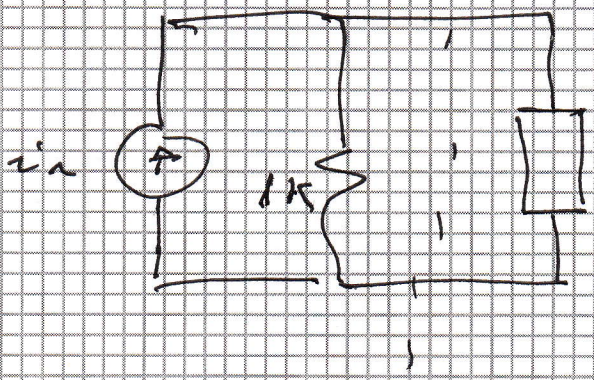
2.6

$i = \sqrt{v-2}$ mA



$v = 0 \longrightarrow i = i_n$

$i = 0 \longrightarrow v = v_n$ (V)

i_1 (mA)

Load Line

Q

Characteristic Curve

$i_n = 74$ mA

10 20 30 40 50 60 70 80

10 20 30 40 50 60 70

2.28

i (mA)	V (volts)	
0.1	0.713	$\Delta V = 0.085$ V
1.0	0.798	
10	0.909	← This should be 0.883 to be consistent. (Text error)

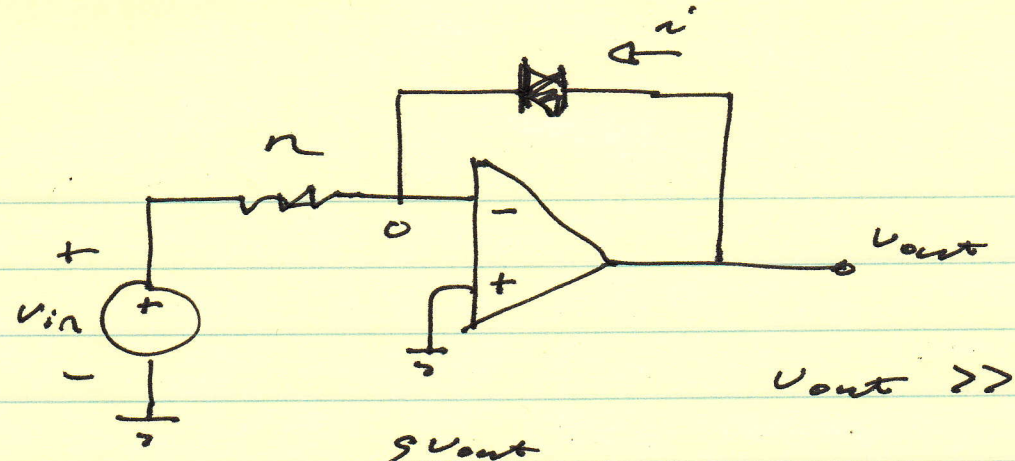
$$\Delta V = 2.3\, n \left(\frac{kT}{q}\right)$$

$$n = \frac{85\ \text{mV}}{2.3 \times 25.9\ \text{mV}} = 1.43$$

$$1\ \text{mA} \cong I_s \exp\left(\frac{798\ \text{mV}}{1.43 \times 25.9\ \text{mV}}\right)$$

