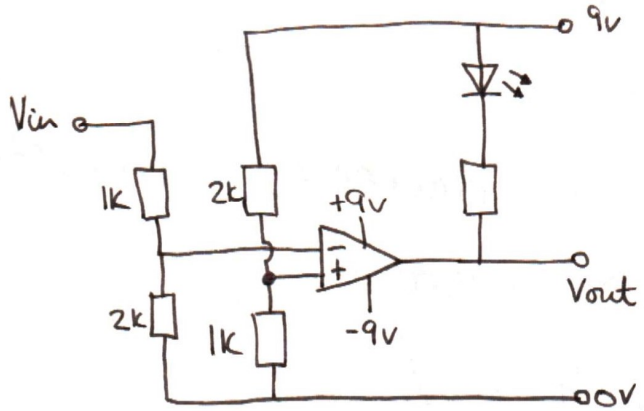
# Homework 2.8.




a) $V = I \times R$

$I = \frac{V}{R}$

$I = \frac{9}{3000}$

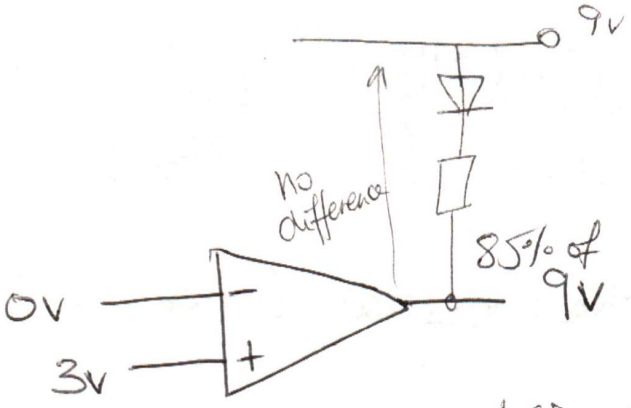
$I = 3mA.$

$V = I \times R$

$V = (3 \times 10^{-3}) \times 1000$

$V = 3v$

b). $Vin = 0v$




LED off.

When the input (Vin) is 0v, it is less than the reference voltage of 3v at the non-inverting input. That means the opamp saturates (85% of 9v), small potential difference between the supply of 9v so the LED does not light.

c) When the voltage into the inverting input becomes greater than the 3V into the non-inverting input the output from the op amp will become negative (assume 0V) and the difference between the 9v supply and the output will be great enough to light the LED.

## Homework 2.9.

a) $V_{out} = -R_f\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} + \frac{V_4}{R_4}\right)$

$$V_{out} = -8\left(\frac{V_1}{80} + \frac{V_2}{40} + \frac{V_3}{20} + \frac{V_4}{10}\right)$$

$$V_{out} = -(0.1V_1 + 0.2V_2 + 0.4V_3 + 0.8V_4).$$

b) $$V_{out} = -8 \times \left(\frac{0.1 \times V_1}{R_1} + \frac{0.2V_2}{R_2} + \frac{0.4V_3}{R_3} + \frac{0.8V_4}{R_4}\right)$$

$$V_{out} = -8 \times \left(\frac{0.5}{80} + \frac{1}{40} + \frac{2}{20} + \frac{4}{10}\right)$$

$$V_{out} = -8 \times (0.00625 + 0.025 + 0.1 + 0.4)$$

$$V_{out} = -4.25V$$

c)

$$V_{out} = -8\left(\frac{5}{80} + \frac{5}{40} + \frac{5}{20} + \frac{5}{10}\right)$$

$$V_{out} = -8(0.0625 + 0.125 + 0.25 + 0.5)$$

$$V_{out} = 7.5V$$

$$V_{out} = -8\left(\frac{0}{80} + \frac{5}{40} + \frac{5}{20} + \frac{5}{10}\right)$$

$$V_{out} = -8(0.125 + 0.25 + 0.5)$$

$$V_{out} = 7V$$

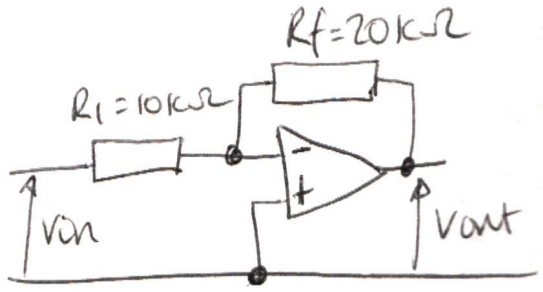
$$V_{out} = -8\left(\frac{5}{80} + \frac{0}{40} + \frac{5}{20} + \frac{5}{10}\right)$$

$$V_{out} = -8(0.0625 + 0.25 + 0.5)$$

$$V_{out} = 6.5V$$

| S4 | S3 | S2 | S1 | Vout |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0.5 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 1.5 |
| 0 | 1 | 0 | 0 | 2 |
| 0 | 1 | 0 | 1 | 2.5 |
| 0 | 1 | 1 | 0 | 3 |
| 0 | 1 | 1 | 1 | 3.5 |
| 1 | 0 | 0 | 0 | 4 |
| 1 | 0 | 0 | 1 | 4.5 |
| 1 | 0 | 1 | 0 | 5 |
| 1 | 0 | 1 | 1 | 5.5 |
| 1 | 1 | 0 | 0 | 6 |
| 1 | 1 | 0 | 1 | 6.5 |
| 1 | 1 | 1 | 0 | 7 |
| 1 | 1 | 1 | 1 | 7.5 |

d)




attach $R_1$ to the output of the amplifier circuit.