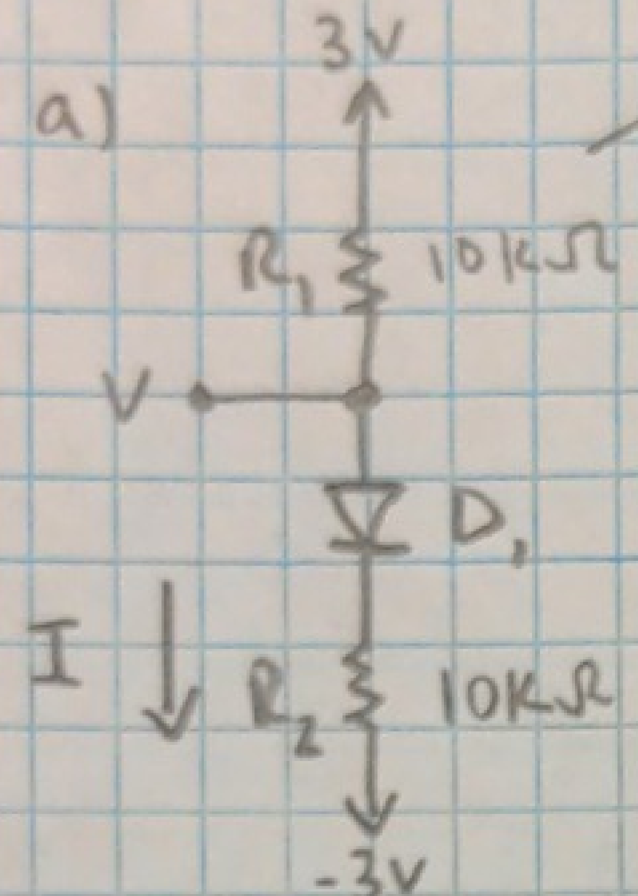
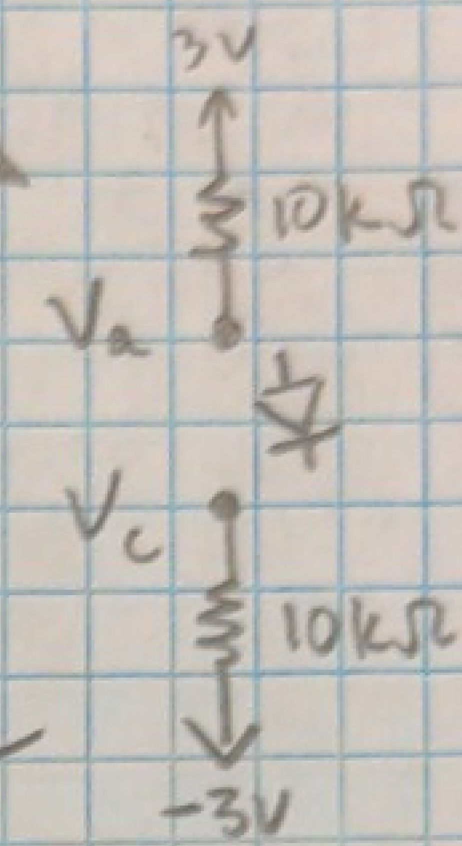
Chris Hunt HW1 ECE322

1. Assuming the diodes are ideal, calculate I, V in the following circuits.

a)



→ Assume Diode is off:



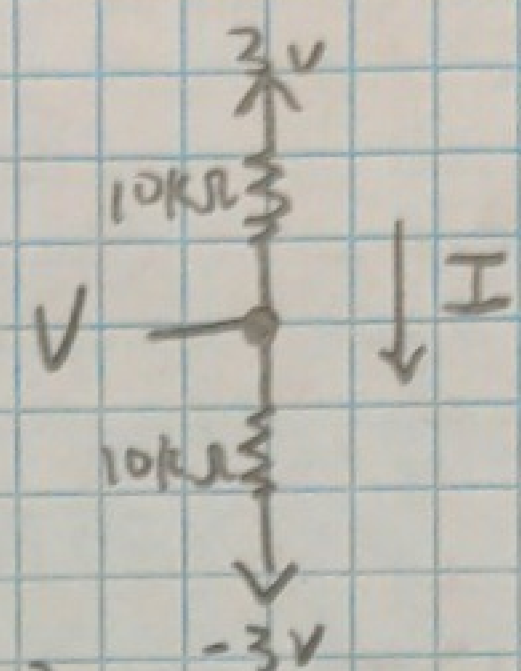
$V_a = 3V$

$V_c = -3V$

$V_a > V_c$

↓

Diode is on



$$I = \frac{3V-(-3V)}{10k\Omega + 10k\Omega}$$

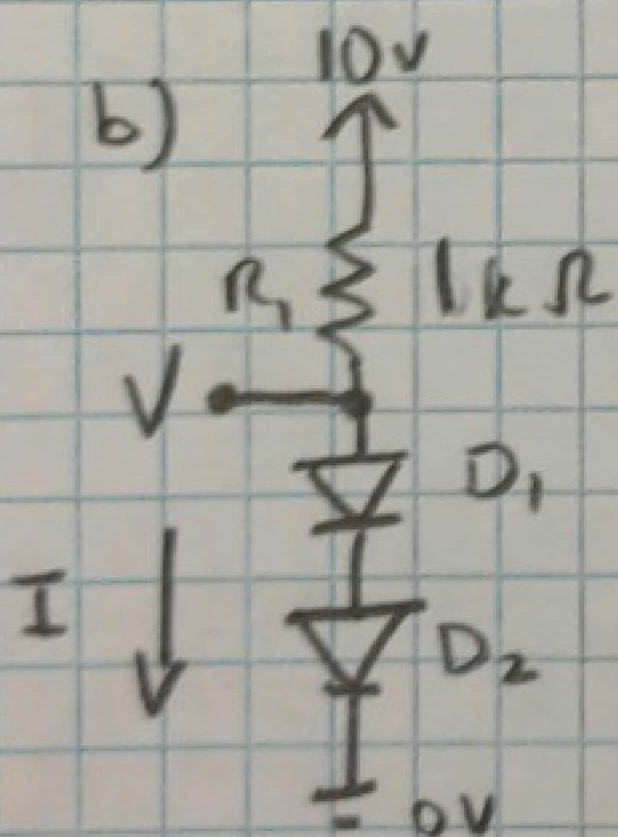
$$I = \frac{6V}{20k\Omega}$$

$$V = 3V - IR_1$$

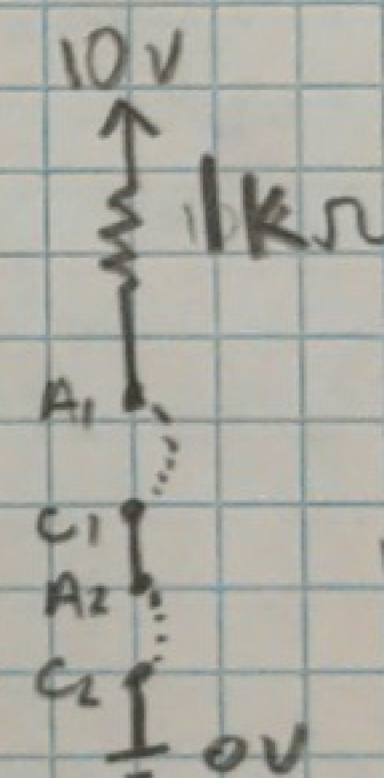
$$V = 3V - (.3mA)(10k\Omega)$$

a: $\boxed{I = .3\,mA \qquad V = 0V}$

b)



→ Assume Diodes are off:



$V_{a_1} = 10V$

$V_{c_1} = 0V$

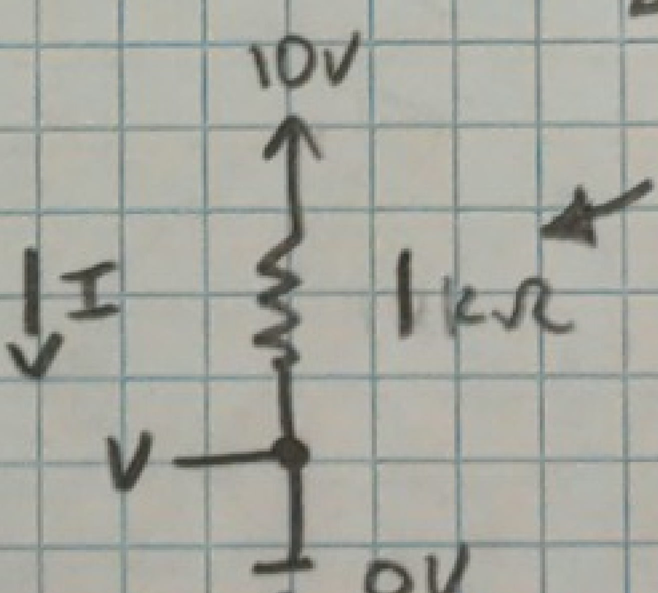
$V_{a_1} > V_{c_1}$

D_1 is on

$V_{a2} = 10V$ $V_{c2} = 0V$

$V_{a2} > V_{c2}$

D_2 is on



$V = 0V$

$$I = \frac{10V - 0V}{1k\Omega}$$

b: $\boxed{V = 0V \qquad I = 10mA}$

→

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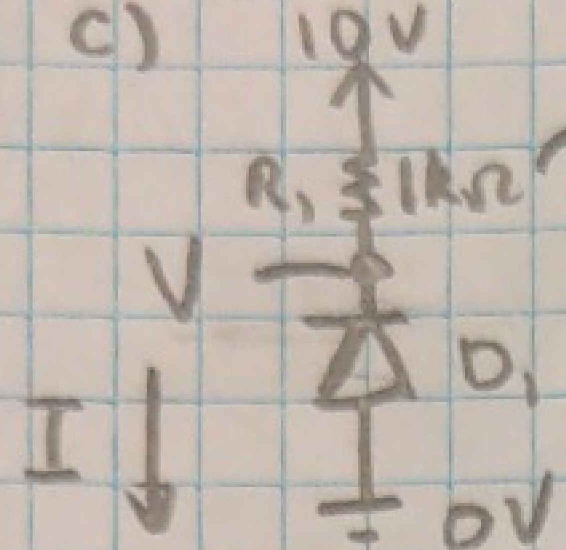
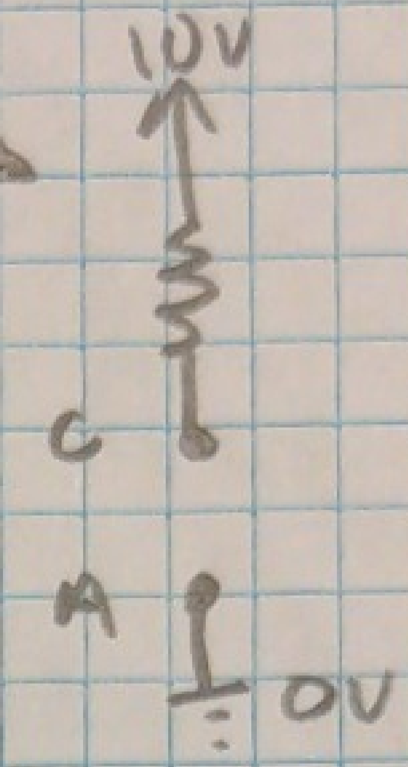
1. c)



Assume Diode is off:

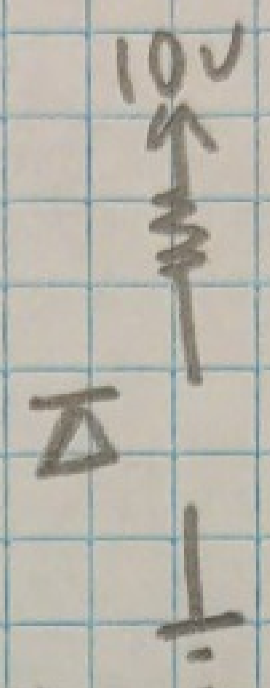


$V_a = 0V$

$V_c = 10V$

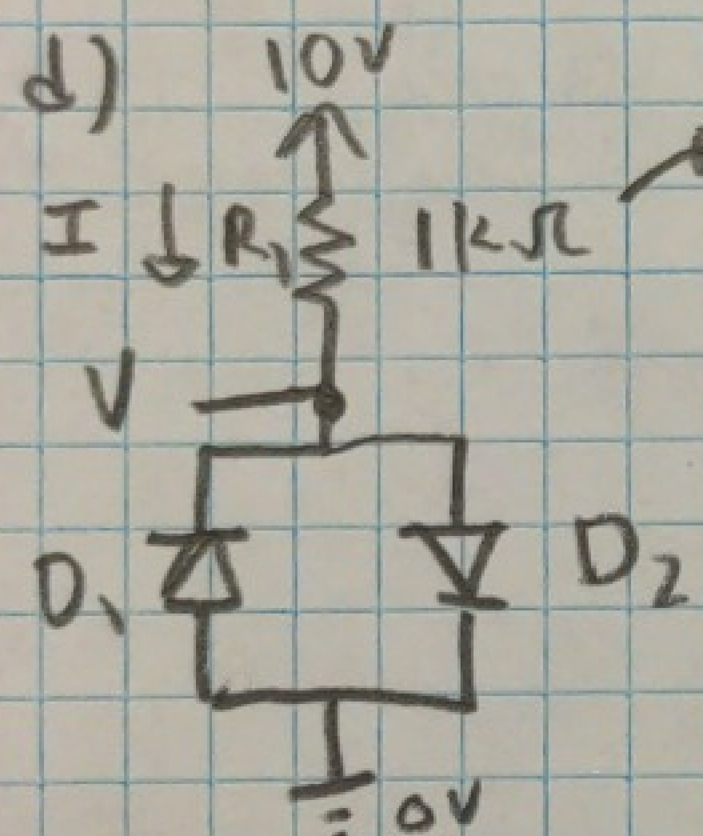
$V_c > V_a$

Diode is off

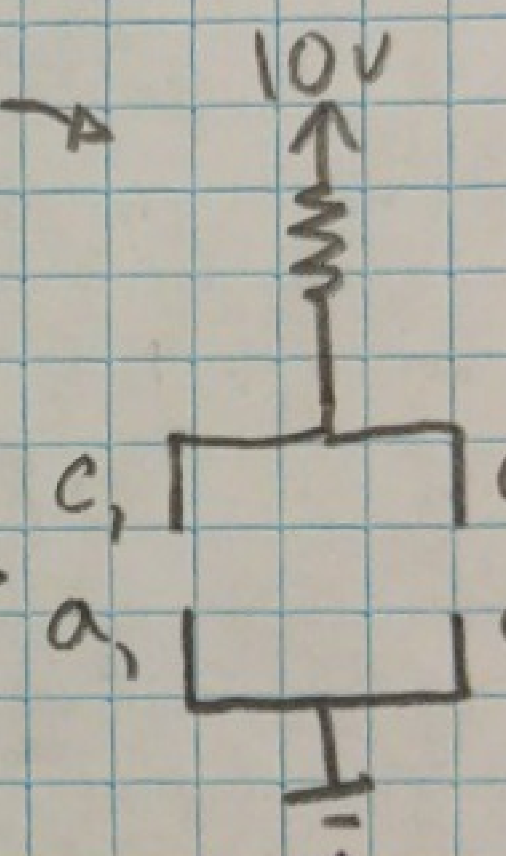


c: $\boxed{V = 10V \quad I = 0A}$

d)



Assume Diodes are off:

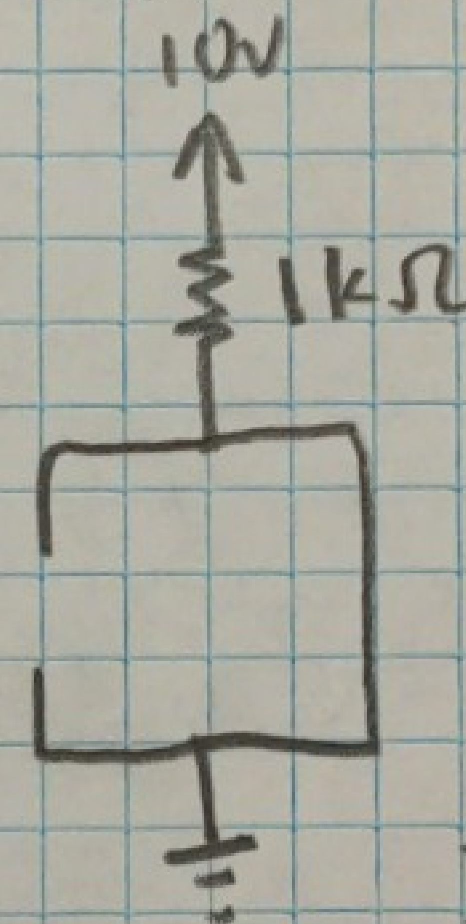


$V_{c_1} = 10V = V_{a_2}$

$V_{a_1} = 0V = V_{c2}$

D_1 is off

D_2 is on



$I = \frac{10V - 0V}{1k\Omega}$

d: $\boxed{V = 0V \quad I = 10mA}$

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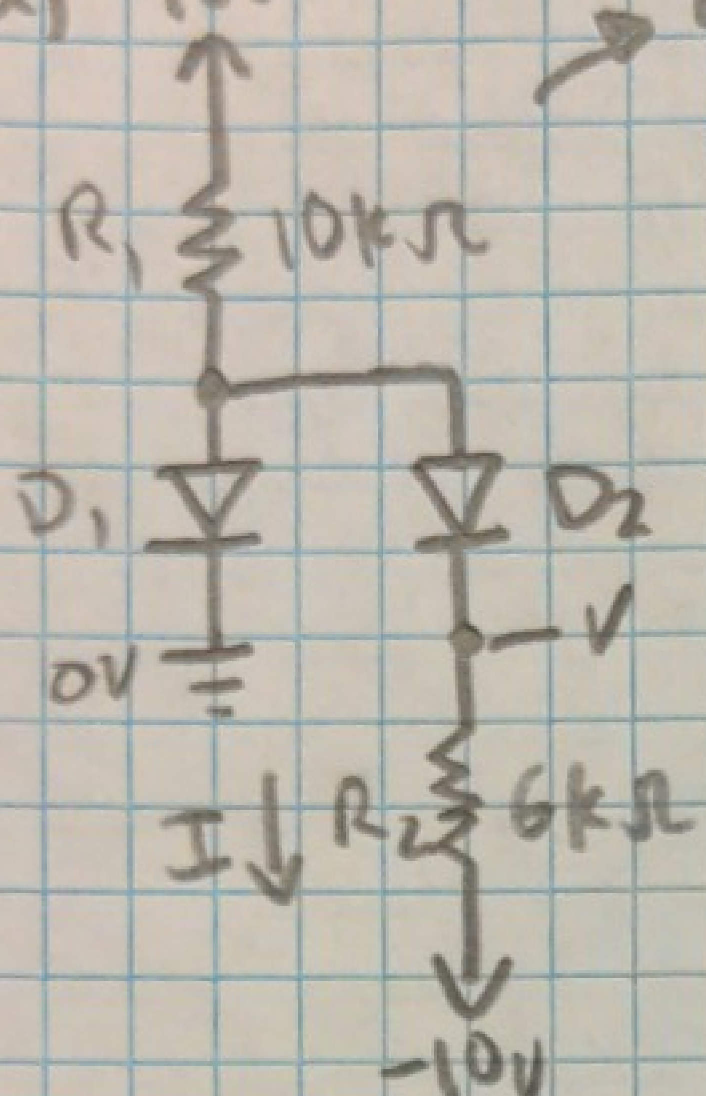
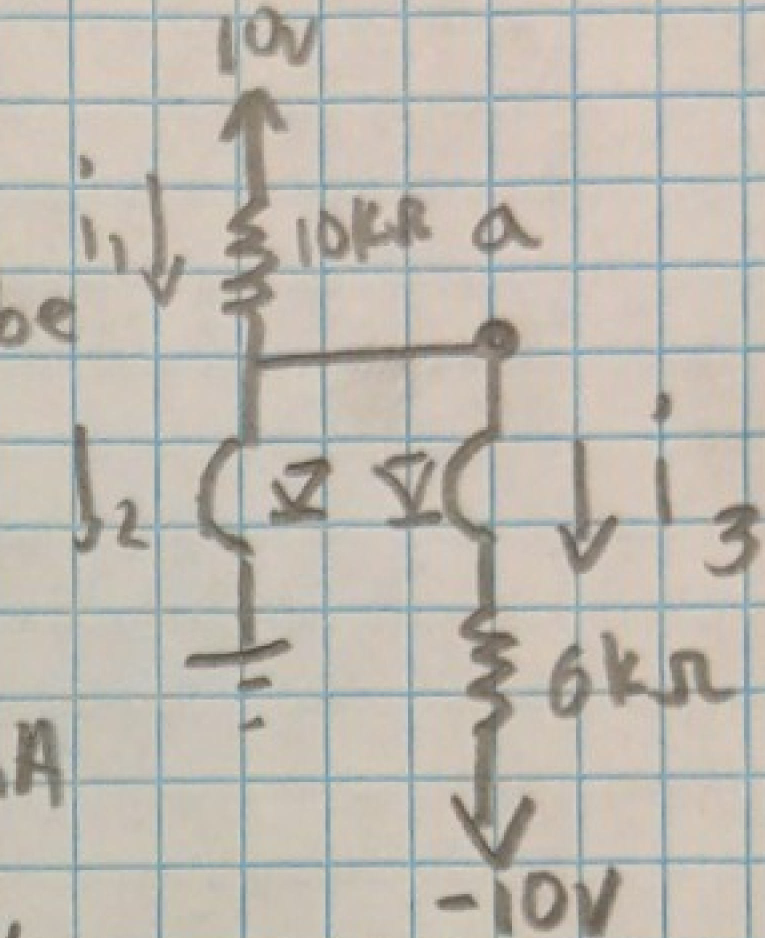
2. Assuming the diodes are ideal, calculate I,V in the following circuits

a)



→ Assume Diodes are on: →



V_a would have to be 0V

$i_1 = \frac{10V - 0V}{10k\Omega} = 1mA$

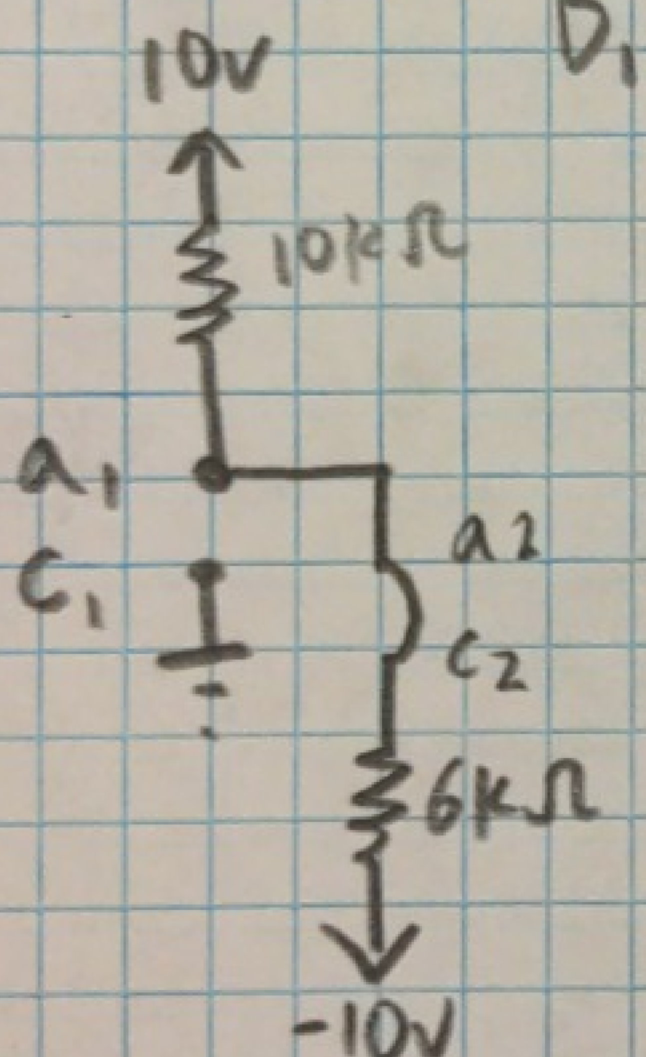
$i_3 = \frac{0V - (-10V)}{6k\Omega} = 1.66mA$

KCL @ a): $i_1 = i_2 + i_3$

$i_2 = i_1 - i_3 \to i_2 = 1mA - 1.66mA$

$i_2 = -.66\ mA$ not possible

D_1 off, D_2 on?



$V_{a_1} = 10V - IR_1$

$V_{a_1} = -2.5V$

$V_{a_1} < V_{c_1}$

Diode is still off

$I = \frac{10V - (-10V)}{16k\Omega} = 1.25mA$

This works!