$$\longrightarrow \quad I_s = 4.39 \times 10^{-13}\ \text{A}$$

2.44

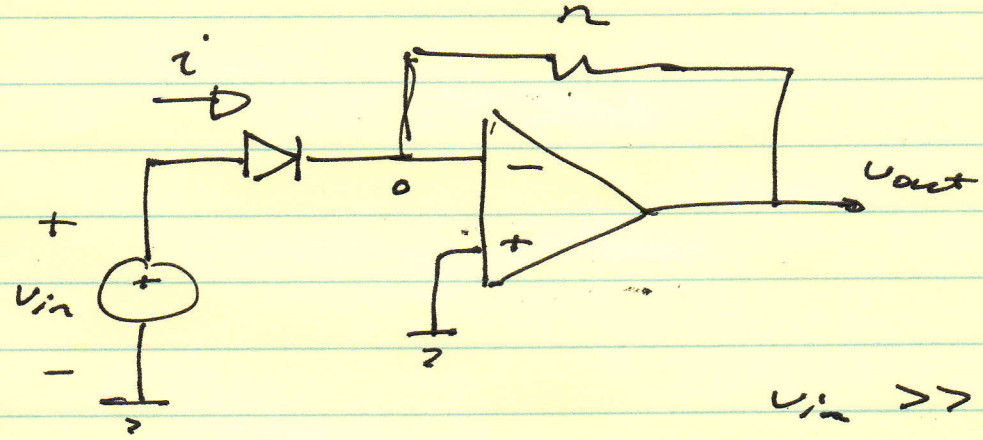


$v_{out} >> \frac{kT}{q}$

$$i \approx I_s e^{\frac{q v_{out}}{kT}} = \frac{-v_{in}}{R}$$

$$v_{out} = \frac{kT}{q} \ln\left(\frac{-v_{in}}{I_s R}\right) \qquad v_{in} < 0$$

