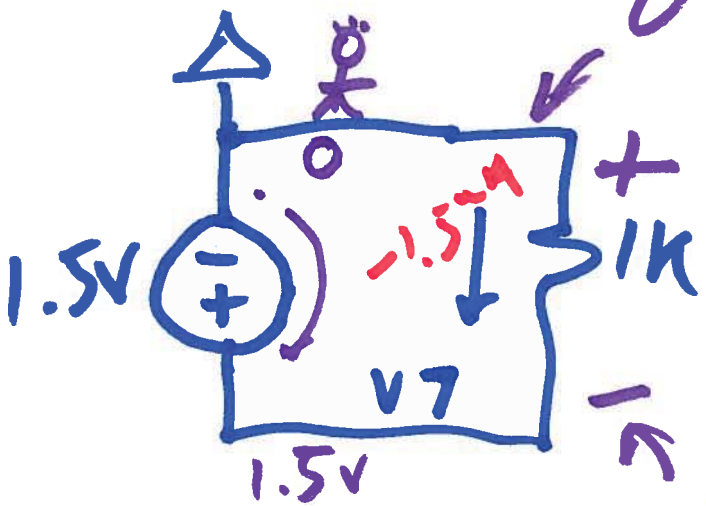
# EE 220
# Circuits I

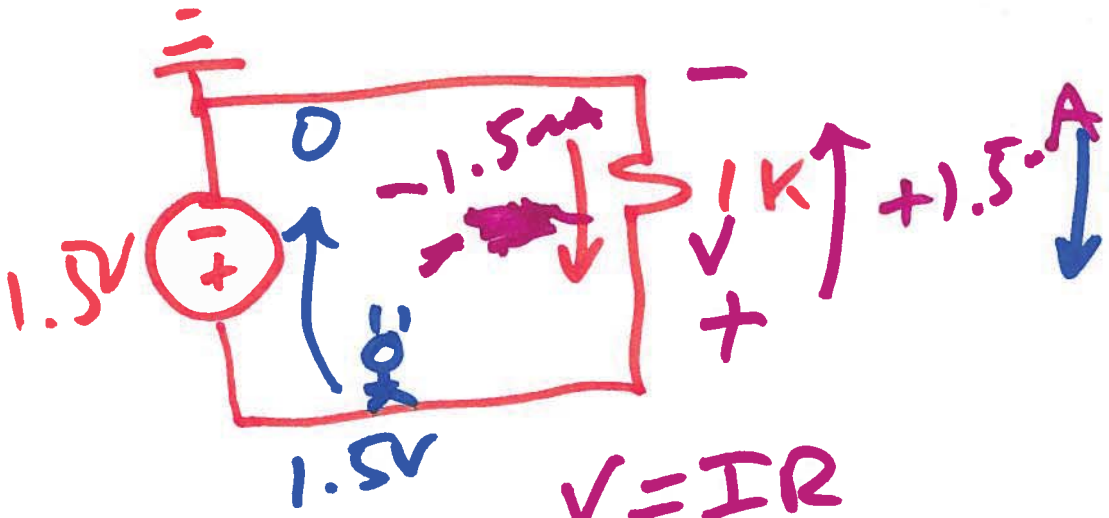
## Lecture 2
## Aug. 30, 2017

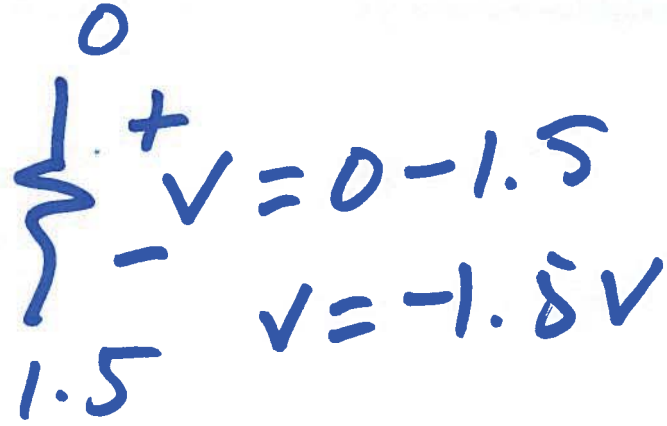
1)