$$\boxed{\begin{aligned} V &= -2.5V \\ I &= 1.25mA \end{aligned}}$$

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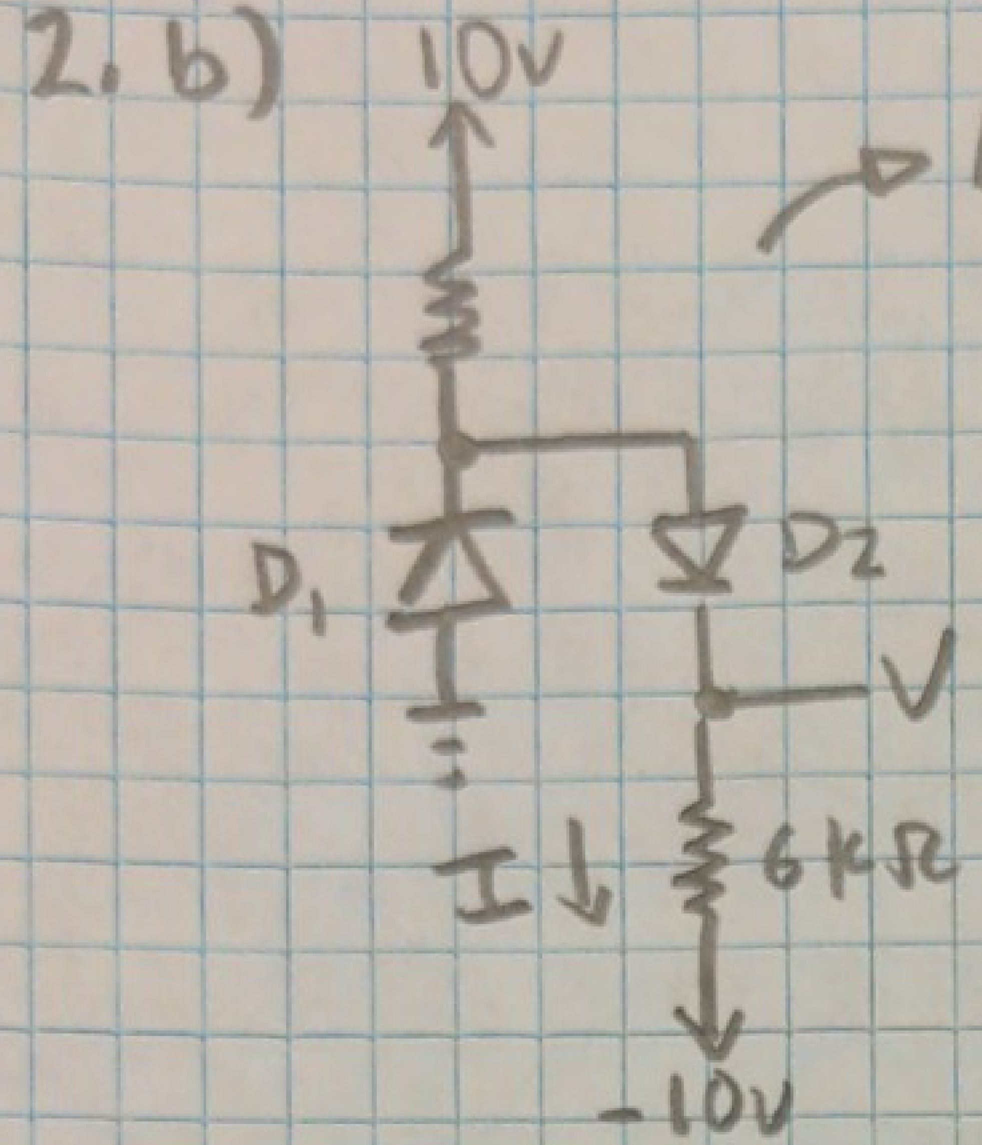
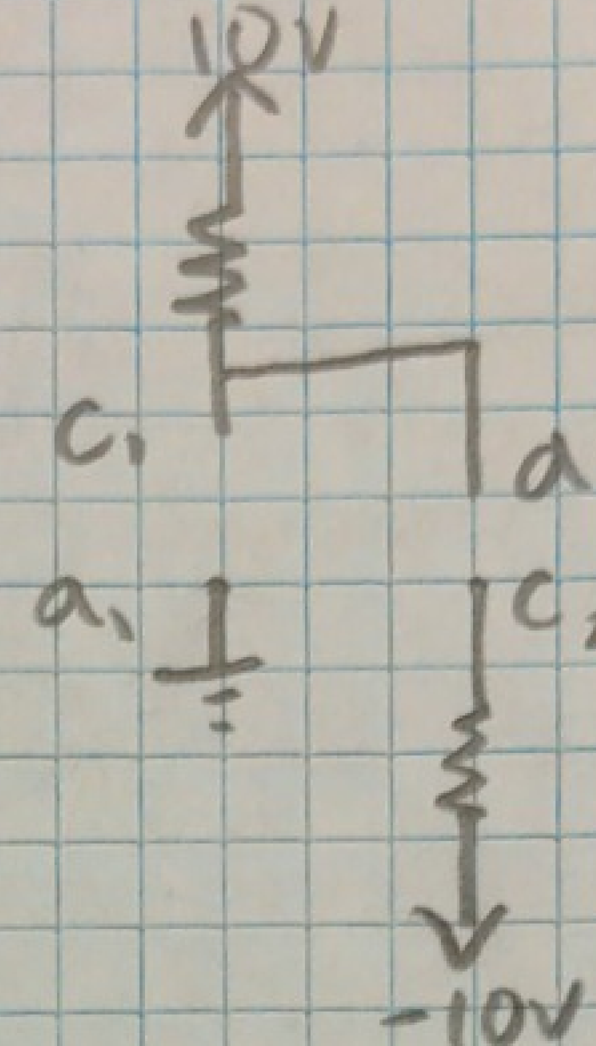
2. b)



Assume diodes are off :)



