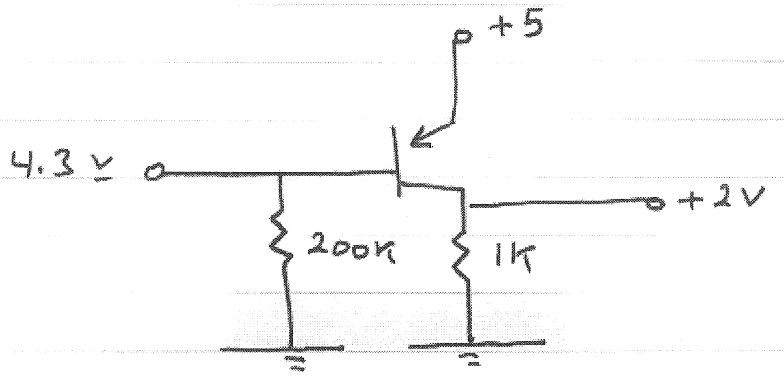
4.20

a)

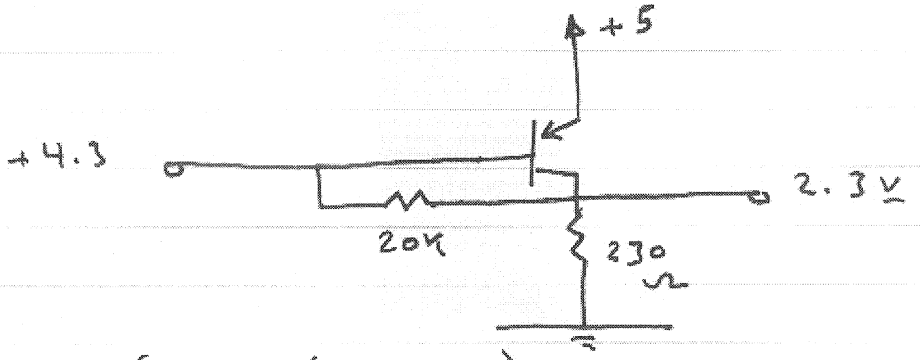


$$I_B = \frac{V_B}{200K} = 0.0215\,mA$$

$$V_C = 1K\, I_C \quad \therefore \quad I_C = \frac{2}{1K} = 2\,mA$$

$$\beta = \frac{I_C}{I_B} = 93$$

b)



$$V_C = (230\Omega)(I_C + I_B)$$

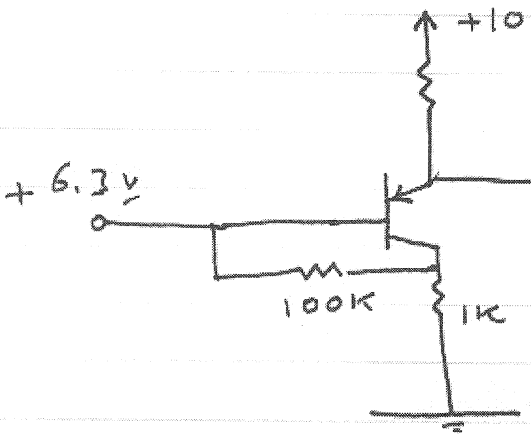
$$\therefore \quad I_C + I_B = I_E = \frac{2.3}{230} = 10\,mA$$

$$I_B = \frac{V_B - V_E}{20K} = \frac{4.3 - 2.3}{20K} = 0.1\,mA$$

$$I_C = I_E - I_B = 9.9\,mA$$

$$B = \frac{I_C}{I_B} = 99.$$

c)



$I_E = \frac{10-7}{1K} = 3mA$

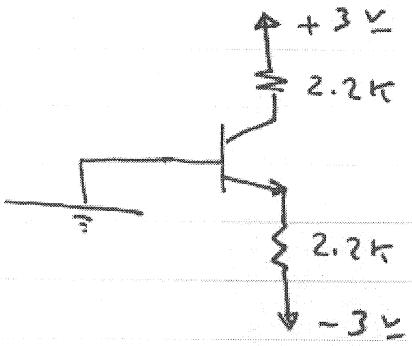
$V_C = 1K\, I_E = 3V$

$I_B = \frac{6.3-3}{100K} = 33\,\mu A$

$I_C = 2.967\,mA \quad \therefore \beta = \frac{I_C}{I_B} = 89.9$

4.26

a)