$R \lessgtr I$ $V = I \cdot R$ (ohm's Law)

$$I = \frac{0 - 1.5}{1k} = -1.5mA$$




$V_+ - V_- = -1.5V$

$V_- = 0$

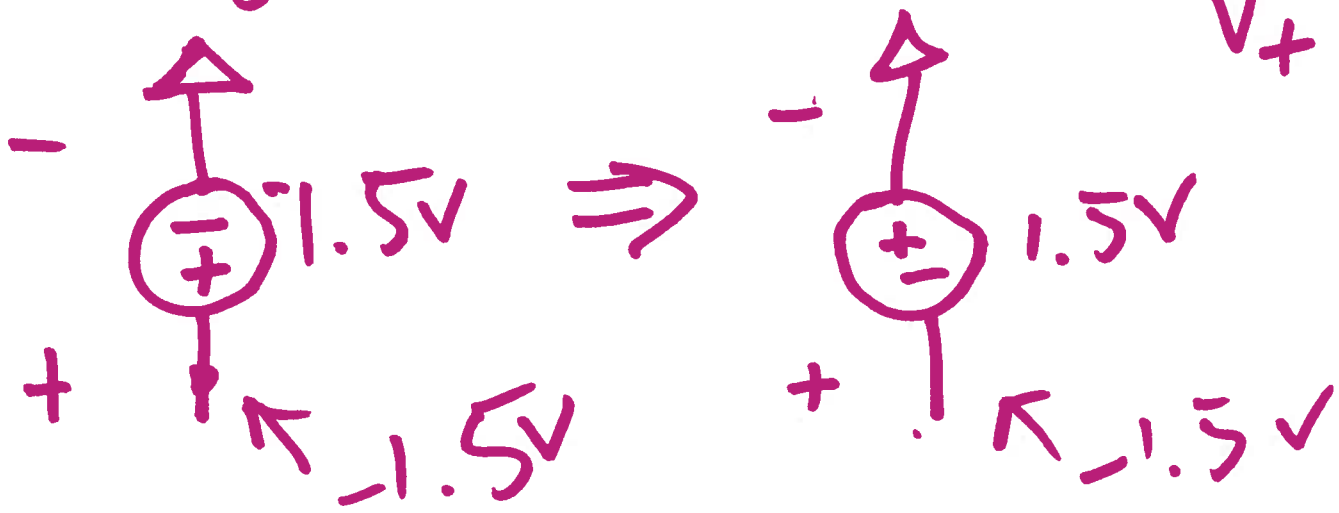
$V = IR$

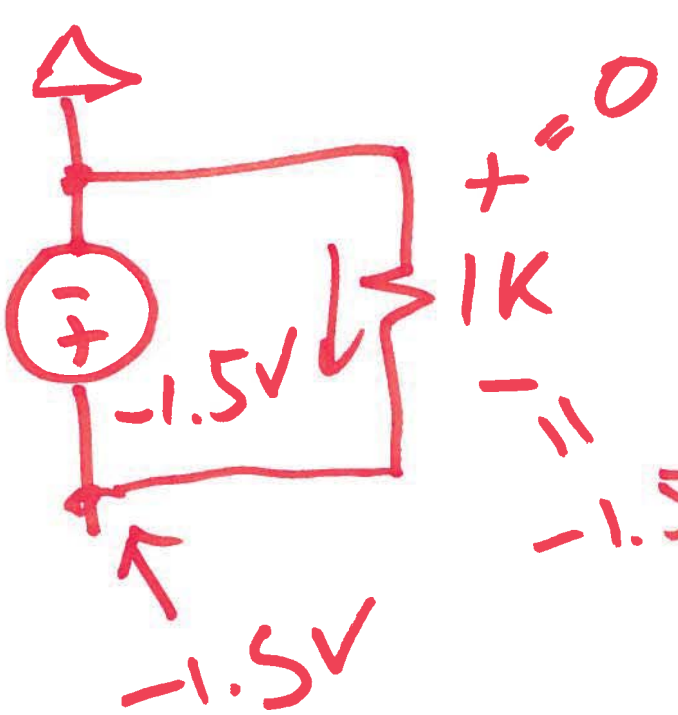
$I = \frac{1.5-0}{1K} = 1.5mA$

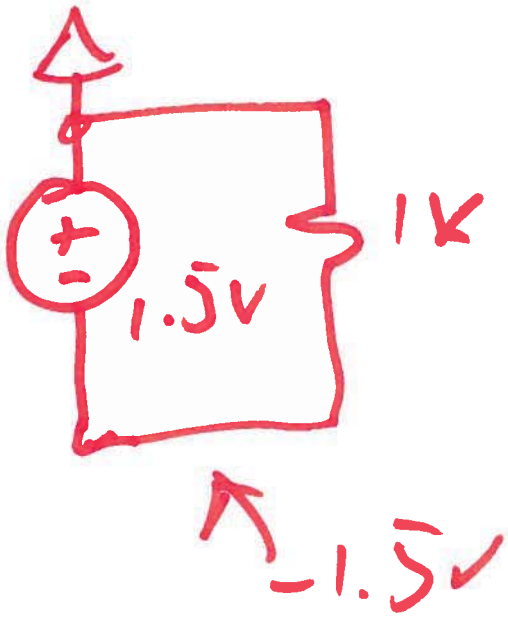
$I = \frac{V}{R} = -1.5mA$

$V_+ - V_- = -1.5V$

