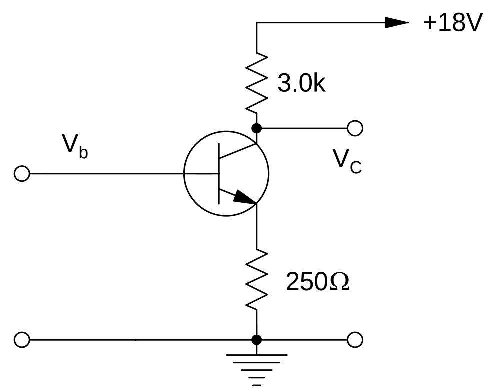
Sketched below is a circuit including a typical NPN silicon transistor.

a. For the case $\boldsymbol{V_b = 1.7}$ ***volts***, calculate the ***voltages*** at the ***emitter*** and ***collector*** of the transistor, and calculate the (estimated) ***base current***.

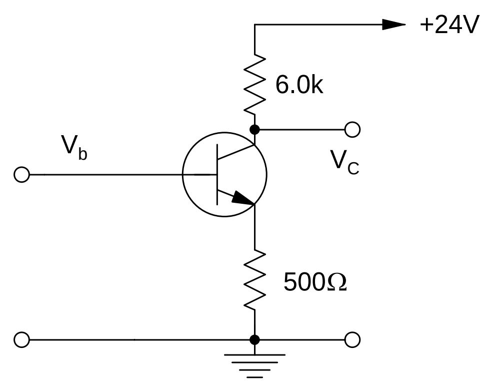
b. Calculate the ***base voltage*** and (estimated) ***base current*** necessary to make the ***collector voltage = 12 V***.



Sketched below is a circuit including a typical NPN silicon transistor.

a. For the case $\boldsymbol{V_b = 1.4}$ ***volts***, calculate the ***voltages*** at the ***emitter*** and ***collector*** of the transistor, and calculate the (estimated) ***base current***.

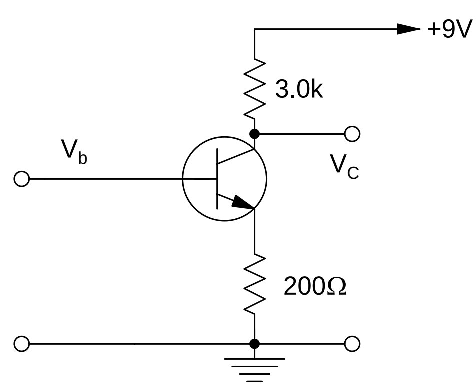
b. Calculate the ***base voltage*** and (estimated) ***base current*** necessary to make the ***collector voltage = 15 V***.



Sketched below is a circuit including a typical NPN silicon transistor.

a. For the case $\boldsymbol{V_b = 1.1}$ ***volts***, calculate the ***voltages*** at the ***emitter*** and ***collector*** of the transistor, and calculate the (estimated) ***base current***.

b. Calculate the ***base voltage*** and (estimated) ***base current*** necessary to make the ***collector voltage = 6 V***.

