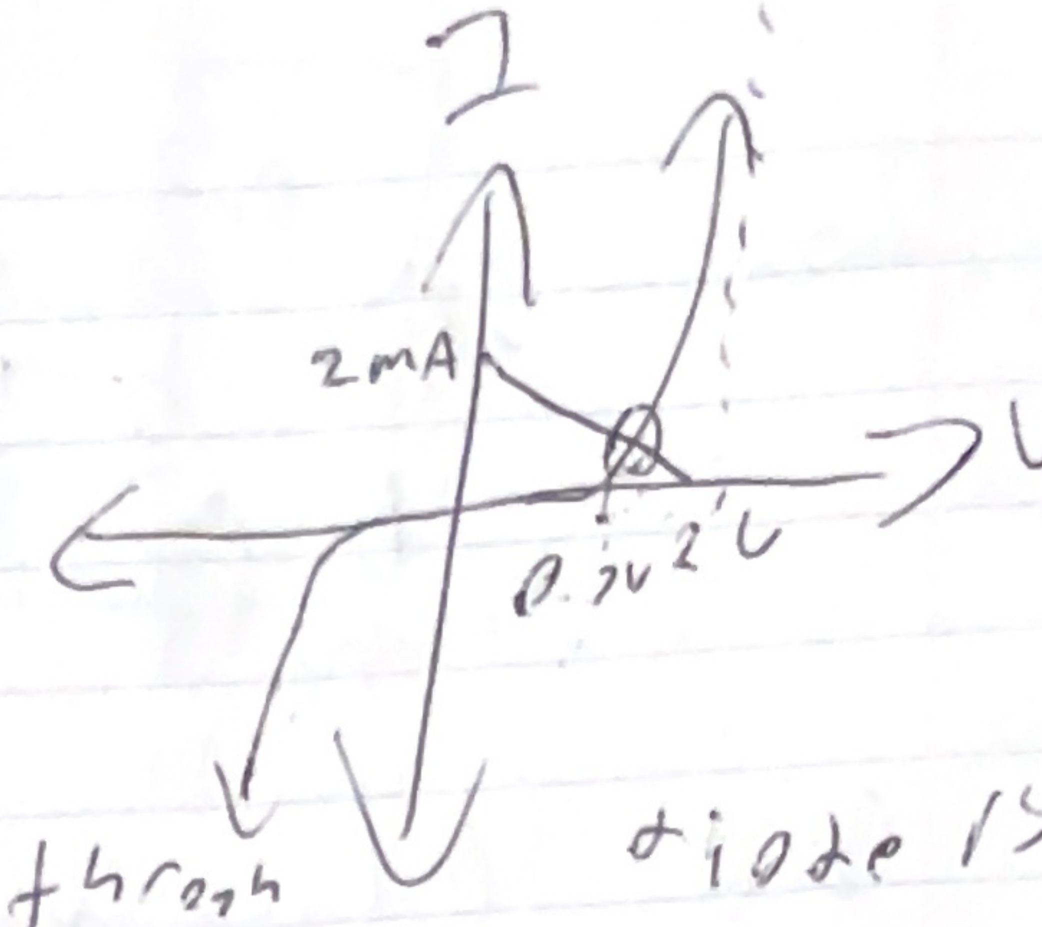
1a



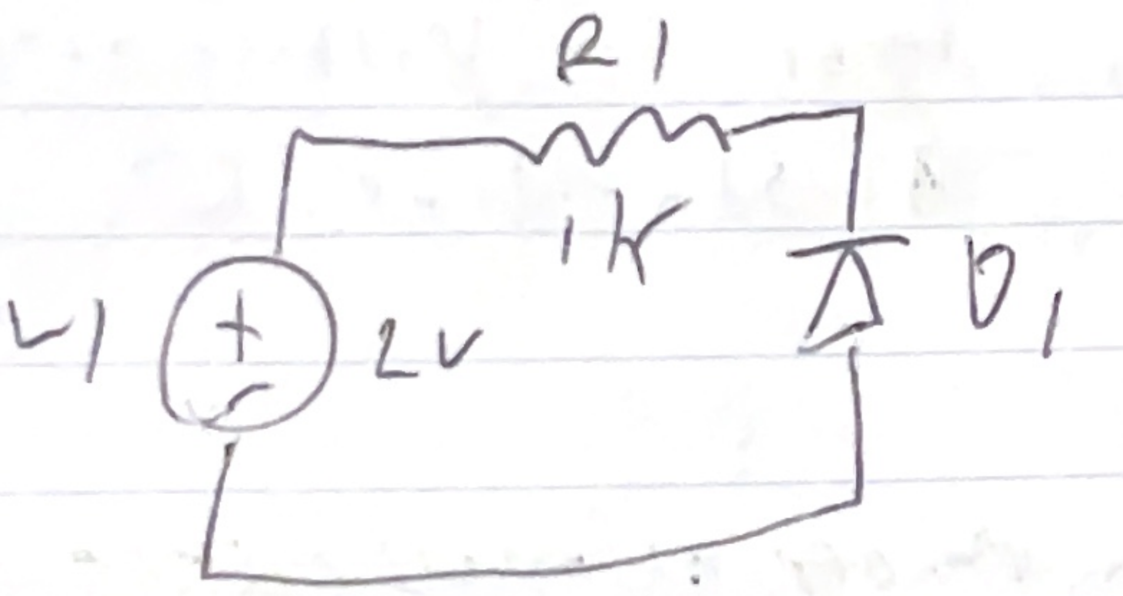
With 2V power source, current through diode is very high (lets all current through). Probably in range of 10^6 or 10^7.

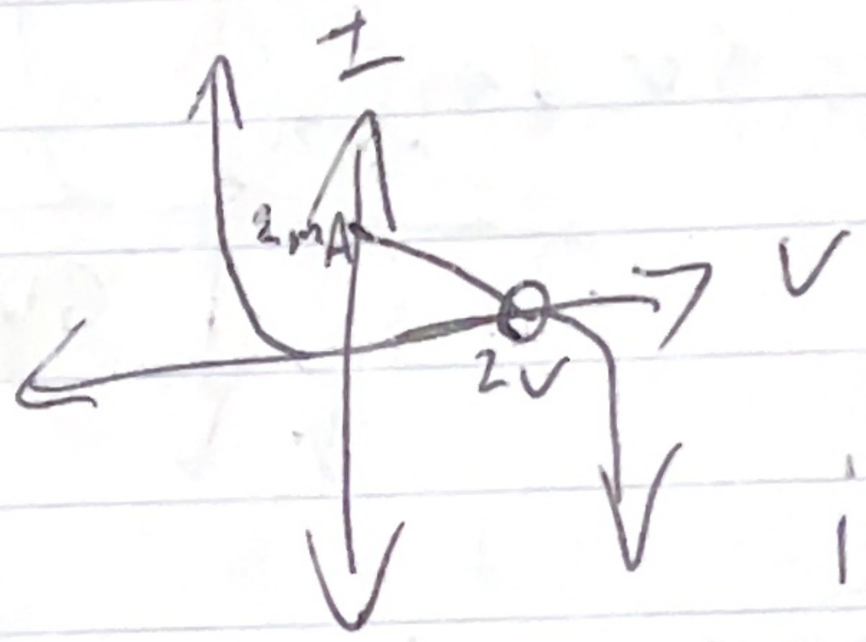