$\beta = 30$

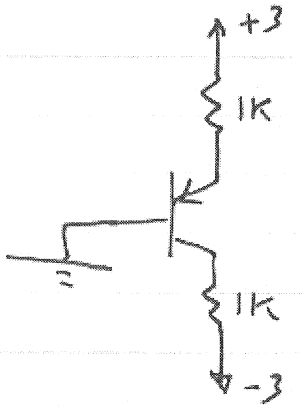
$V_B = 0$, $V_E = -0.7V$, $I_E = \frac{-0.7+3}{2.2K} = 1.05\,mA$

$I_C = \alpha I_E = 1.02\,mA$

$I_B = \frac{I_C}{\beta} = 0.034\,mA$

$V_C = 3 - (2.2K)\, I_C = 0.756V$

b)



$V_B = 0$, $V_E = 0.7V$

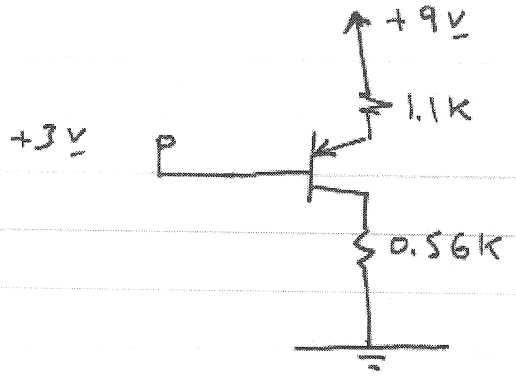
$I_E = \frac{3-0.7}{1K} = 2.3\,mA$

$I_C = \alpha I_E = 2.23\,mA$

$I_B = \frac{I_C}{\beta} = 0.743\,mA$

$V_C = 1K\, I_C - 3 = -0.77V$

c)

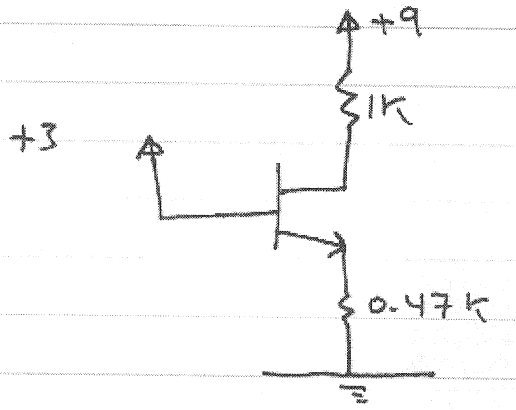


$V_{EB} = V_E - V_B \quad \therefore V_E = 3.7\,V$

$I_E = \frac{9-3.7}{1.1K} = 4.82\,mA \quad , \quad I_C = \alpha I_E = 4.66\,mA$

$V_C = (0.56K)I_C = 2.62\,V \quad ; \quad I_B = \frac{I_C}{\beta} = 0.155\,mA$

d)



$V_E = 3 - 0.7 = 2.3\,V$

$I_E = \frac{2.3}{0.47} = 4.89\,mA$

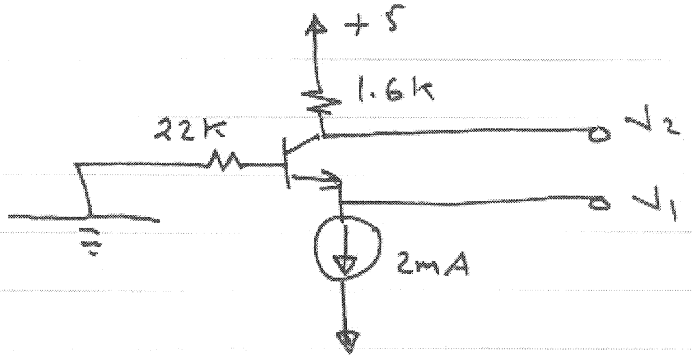
$I_C = \alpha I_E = 4.73\,mA$

$V_C = 9 - 1K I_C = 4.22\,V$

$I_B = \frac{I_C}{\beta} = 0.158\,mA$

4.46

a)