$V_+ = -1.5V$

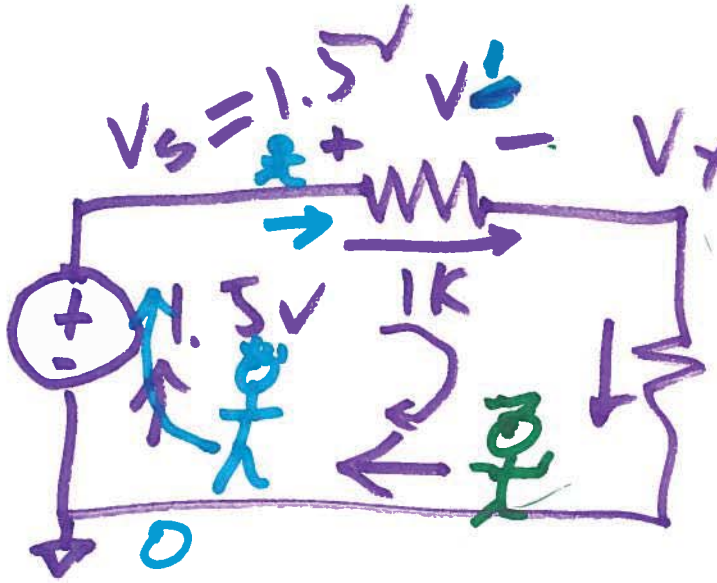





$$I = \frac{V_+ - V_-}{1K} = \frac{0-(-1.5V)}{1K}$$

$$= 1.5\,mA$$




$V_x = V_2 = 2K \cdot \frac{1}{2}mA$

$= 1V$

$I = \frac{1.5V}{3K} = \frac{1}{2}mA$

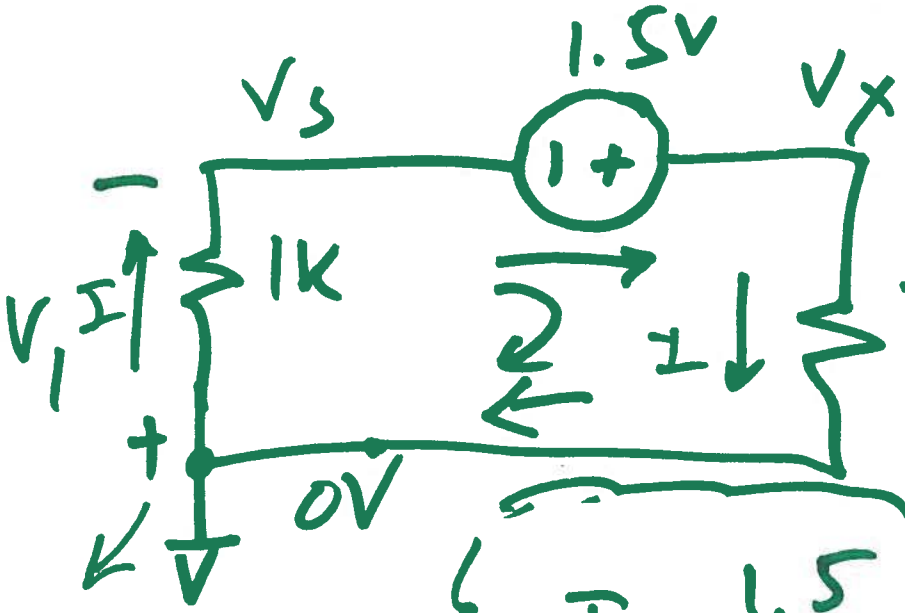
$= 500\mu A$

$1.5V - V_1 - V_2 = 0$ (Kirchoff's Voltage Law)

