Check your calculations and results by using LTSpice to simulate the circuits

1.

a. Using the characteristics shown below , determine I_D and V_D for the circuit shown below .
b. Repeat part (a) with R = 0.47 k_.
c. Repeat part (a) with R = 0.68 k_.
d. Is the level of V_D relatively close to 0.7 V in each case?
How do the resulting levels of I_D compare? Comment accordingly.

Answers

(a) $I_D = \dfrac{E}{R} = \dfrac{6\text{ V}}{0.2\text{ k}\Omega} = 30\text{ mA}$

The load line extends from $I_D = 30$ mA to $V_D = 6$ V.

$V_{D_Q} \cong \mathbf{0.95\ V}$, $I_{D_Q} \cong \mathbf{25.3\ mA}$

(b) $I_D = \dfrac{E}{R} = \dfrac{6\text{ V}}{0.47\text{ k}\Omega} = 12.77\text{ mA}$

The load line extends from $I_D = 12.77$ mA to $V_D = 6$ V.

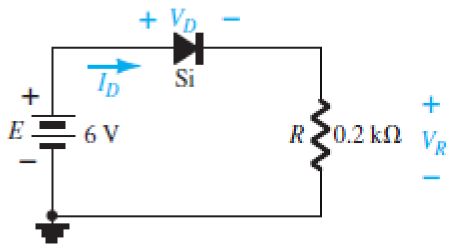
$V_{D_Q} \cong \mathbf{0.8\ V}$, $I_{D_Q} \cong \mathbf{11\ mA}$

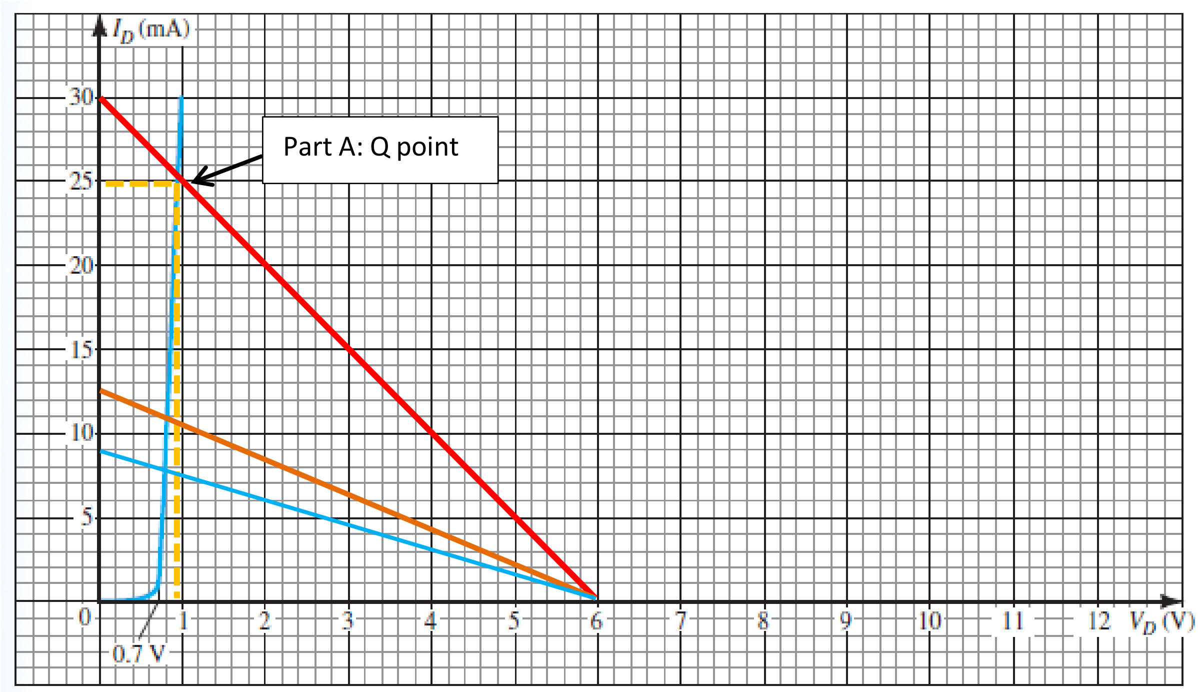
(c) $I_D = \dfrac{E}{R} = \dfrac{6\text{ V}}{0.68\text{ k}\Omega} = 8.82\text{ mA}$

The load line extends from $I_D = 8.82$ mA to $V_D = 6$ V.