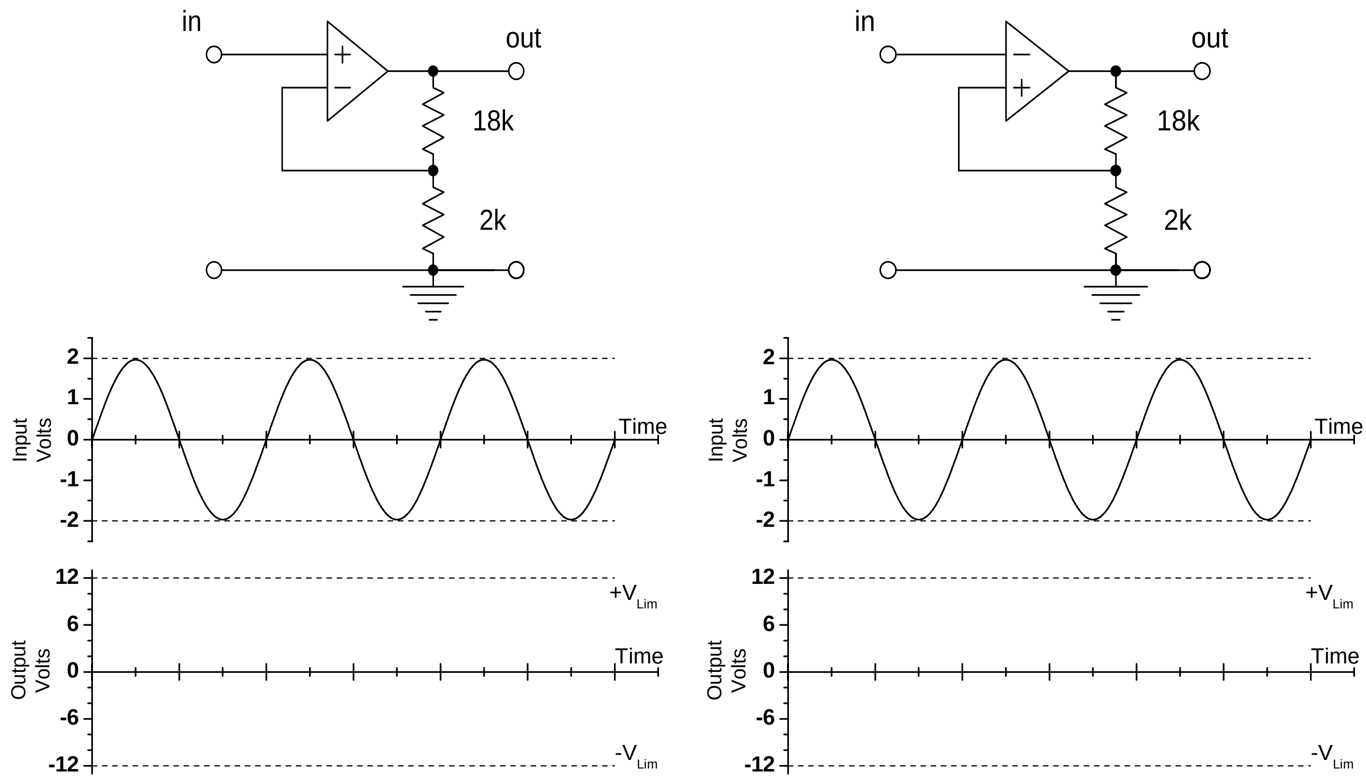


Design a "standard" transistor amplifier circuit using an ***18 V*** power supply to meet the specifications: $\boldsymbol{R_{out} \leq 3.0k, A \geq 12,}$ ***and*** $\boldsymbol{R_{in} \geq 12k}$. (You should ***sketch the circuit*** and your answers should consist of values for the following: $\boldsymbol{R_C, R_E, R_{B1}, R_{B2}, V_C, V_E, V_B, I_C,}$ ***and*** $\boldsymbol{I_B}$. Also, your values for $\boldsymbol{R_{B1}}$ and $\boldsymbol{R_{B2}}$ should be calculated with the estimated $\boldsymbol{I_B}$ taken into account.)