1b $I = I_0 (e^{V/V_t})$ $I_0 = 10^{-9}$ $V_t = 26mV$

$I = 10^{-9} (e^{2/0.026}) \rightarrow 2.55 \; 10^{24}$ A

Answers agree, both are very large numbers so they agree

1c





diode current is roughly 0A

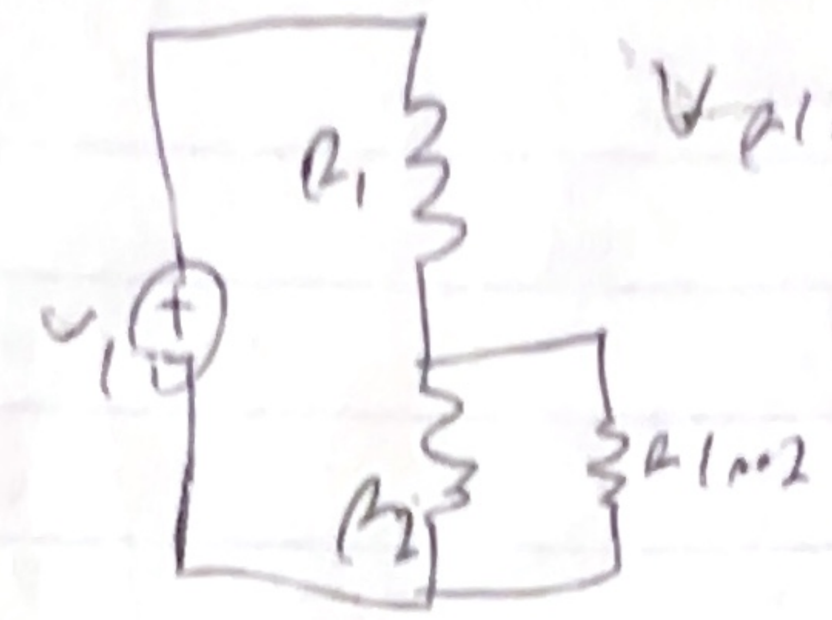
1.2 voltage is flipped, so equation becomes