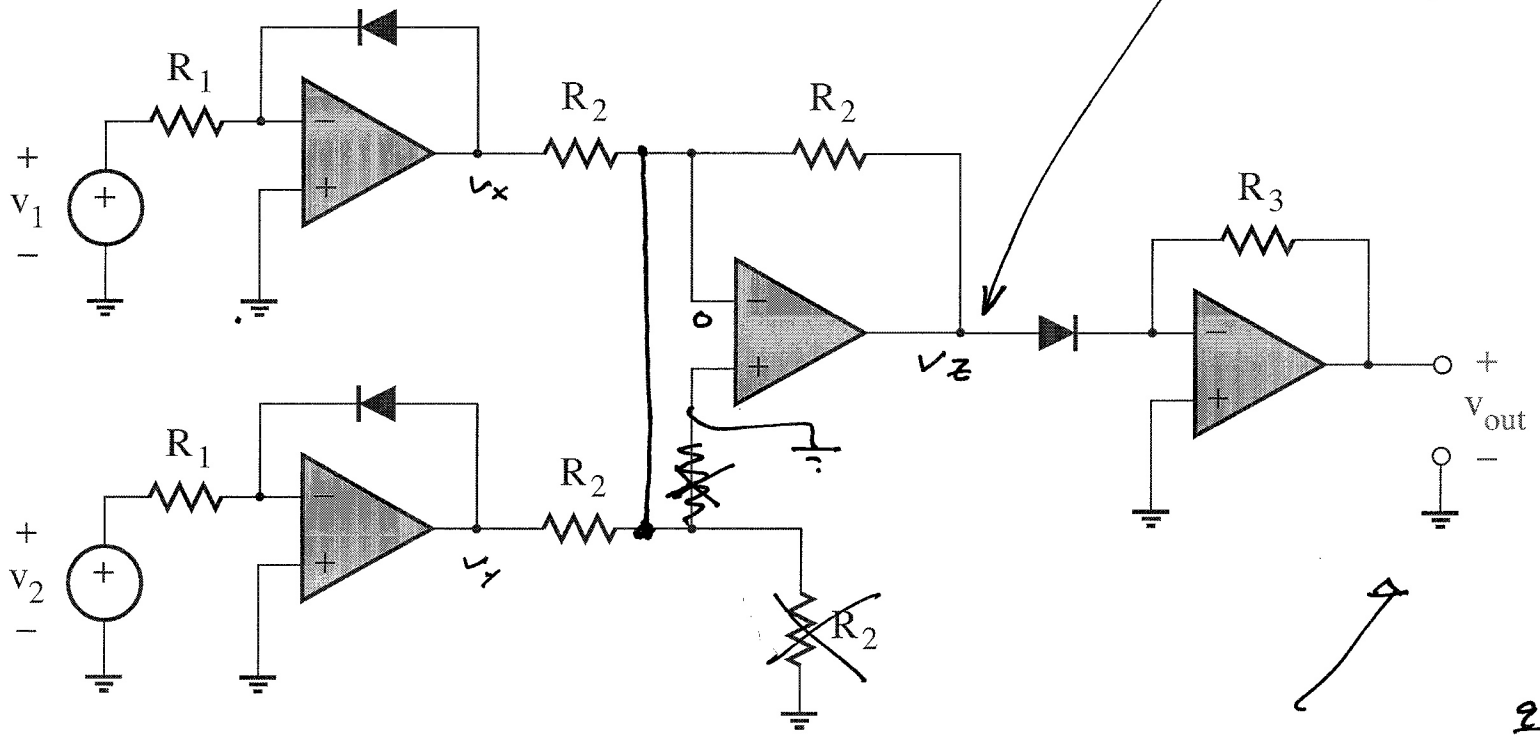
2.45



$v_{in} >> \frac{kT}{q}$

$$i \approx I_s e^{\frac{q v_{in}}{kT}} = \frac{-v_{out}}{R}$$

$$v_{out} = -I_s R e^{\frac{q v_{in}}{kT}} \qquad v_{in} > 0$$



$$v_z = -v_x - v_y$$

$$= -\frac{kT}{q} \ln\left(\frac{v_1 v_2}{I_0^2 R_1^2}\right)$$

$$v_x = \frac{kT}{q} \ln\left(\frac{-v_1}{I_0 R_1}\right)$$

$$v_y = \frac{kT}{q} \ln\left(\frac{-v_2}{I_0 R_1}\right)$$

$$v_{out} = -I_0 R_3 e^{\frac{q v_{out}}{kT}}$$

$$= \frac{v_1 v_2 R_3}{I_0 R_1^2}$$

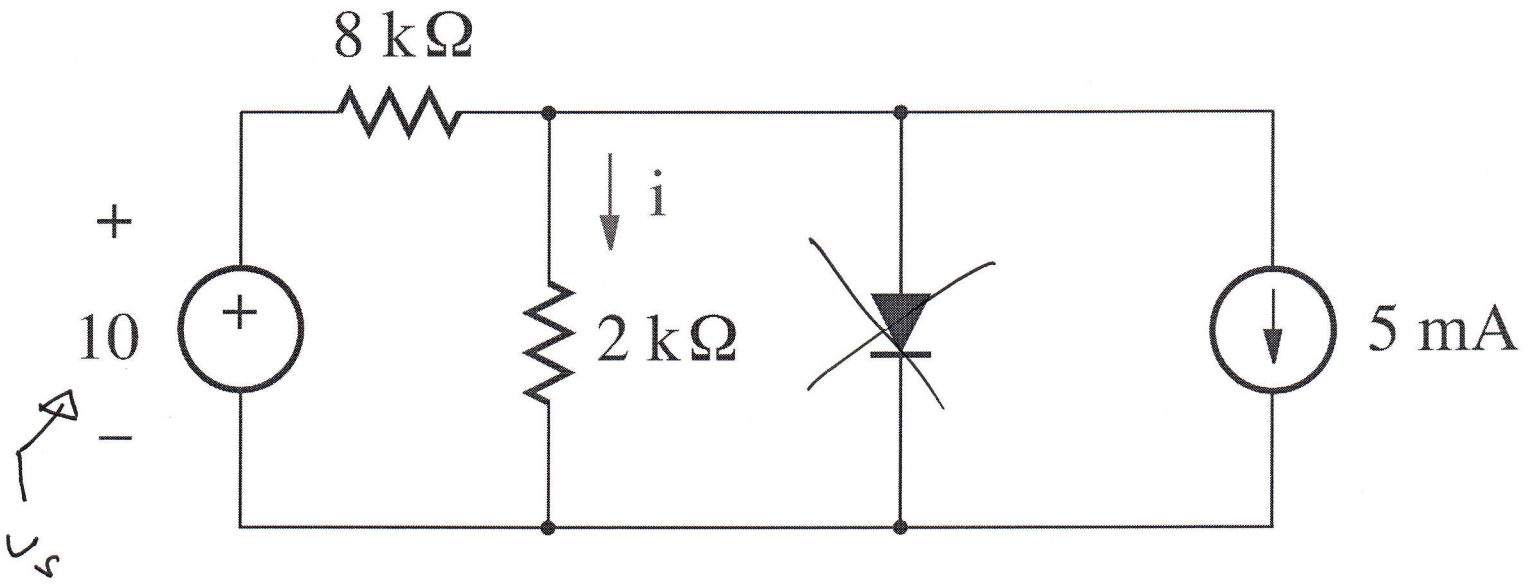
multiplier

3.6 At diode breakpoint, $\frac{v_s}{8} = 5$

$\rightarrow v_s = 40$ diode on for $v_s > 40$

But $v_s = 10$, so the diode is off.

