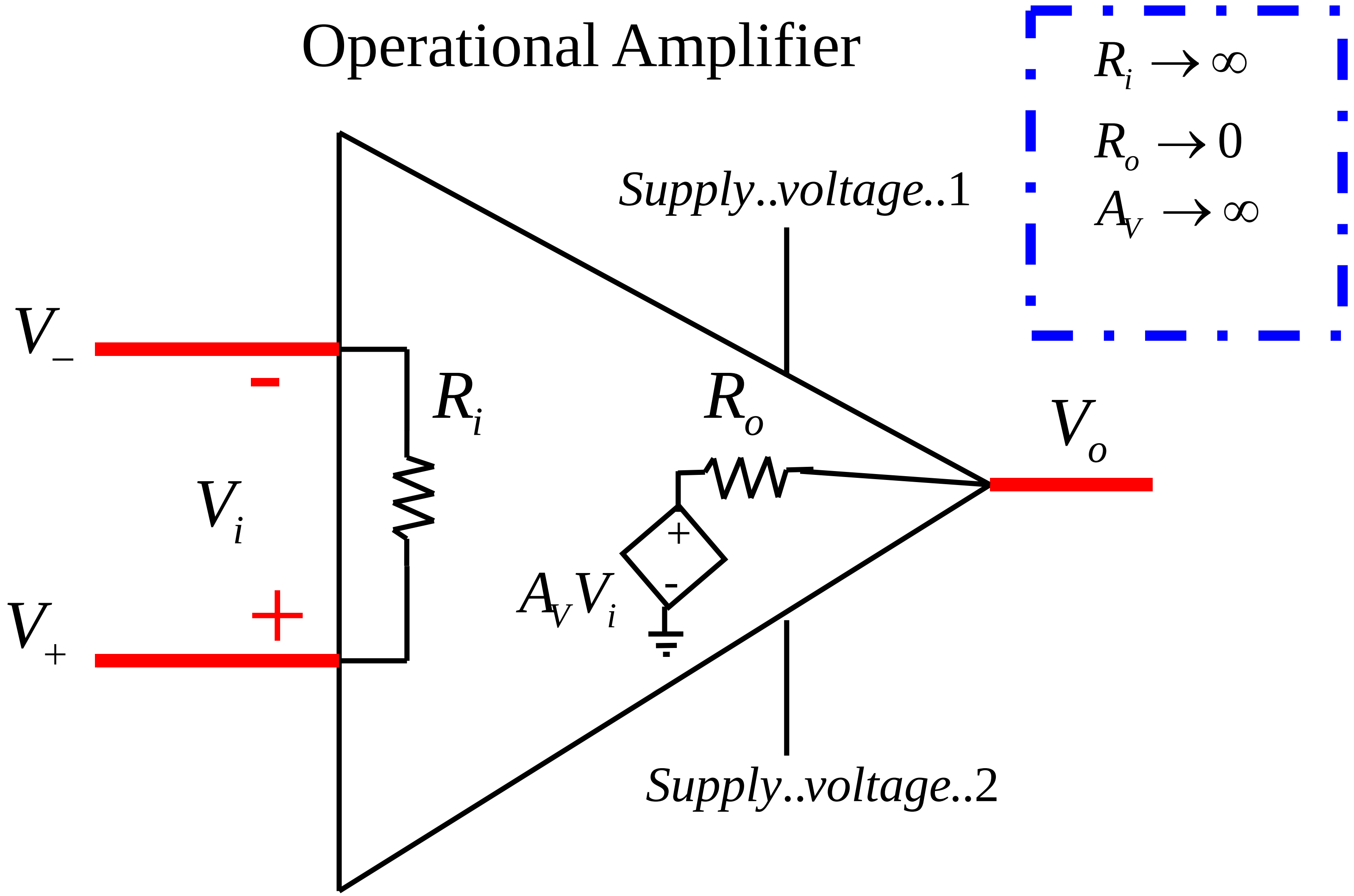
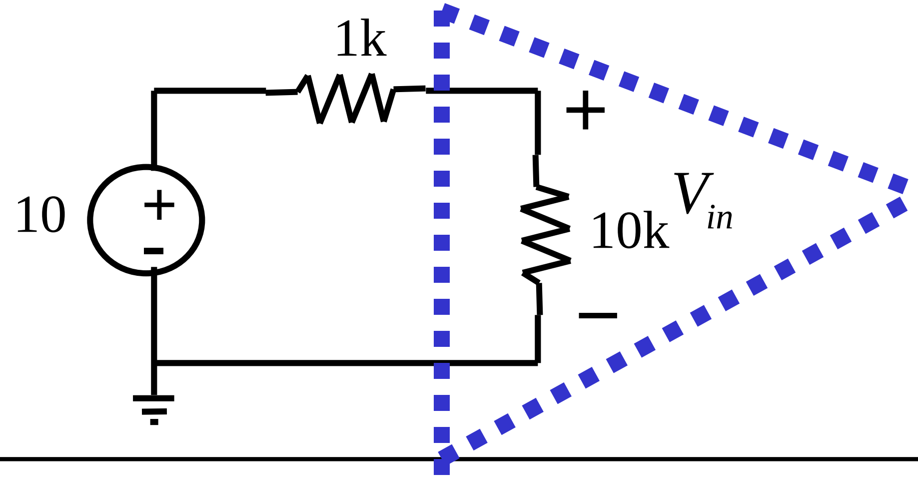
Operational Amplifier