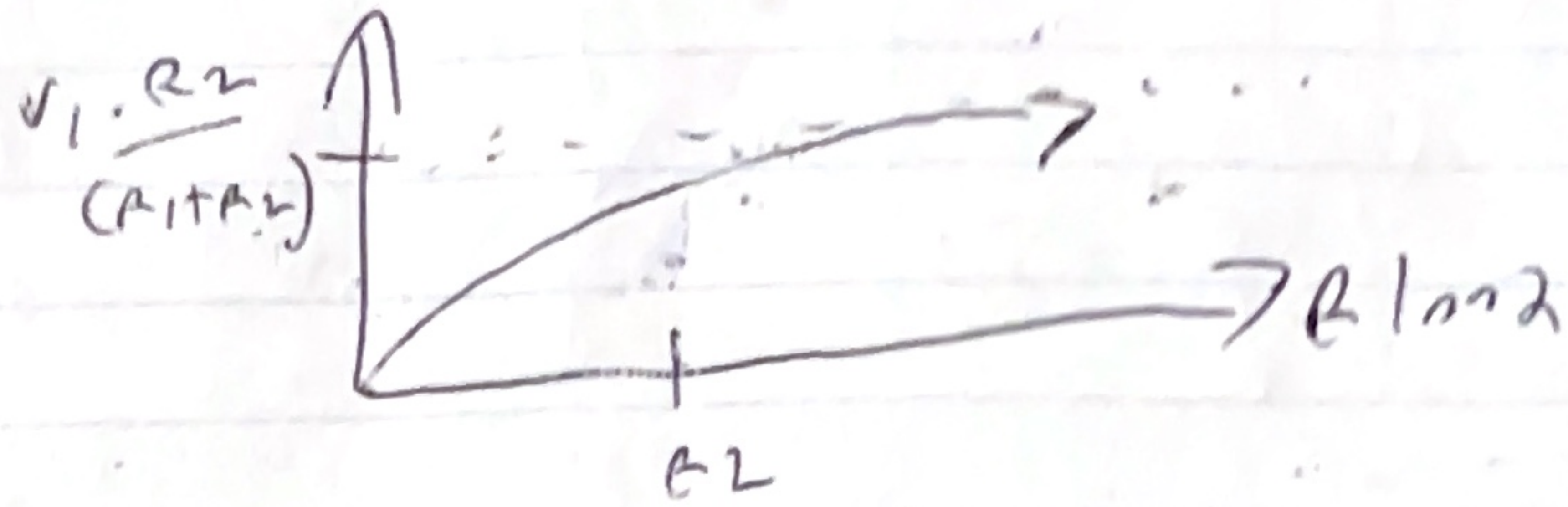
$I = 10^{-9} (e^{-2/0.026}) = 3.92 \; 10^{-43}$ A

Numbers agree!

