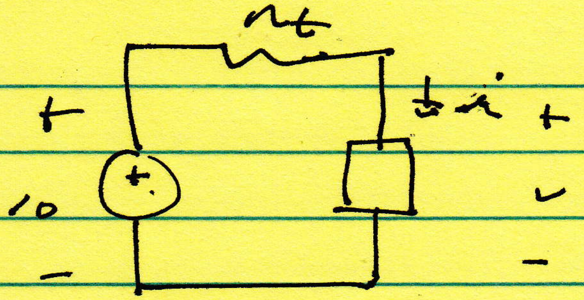
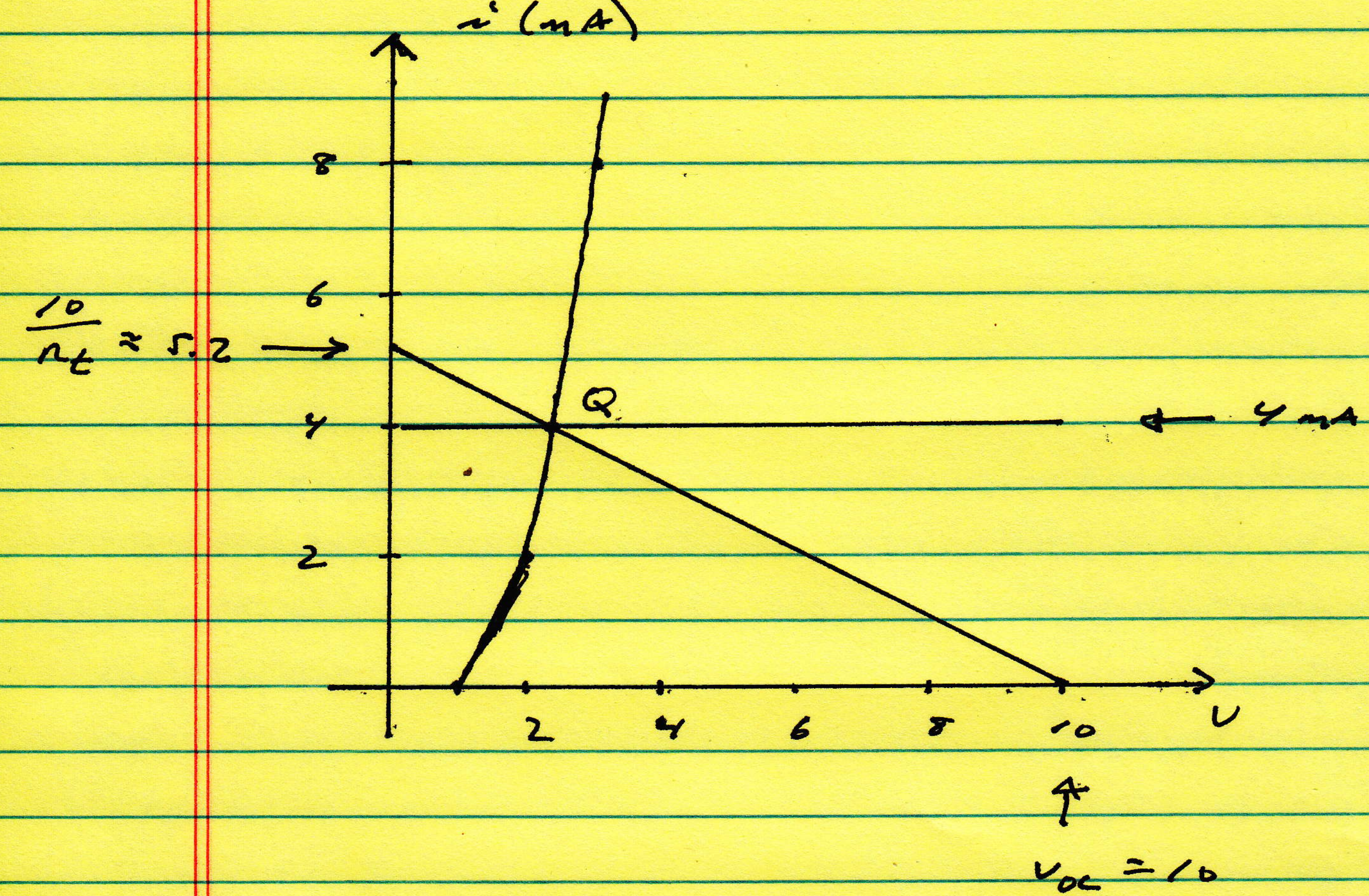
2.5