$\beta = \infty$

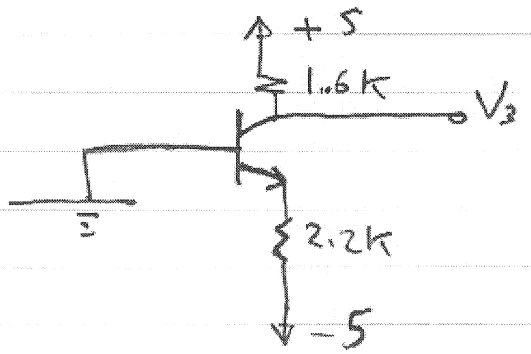
$\therefore I_B \to 0$

$I_E = 2mA \quad \therefore I_C = \alpha I_E \cong I_E = 2mA$

$V_2 = 5 - (1.6k) I_C = 1.8\ V$

$V_1 = V_{EB} = -0.7 \quad (\text{since } I_B \to 0)\ V_B = 0$

b)



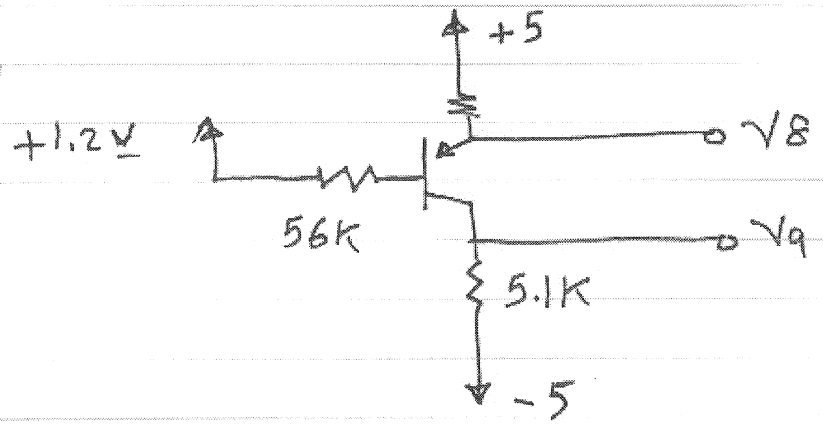
$I_E = \frac{5 - 0.7}{2.2k} = 1.954mA$

$V_3 = 5 - (1.6k) I_C$

$\therefore V_3 = 1.87\ V$

c) The same answers as part (b)

d)



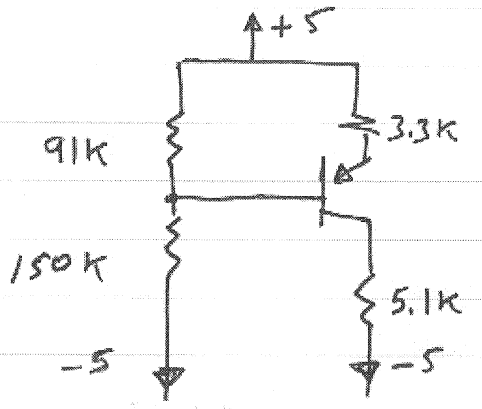
$V_B = 56K\, I_B + 1.2V \approx 1.2V$

$I_E = \frac{5 - 0.7 - 1.2}{3.3K} = 0.939\ mA$

$V_8 = 5 - 3.3K\, I_E = 1.9V$

$V_9 = (5.1K)\, I_C - 5 = -0.209V$

e)