2a

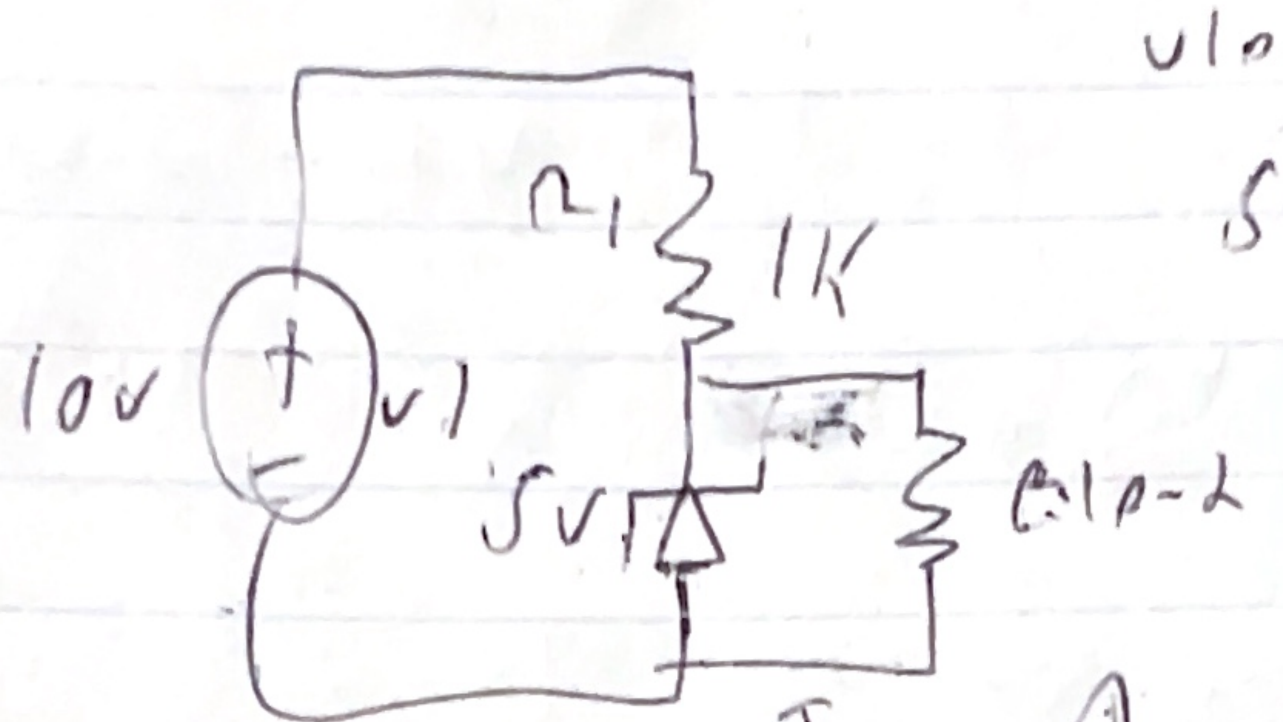
$V_{load} = \frac{R_2 V_1}{R_1 + R_2}$ $\quad V_{load} = V_L \frac{R_2 \| R_{load}}{R_1 + (R_2 \| R_{load})}$