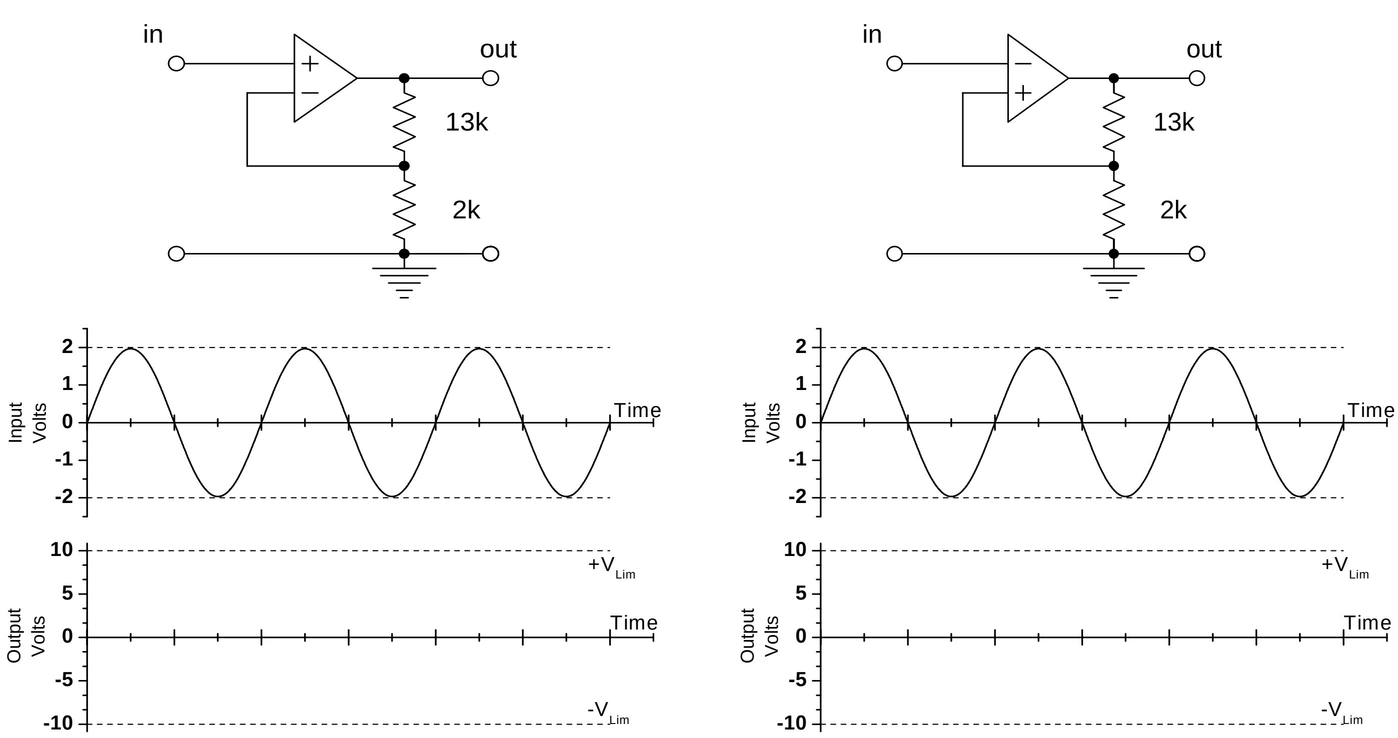
Design a "standard" transistor amplifier circuit using a ***24 V*** power supply to meet the specifications: $\boldsymbol{R_{out} \leq 2.5k, A \geq 10,}$ ***and*** $\boldsymbol{R_{in} \geq 15k}$. (You should ***sketch the circuit*** and your answers should consist of values for the following: $\boldsymbol{R_C, R_E, R_{B1}, R_{B2}, V_C, V_E, V_B, I_C,}$ ***and*** $\boldsymbol{I_B}$. Also, your values for $\boldsymbol{R_{B1}}$ and $\boldsymbol{R_{B2}}$ should be calculated with the estimated $\boldsymbol{I_B}$ taken into account.)

Design a "standard" transistor amplifier circuit using a ***9 V*** power supply to meet the specifications: $\boldsymbol{R_{out} \leq 2.7k, A \geq 15,}$ ***and*** $\boldsymbol{R_{in} \geq 10k}$. (You should ***sketch the circuit*** and your answers should consist of values for the following: $\boldsymbol{R_C, R_E, R_{B1}, R_{B2}, V_C, V_E, V_B, I_C,}$ ***and*** $\boldsymbol{I_B}$. Also, your values for $\boldsymbol{R_{B1}}$ and $\boldsymbol{R_{B2}}$ should be calculated with the estimated $\boldsymbol{I_B}$ taken into account.)

