

Question 1

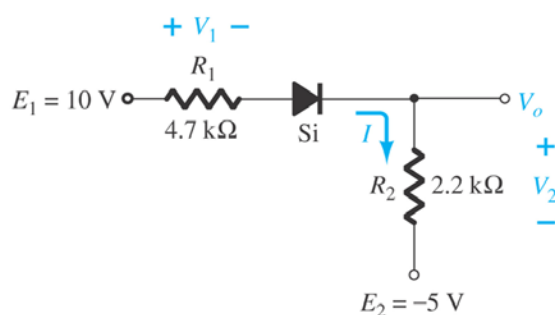
Consider 2 semiconductor samples: Sample A: $N_D = 10^{16} \text{ cm}^{-3}$ (donors); Sample B: $N_A = 10^{16} \text{ cm}^{-3}$ (acceptors). Sample A is longer than Sample B by two times. Both samples have the same width and height.

- Find the concentration of holes (p) and electrons (n) for each sample
- Determine whether the samples are P-type or N-type semiconductors
- Find the conductivity and resistivity of each sample
- Which sample has larger resistance?

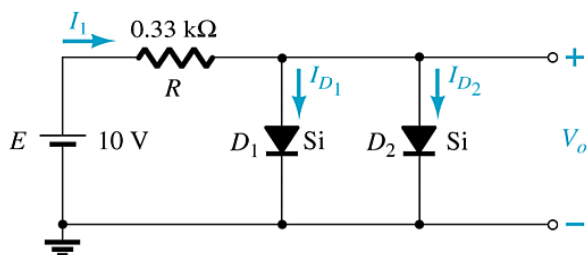
Assume the values of carrier mobility provided in the reference sheet.

Question 2

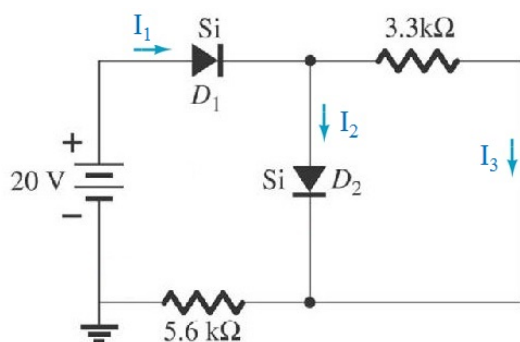
For the circuit below, determine the state of the diode and find I , V_1 , V_2 , and V_o .

**Question 3**

For the circuit below, determine the state of diodes D_1 and D_2 , and find I_1 , I_{D1} , I_{D2} , and V_o .

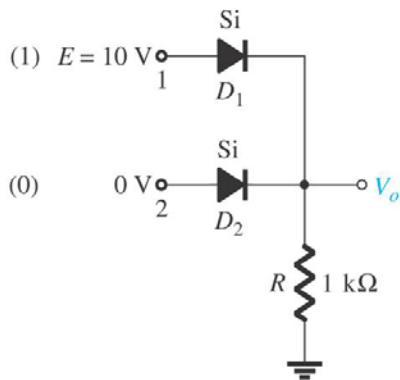
**Question 4**

For the circuit below, determine the state of diodes D_1 and D_2 , and find I_1 , I_2 , and I_3 .



Question 5

For the circuit below, determine the states of diodes D_1 and D_2 , and find V_o and the diode currents.

**Question 6**

In the case of an NMOS, by convention we have always assumed that V_{DS} is always positive for the normal operation of the NMOS. If V_{DS} is negative (say -1 V), what is the state of the pn-junctions at the source and drain regions in relation to the body (which is connected to the source)?

Explain why V_{DS} cannot be negative for an NMOS in the normal operation of a MOSFET.

Numerical Answers

Question 1: Sample B has higher resistance

	$n \text{ (cm}^{-3}\text{)}$	$p \text{ (cm}^{-3}\text{)}$	Type	Conductivity $(\Omega\text{m})^{-1}$	Resistivity (Ωm)
Sample A	10^{16}	2.25×10^4	N	192	5.21×10^{-3}
Sample B	2.25×10^4	10^{16}	P	64	1.56×10^{-2}

Question 2: Forward biased. $I = 2.07\text{mA}$, $V_1 = 9.73\text{V}$, $V_2 = 4.55\text{V}$, $V_o = -0.45\text{V}$

Question 3: Both diodes are forward biased. $I_1 = 28.18\text{mA}$, $I_{D1} = I_{D2} = 14.09\text{mA}$

Question 4: Both diodes are forward biased. $I_1 = 3.32\text{mA}$, $I_2 = 3.11\text{mA}$, $I_3 = 0.212\text{mA}$

Question 5: D_1 is forward biased, D_2 is reverse biased; $V_o = 9.3\text{V}$, $I_{D1} = 9.3\text{mA}$, $I_{D2} = 0\text{mA}$

Question 6: Source: Reverse biased, Drain: Forward biased. Current will thus flow between drain and body, and the MOSFET no longer operates normally as a MOSFET.