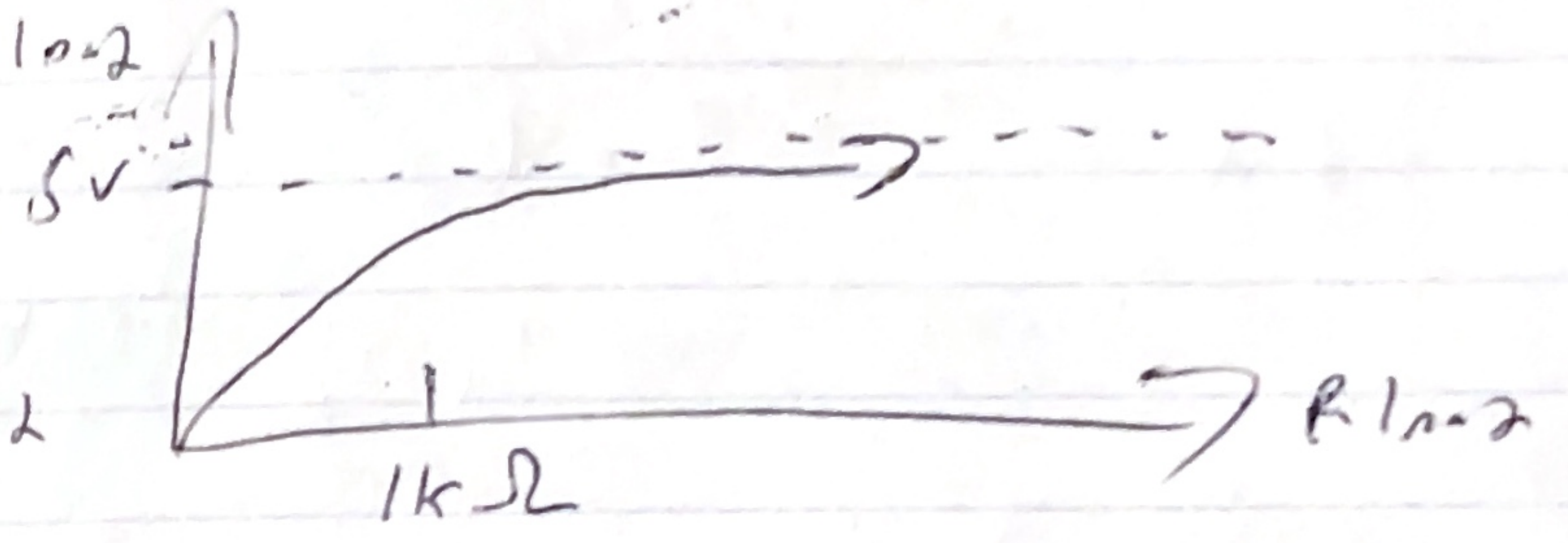




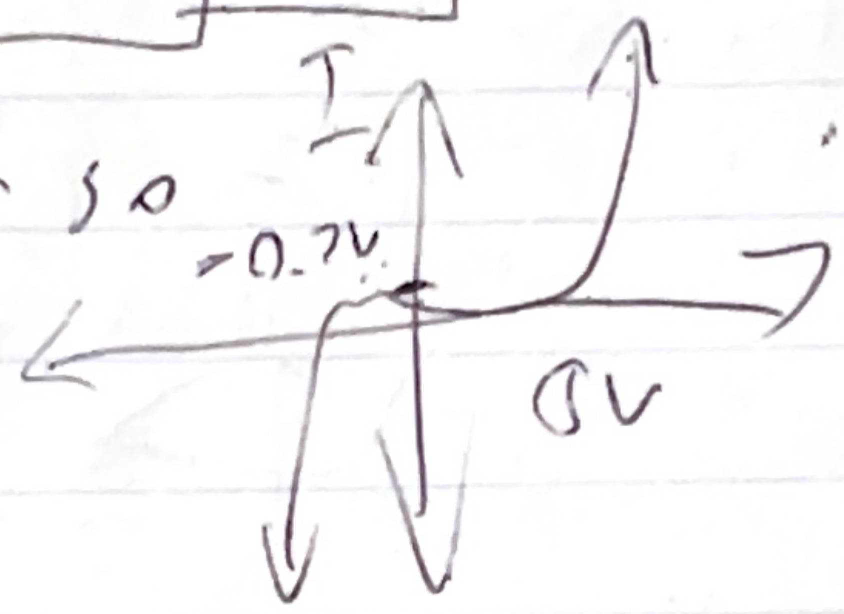
2b Rload must be much greater than other resistances otherwise current will go through load instead of circuit.

2c





$V_2 = 5V$ so



2d Same. R load must be large for voltage across load to stabilize.

