I_{S_1}

I_{D_2}

I_{D_1}

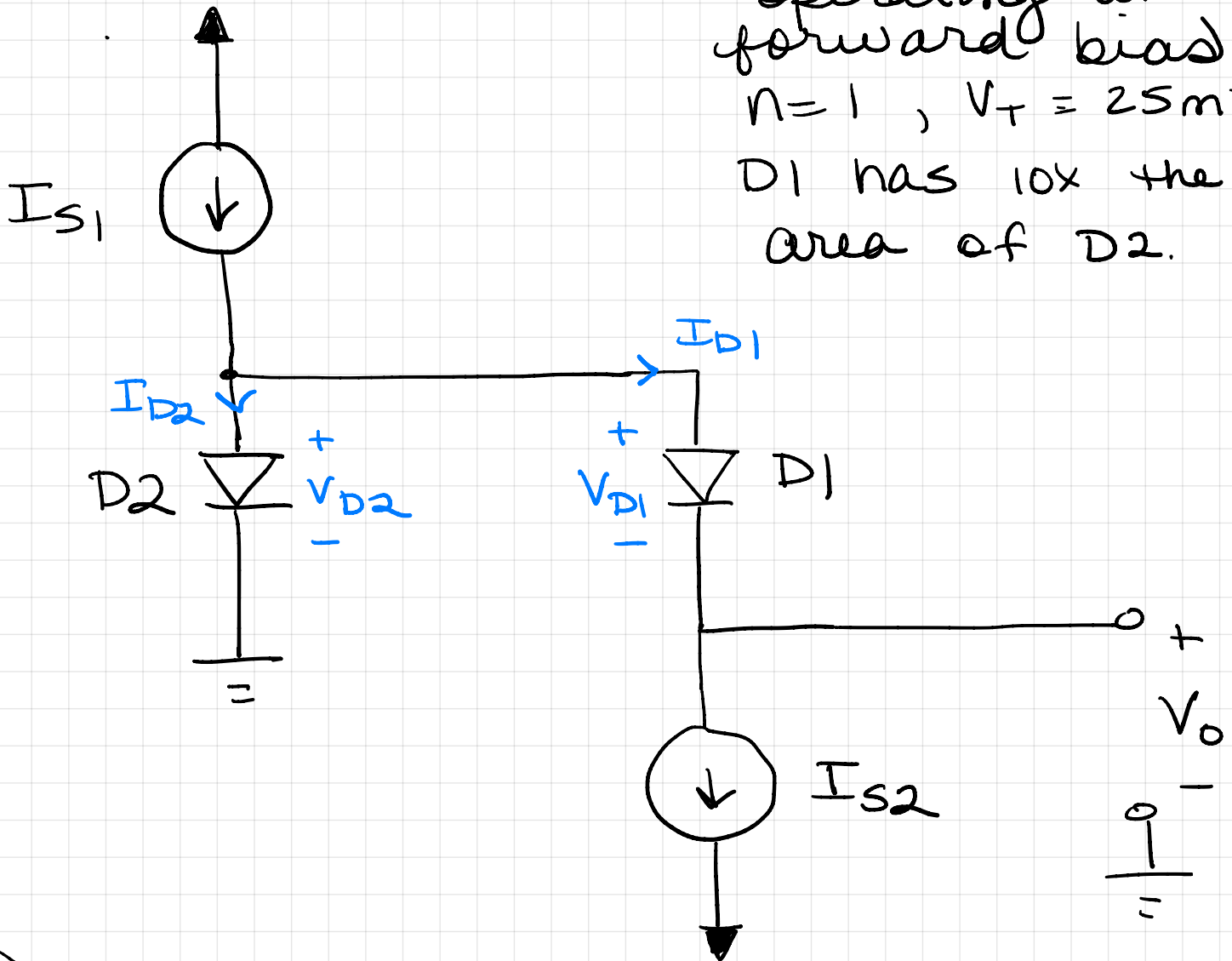D2 V_{D_2} + / −

V_{D_1} + / −   D1

I_{S_2}

V_o + / −

D1 & D2 are operating in forward bias

$n = 1$, $V_T = 25mV$

D1 has 10x the area of D2.

a) $I_{S_1} = 10mA$

$I_{S_2} = 2mA$

What is V_o?

$$I = I_S \exp\left(\frac{V}{V_T}\right)$$

↑ saturation or scale

$I_{D_1} = 2mA$

by KCL $I_{D_2} = 10 - I_{D_1}$

$I_{D_2} = 8mA$

$D_2 \rightarrow I_S$

$D_1 \rightarrow 10 I_S$

by KVL: $V_{D2} - V_{D1} - V_0 = 0$

$$V_0 = V_{D2} - V_{D1}$$

$$I_{D2} = I_S \exp\left(\frac{V_{D2}}{V_T}\right)$$

$$I_{D1} = 10 I_S \exp\left(\frac{V_{D1}}{V_T}\right)$$

$$\frac{I_{D1}}{I_{D2}} = \frac{10 I_S \exp(V_{D1}/V_T)}{I_S \exp(V_{D2}/V_T)}$$

2mA

8mA

$$\frac{2}{8} = 10 \exp\left(\frac{V_{D1} - V_{D2}}{V_T}\right)$$

$$\frac{2}{8} = 10 \exp\left(-V_0/V_T\right)$$

$$\exp\left(-\frac{V_0}{V_T}\right) = 0.025$$

$$V_0 = -(.025) \ln(.025) \overset{\alpha^{V_T}}{}$$

$$\boxed{V_0 = 92.22 \text{ mV}}$$

b) $V_0 = 50\text{mV}$, what must I_{s2} be changed to?

$$I_{D2} = I_{s1} - I_{s2}$$

$$I_{D1} = I_{s2}$$

$$\frac{I_{D2}}{I_{D1}} = \frac{I_{s1} - I_{s2}}{I_{s2}} = \frac{I_s \exp(^{V_{D2}}/_{V_T})}{10 I_s \exp(^{V_{D1}}/_{V_T})}$$

$$\frac{10 - I_{s2}}{I_{s2}} = \frac{1}{10} \exp\left(\frac{V_{D2} - V_{D1}}{V_T}\right)$$

$$V_0 = V_{D2} - V_{D1} = 50\text{mV}$$

$$\frac{10 - I_{s2}}{I_{s2}} = \frac{1}{10} \exp\left(\frac{50}{25}\right)$$

$$\frac{10 - I_{s2}}{I_{s2}} = 0.739$$

$$10 - I_{s2} = 0.739 \, I_{s2}$$

$$I_{s2} = 5.75 \, mA$$