$R_{TH} = 91K \| 150K$

$R_{TH} = 56.64K$

$V_{TH} = V_B = \frac{150K}{150K+9K} \cdot 10 - 5$

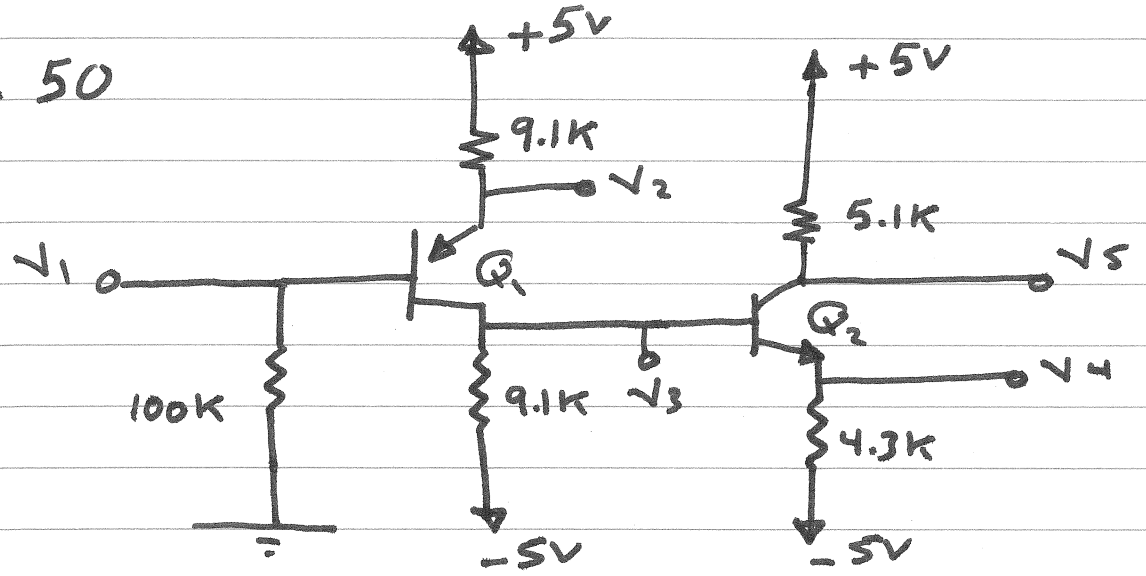
$\therefore V_{TH} = 1.224V$

$I_E = \frac{5 - 0.7 - 1.224}{3.3K} = 0.9321\ mA$

$V_{11} = 5 - (3.3K)\, I_E = 1.924V$

$V_{12} = (5.1K)\, I_C - 5 = -0.2463$

4 - 50



a) $\beta = \infty$; $I_B \approx 0$ and $I_C \approx I_E$

$V_1 = 100K\, I_B = 0$

$5 = 9.1K\, I_{E_1} + V_{EB_1} + 100K\, I_{B_1}$

$\therefore I_{E_1} = \frac{5 - 0.7}{9.1K} = 0.4725\ mA$

$V_2 = 5 - 9.1K\, I_{E_1} = 0.7\ V$

$V_3 = 9.1K\,(I_{C_1} - I_{B_2}) - 5 = -0.7V$

$-9.1K\,(I_{C_1} - I_{B_2}) + V_{BE_2} + 4.3K\, I_{E_2} = 0$

$\therefore I_{E_2} = 0.837\ mA$

$V_4 = 4.3K\, I_{E_2} - 5 = -1.4\ V$

$V_5 = 5 - 5.1K\, I_{C_2} = 0.73\ V$

b) $\beta = 100$

$$5 = 9.1K\, I_{E_1} + V_{EB_1} + 100K\, I_B$$

$$\therefore I_{E_1} = \frac{5 - 0.7}{9.1K + \frac{100K}{101}} = 0.426\ mA$$

$$I_{B_1} = \frac{I_{E_1}}{101} = 0.00422\ mA$$

$$I_{C_1} = 0.422\ mA$$

$$V_1 = 100K\, I_{B_1} = 0.422\ V$$

$$V_2 = 5 - 9.1K\, I_{E_1} = 1.1234\ V$$

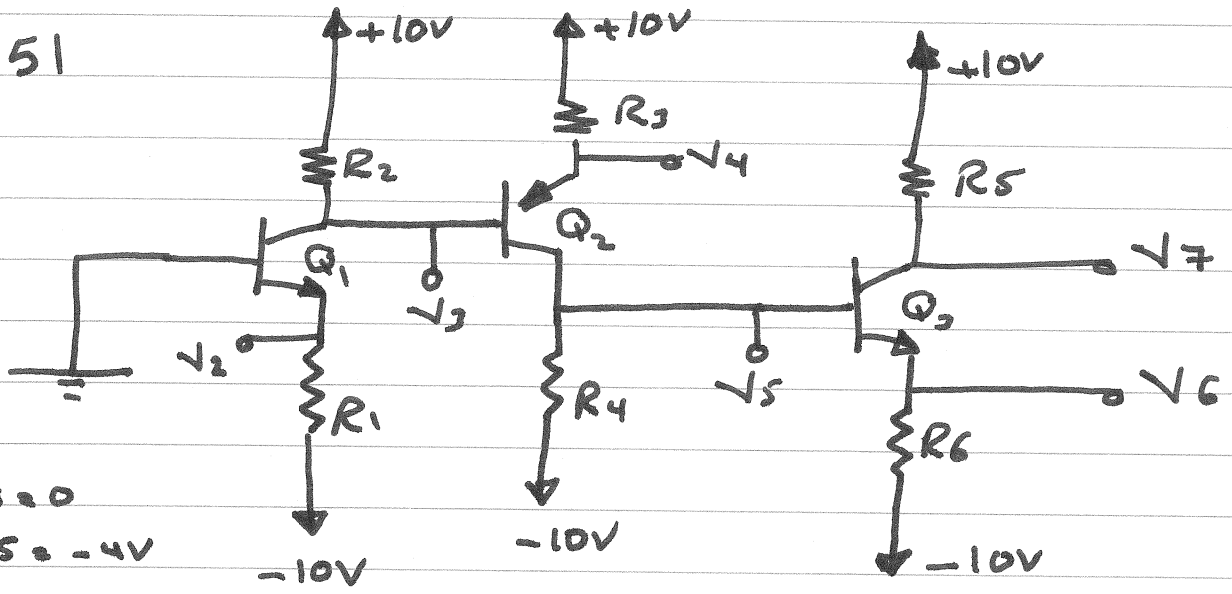
$$-9.1K\left(I_{C_1} - I_{B_2}\right) + 0.7 + 4.3K\, I_{E_2} = 0$$