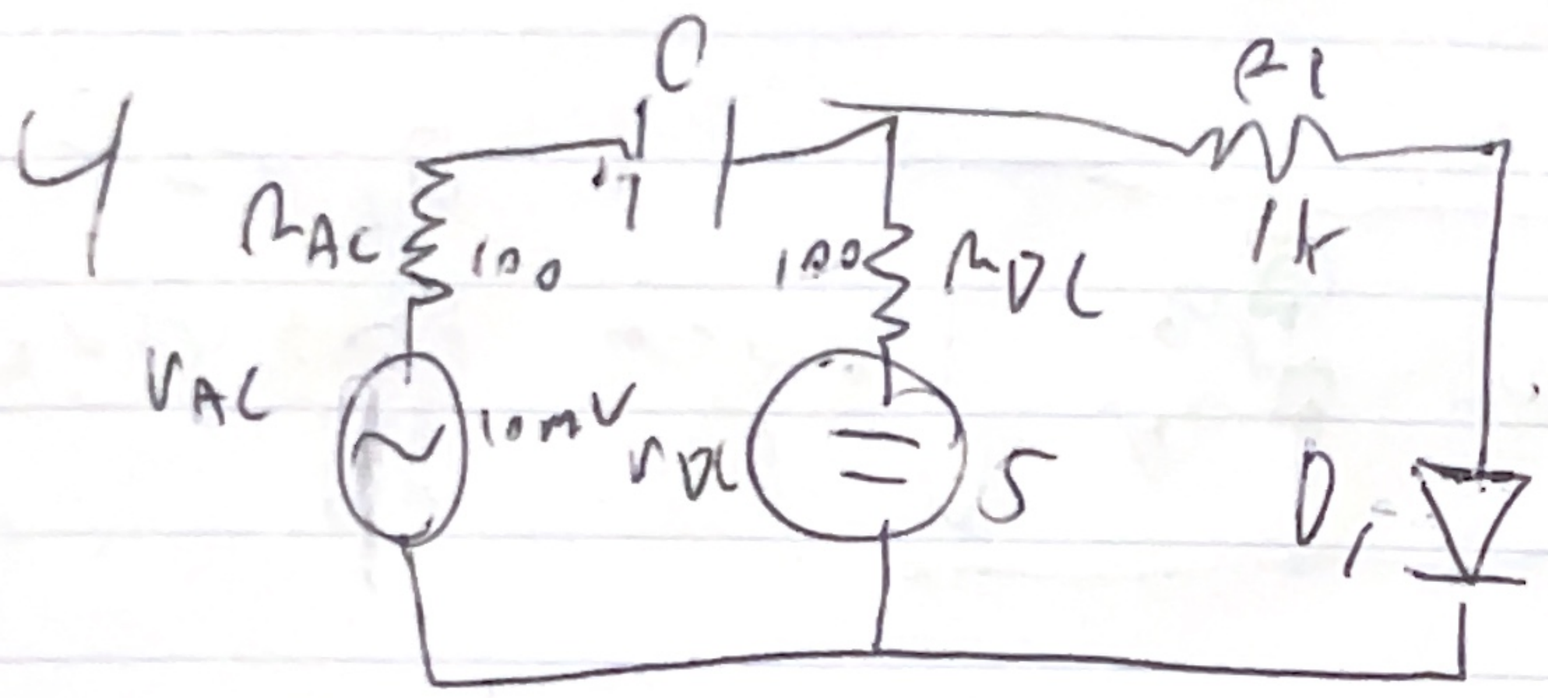
2e First circuit has a more adjustable curve since switching R_1 will result in Vload changing more. But second circuit, thanks to zener diode, has a much more adjustable voltage stabization, as it is equal to V_2.

$V_{source} =$ V_{middle} V_Z

3a The Zener diode is there to smooth the voltage out.

3b A large part of the AC voltage is clipped off if V_A of V_{source} is $> V_Z$.