$V_2 + V_1 - 1.5 = 0$

$I \cdot 2K + I \cdot 1K - 1.5 = 0$

$I = \frac{1.5}{3K} = \frac{1}{2}mA$




$I = \frac{1.5}{3k} = \frac{1}{2}mA$

$V_+ = 0$

$V_- = V_S$

$V_1 = V_+ - V_-$

$= 0 - V_S = \boxed{-V_S = V_1} =$

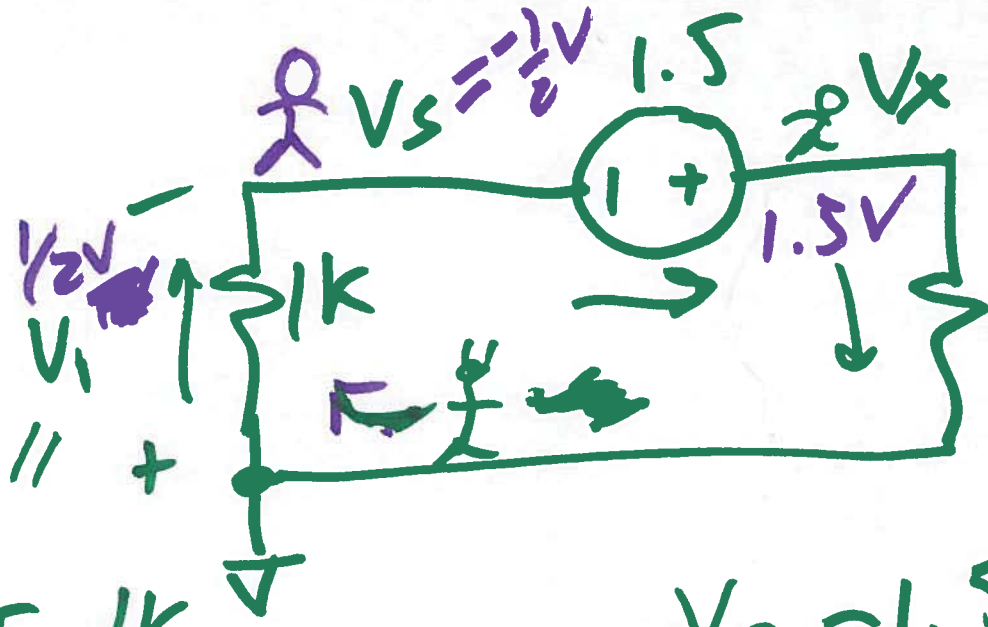
$V_2 = I \cdot 2k$

$= V_+ - V_-$

$= V_X - 0$

$\boxed{V_2 = V_X}$

$V = I \cdot R$




$V_x - V_s = 1.5V$