$\rightarrow$ open



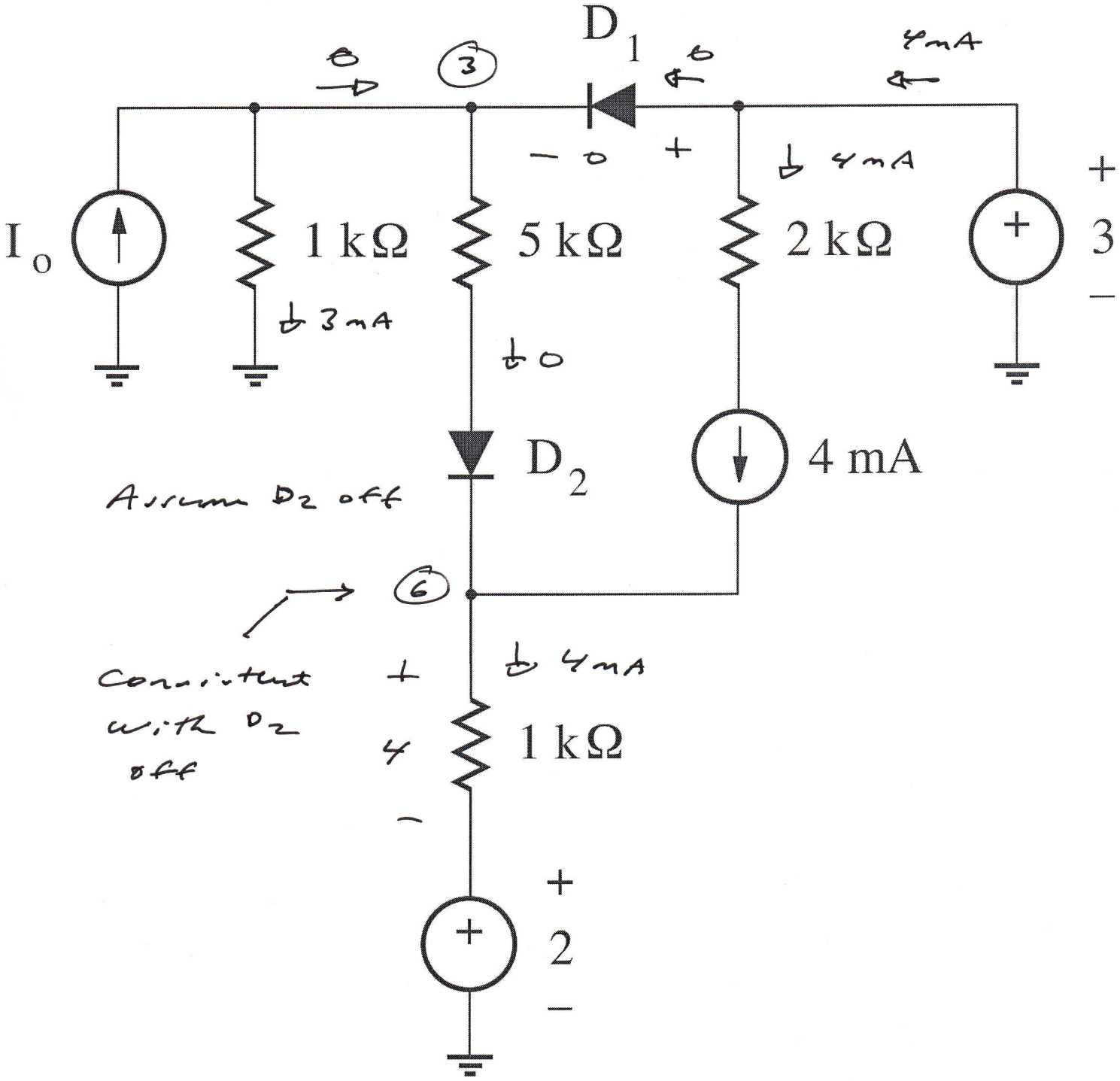
superposition

$$i = \frac{10}{10} + (-5)\frac{\frac{1}{2}}{\frac{1}{2}+\frac{1}{8}} = -3 \text{ mA}$$