$V_{c_1} = V_{a_2} = 10V$

$V_{a_1} = 0V$

$V_{c_2} = -10V$

$D_1)$ $V_{a_1} < V_{c_1}$

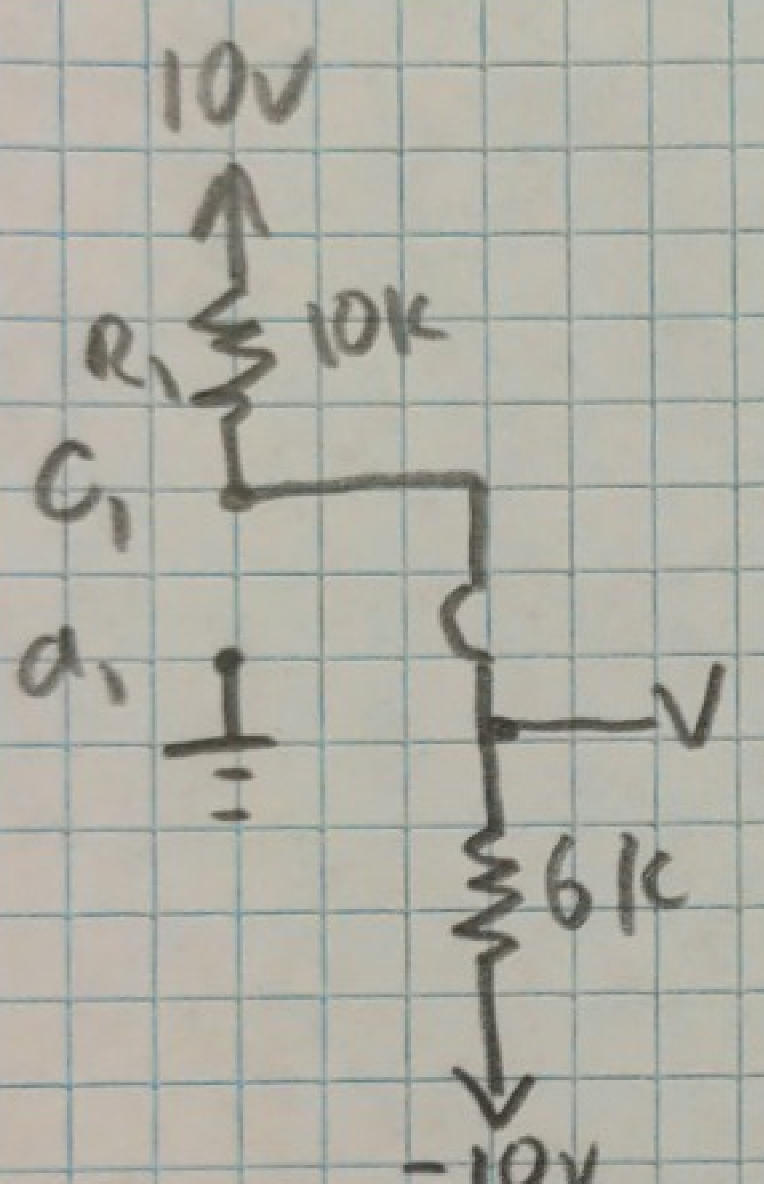
D_1 is off

$D_2)$ $V_{a_2} > V_{c_2}$

D_2 is on

$$I = \frac{(10V - (-10V))}{16k\Omega} = 1.25\,mA$$

Test it



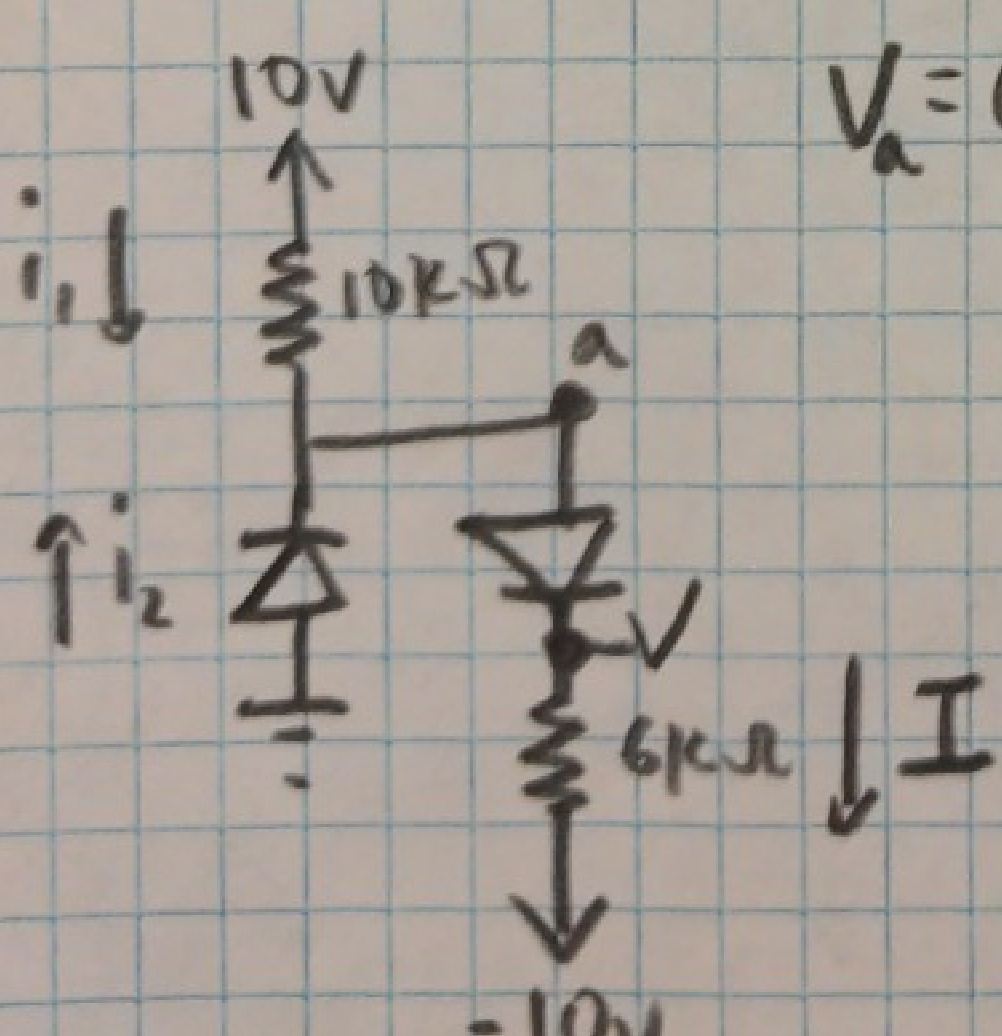
$V_{c_1} = 10V - IR_1$

$V_{c_1} = -2.5V$

$V_{a_1} = 0V$

$V_{a_1} > V_{c_1}$

D_1 is on



$V_a = 0V = V$

KCL@ a) $I = i_1 + i_2$

$$I = \frac{0 - (-10V)}{6k\Omega} = 1.67\,mA$$

$$i_1 = \frac{10V}{10k\Omega} = 1\,mA$$

$1.67mA = 1mA + i_2$

$i_2 = .67mA$

$$\boxed{\begin{array}{c} V = 0 \\ I = 1.67mA \end{array}}$$

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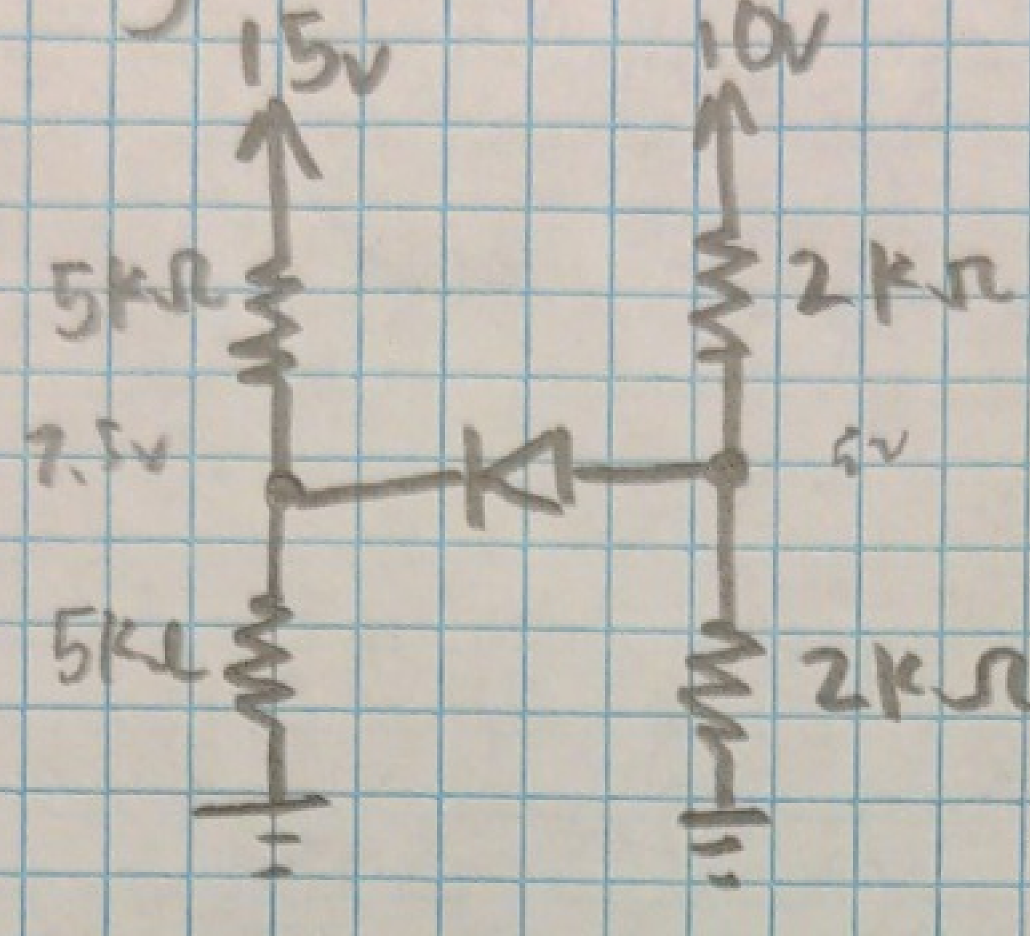
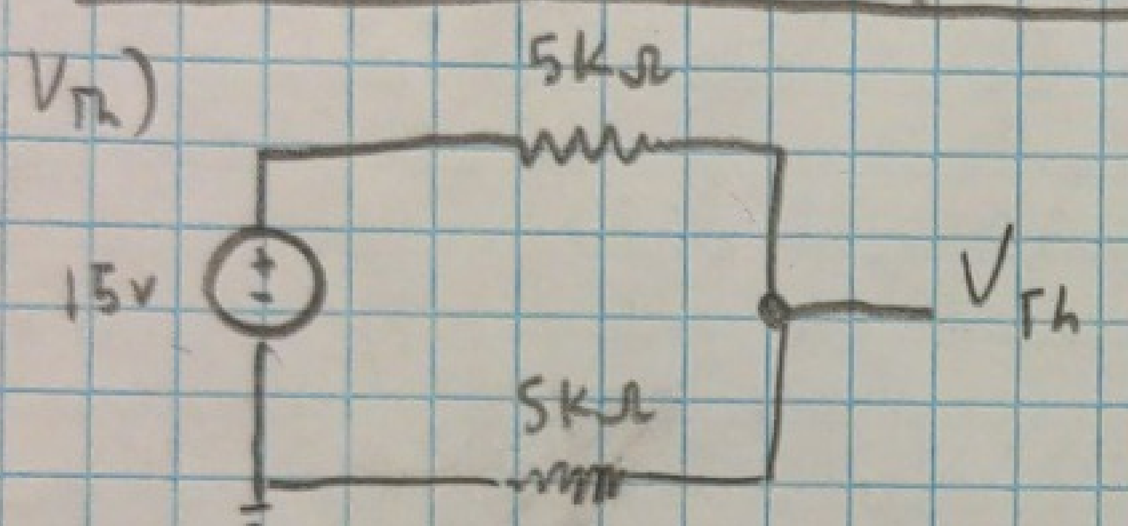
3. Assuming the diodes are ideal, use thevenin's theorem to simplify the circuit and find V, I



Left side Thevenin Equivalent:

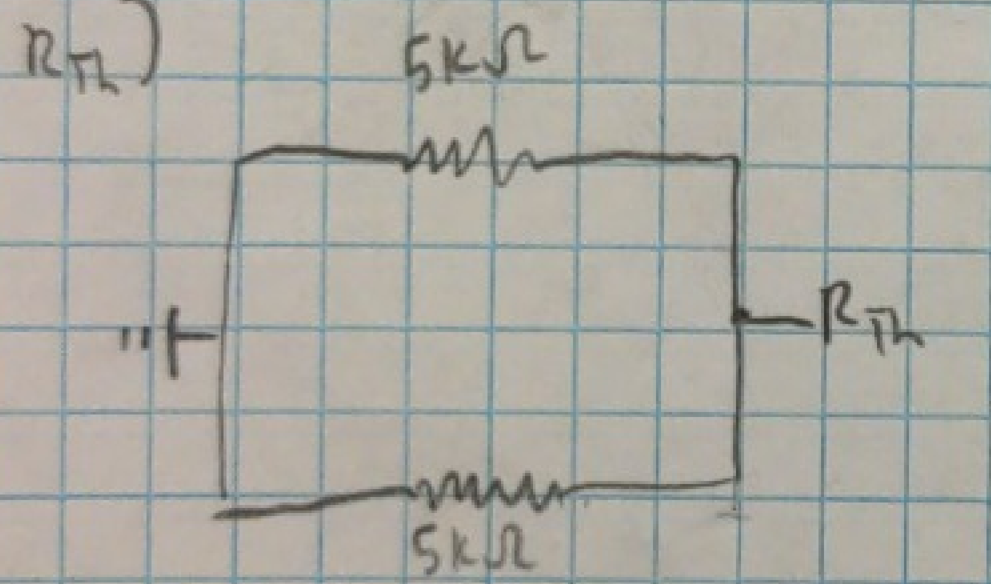
V_{Th})