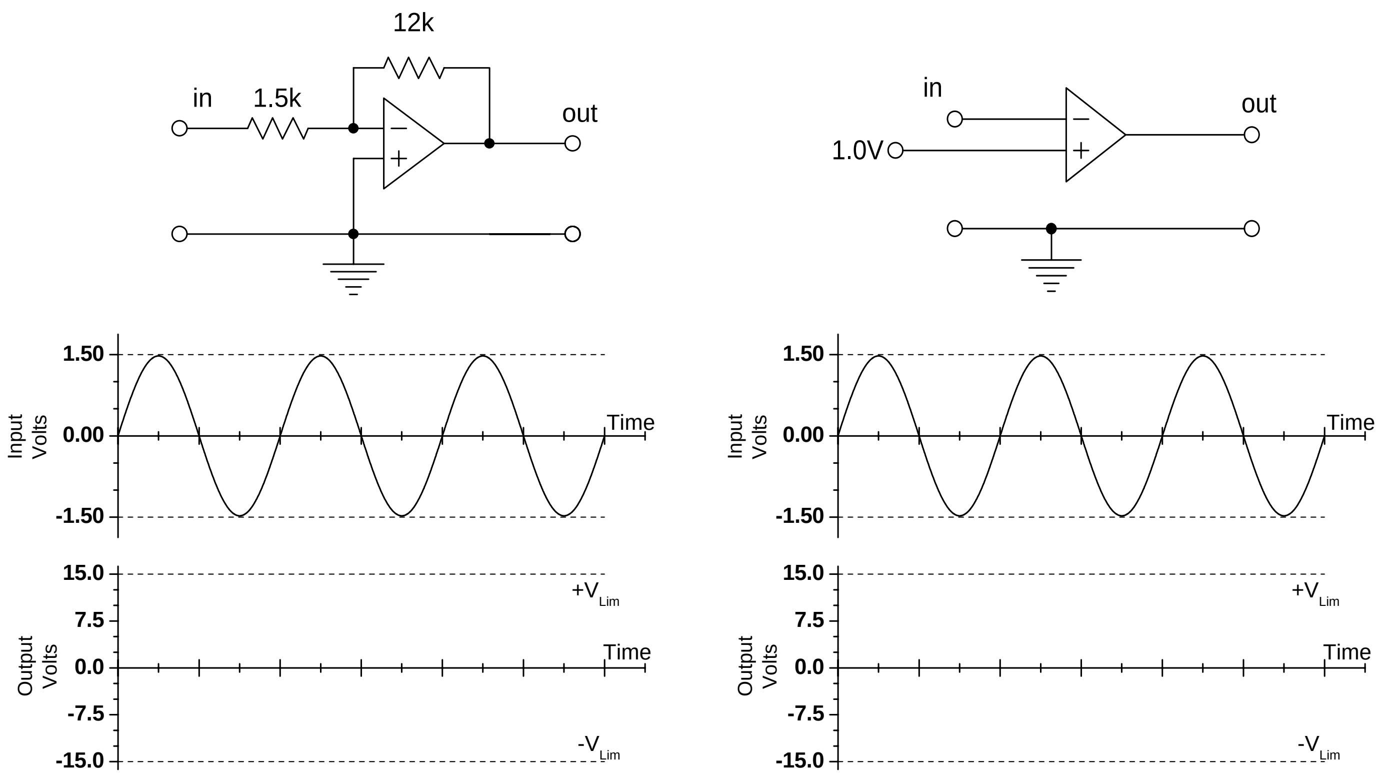
For the circuits sketched below, the output voltage of the "typical" operational amplifier is restricted to the range $-V_{Lim} \le V_{out} \le +V_{Lim}$. For both cases, sketch the output waveform on the graphs labeled ***"Output Volts"*** (below the sketch of the sine wave input voltage). (The horizontal dashed lines on the output graphs indicate the output voltage limits, $\pm$ $V_{Lim} = \pm 12V$.) The output waveform must include labels indicating voltage values and vertical lines between the input and output graphs should "key" the output waveform to the input. ***(Examine the circuits carefully!!!)***