4

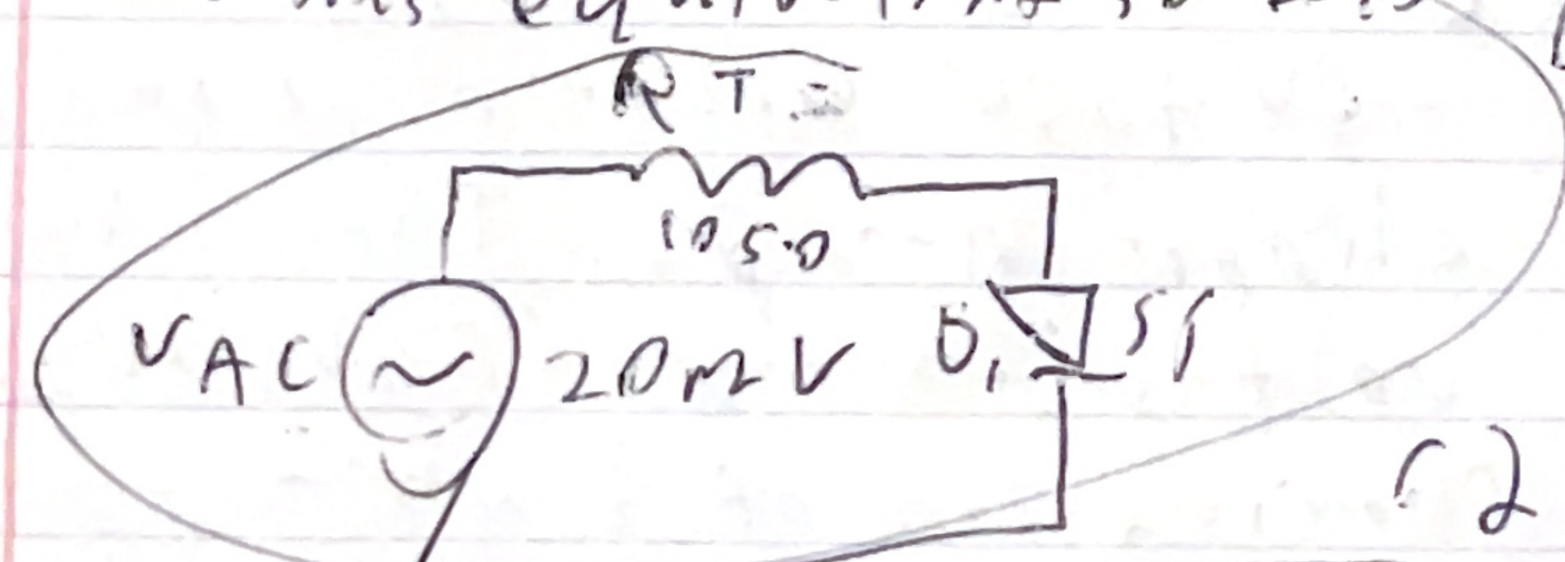


4a VDC sees 1100 Ω resistance — RDC and R1 in Series since C lets through no DC

$$I = \frac{V_{DC} - V_{diode}}{R} = \frac{4.3}{1100} = 3.9\,mA = I_{DC}$$

4b $$r_d = \frac{V_T}{I_{DC}} = \frac{26\,mV}{3.9\,mA} = 6.66\,\Omega$$

Draw AC = shorts DC so C can be shorted too using equivalent sources RACDC becomes 50 and VAC → 20 mV



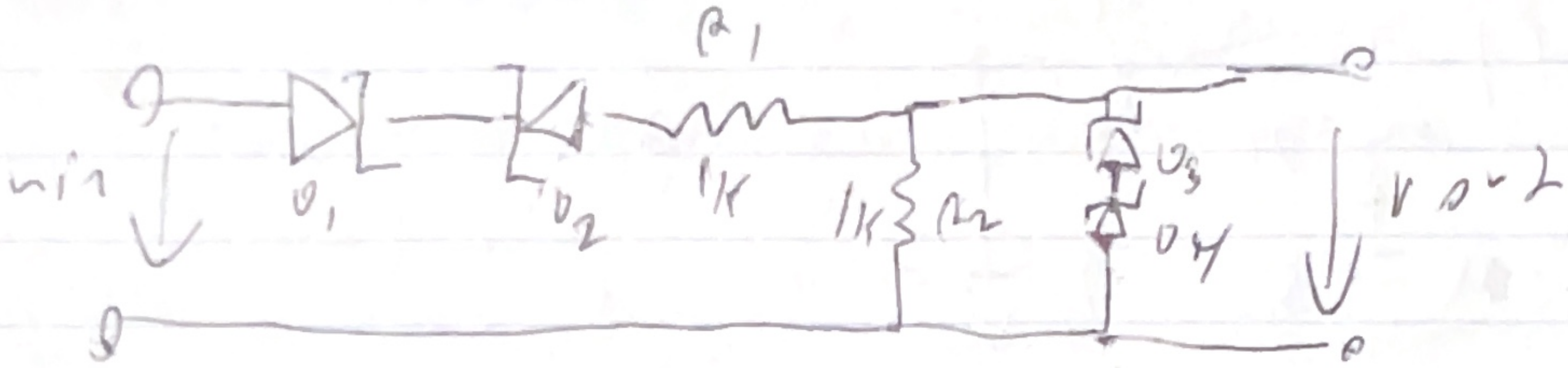
4c $$V_{AC}^{Diode} = \frac{r_d}{R + r_d} V_{AC}$$

$r_d = 6.66$ $R = 1050$ $V_{AC} = 0.02$

V_{AC} Diode $= 0.13$ mV

$V = IR$ $\quad v = 0.13$ $R = 6.66$ $I = 0.0195$ mA

5a Diode threshold voltage is the voltage at which the diode has enough energy to "turn on". These are silicon zener diodes so the value for the circuit is ~0.7V. Zener voltage is the voltage where reverse breakdown happens, which also lets current through. In the circuit it is 5V.