$i = 2(v-1)^2$ mA, $\quad v \geq 1$

$i = 0 \qquad v < 1$



$r_t \approx \frac{10}{5.2} \approx 1.9\text{K}$

exact solution is $r_t = 1.90\text{K}$

2.27 i (mA) $\quad v$

	0.1	0.660	
×	1.0	0.738	$\Delta v = 0.078\,V$
	10	0.816	

$$\Delta v = n\left(\frac{kT}{q}\right)\ln 10$$

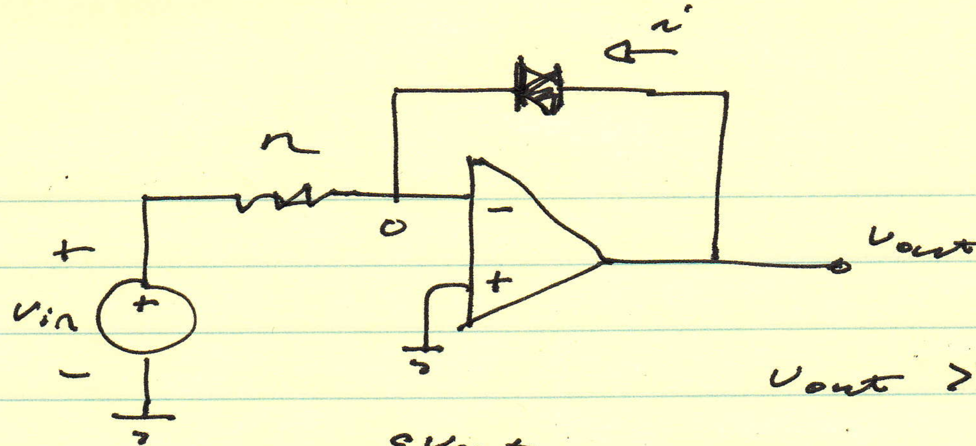
$$\rightarrow n = \frac{0.078\,V}{0.0259\,V \times 2.303} = 1.31$$

$$i = I_s\left(e^{\frac{qv}{nkT}} - 1\right) \approx I_s e^{\frac{qv}{nkT}}$$

$$\rightarrow I_s = \frac{10^{-3}\,A}{\exp\left(\frac{0.738}{1.31 \times 0.0259}\right)}$$

