Solution For line segment A of Figure 10.19, the intercept on the voltage axis is 0.6 V and the reciprocal of the slope is 10 Ω. Hence, the circuit model for the diode on this segment is a 10-Ω resistance in series with a 0.6-V source, as shown in the figure. Line segment B has zero current, and therefore, the equivalent circuit for segment B is an open circuit, as illustrated in the figure. Finally, line segment C has an intercept of −6 V and a reciprocal slope of 12 Ω, resulting in the equivalent circuit shown. Thus, this diode can be approximated by one of these linear circuits, depending on where the operating point is located. ■

Example 10.7 Analysis Using a Piecewise-Linear Model

Use the circuit models found in Example 10.6 to solve for the current in the circuit of Figure 10.20(a).

Solution Since the 3-V source has a polarity that results in forward bias of the diode, we assume that the operating point is on line segment A of Figure 10.19. Consequently, the equivalent circuit for the diode is the one for segment A. Using this equivalent circuit, we have the circuit of Figure 10.20(b). Solving, we find that $i_D = 80$ mA. ■

Exercise 10.9 Use the appropriate circuit model from Figure 10.19 to solve for v_o in the circuit of Figure 10.21 if **a.** $R_L = 10$ kΩ and **b.** $R_L = 1$ kΩ. (*Hint:* Be sure that your answers are consistent with your choice of equivalent circuit for the diode—the various equivalent circuits are valid only for specific ranges of diode voltage and current. The answer must fall into the valid range for the equivalent circuit used.)

Answer **a.** $v_o = 6.017$ V; **b.** $v_o = 3.333$ V. □

Exercise 10.10 Find a circuit model for each line segment shown in Figure 10.22(a). Draw the circuit models identifying terminals a and b for each equivalent circuit.

Answer See Figure 10.22(b). Notice the polarity of the voltage sources with respect to terminals a and b. □

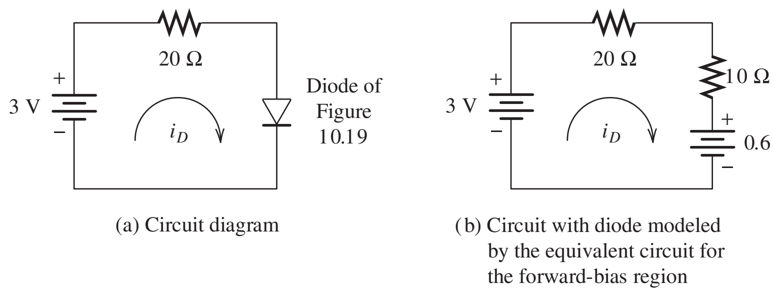


Figure 10.20 Circuit for Example 10.7.

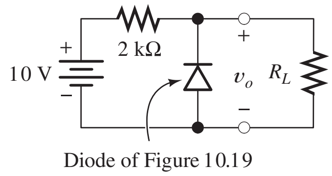
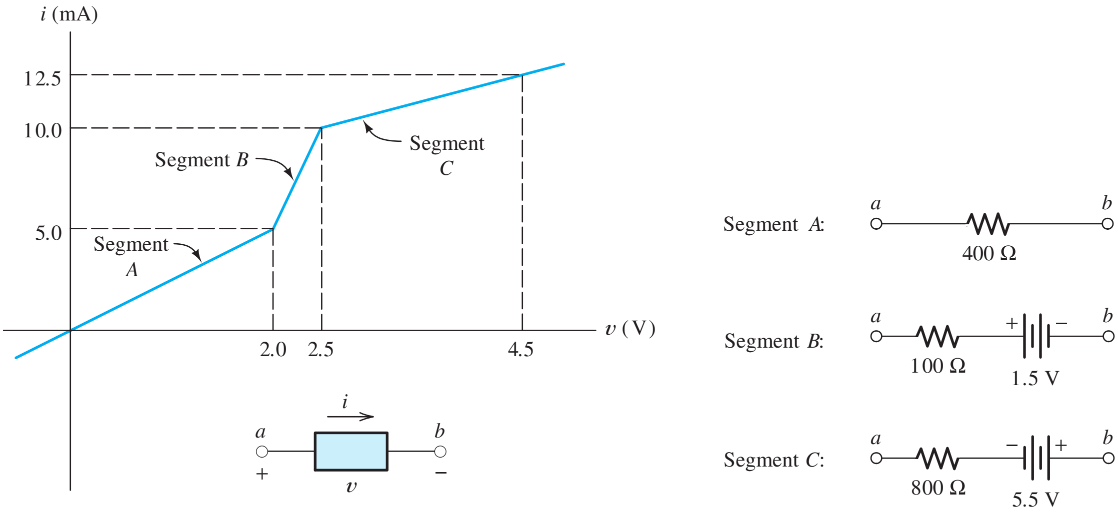


Figure 10.21 Circuit for Exercise 10.9.



(a) Volt–ampere characteristic

(b) Equivalent circuits

Figure 10.22 Hypothetical nonlinear device for Exercise 10.10.

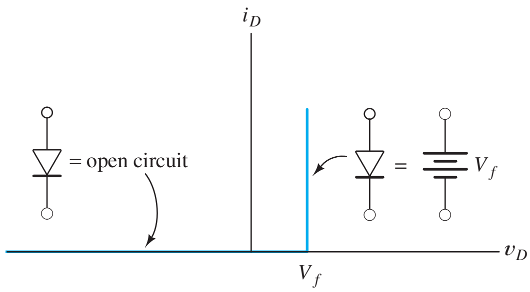


Figure 10.23 Simple piecewise-linear equivalent for the diode.

Simple Piecewise-Linear Diode Equivalent Circuit

Figure 10.23 shows a simple piecewise-linear equivalent circuit for diodes that is often sufficiently accurate. It is an open circuit in the reverse-bias region and a constant voltage drop in the forward direction. This model is equivalent to a battery in series with an ideal diode.

10.6 RECTIFIER CIRCUITS

Now that we have introduced the diode and some methods for analysis of diode circuits, we consider some additional practical circuits. First, we consider several types of **rectifiers**, which convert ac power into dc power. These rectifiers form the basis for electronic **power supplies** and battery-charging circuits. Typically, a power supply takes power from a raw source, which is often the 60-Hz ac power line, and delivers steady dc voltages to a load such as computer circuits or television circuits. Other applications for rectifiers are in signal processing, such as demodulation of a radio signal. (*Demodulation* is the process of retrieving the message, such as a voice or video signal.) Another application is precision conversion of an ac voltage to dc in an electronic voltmeter.