$V_{Th} = 15v\left(\frac{5k}{10k}\Omega\right)$

$V_{Th} = 7.5v$

R_{Th})

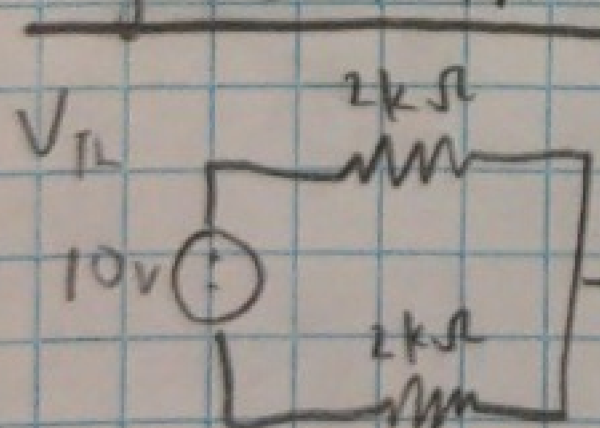


$R_{Th} = 5k\Omega \,||\, 5k\Omega$

$R_{Th} = 2.5k\Omega$

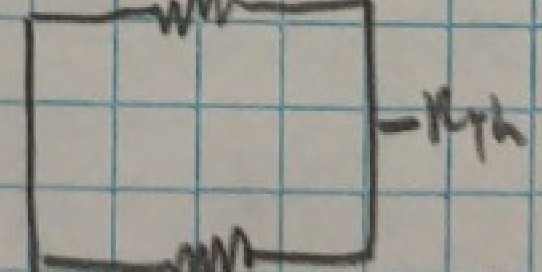
Right side Thevenin Equivalent:

V_{Th}



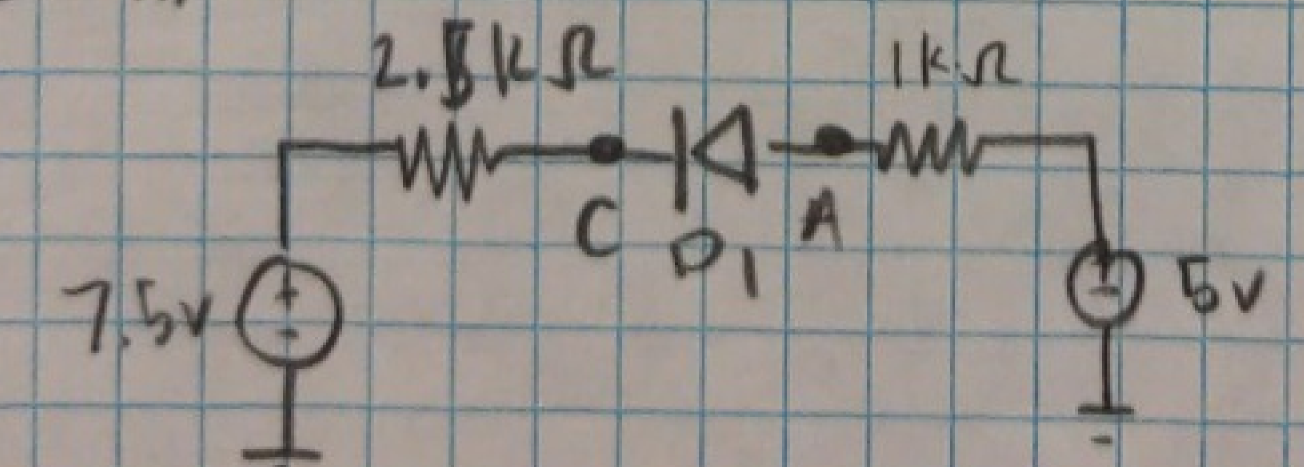
$V_{Th} = 10v\left(\frac{2k\Omega}{4k\Omega}\right)$

$V_{Th} = 5v$



$R_{Th} = 2k\Omega \,||\, 2k\Omega$

$R_{Th} = 1k\Omega$



Assume D_1 is off:

$V_c = 7.5v \quad V_a = 5v$

$V_a < V_c$

D_1 is off

no current

$$\boxed{\begin{array}{l} V = 5v - 7.5v = -2.5v \\ I = 0\,A \end{array}}$$

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4. A diode is conducting in forward bias region with a current of 1 mA and $V_d = 0.7v$. If the current is changed to 10 mA, what is V_d?

$V_{th} = 25mV$ $I_d = I_s(e^{V_d/\eta V_{th}} - 1)$

First Find I_s)

$$1mA = I_s(e^{0.7/.025} - 1) \rightarrow I_s = \frac{0.001}{e^{0.7/.025} - 1}$$

$$I_s = 6.91 \times 10^{-16}$$

Find V_d)

$I = 10mA$ $I_s = 6.91 \times 10^{-16}$ $V_{th} = 25mV$

$$I = I_s(e^{V_d/\eta V_{th}} - 1)$$

$$\frac{I}{I_s} + 1 = e^{V_d/\eta V_{th}}$$

$$\ln\left(\frac{I}{I_s} + 1\right) = \frac{V_d}{\eta V_{Th}}$$

$$\eta V_{th} \ln\left(\frac{I}{I_s} + 1\right) = V_d$$

$$V_d = 0.025 \ln\left(\frac{0.01}{6.91 \times 10^{-16}} + 1\right)$$

$$\boxed{V_d = 0.757v}$$

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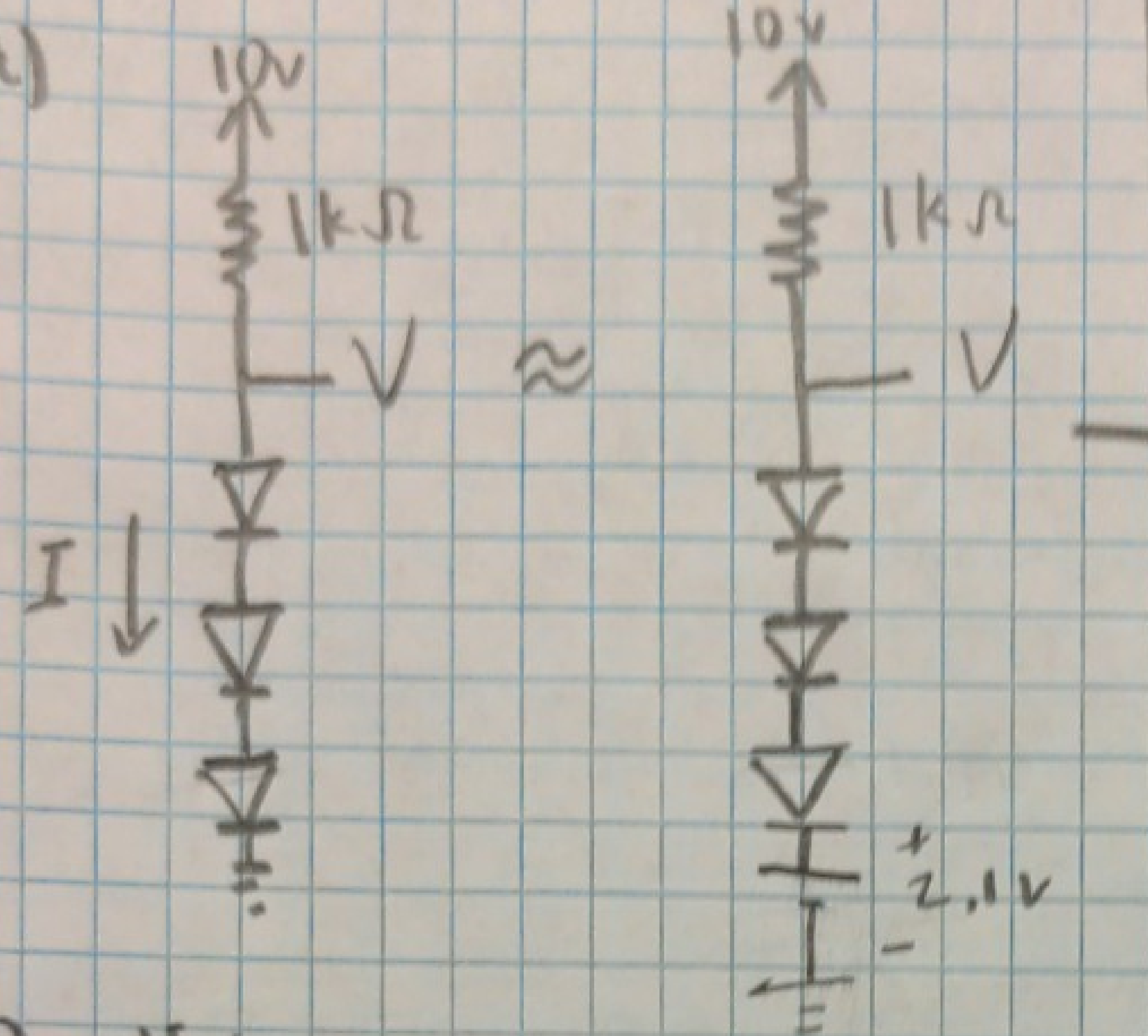
5. Assuming the constant voltage drop model ($V_D = 0.7V$) Calculate V, I