$$= 3.58 \times 10^{-13}\,A$$

2.44

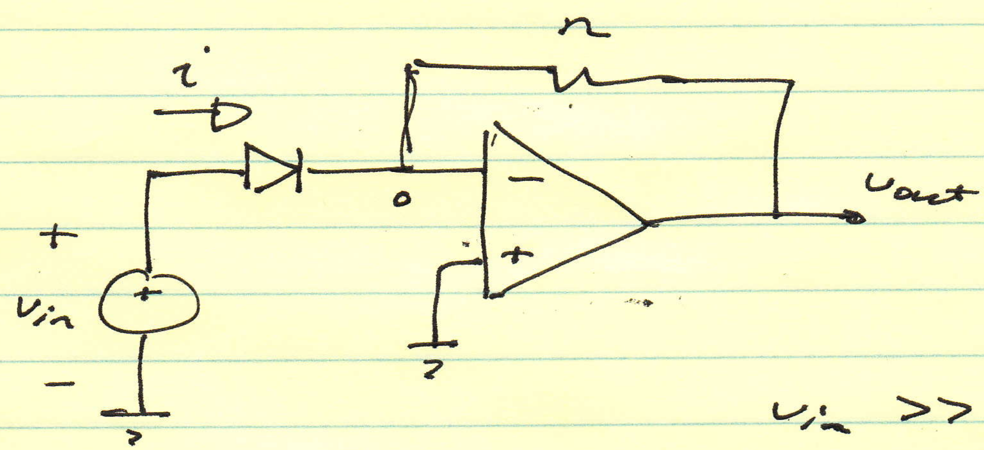


$v_{out} \gg kT/q$

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

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

2.45



$v_{in} \gg kT/q$

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

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

2.46

$$\frac{v_1}{R_1} + i = 0 \qquad i \approx I_s e^{\frac{q v_x}{kT}}$$

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

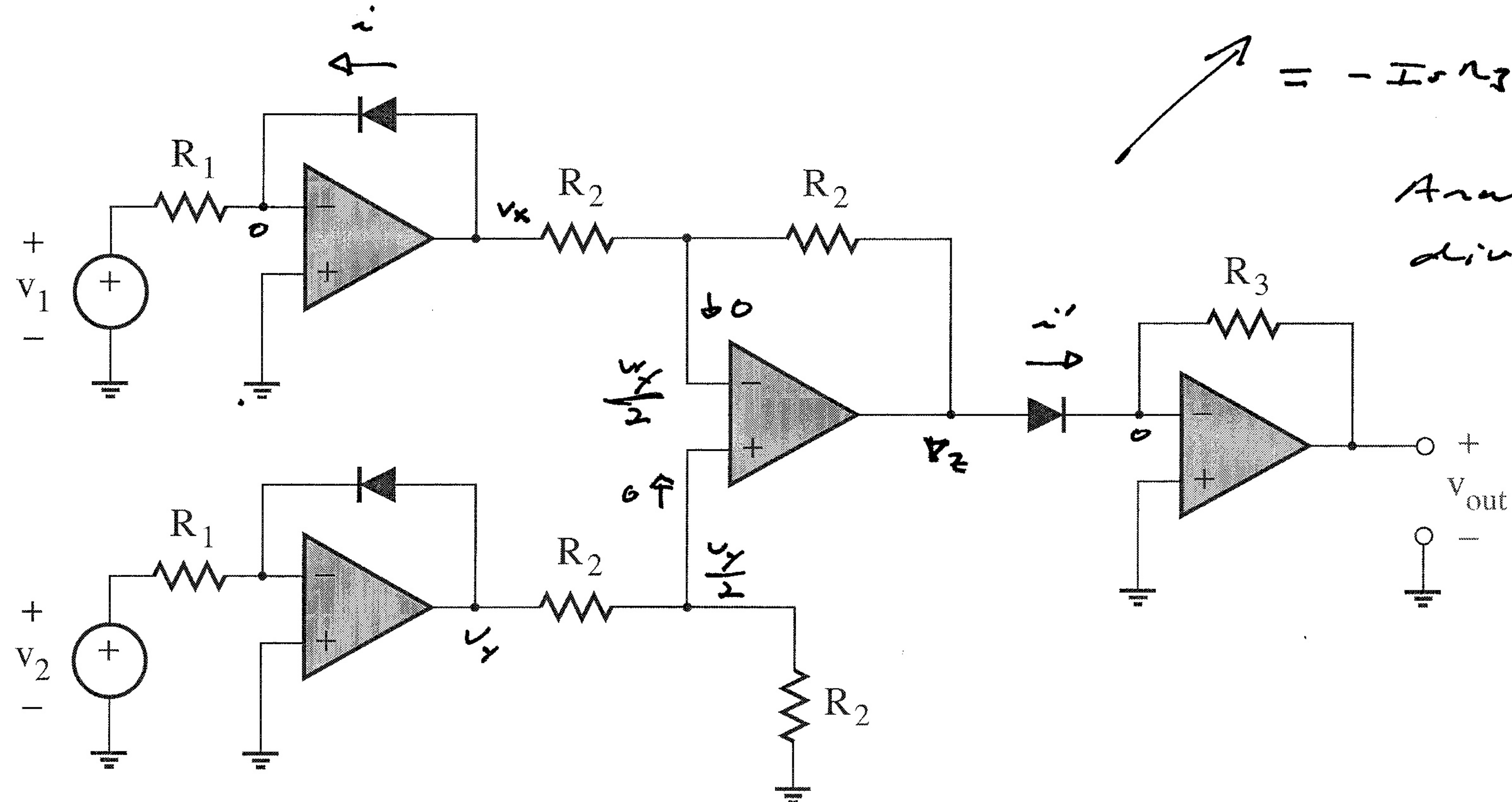