$V_2 = I \cdot 2k$

$V_2 - 1.5 + V_1 = 0$

$V_s = -0.5V$

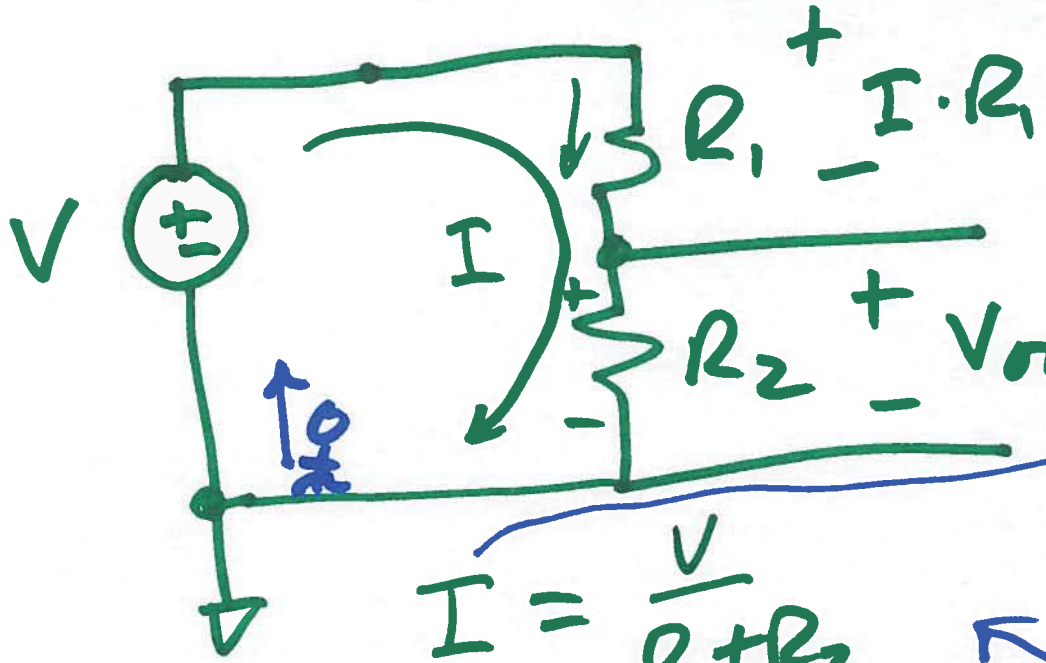
$I \cdot 2k - 1.5 + I \cdot 1k = 0$

$-0.5V + 1.5V - 1V = 0$

$I = \frac{1.5}{3k} = \frac{1}{2}mA$

$V_2 = \frac{1}{2}mA \cdot 2k = 1V$

$V_1 = \frac{1}{2}mA \cdot 1k = \frac{1}{2}V$

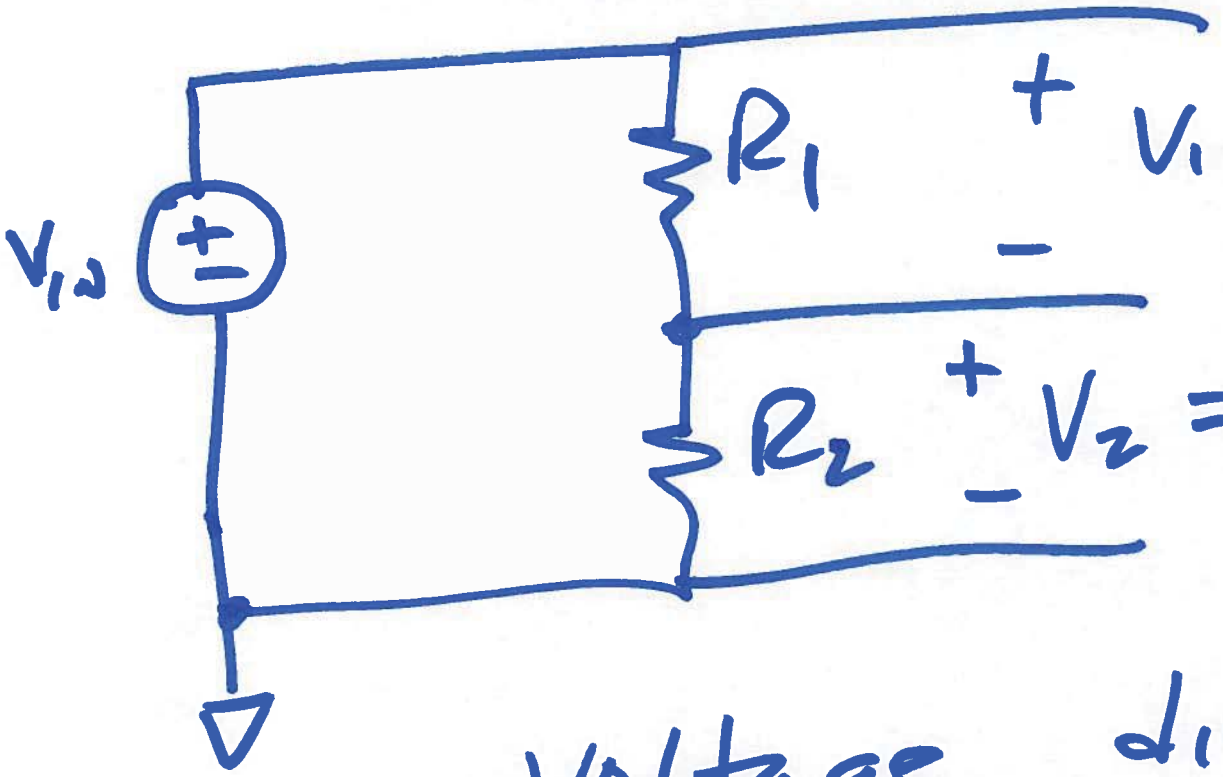



$$I = \frac{V}{R_1 + R_2}$$