D_1 $V_Z = 5V$

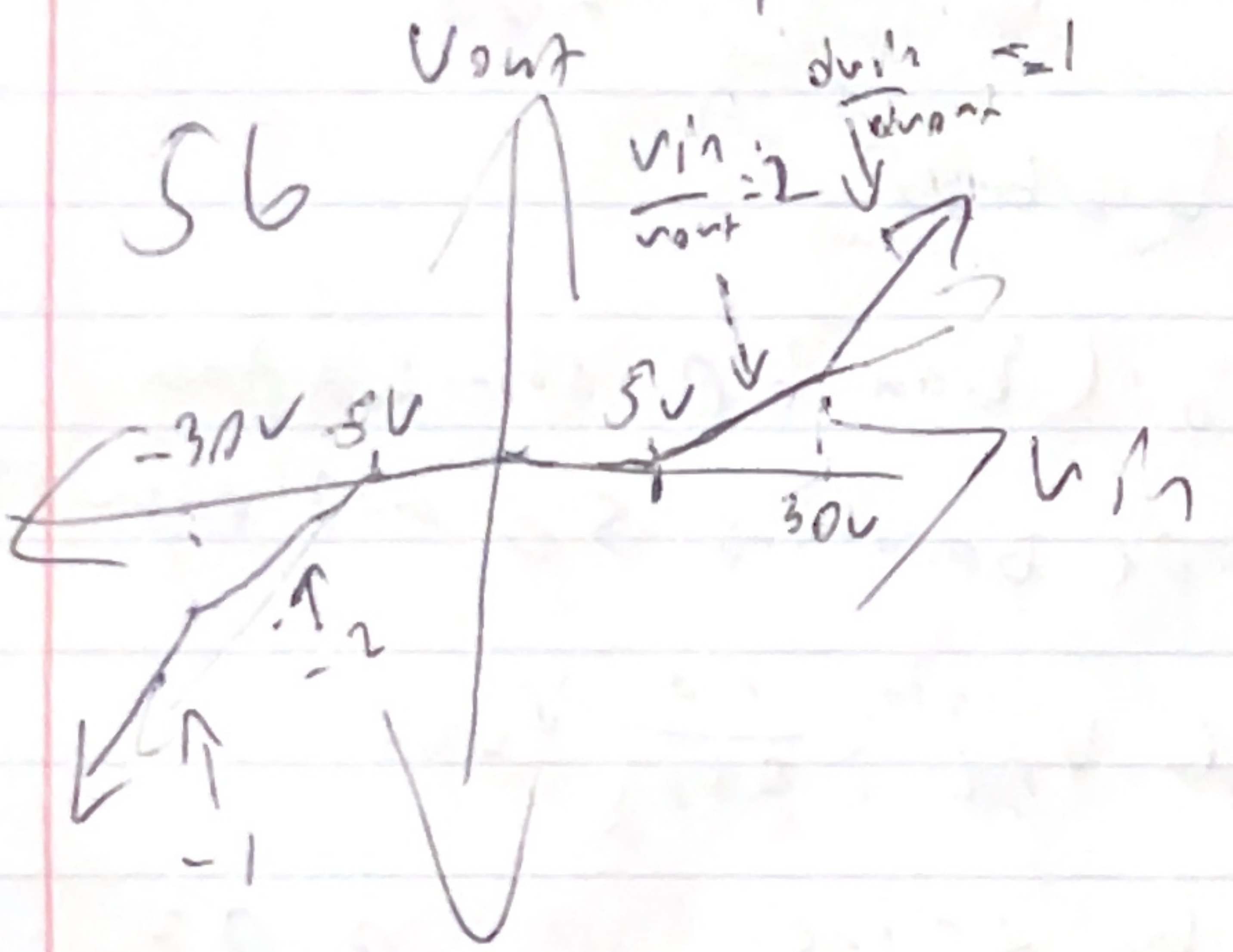
$D_{2,3,4}$ $V_Z = 5V$

D_1 and D_2 make a reverse clipper.

R_1 and R_2 make a $\frac{1}{2}$ voltage divider.

D_3 and D_4 smooth (no real effect on DC) except at 10v across D_3 D_4 where voltage divider becomes obsolete

5b



5c There is no vout between -5V to 5V because of the reverse clipper D_1 and D_2. They only let voltage through if $|V| > V_Z$. There is a slope of $\frac{1}{2}$ when $|V| > 5$ and $|V| < 30$ and a slope of 1 when $|V| > 30$. This is because D_1 and D_2 steal 10vs, R_1 and R_2 halve the voltage, and it takes 10v going across D_3 D_4 for voltage to go through.

$\frac{1}{2}(X-10) = 10$ $X = 30$

5d $\frac{1}{2}(X-5) \rightarrow \frac{1}{2}5$ $\frac{5}{2}V$ and $\frac{5}{2}mA$

5e $X - 17.5 \rightarrow$ 12.5V and 12.5mA