$$i' + \frac{v_{out}}{R_3} = 0$$

$$i' \approx I_s e^{\frac{q v_{out}}{kT}}$$

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

$$= -I_s R_3 \left(\frac{v_2}{v_1}\right)$$

Analog divider



similarly,

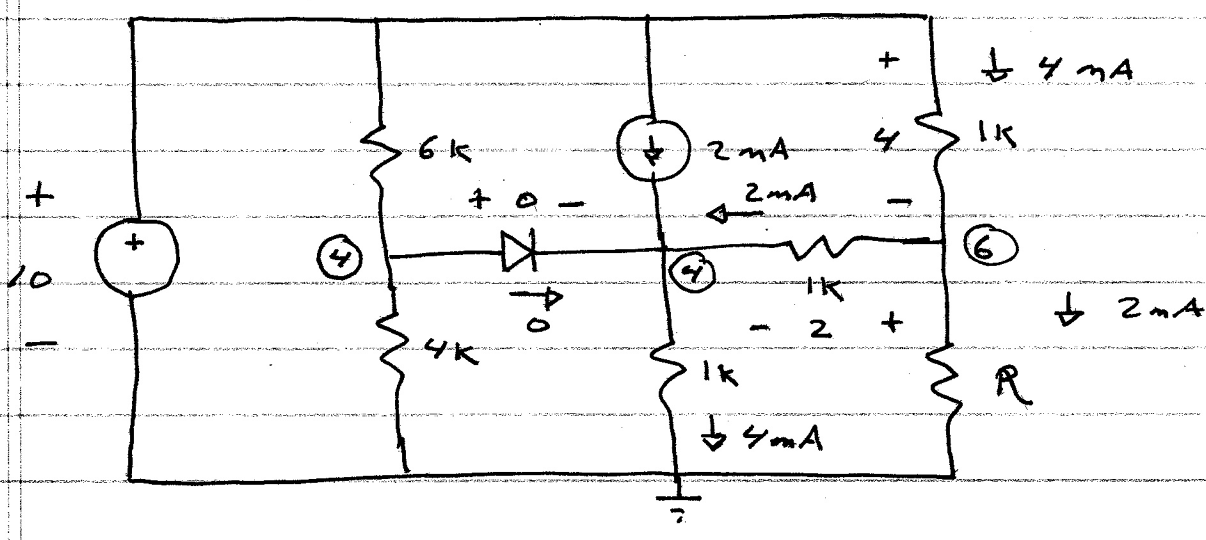
$$v_y = \frac{kT}{q} \ln\left(\frac{-v_2}{I_s R_1}\right)$$

v_x, v_y must be <u>negative</u>

$$\frac{v_x - \frac{v_y}{2}}{R_2} + \frac{v_z - \frac{v_y}{2}}{R_2} = 0$$

$$\rightarrow \quad v_z = v_y - v_x = \frac{kT}{q} \ln\left(\frac{v_2}{v_1}\right)$$