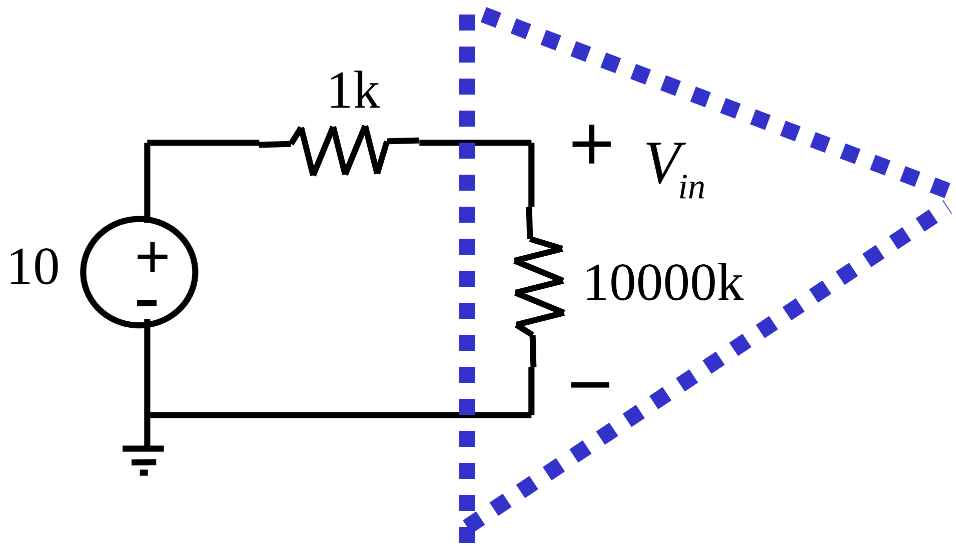


$R_i \to \infty$



$$V_{in} = \frac{10k}{10k + 1k} 10$$

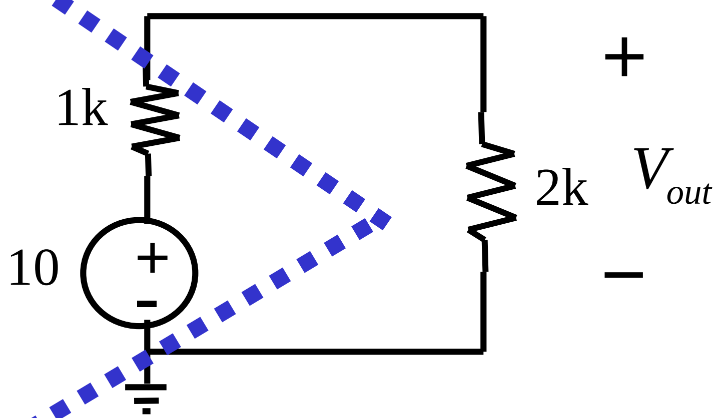
$$= 9.09v$$



$$V_{in} = \frac{10000k}{10000k + 1k} 10$$

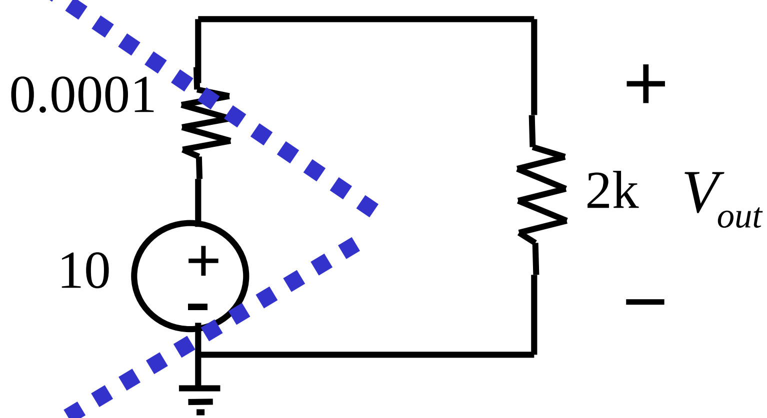
$$= 9.999v$$

$R_o \to 0$



$$V_{out} = \frac{2k}{1k + 2k} 10$$

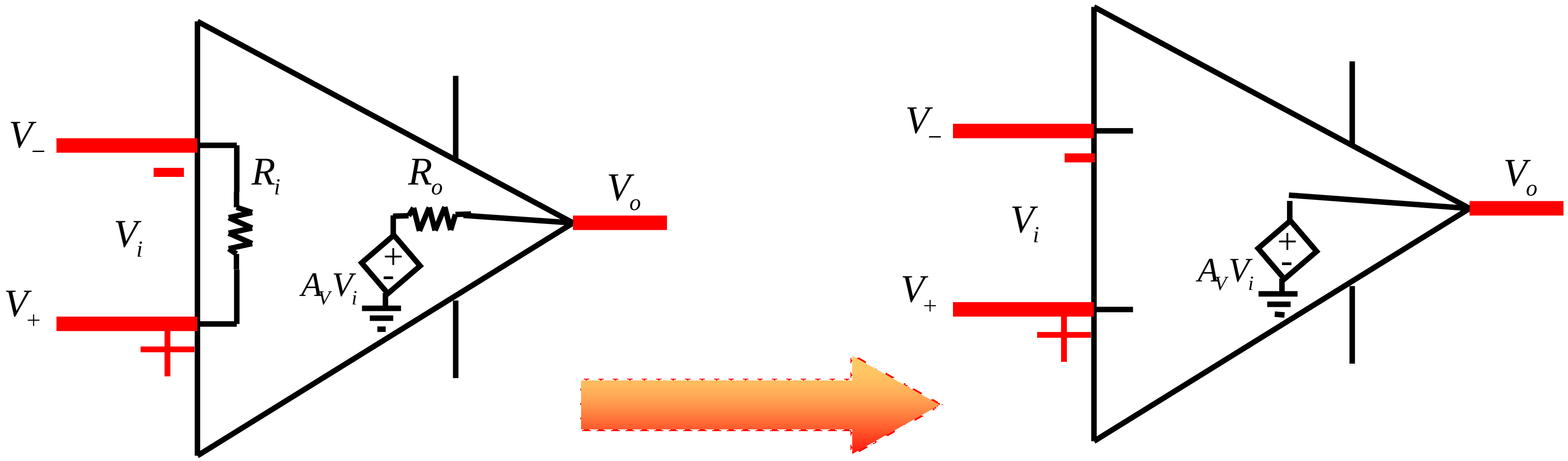
$$= 6.6667v$$



$$V_{out} = \frac{2k}{0.0001 + 2k} 10$$