$$\therefore I_{E_2} = 0.715\ mA$$

$$V_3 = 9.1K\left(I_{C_1} - I_{B_2}\right) - 5 = -1.22\ V$$

$$V_4 = 4.3K\, I_{E_2} - 5 = -1.9255\ V$$

4.51



$V_3 = 0$

$V_5 = -4V$

$V_7 = +2V$

$I_{E_1} = I_{E_2} = 2mA \; ; \; I_{E_3} = 4mA$

a) $\beta = \infty \longrightarrow I_B \approx 0 \; ; \; I_C \approx I_E$

$$V_2 = -V_{BE_1} = -0.7$$

$$R_1 = \frac{-0.7+10}{I_{E_1}} = \frac{10-0.7}{2mA} = 4.65K \longrightarrow 4.7K$$

$$R_2 = \frac{10-V_3}{I_{C_1}} = \frac{10}{2mA} = 5K \longrightarrow 5.1K$$

$$V_4 = V_{EB_2} + V_3 = 0.7+0 = 0.7V$$

$$R_3 = \frac{10-V_4}{I_{E_2}} = \frac{10-0.7}{2mA} = 4.65K \longrightarrow 4.7K$$

$$R_4 = \frac{V_5+10}{I_{E_2}} = \frac{-4+10}{2mA} = 3K$$

$$V_6 = V_{EB_3} + V_5 = -0.7-4 = -4.7V$$

$$R_6 = \frac{V_6+10}{I_{E_3}} = \frac{-4.7+10}{4mA} = 1.325K \longrightarrow 1.3K$$

$$R_5 = \frac{10-V_7}{I_{C_3}} = \frac{10-2}{4mA} = 2K$$

b) $\beta = 100$

$$10 = V_{BE_1} + R_1 I_{E_1}$$

$$\therefore I_{E_1} = \frac{10 - 0.7}{R_1} = \frac{10 - 0.7}{4.7k} = 1.98\,mA$$

$$I_{C_1} = \alpha I_{E_1} = \frac{100}{101} I_{E_1} = 1.96\,mA$$

$$R_3 I_{E_2} + V_{EB_2} - R_2 (I_{C_1} - I_{B_2}) = 0$$

$$\therefore I_{E_2} = \frac{R_2 I_{C_1} - V_{EB_2}}{R_3 + \frac{R_2}{\beta + 1}} = 1.96\,mA$$

$$I_{C_2} = \alpha I_{E_2} = 1.94\,mA$$

$$-R_4 (I_{C_2} - I_{B_2}) + V_{BE_3} + R_6 I_{E_3} = 0$$

$$\therefore I_{E_3} = 3.85\,mA$$

$$\therefore I_{C_3} = 3.81\,mA$$

$$V_2 = R_1 I_{E_1} - 10 = -0.694\,V$$

$$V_3 = 10 - R_3 I_{E_2} - 0.7 = 0.088\,V$$

$$V_4 = 10 - R_3 I_{E_3} = 0.788\,V$$

$$V_6 = R_6 I_{E_3} - 10 = -5\,V$$

$$V_5 = V_{BE_3} + V_6 = -4.3\,V$$

$$V_7 = 10 - R_5 I_{C_3} = 2.38\,V$$