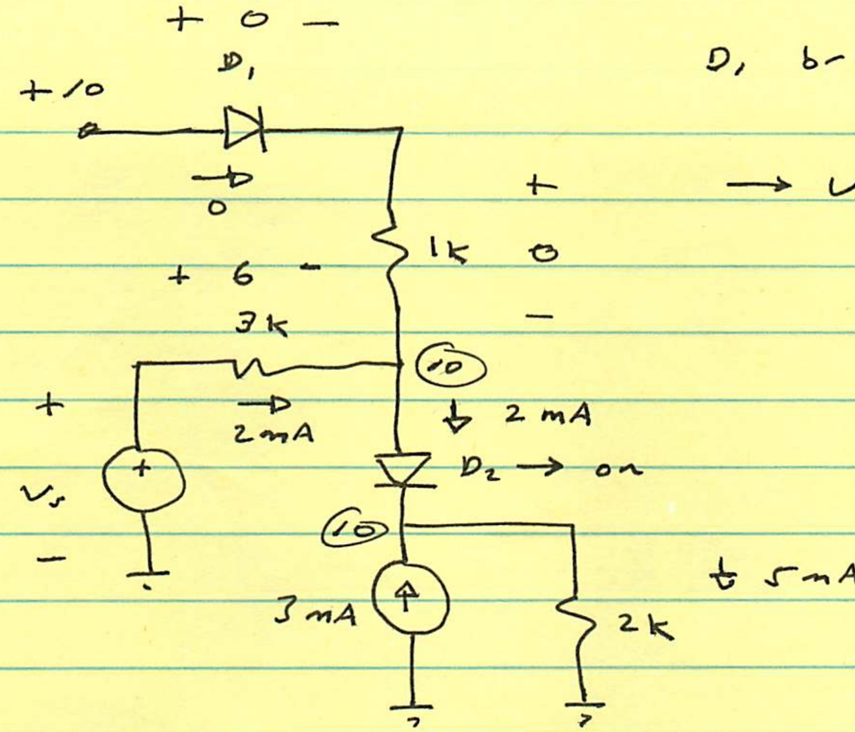
3.4



mark up diagram! Diode at breakpoint.