$$\approx 10\mathbf{v}$$

Ideal Op. Amp

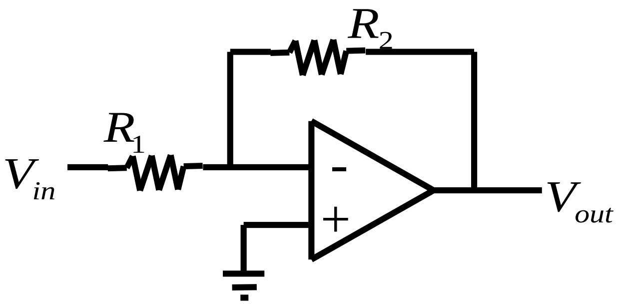


$R_i \to \infty$ ⟹ $\boxed{I_i \approx 0}$

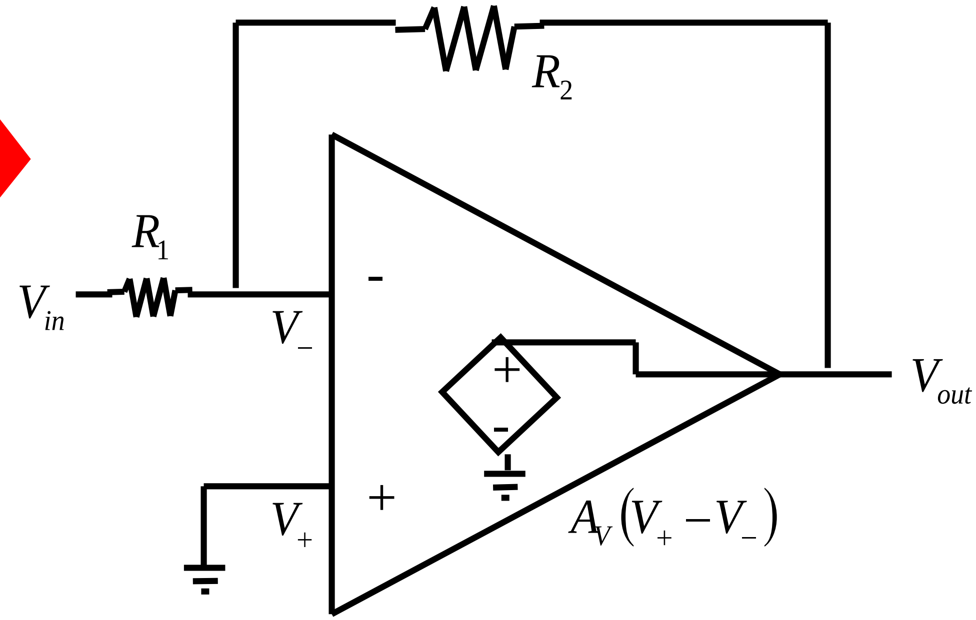
$\mathbf{R_o} \to 0$ ⟹ $\dfrac{V_o}{V_i} = A_V \Rightarrow V_i = \dfrac{V_o}{A_V} \Rightarrow V_+ - V_- = \dfrac{V_o}{A_V}$

$A_V \to \infty$ ⟹ $V_+ - V_- = \dfrac{V_o}{A_V} \Rightarrow \boxed{\mathbf{V_+ \approx V_-}}$