$$V_{OUT} = V \cdot \frac{R_2}{R_1 + R_2}$$

$$V - I \cdot R_1 - I \cdot R_2 = 0$$

voltage divider equation



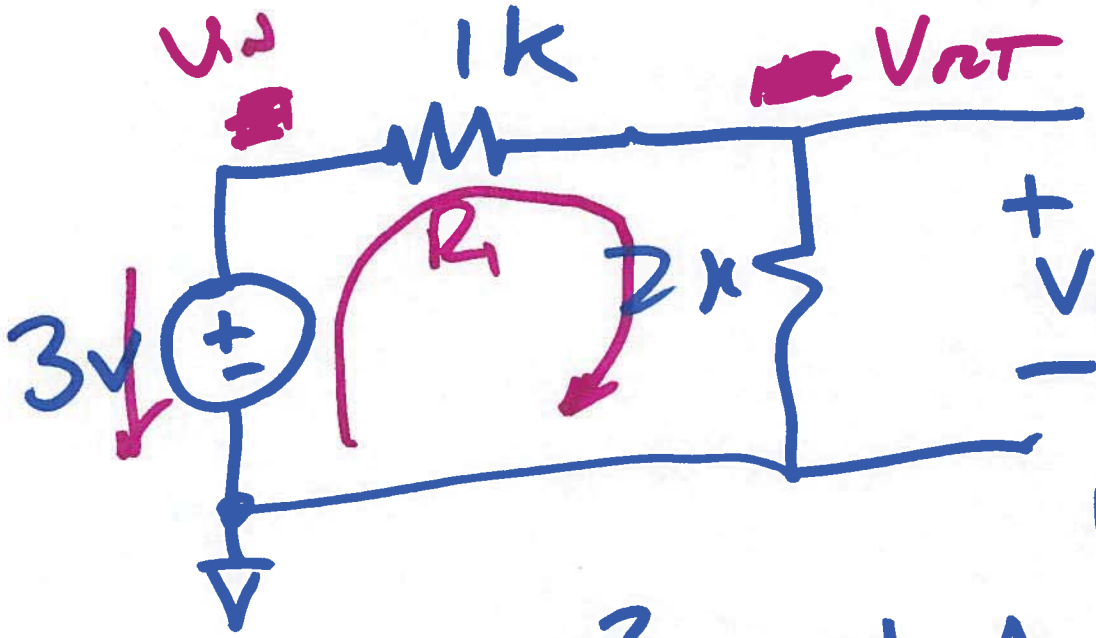

$$V_1 = V_{IN} \cdot \frac{R_1}{R_1 + R_2}$$

$$V_2 = V_{IN} \cdot \frac{R_2}{R_1 + R_2}$$

Voltage divider

# Example

Problem 1



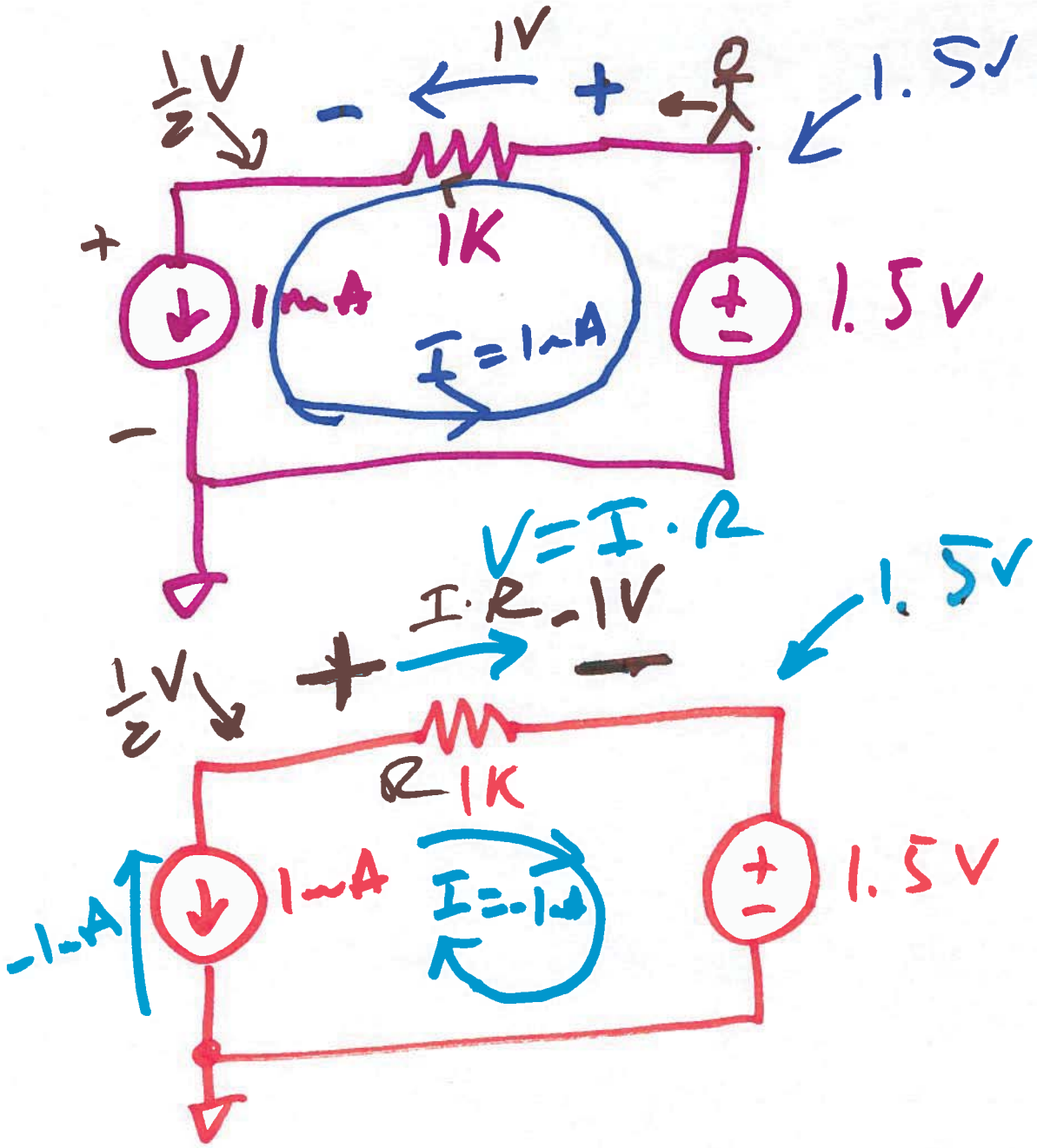

```
V1  VIN 0 DC 3V
R1  Vin VOUT 1K
R2  VOUT 0 2k
.OP
.end
```