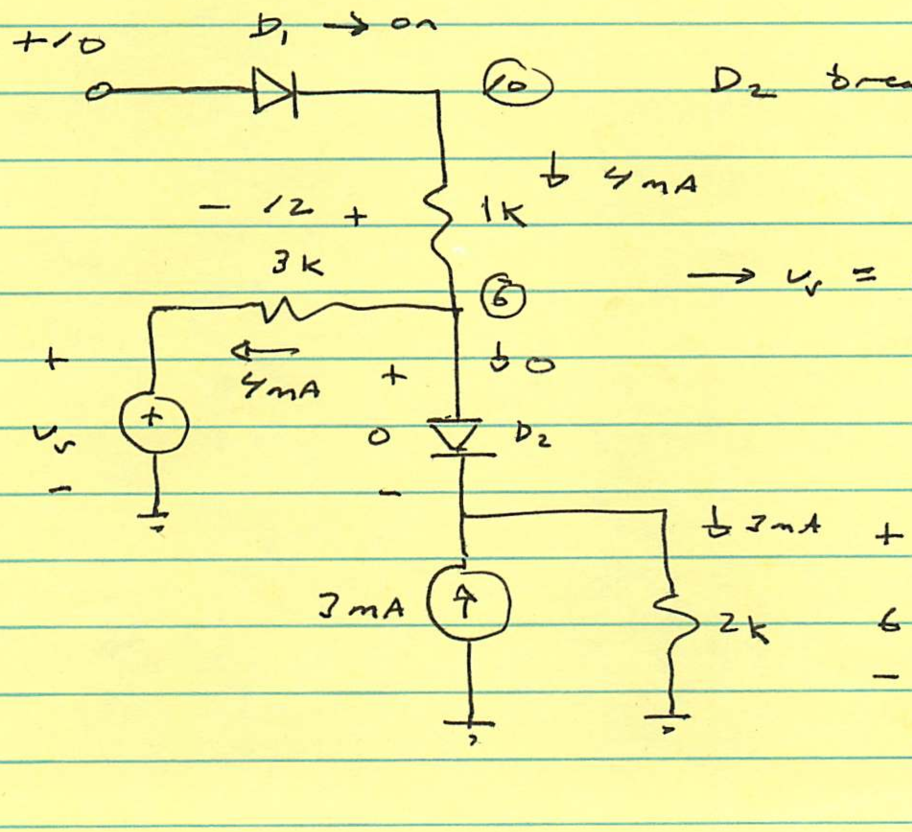
$$R = \frac{6V}{2mA} = 3K$$

3.11



D_1 breakpoint

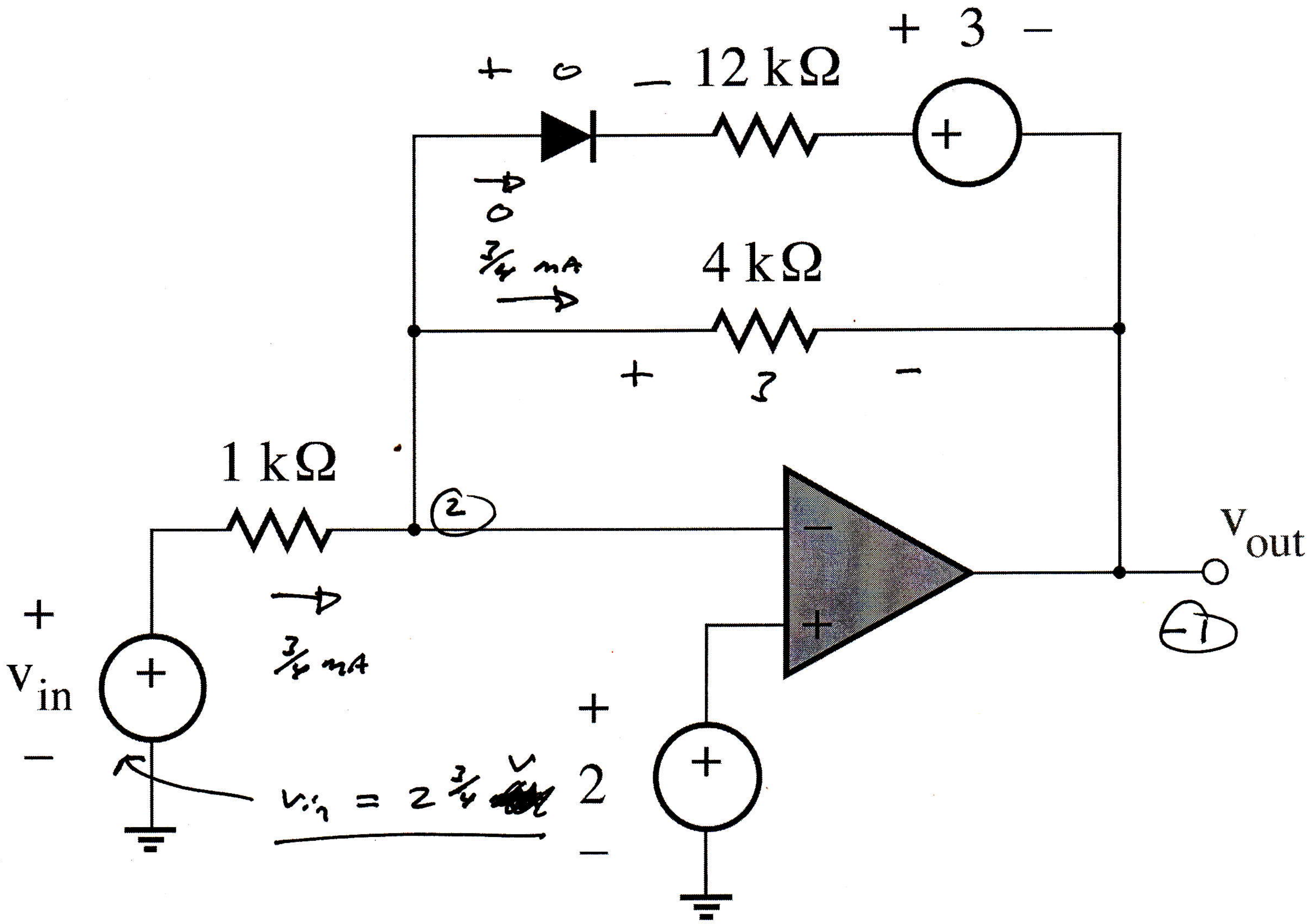
→ $v_s = 16V$



D_2 breakpoint

→ $v_s = 6 - 12 = -6V$

3.22 Mark up the diagram to find the diode breakpoint.

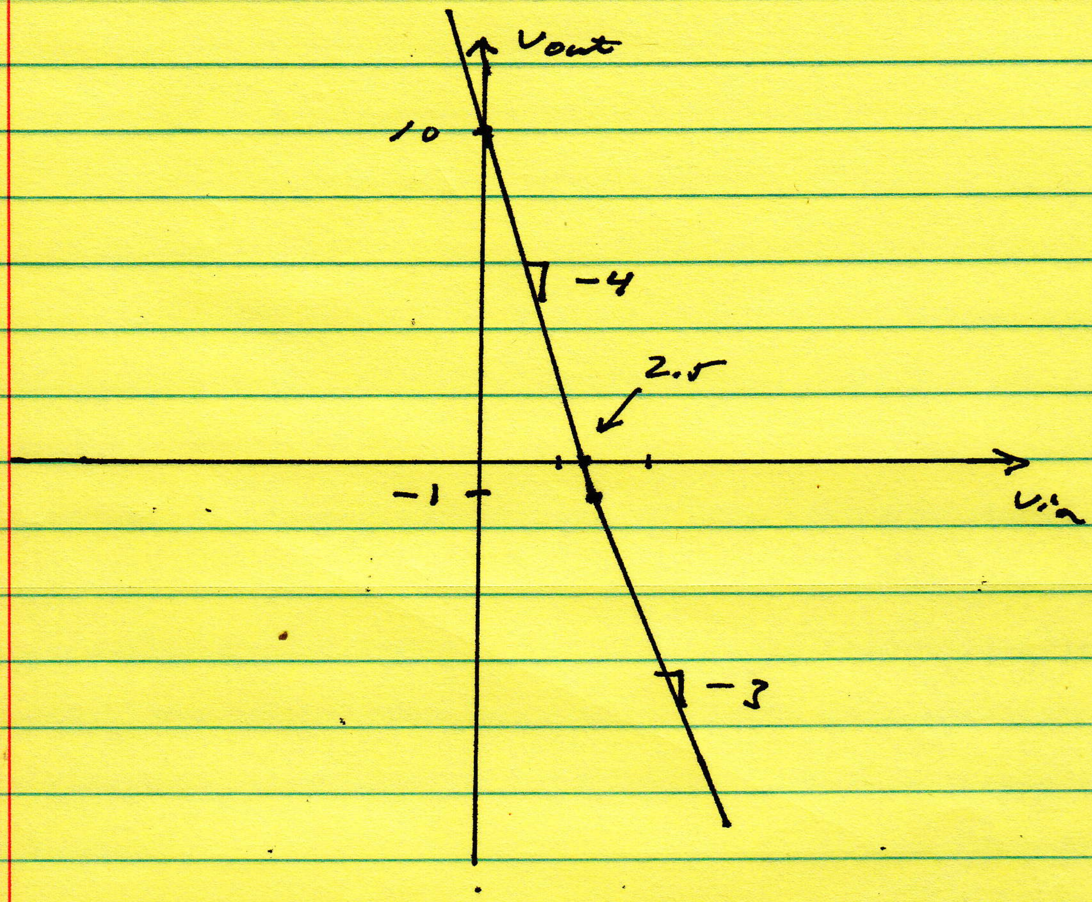


$v_{in} < 2\frac{3}{4}$ v $\longrightarrow$ diode off

Then $\dfrac{v_{in} - 2}{1} + \dfrac{v_{out} - 2}{4} = 0$

$v_{out} = -4v_{in} + 10$

2.22 (cont.)



If the diode is on ($V_{in} > 2.75\,V$) the slope of the transfer characteristic is

$$m = -\frac{4K \parallel 12K}{1K} = -3$$