current source off

voltage source off

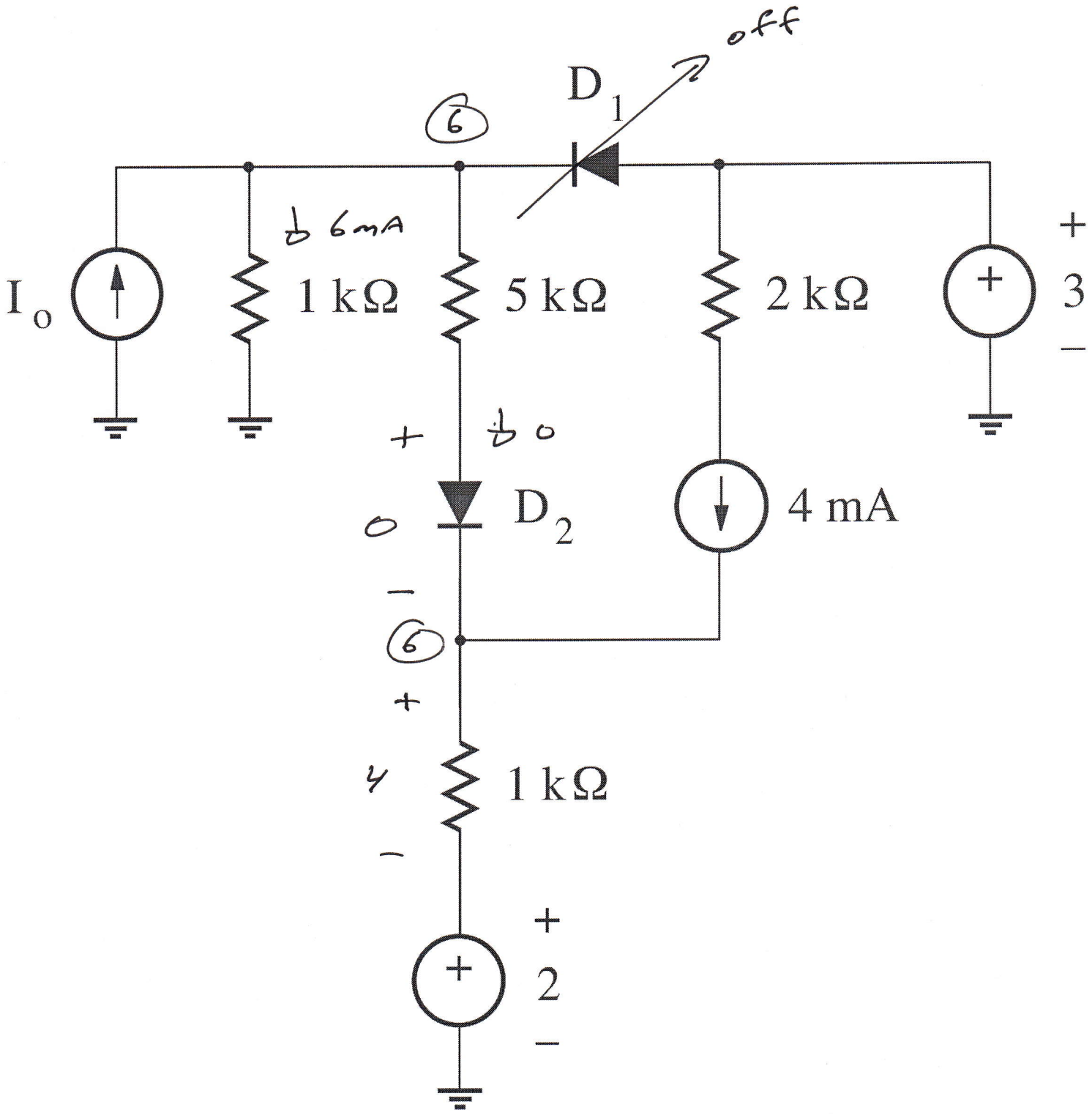
3.10 D_1 breakpoint mark up diagram



$I_0 = 3\text{ mA}$