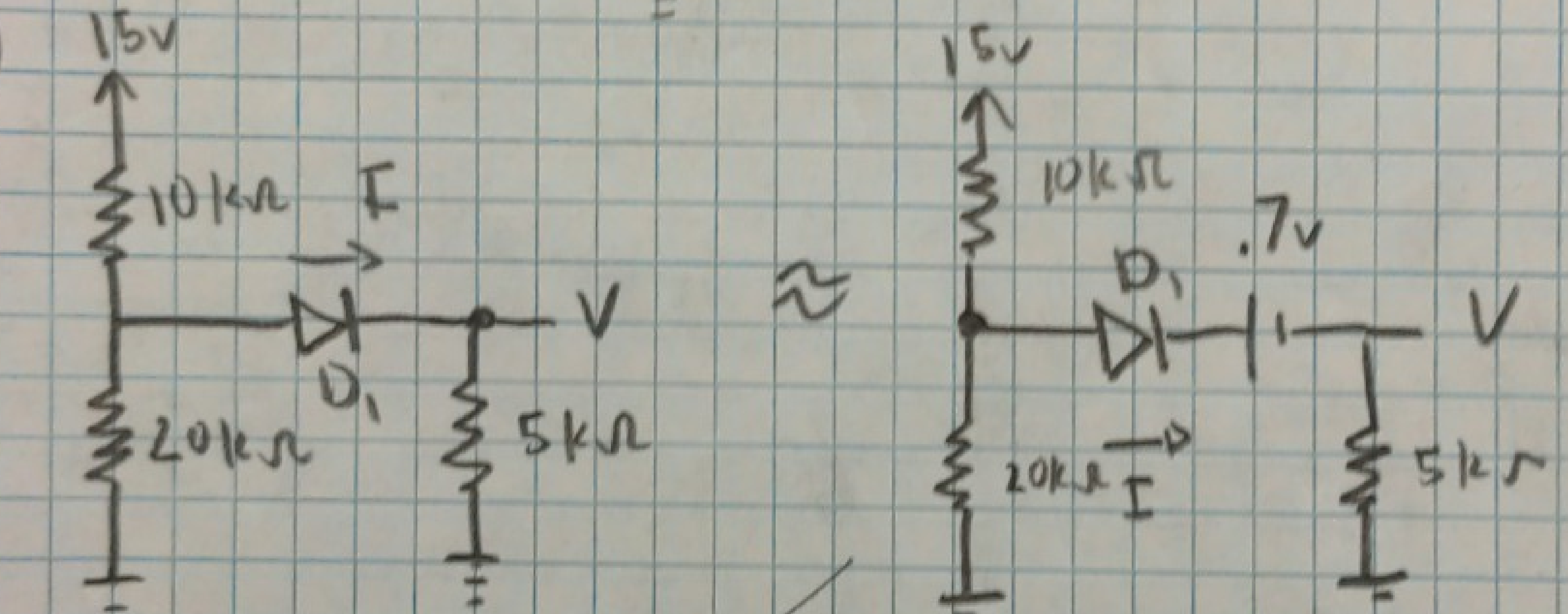
a)

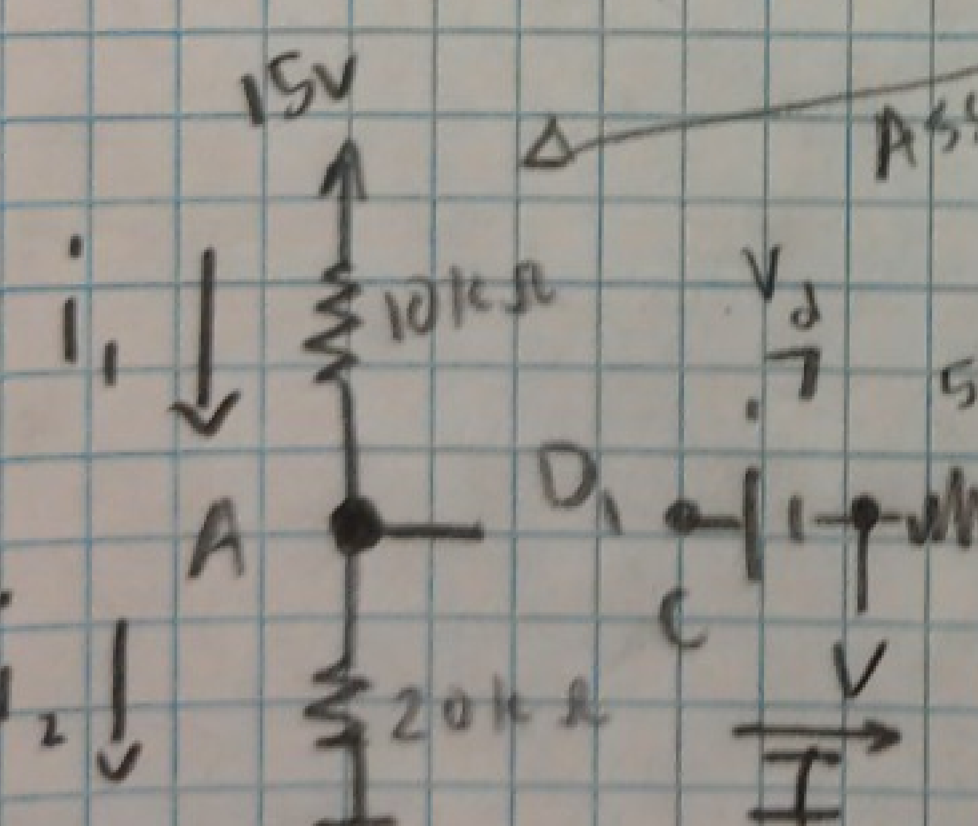


$V = 2.1V$

$I = \frac{10V - 2.1V}{1k\Omega} = 7.9mA$

b)





Assume off

$V_a = 15V\left(\frac{20k\Omega}{30k\Omega}\right) = 10V$

$V_c = 0.7V \quad V_a > V_c \quad D_1$ is on

KCL @ A) $i_1 = i_2 + I$

$$\left(\frac{15V - V_A}{10k\Omega} = \frac{V_A}{20k\Omega} + \frac{V_A - 0.7V}{5k\Omega}\right) 20k\Omega$$

