

Assignment 3 - Solutions.

①(a) Determine the thermal voltage (V_T) at 25°C .

$$T_K = T_C + 273 = 25 + 273 = 298\text{K}$$

$$V_T = \frac{kT}{q} \quad (k = 1.38 \times 10^{-23} \text{ J/K}, q = 1.6 \times 10^{-19} \text{ C})$$

$$V_T = \frac{(1.38 \times 10^{-23} \text{ J/K})(298\text{K})}{(1.6 \times 10^{-19} \text{ C})} \approx 25.69 \text{ mV} //$$

(b). I_D ?

$$I_S = 40 \text{ nA}, n = 2, V_D = 0.5 \text{ V}, V_T = 25.69 \text{ mV}$$

$$I_D = I_S (e^{V_D/nV_T} - 1)$$

$$I_D = 40 \text{ nA} (e^{0.5/(2 \times 25.69)} - 1) = 40 \text{ nA} (e^{9.73} - 1) \approx 40 \text{ nA} (16813)$$

$$I_D = 0.673 \text{ mA} //$$

②(a). $E = 30 \text{ V}$

$$R = 1.5 \text{ k}\Omega$$

$$V_D = 0.7 \text{ V}$$

$$V_R = E - V_D$$

$$V_R = 30 \text{ V} - 0.7 \text{ V}$$

$$V_R = 29.3 \text{ V}$$

$$I_D = \frac{V_R}{R} = \frac{29.3 \text{ V}}{1.5 \text{ k}\Omega}$$

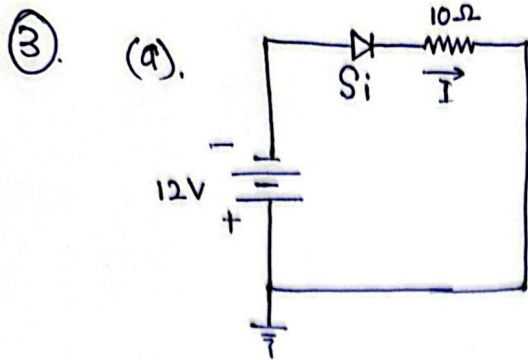
$$I_D = 19.53 \text{ mA} //$$

(b). $V_D = 0 \text{ V}$

$$V_R = E = 30 \text{ V}$$

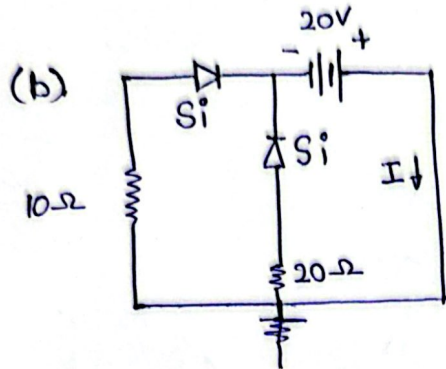
$$I_D = \frac{30 \text{ V}}{1.5 \text{ k}\Omega} = 20 \text{ mA} //$$

(c). Yes, the ideal model is a good approximation here because the source voltage (30V) is much larger than the diode drop (0.7V), leading to only a 2.35% difference in current.



In here positive terminal of 12V source connected to n-side, so the diode is reversed biased.

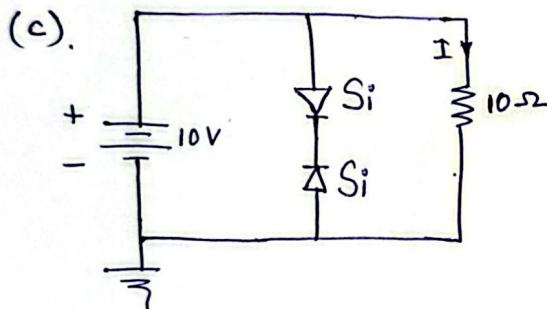
$$\therefore I = 0A //$$



Both diodes are forward-biased, the 20V source is the primary driver.

the path through the Si diode to the right has a total voltage of $20V - 0.7V = 19.3V$

$$I = \frac{19.3V}{20\Omega} = 0.965A //$$



Top diode is reverse biased,

$$I = \frac{10V}{10\Omega} = 1A //$$

④ (a). The Si diode and GaAs diode are parallel. The Si diode will turn on first and 'Clamp' the voltage, preventing the GaAs diode from conducting.

$$V_0 = 1V - 0.7V = 0.3V$$

$$I = \frac{V_0}{R} = \frac{0.3V}{1k\Omega} = 0.3mA$$

④ (b). Total diode drop = $0.7V + 0.7V = 1.4V$.

Total voltage across the circuit = $16V - (-4V) = 20V$.

$$V_0 = 16V - 1.4V = 14.6V$$

$$I = \frac{V_0 - (-4V)}{4.7k\Omega} = \frac{14.6V + 4V}{4.7k\Omega} = \frac{18.6V}{4.7k\Omega} = 3.96mA //$$