D_1 on for $I_0 < 3\text{ mA}$

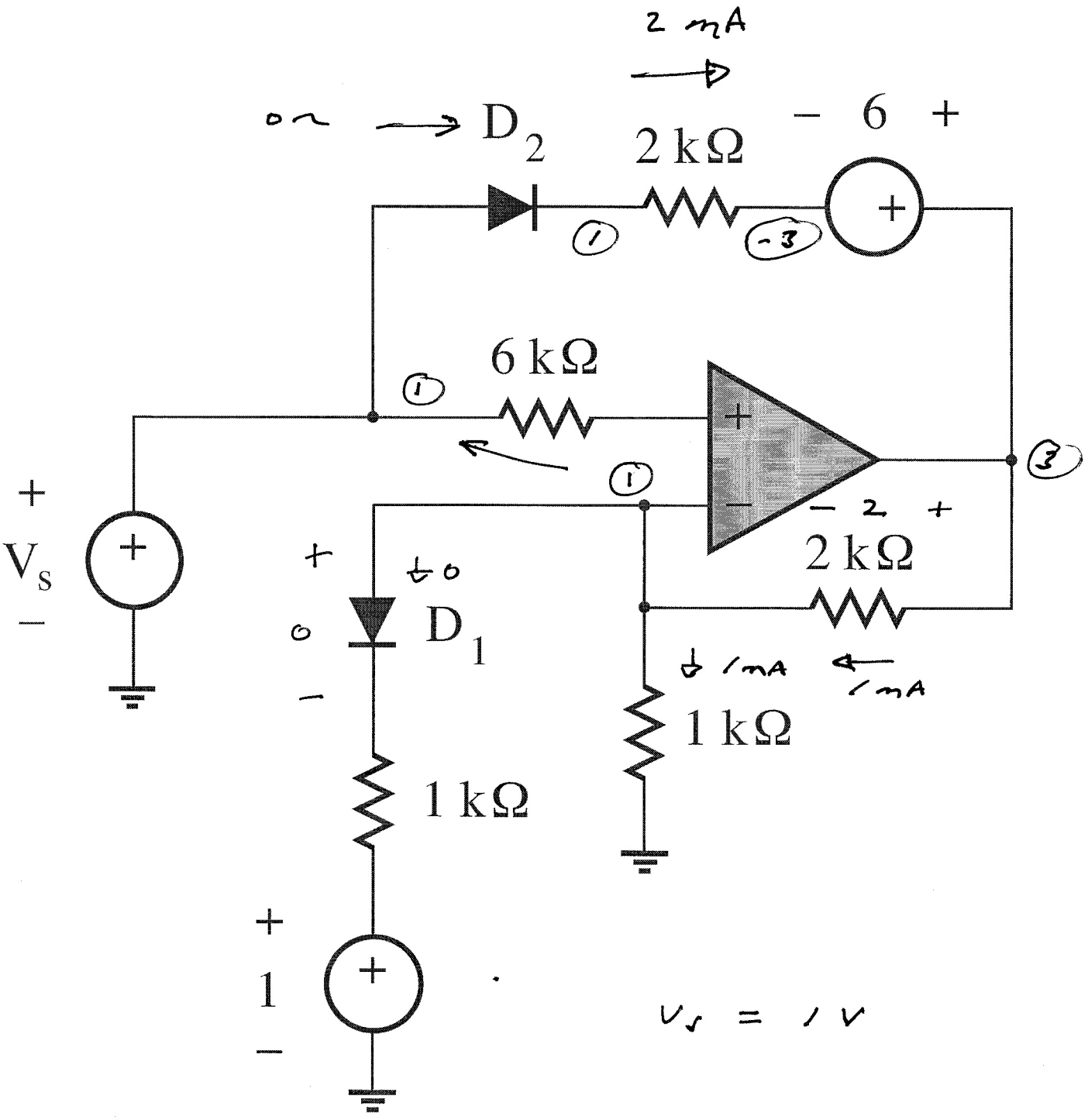
3.10 D_2 breakpoint mark up diagram



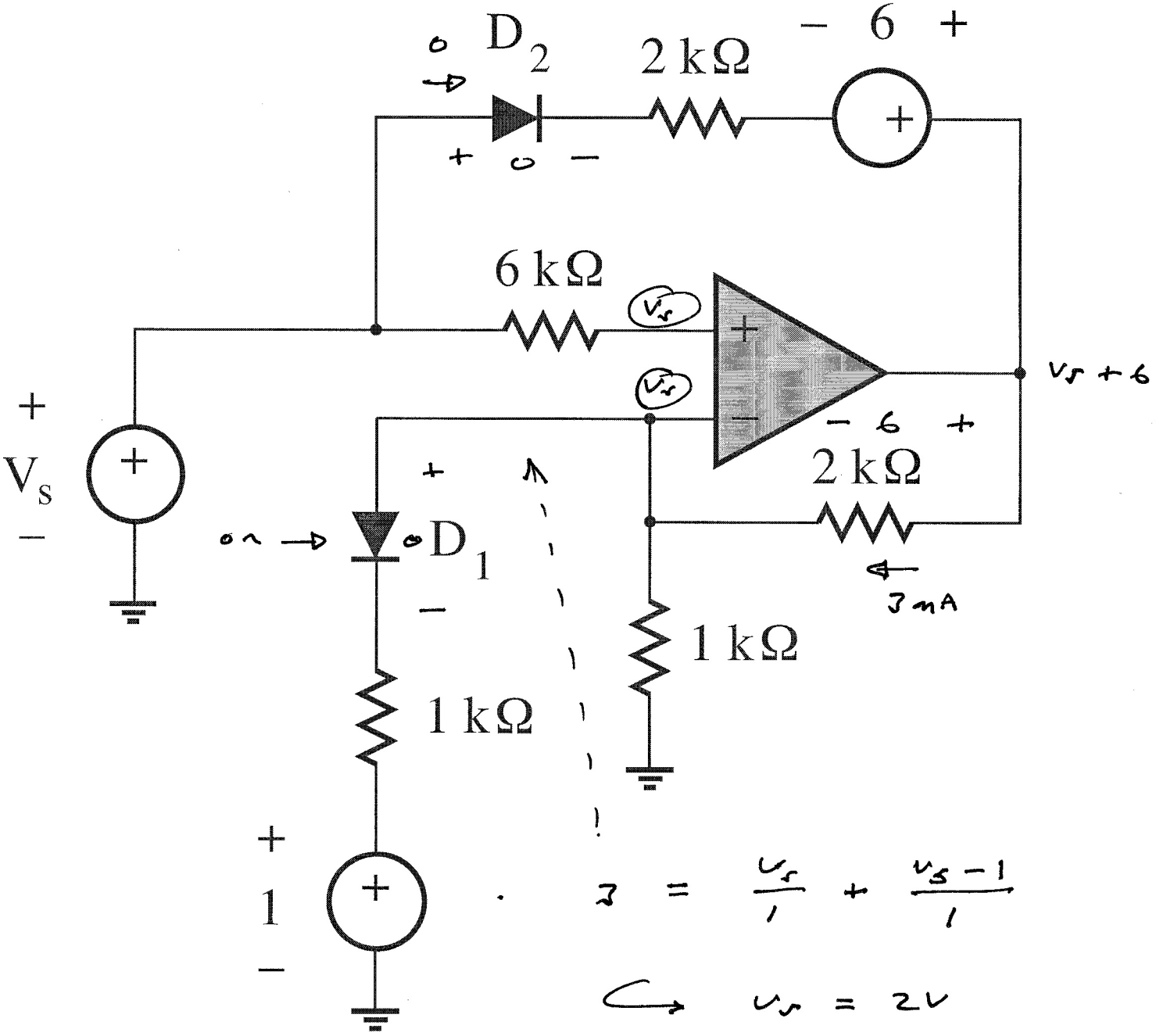
$I_o = 6\ mA$

D_2 on for $I_o > 6\ mA$

3.21 D, breakpoint



D_2 breakpoint



$$i = \frac{v_s}{1} + \frac{v_s - 1}{1}$$

$$\hookrightarrow \quad v_s = 2\,V$$