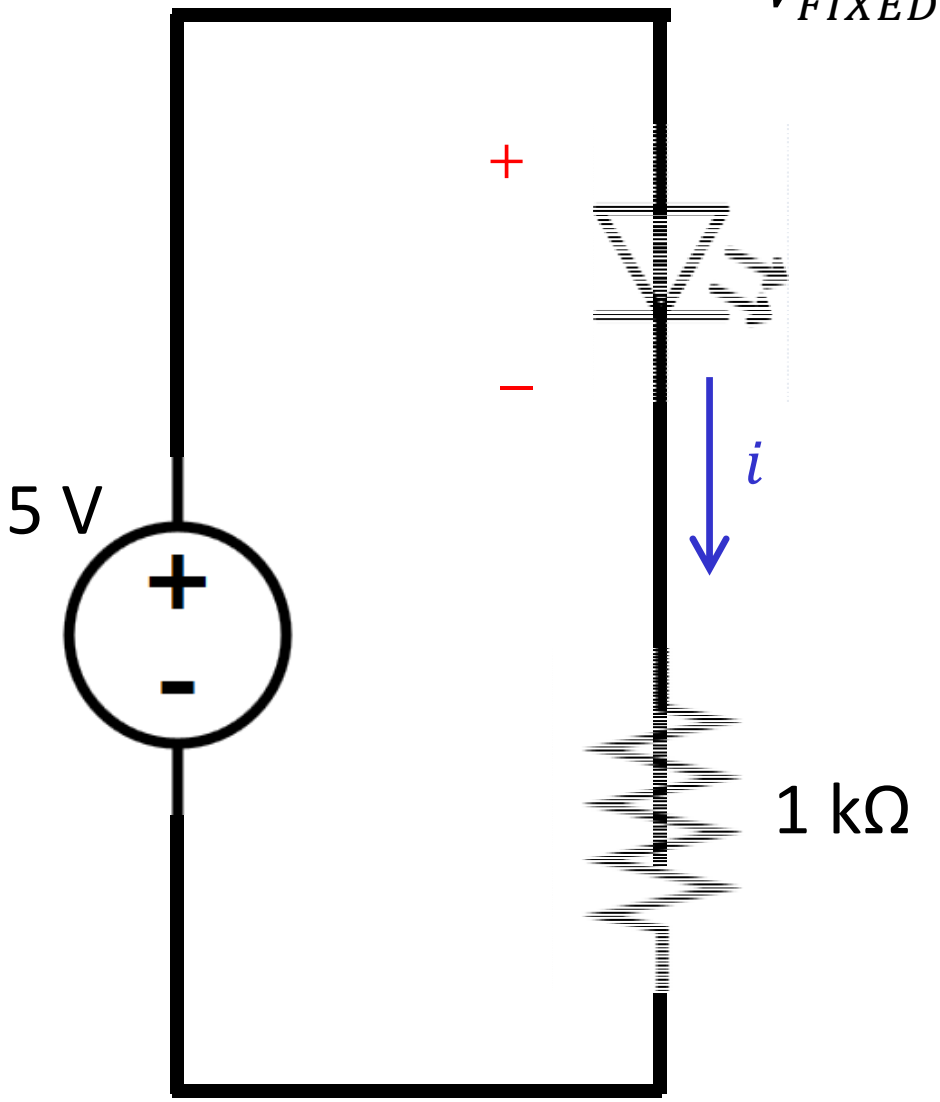
Other components $v = f(i)$



LED



Approximation: if there is any (positive) current flowing through it, $v = V_{FIXED}$.
Otherwise, is must be that $v < V_{FIXED}$