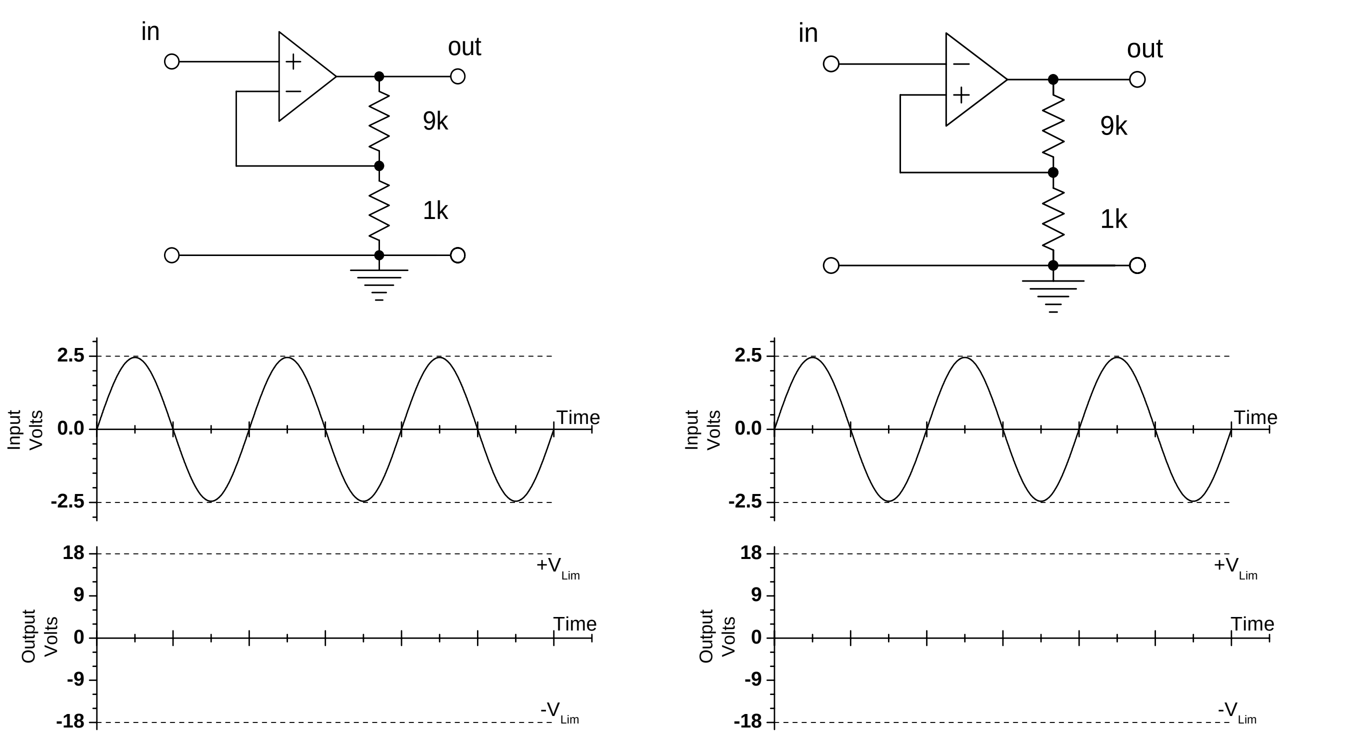
For the circuits sketched below, the output voltage of the "typical" operational amplifier is restricted to the range $-V_{Lim} \le V_{out} \le +V_{Lim}$. For both cases, sketch the output waveform on the graphs labeled ***"Output Volts"*** (below the sketch of the sine wave input voltage). (The horizontal dashed lines on the output graphs indicate the output voltage limits, $\pm$ $V_{Lim} = \pm 18V$.) The output waveform must include labels indicating voltage values and vertical lines between the input and output graphs should "key" the output waveform to the input. ***(Examine the circuits carefully!!!)***



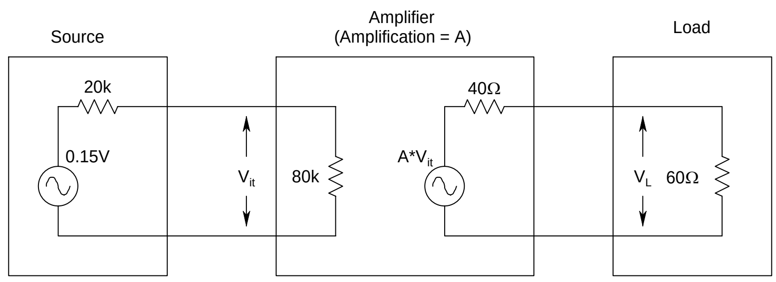
For the circuits sketched below, the output voltage of the "typical" operational amplifier is restricted to the range $-V_{Lim} \le V_{out} \le +V_{Lim}$. For both cases, sketch the output waveform on the graphs labeled ***"Output Volts"*** (below the sketch of the sine wave input voltage). (The horizontal dashed lines on the output graphs indicate the output voltage limits, $\pm V_{Lim} = \pm 10V$.) The output waveform must include labels indicating voltage values and vertical lines between the input and output graphs should "key" the output waveform to the input. ***(Examine the circuits carefully!!!)***