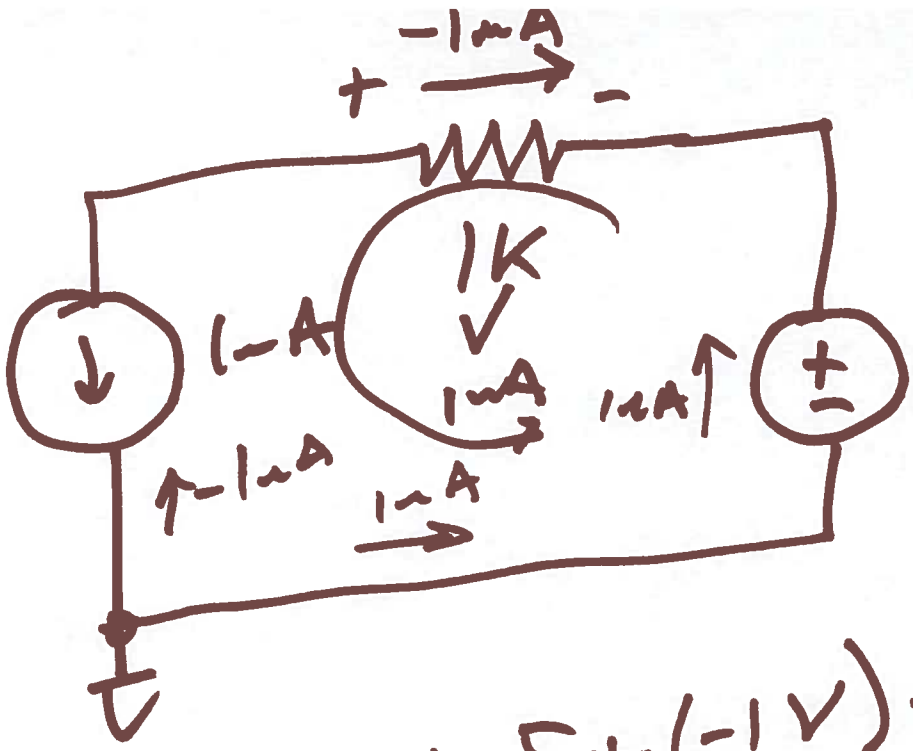
$V_{OUT} = ?$

$$I = \frac{3}{3k} = 1mA$$

$$V_{OUT} = \frac{3.2k}{2k+1k}$$

$$= \frac{6k}{3k} = 2V$$


1V
1.5V
1K
1mA
I = 1mA
1.5V
V = I · R
I · R = 1V
1.5V
R 1K
1mA
I = -1mA
1.5V
-1mA



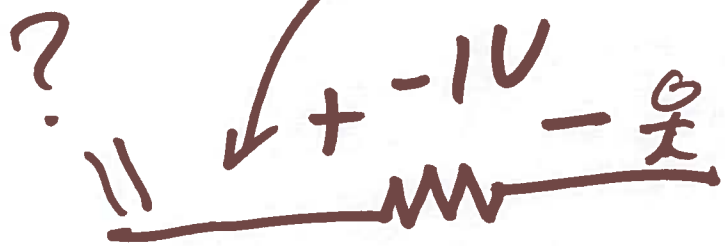

$V = I \cdot R$

$= (-1.0\text{mA}) \cdot 1\text{K}$

$= -1\text{V}$

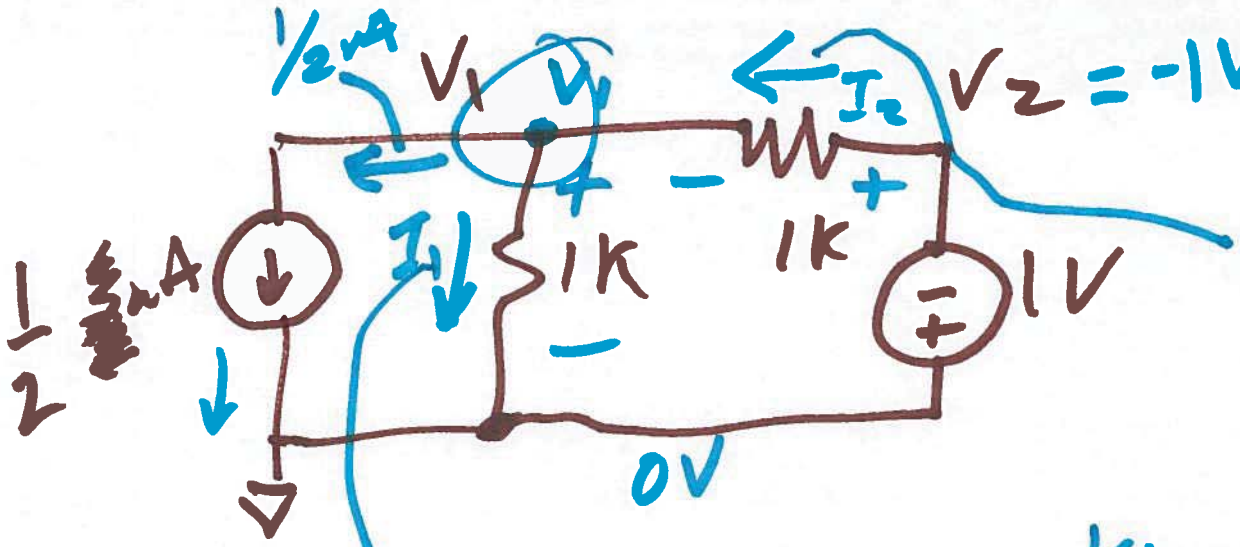
$1.5 + (-1\text{V}) = \frac{1}{2}\text{V} = 0.5\text{V}$