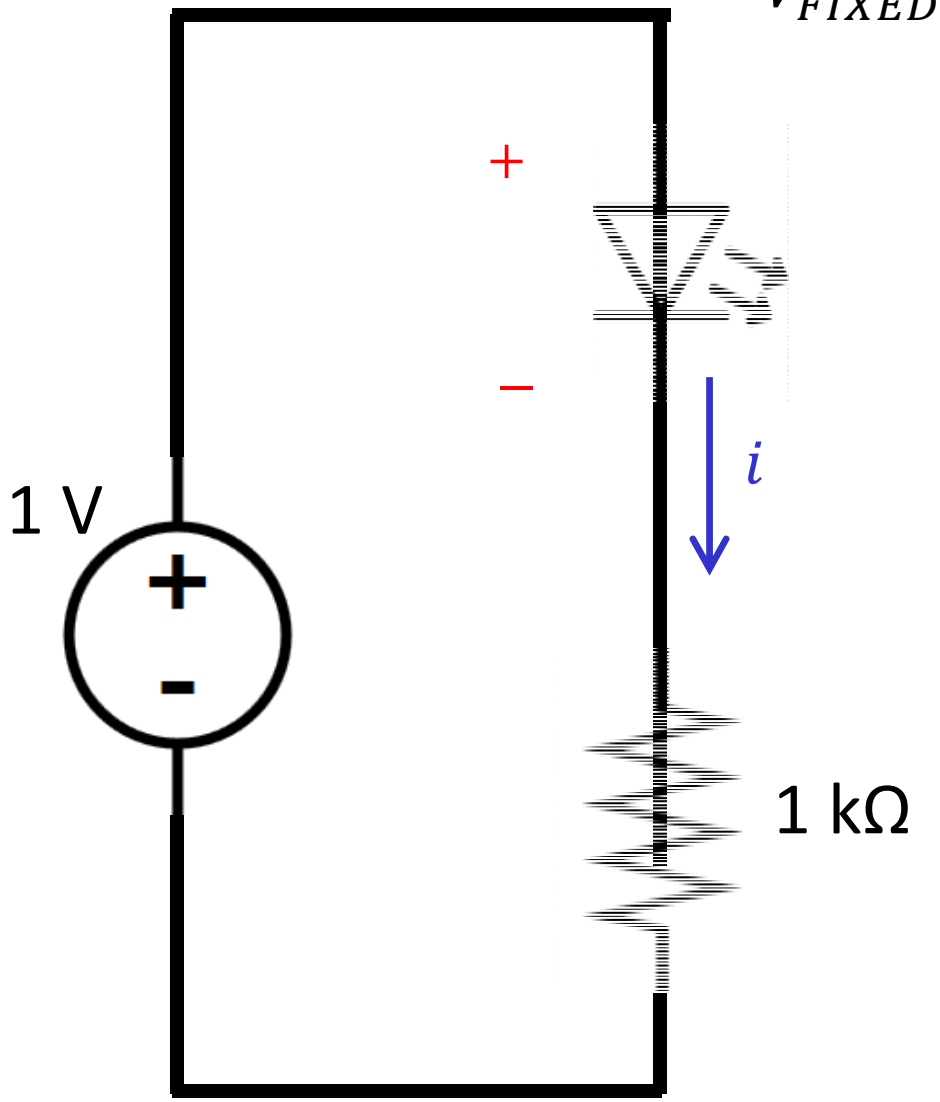


V_{FIXED} = 3 V

1. Assume there is no current
2. Assume there is some current

i = 2 mA

V_{FIXED} = 3 V



If the voltage over the LED V_{FIXED} is 3V, what is the current i ?

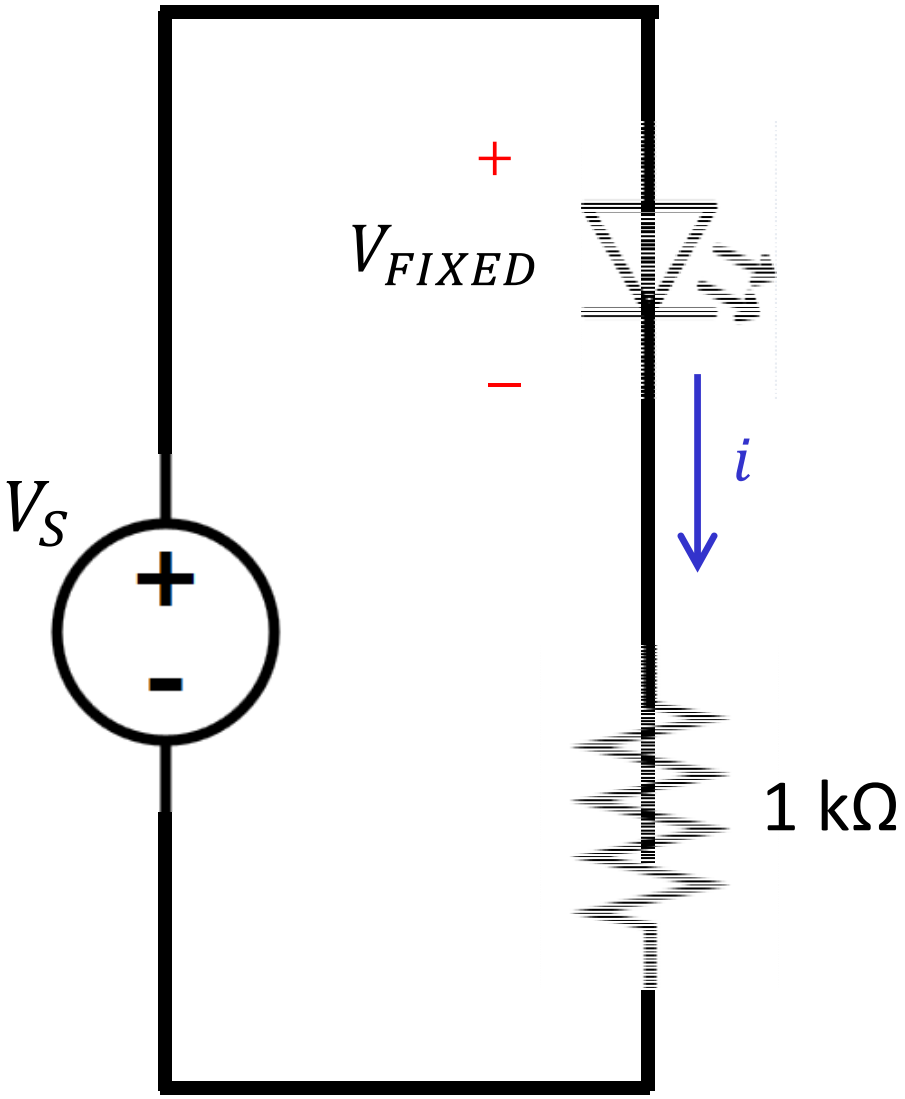
[A] 0 mA

[B] 1 mA

[C] 2 mA

[D] 3 mA

[E] 5 mA



Generate V_S

HIGH: light on
LOW: light off