Each collector has a quiescent voltage of approximately:

$$V_C = 15\text{ V} - (1\text{ mA})(5\text{ k}\Omega) = 10\text{ V}$$

Figure 17-6*b* shows the dc voltages, and Fig. 17-6*c* shows the currents. (*Note:* The standard arrowhead indicates conventional flow, and the triangular arrowhead indicates electron flow.)

PRACTICE PROBLEM 17-1 In Fig. 17-6*a*, change R_E to 5 kΩ and find the ideal currents and voltages.

Example 17-2

MultiSim

Recalculate the currents and voltages for Fig. 17-6*a* using the second approximation.

SOLUTION The tail current is:

$$I_T = \frac{15\text{ V} - 0.7\text{ V}}{7.5\text{ k}\Omega} = 1.91\text{ mA}$$

Each emitter current is half of the tail current:

$$I_E = \frac{1.91\text{ mA}}{2} = 0.955\text{ mA}$$

and each collector has a quiescent voltage of:

$$V_C = 15\text{ V} - (0.955\text{ mA})(5\text{ k}\Omega) = 10.2\text{ V}$$

As you can see, the answers change only slightly when the second approximation is used. In fact, if the same circuit is built and tested with MultiSim (EWB), the following answers result with 2N3904 transistors:

$$I_T = 1.912\text{ mA}$$

$$I_E = 0.956\text{ mA}$$

$$I_C = 0.950\text{ mA}$$

$$V_C = 10.25\text{ V}$$

These answers are almost the same as the second approximation and not much different from the ideal answers. The point is that ideal analysis is adequate for many situations. If you need more accuracy, use either the second approximation or MultiSim analysis.

PRACTICE PROBLEM 17-2 Repeat Example 17-2 using a 5 kΩ emitter resistor.

Example 17-3

MultiSim

What are the currents and voltages in the single-ended output circuit of Fig. 17-7*a*?

SOLUTION Ideally, the tail current is:

$$I_T = \frac{12\text{ V}}{5\text{ k}\Omega} = 2.4\text{ mA}$$

Each emitter current is half of the tail current:

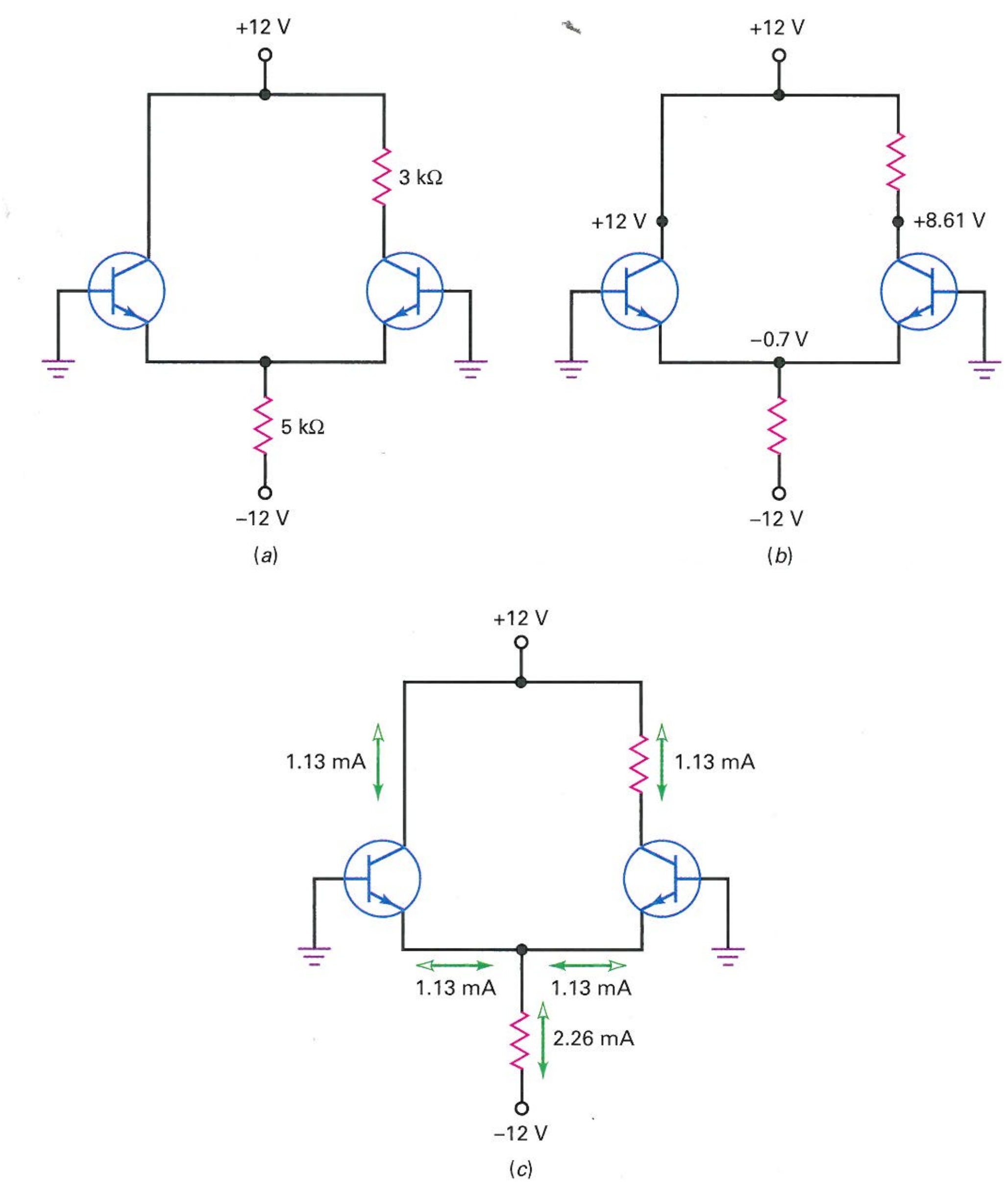
$$I_E = \frac{2.4\text{ mA}}{2} = 1.2\text{ mA}$$

The collector on the right has a quiescent voltage of approximately:

$$V_C = 12\text{ V} - (1.2\text{ mA})(3\text{ k}\Omega) = 8.4\text{ V}$$

and the one on the left has 12 V.

Figure 17-7 Example.



With the second approximation, we can calculate:

$$I_T = \frac{12\text{ V} - 0.7\text{ V}}{5\text{ k}\Omega} = 2.26\text{ mA}$$

$$I_E = \frac{2.26\text{ mA}}{2} = 1.13\text{ mA}$$

$$V_C = 12\text{ V} - (1.13\text{ mA})(3\text{ k}\Omega) = 8.61\text{ V}$$

Figure 17-7*b* shows the dc voltages, and Fig. 17-7*c* shows the currents for the second approximation.

PRACTICE PROBLEM 17-3 In Fig. 17-7*a*, change R_E to 3 kΩ. Determine the currents and voltages with the second approximation.