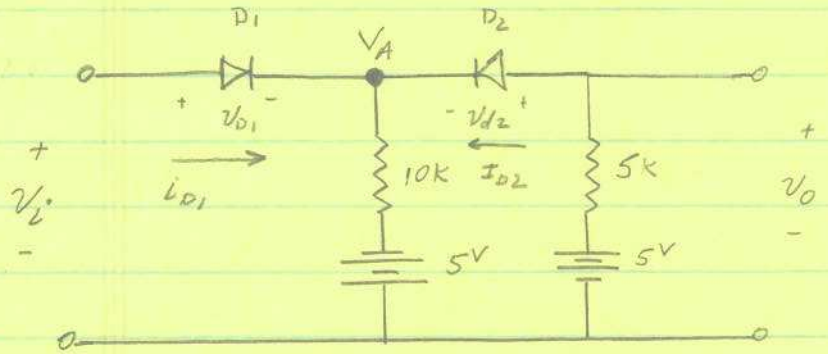
Multiple Diode Circuits

Consider the following



Assume $V_\gamma = 0.7^V$

FIND V_o for a) $V_I = 0^V$, b) $V_I = 4^V$

a) $V_I = 0^V$

Lets assume that D1 is off, D2 is ON

then KCL: $-5^V + i_{D2}\,5k + 0.7^V + i_{D2}\,10k - 5^V = 0$

$$i_{D2} = \frac{10^V - 0.7^V}{10k + 5k} = 0.62^{mA}$$

$$V_o = 5^V - (0.62^{mA})(5k) = 1.9^V$$

$$V_{D2} = V_o - V_A = 1.9 - (-5^V + 10(0.62)) =$$
$$= 1.9 - 1.2 = 0.7^V \quad (ON)$$

$$V_{D1} = -V_A = -1.2^V \quad (OFF)$$

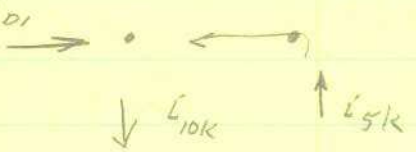
$\therefore$ Our Assumptions are correct!

Suppose we had assumed D_1 & D_2 were ON, then?

$V_A = V_I - V_\gamma = -0.7^V$

$V_0 = V_A + V_\gamma = 0^V$

$i_{5k} = \frac{5^V - 0^V}{5k} = 1^{mA}$



$i_{10k} = \frac{-0.7^V - (-5^V)}{10k} = 0.43^{mA}$

$i_{D1} = i_{10k} - i_{5k} = 0.43^{mA} - 1^{mA} = -0.57^{mA}$

We know that this can not be, since reverse current does not flow through a forward biased diode.

Suppose we had assumed D1 & D2 OFF?

$V_0 = 5^V$

$V_a = -5^V$

$V_{d_1} = V_I - V_a = 0 - (-5^V) = 5^V$ Fwd bias

$V_{d_2} = V_0 - V_a = 5^V - (-5^V) = 10^V$ Fwd bias

Suppose we had D1 ON & D2 OFF?

$V_a = -0.7$

$V_0 = 5^V$

$V_{d_2} = 5 - (-0.7) = 5.7^V$ Fwd bias

6) $V_I = 4^V$

Assume D1 & D2 are ON.

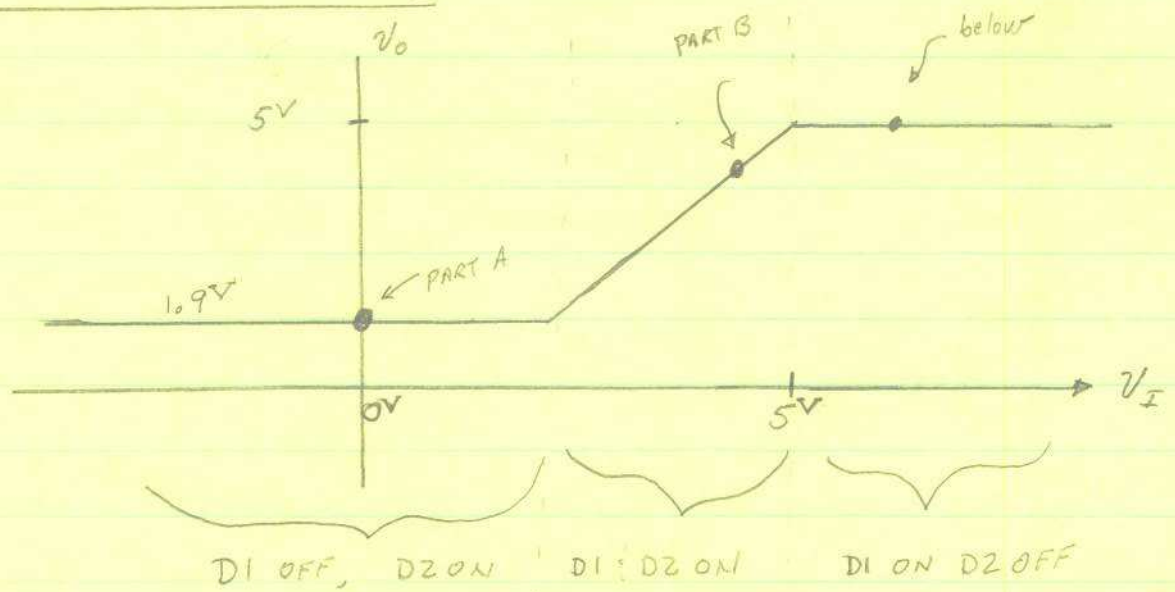
Then $V_o = V_I - 0.7^V + 0.7^V = V_I = 4^V$

$$i_{5k} = i_{D2} = \frac{5^V - 4^V}{5k} = 0.2^{mA} \uparrow up$$

$$i_{10k} = \frac{V_A - (-5^V)}{10k} = \frac{(4 - 0.7)(+5)}{10k} = \frac{3.3+5}{10k} = 0.83^{mA} \downarrow$$

$$i_{D1} = i_{10k} - i_{5k} = 0.83 - 0.2 = \underline{0.63^{mA}}$$

c) SKETCH V_o vs. V_I



Let $V_I = 5.1^V$, D1 ON, D2 OFF

$V_a = V_I - 0.7^V = 4.4^V$

$V_{d2} = V_o - V_a = 5.0 - 4.4 = 0.6^V$ (OFF)