Ex. 3



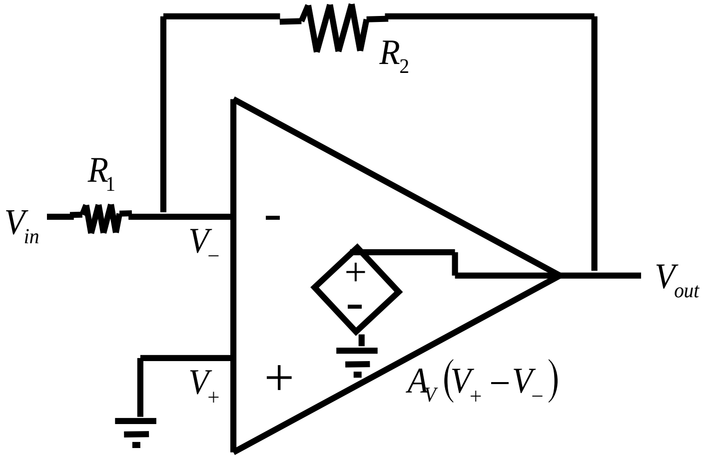
$$\mathbf{K_F = ?}$$



$$\boxed{V_{out} = A_V(V_+ - V_-)}$$

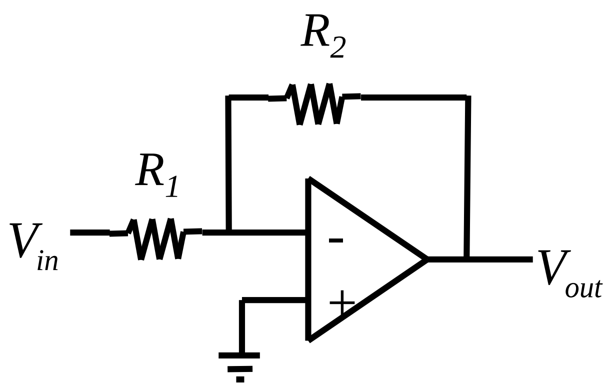
$$\boxed{V_+ = 0}$$

$$\boxed{\frac{V_{in} - V_-}{R_1} + \frac{V_{out} - V_-}{R_2} = 0}$$



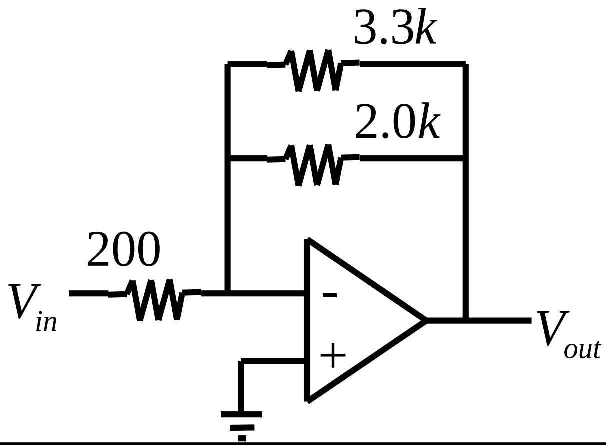
$$K_F = \frac{V_{out}}{V_{in}} = -\frac{1-\left[\dfrac{R_1}{R_1+R_2}\right]}{\dfrac{1}{A_V}+\left[\dfrac{R_1}{R_1+R_2}\right]}$$

