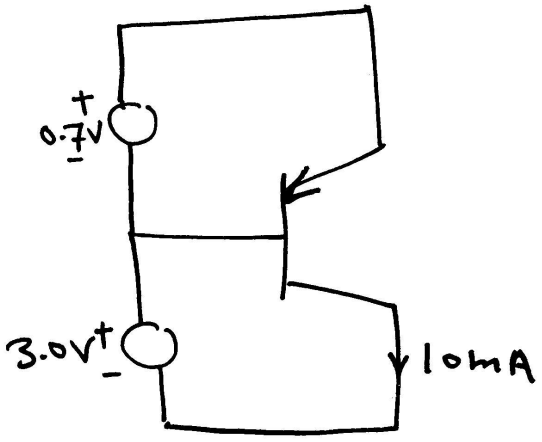
(1)



Find the value of the transistor Saturation Current

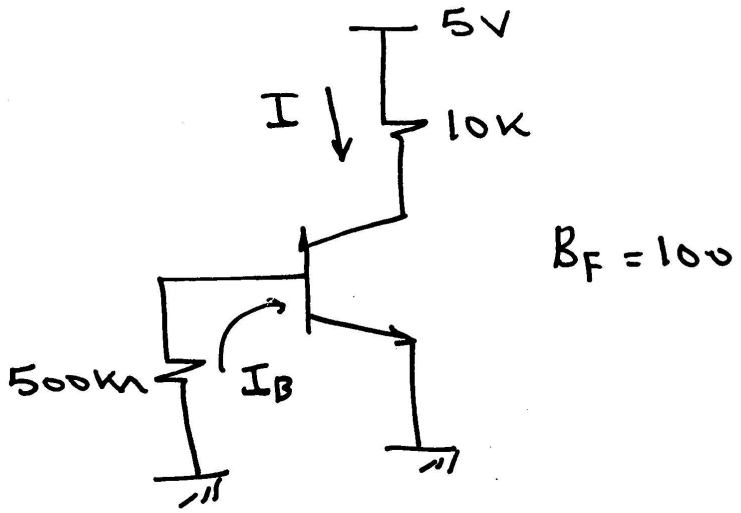
Answer: $V_{EB} = 0.7 > 0$ BE Junction is Forward-biased

* $V_{BC} > 0$ BC Junction is reverse-biased

* transistor is in Forward active region $\Rightarrow I_C = I_S \exp\left(\frac{V_{EB}}{V_T}\right)$

$\therefore 10mA = I_S \exp\left(\frac{0.7}{0.025}\right) \Rightarrow I_S = 6.9 \times 10^{-15}$ A

(2)



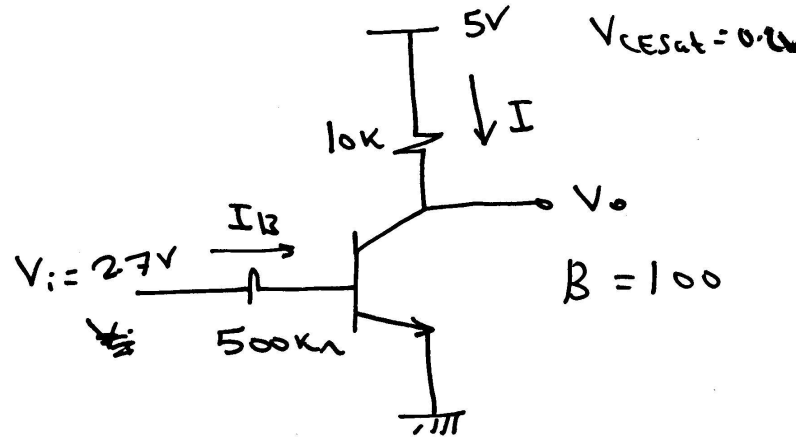
Find the current I for the shown circuit.

* Battery is trying to push current in the shown direction $\Rightarrow$ transistor either in cut-off, Forward active region or saturation region
* If transistor in Forward active or Saturation $\Rightarrow$ $V_B = -I_B * 500K < V_E$

$\therefore V_{BE} < 0 \Rightarrow$ contradiction

$\therefore$ transistor is off and $I = 0$ A

(3)



Find the current I for $V_i = 0, 2.7V$ and 5V

* For $V_i = 0V$, transistor must be off
  $I = 0A$

* For $V_i = 2.7V$, we assume Forward active region

$$I_B = \frac{2.7V - 0.7V}{500K} = 4mA$$

$$I_C = \beta I_B = 0.4mA$$

$$V_C = V_o = 5 - 0.4 * 10^{-3} * 10^4 = 1V$$

$\therefore V_C > V_B \Rightarrow$ BC Junction is reverse biased

Our assumption is valid

* For $V_i = 5V$

Assuming forward active region

$I_B = \frac{5 - 0.7}{500K} = 8.6 mA$

$I_C = \beta I_B = 100 * 8.6 mA = 0.86 mA$

$\therefore V_C = 5 - 0.86 * 10 = -3.6 \Longrightarrow$ reject

It follow that transistor is saturated

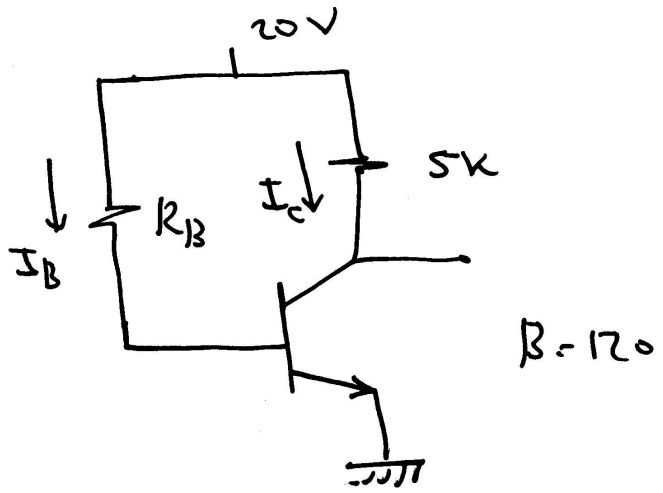
and $V_{CE} = V_{CEsat} = 0.2V$

$I_C = \frac{5 - 0.2}{10K} = 0.48 mA$

Notice that $I_C < \beta I_B$ for saturat

region

(5)



Find R_B such that $V_{CEQ} = 10V$

Transistor is in forward active region

$$I_C = \frac{20-10}{5K} = 2mA$$

$$I_B = \frac{I_C}{\beta} = \frac{2mA}{120} = 16.66\mu A$$

But $I_B = \frac{20-0.7}{R_B} \Rightarrow R_B = \frac{19.3}{16.6} \times 10^6$

$\therefore R_B = 1.16 M\Omega$