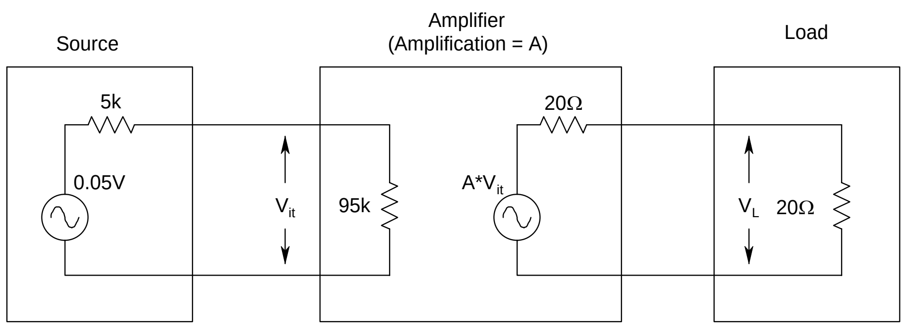
For the circuits sketched below, the output voltage of the ideal operational amplifier is restricted to the range $-V_{Lim} \le V_{out} \le +V_{Lim}$. For both cases, sketch the output waveform on the graphs labeled ***"Output Volts"*** (below the sketch of the sine wave input voltage). (The horizontal dashed lines on the output graphs indicate the output voltage limits, $\pm V_{Lim} = \pm 15V$.) The output waveform must include labels indicating voltage values and must include vertical lines to clearly show the time relationship between the input and output graphs. ***(Examine the circuits carefully!!!)***



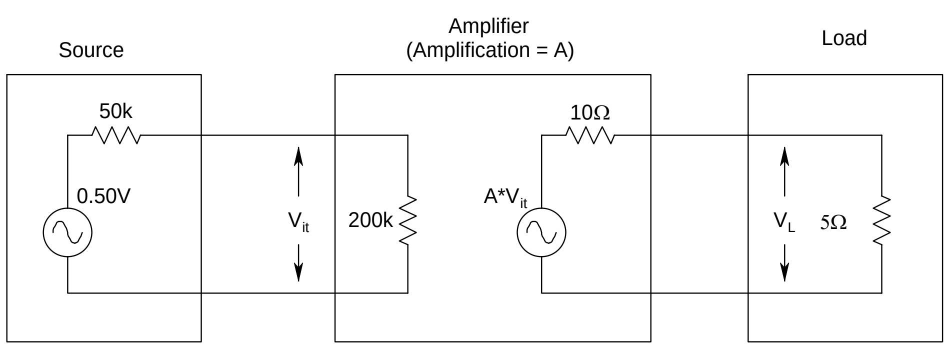
For the amplifier system sketched below, calculate the minimum value of the amplification (A) needed to obtain voltage across the load (V_L) of ***12 Volts***.



For the amplifier system sketched below, calculate the minimum value of the amplification (A) needed to obtain voltage across the load (V_L) of ***6 Volts***.



For the amplifier system sketched below, calculate the minimum value of the amplification (A) needed to obtain voltage across the load (V_L) of ***10 Volts***.