$V_{D_Q} \cong \mathbf{0.78\ V}$, $I_{D_Q} \cong \boxed{7.8\text{ mA}}$

The resulting values of V_{D_Q} are quite close, while I_{D_Q} extends from 7.8 mA to 25.3 mA.





I_D (mA)
30
25
20
15
10
5
0
Part A: Q point
1
2
3
4
5
6
7
8
9
10
11
12
V_D (V)
0.7 V

2.

a. Using the approximate characteristics for the Si diode, determine V_D, I_D, and V_R for the circuit shown below.
b. Perform the same analysis as part (a) using the ideal model for the diode.
c. Do the results obtained in parts (a) and (b) suggest that the ideal model can provide a good approximation for the actual response under some conditions?

Answer

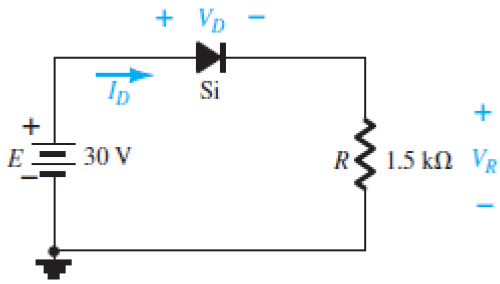
(a) $I_D = I_R = \dfrac{E - V_D}{R} = \dfrac{30\text{ V} - 0.7\text{ V}}{1.5\text{ k}\Omega} = \mathbf{19.53\text{ mA}}$

$V_D = \mathbf{0.7\text{ V}}$, $V_R = E - V_D = 30\text{ V} - 0.7\text{ V} = \mathbf{29.3\text{ V}}$

(b) $I_D = \dfrac{E - V_D}{R} = \dfrac{30\text{ V} - 0\text{ V}}{1.5\text{ k}\Omega} = \mathbf{20\text{ mA}}$

$V_D = \mathbf{0\text{ V}}$, $V_R = \mathbf{30\text{ V}}$

Yes, since $E \gg V_T$ the levels of I_D and V_R are quite close.



3. Determine the current *I* for each of the configurations shown below, using the approximate equivalent model for the diode.

Answer:

(a) $I = \mathbf{0\ mA}$; diode reverse-biased.

(b) $V_{20\Omega} = 20\ \text{V} - 0.7\ \text{V} = 19.3\ \text{V}$ (Kirchhoff's voltage law)

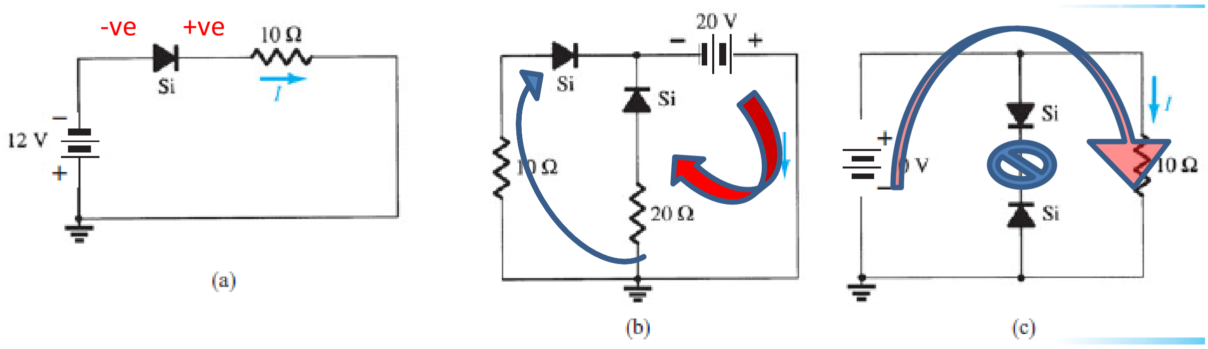
$$I(20\ \Omega) = \frac{19.3\ \text{V}}{20\ \Omega} = 0.965\ \text{A}$$