$30V - 2V_a = V_a + 4V_a - 2.8V$

$7V_a = 32.8V$

$V_a = 4.69V$

$V = V_a - 0.7V$

$V = 3.98V$

$I = \frac{3.98V}{5k\Omega} = 0.797mA$

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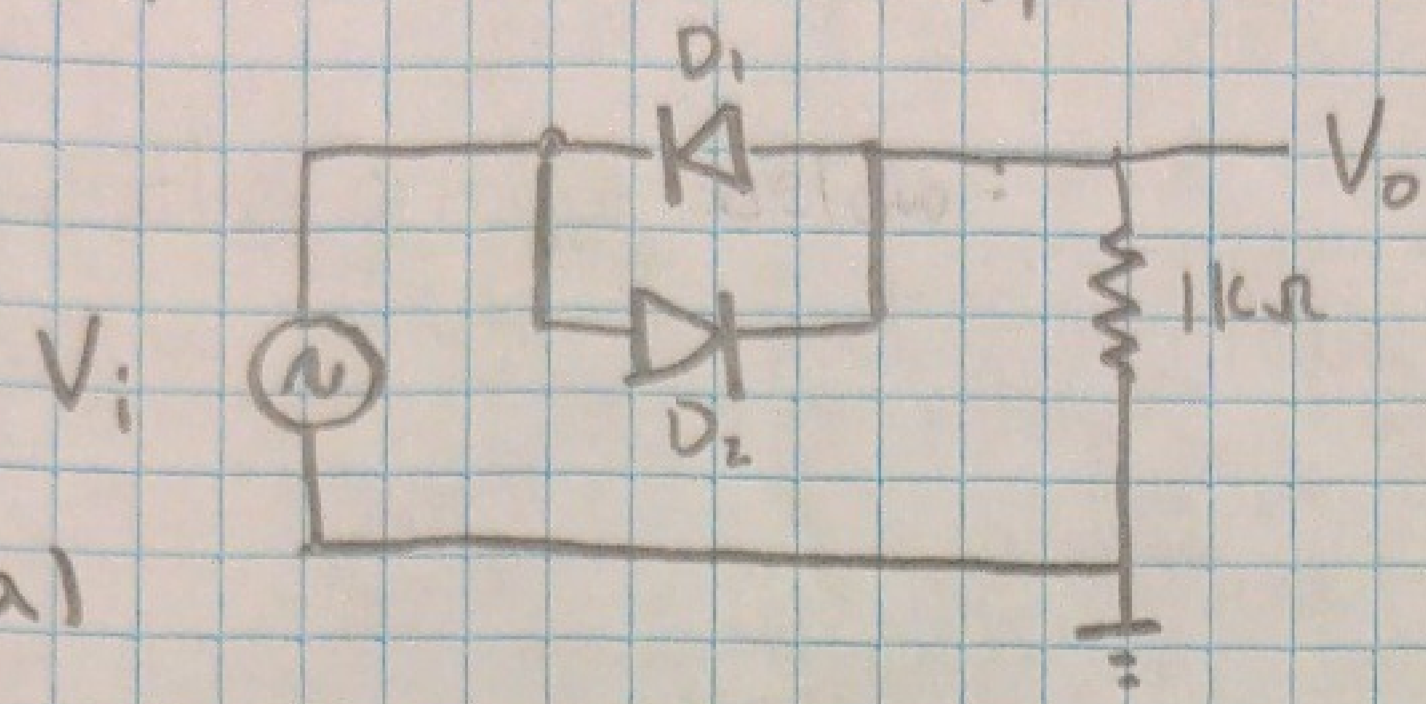
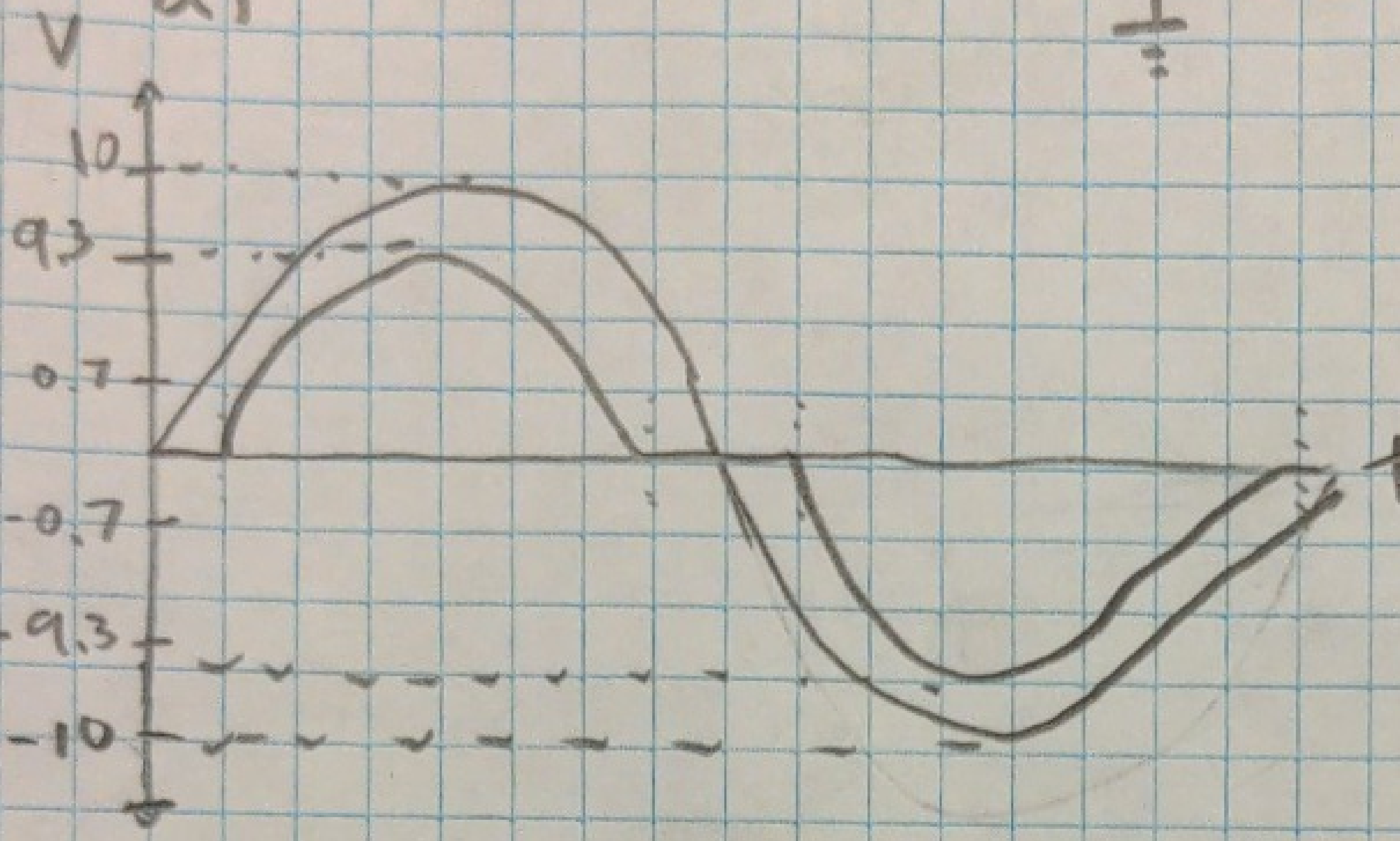
6.



Assume $V_D = 0.7V$

$V_i = 10\sin(\omega t)$

a)



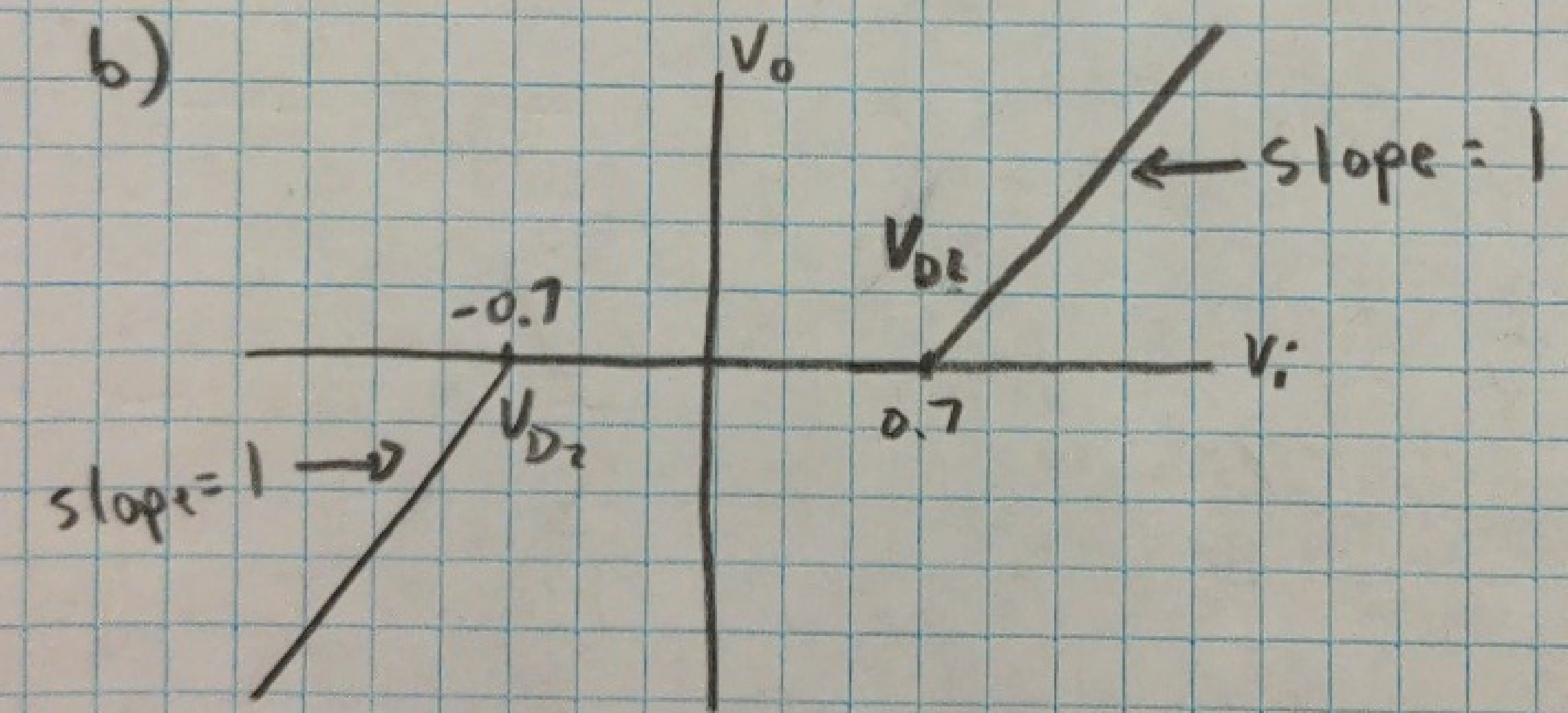
There are 3 distinct regions of V_i that determine V_o.

I: $V_i > 0.7$ — D_1 OFF, D_2 ON

II: $V_i < -0.7$ — D_1 ON, D_2 OFF

III: $-0.7 < V_i < 0.7$ — D_1 OFF, D_2 OFF

b)



c) What is the average value of V_o?

The waveform retains the symmetry of V_i.

The average value of V_o is therefore 0.