Another way to bias a BJT small signal amplifier is to use one voltage source and one current source. This biasing scheme has a number of important advantages:

1. The DC emitter current is independent of $\beta$ or BJT temperature!

   Therefore, the DC collector current $I_C = \alpha I_E \approx I_E$ is nearly independent of these parameters as well.

2. This means that the emitter voltage can be set at an arbitrarily low value!

   Therefore, the output voltage swing can be much larger than an equivalent single-supply amplifier!

3. We can make resistors $R_1$ and $R_2$ large without making design sensitive to temperature and $\beta$. 
The current source: not as easy as it appears

Note that ideally, we would set the emitter voltage to zero \( (V_E = 0) \), and thus the collector voltage to \( V_C = V_{cc}/2 \) to maximize the output swing (i.e., maximize the largest possible undistorted output signal).

Q: But, isn’t it diddly darn difficult to actually build an ideal current source!?  

A: True! For reasons we shall study later, most current sources require a minimum voltage across them in order to operate properly.
**Put collector voltage half way between floor and ceiling**

Thus, our **bias rule** should be:

*Make the DC emitter voltage $V_E$ as small as possible (and still have the current source work!).*

Then set the **current source** to a value equal to the desired DC collector current (i.e., $I_C \approx I_E$):

$$I = I_E \approx I_C$$

To maximize the output voltage swing, we still want to place the DC collector voltage $V_C$ **half way** between $V_{CC}$ and $V_E$.

$$V_C = \frac{V_{CC} + V_E}{2}$$

The **collector resistor** therefore should be:

$$R_C = \frac{V_{CC} - V_C}{I_C} = \frac{V_{CC} - V_C}{I} = \frac{V_{CC} - V_E}{2I}$$
$R_1$ and $R_2$: same as before

The remaining resistors $R_1$ and $R_2$ are determined in the same manner as with the single-supply bias design, i.e.:

$$R_1 = \frac{V_{CC} - V_B}{I_1}$$

and

$$R_2 = \frac{V_B}{I_2} \approx \frac{V_B}{I_1}$$

where the base voltage is approximately:

$$V_B = 0.7 + V_E$$

and the current $I_1$ is any value in the range:

$$0.1I_C < I_1 < I_C$$
Just the kind of subtle topic I might put on an exam

For example, say we wish to design a biasing network where:

\[ I_C = 2 \text{ mA} \quad V_E \geq 2.0 \text{ V} \quad V_{cc} = 15.0 \text{ V} \quad I_1 = 0.5 I_C \]

The result would be:

![Diagram showing the biasing network with resistor values and currents.

It is obvious to me that this bias design satisfies the parameters described above.

But, don’t take my word for it—verify for yourself that these resistor values are correct.