$$@\, A_V \to \infty$$



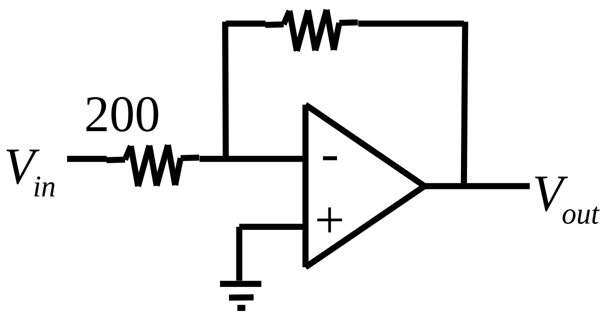
$$\boxed{K_F = \frac{V_{out}}{V_{in}} = -\frac{R_2}{R_1}}$$

Ex. 4



$$A_F = ?$$

$$\frac{1}{\frac{1}{3.3k} + \frac{1}{2.0k}} = 1.245k$$

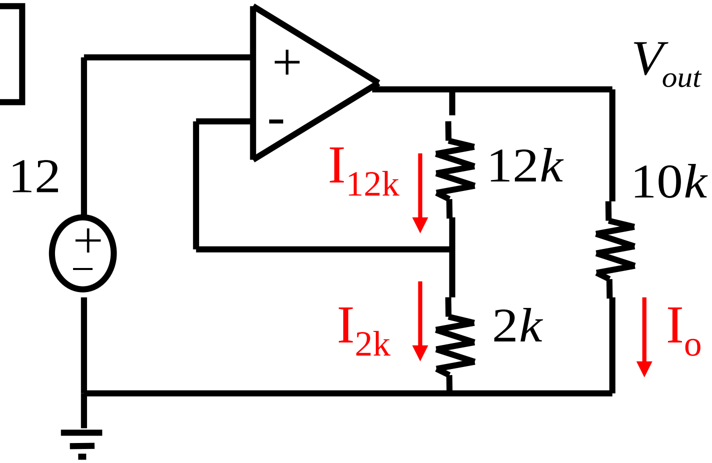


$$A_F = \frac{V_{out}}{V_{in}}$$

$$= -\frac{1.245k}{200}$$

$$\boxed{A_F = -6.23}$$

Ex.