Design and sketch a circuit ***using no more than 2 operational amplifiers*** to combine the ***variable*** input voltages (V_1, V_2, and V_3) and the ***constant*** input ***-15V*** to give the output:

$$V_{out} = 3V_1 + 4V_2 - 2V_3 + 5\text{volts}$$

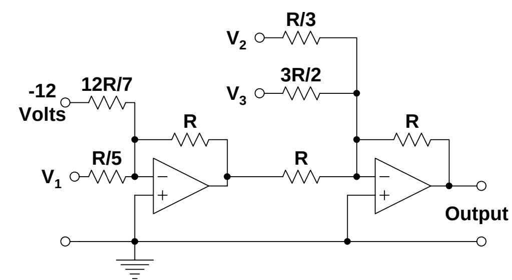
Design and sketch a circuit ***using no more than 2 operational amplifiers*** to combine the ***variable*** input voltages (V_1, V_2, and V_3) and the ***constant*** input ***+5V*** to give the output:

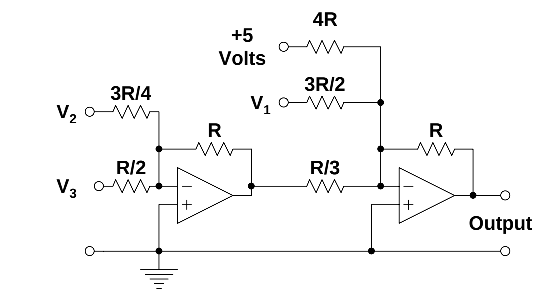
$$V_{out} = 4V_1 - V_2 + 5V_3 - 7\text{ volts}$$

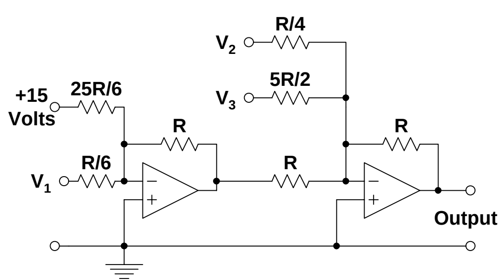
Design and sketch a circuit ***using no more than 2 operational amplifiers*** to combine the ***variable*** input voltages (V_1, V_2, and V_3) and the ***constant*** input ***-12V*** to give the output:

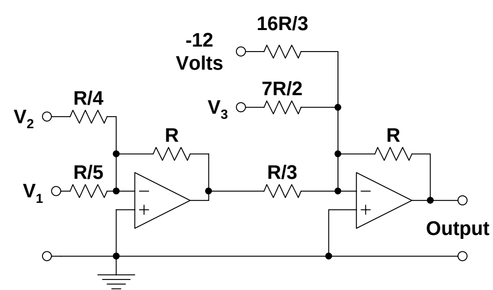
$$V_{out} = 5V_1 - 3V_2 + 2V_3 - 3\text{ volts}$$

Write the relationship between output and the ***variable*** and constant input voltages (V_1, V_2, and V_3) for the circuits sketched below. ***(Pay careful attention to the components.)***

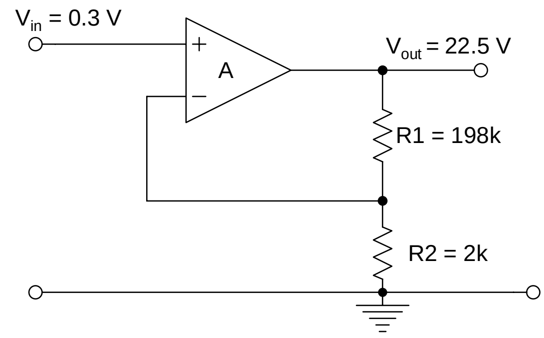








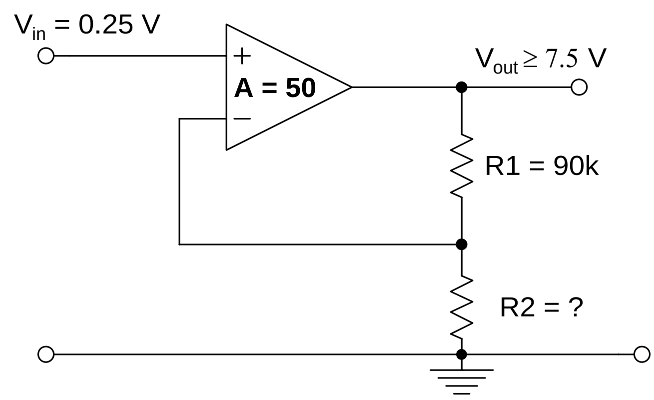
Sketched below is a circuit incorporating an amplifier in the "non-inverting" configuration used for operational amplifiers. The "**basic amplifier relation,**" is $\mathbf{V_{out} = A(V_+ - V_-)}$. Use this relation to calculate the following:(*You may assume the input resistance of the amplifier to be sufficiently high that negligible current enters it.*)



a. The ***minimum*** value of ***A*** necessary for the input shown to generate the output shown.

b. The ***output voltage*** for very large values of ***A*** (approaching ∞).