?




$-\ 1\text{V}\ +$

$1.5 - 1\text{V} = \frac{1}{2}\text{V}$




$I_2 \cdot 1k = V_2 - V_1$

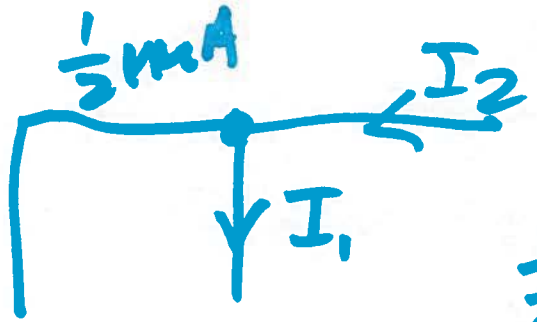
$-1V$

$I_1 \cdot R = V_1$

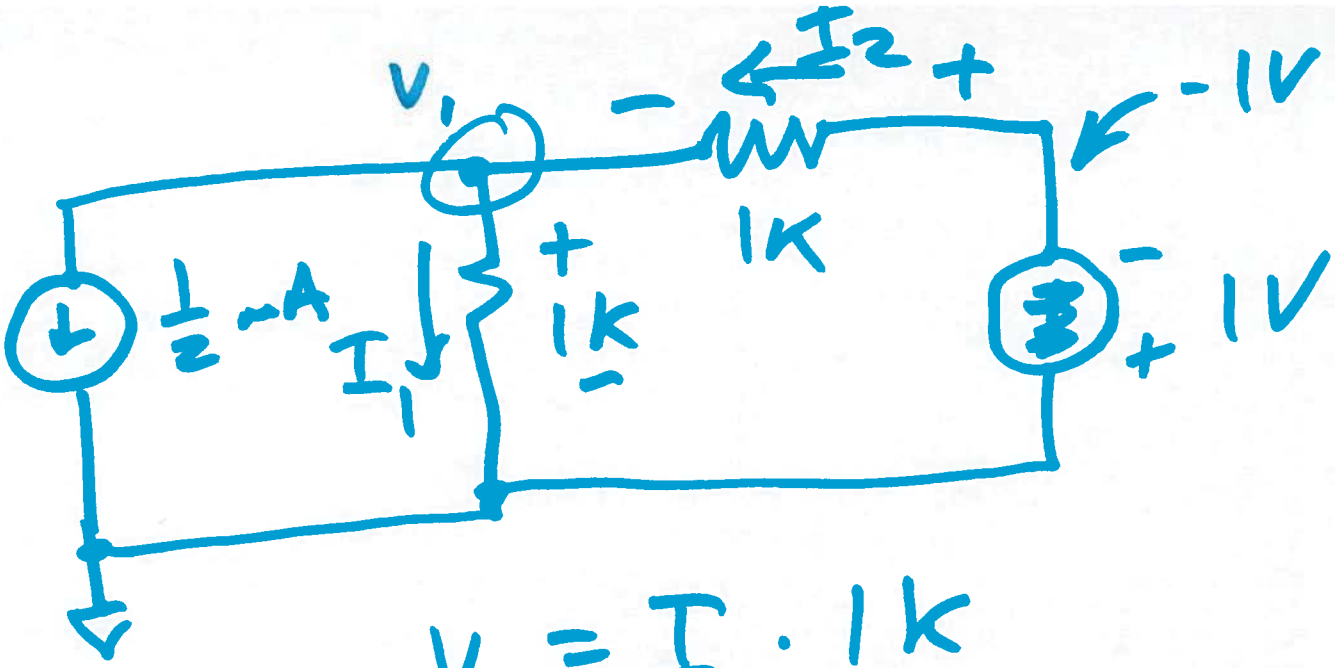
$I_1 = \frac{V_1}{R}$

Kirchoff's current law

Sum of currents into a node must equal zero




$\frac{1}{2}mA + I_1 + I_2 = 0$




$$V_1 = I_1 \cdot 1k$$

$$-1 - V_1 = I_2 \cdot 1k$$

$$\frac{1}{2}mA + I_1 - I_2 = 0$$