$$I_o = ?$$

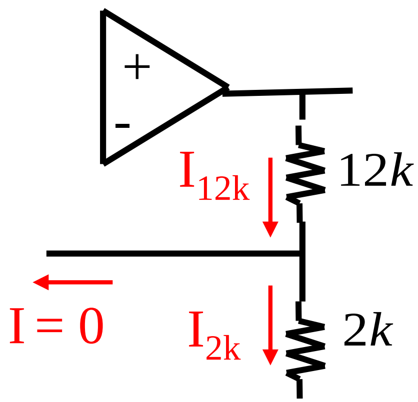
$$V_+ = V_- = 12$$

$$I_{2k} = \frac{V_-}{2k}$$

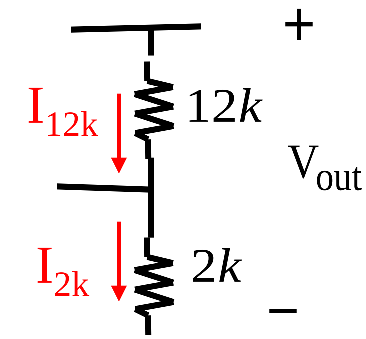
$$= \frac{V_+}{2k}$$

$$= \frac{12}{2k}$$

$$= 6mA$$

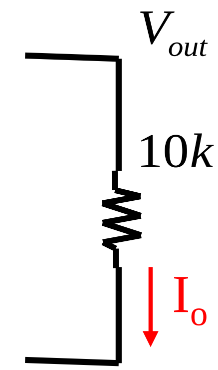


$$I_{12k} = I_{2k} = 6mA$$



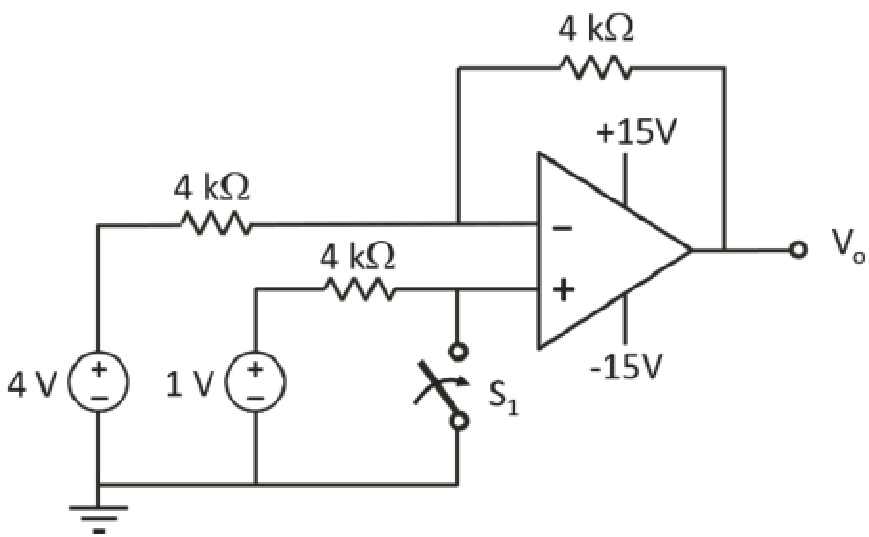
$$V_{out} = (12k + 2k) * 6m$$

$$= 84v$$

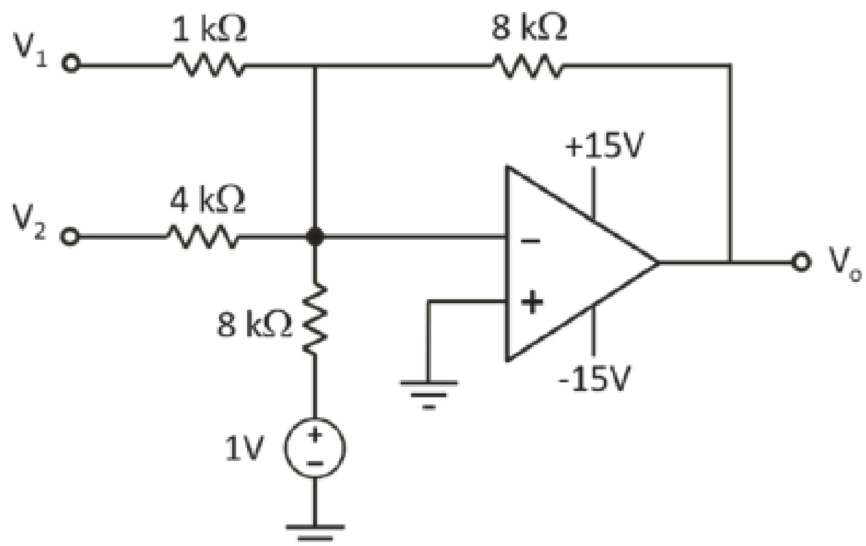


$$I_o = \frac{84}{10k} = 8.4mA$$

Assuming ideal op amp, find the voltage V_o, (a) when the switch, S_1, is open, and (b) when S_1 is closed.



Assuming ideal op amp, determine an expression for the output voltage, V_o, in terms of the inputs, V_1, and V_2.



Find V_o and I_s assuming ideal op amps.