$$V(10\ \Omega) = 20\ \text{V} - 0.7\ \text{V} = 19.3\ \text{V}$$

$$I(10\ \Omega) = \frac{19.3\ \text{V}}{10\ \Omega} = 1.93\ \text{A}$$

$$I = I(10\ \Omega) + I(20\ \Omega) = \mathbf{2.895\ A}$$

(c) $I = \dfrac{10\ \text{V}}{10\ \Omega} = \mathbf{1\ A}$; center branch open



4. Determine the level of V_o for each network shown below

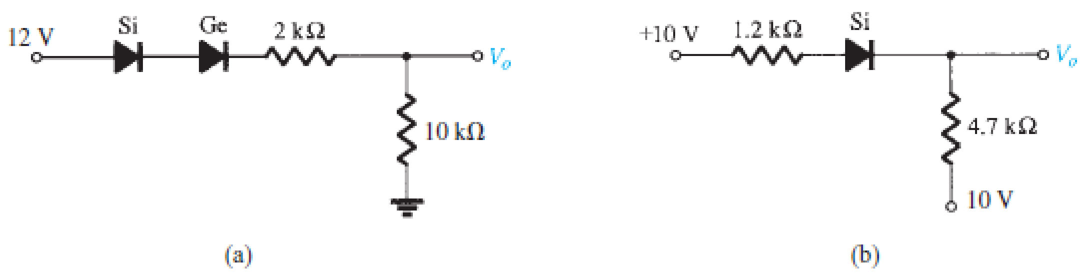
Answer:

For circuit A, use a voltage divider network calculation

For circuit B, both supplies are 10 volts so the output is 10 V, this is because the diode is not biased

(a) $V_o = \dfrac{10\ \text{k}\Omega(12\ \text{V} - 0.7\ \text{V} - 0.3\ \text{V})}{2\ \text{k}\Omega + 10\ \text{k}\Omega} = \mathbf{9.17\ V}$

(b) $V_o = \mathbf{10\ V}$



5. Determine V_o and I for the networks shown below.

Answer:

For Part A, The Si diode will be “on” when the voltage is 0.7 Volts, this means the GaAs diode will not reach Vk or on voltage of 1.2 V because the Si diode will “hold” the voltage across both diodes at 0.7 V

For Part B, use KVL

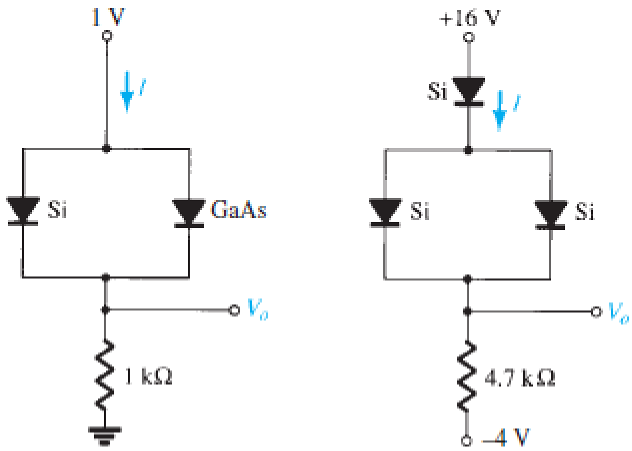
(a) Si diode “on” preventing GaAs diode from turning “on”:

$$I = \frac{1\text{ V} - 0.7\text{ V}}{1\text{ k}\Omega} = \frac{0.3\text{ V}}{1\text{ k}\Omega} = \mathbf{0.3\text{ mA}}$$

$$V_o = 1\text{ V} - 0.7\text{ V} = \mathbf{0.3\text{ V}}$$

(b) $$I = \frac{16\text{ V} - 0.7\text{ V} - 0.7\text{ V} + 4\text{ V}}{4.7\text{ k}\Omega} = \frac{18.6\text{ V}}{4.7\text{ k}\Omega} = \mathbf{3.96\text{ mA}}$$

$$V_o = 16\text{ V} - 0.7\text{ V} - 0.7\text{ V} = \mathbf{14.6\text{ V}}$$



(a) (b)