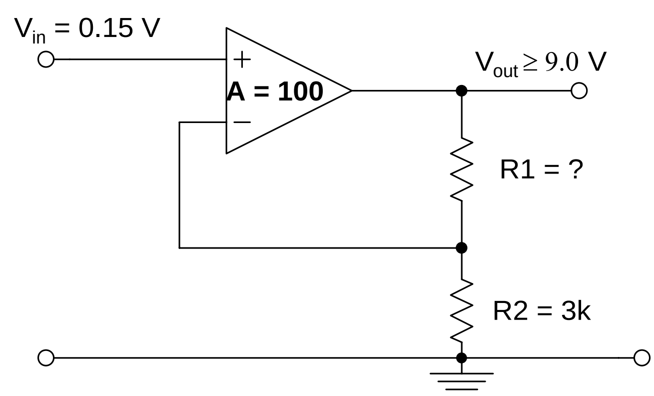
Sketched below is a circuit incorporating an amplifier in the "non-inverting" configuration used for operational amplifiers. The "**basic amplifier relation,**" is $\mathbf{V_{out} = A(V_+ - V_-)}$. Use this relation to calculate the following:(*You may assume the input resistance of the amplifier to be sufficiently high that negligible current enters it.*)



a. The ***minimum*** value of R_1 necessary for the input shown to generate the output shown.

b. The ***output voltage*** (using the R_2 value shown and the value of R_1 calculated above) for very large values of ***A*** (***approaching*** ∞).

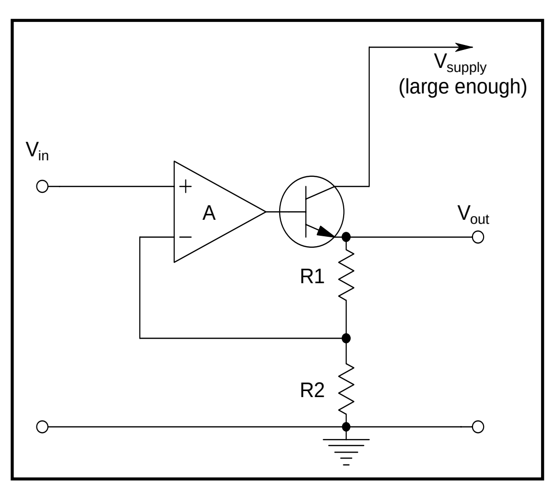
Sketched below is a circuit incorporating an amplifier in the "non-inverting" configuration used for operational amplifiers. The "**basic amplifier relation,**" is $\mathbf{V_{out} = A(V_+ - V_-)}$. Use this relation to calculate the following:(*You may assume the input resistance of the amplifier to be sufficiently high that negligible current enters it.*)



a. The ***minimum*** value of R_1 necessary for the input shown to generate the output shown.

b. The ***output voltage*** (using the R_2 value shown and the value of R_1 calculated above) for very large values of ***A*** (***approaching*** ∞).

Sketched below is a circuit incorporating an amplifier and a transistor in the configuration used for voltage regulators.



a. The "**basic amplifier relation,**" is $\mathbf{V_{OA} = A(V_+ - V_-)}$. Use this relation to calculate V_{out} for the case $V_{in} = 0.25$ V, $R_1 = 95k$, $R_2 = 5k$, ***and*** $A = 15$. In this calculation, you ***MUST*** include the transistor's base-emitter voltage, V_{BE}. (*You may assume the input resistance of the amplifier to be sufficiently high that negligible current enters it.*)

b. Calculate the output for the input voltage and resistors in ***(a)*** when $A \to \infty$.

c. Calculate the value of ***A*** needed to make the result in ***(a)*** 90% of the value in ***(b)***.