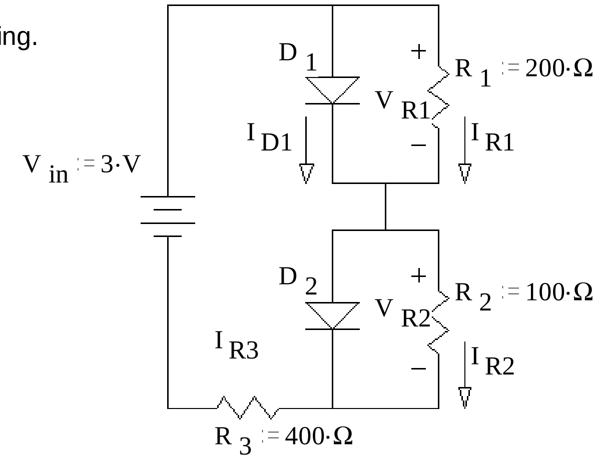
Exam-type Diode Circuit Examples

On an exam, I usually tell you what assumptions to make about the diodes, then you can show that you know how to analyze the circuit and test those assumptions. Since everyone starts with the same assumptions, everyone should do the same work.

Assume that diode D_1 is conducting and that diode D_2 is not conducting.



a) Find V_{R1}, I_{R1}, I_{R3}, I_{D1}, V_{R2} based on these assumptions.
Do not recalculate if you find the assumptions are wrong.

$V_{R1} =$ ________

$I_{R1} =$ ________

$I_{R3} =$ ________

$I_{D1} =$ ________

$V_{R2} =$ ________

Solution:

$V_{R1} := 0.7 \cdot V$

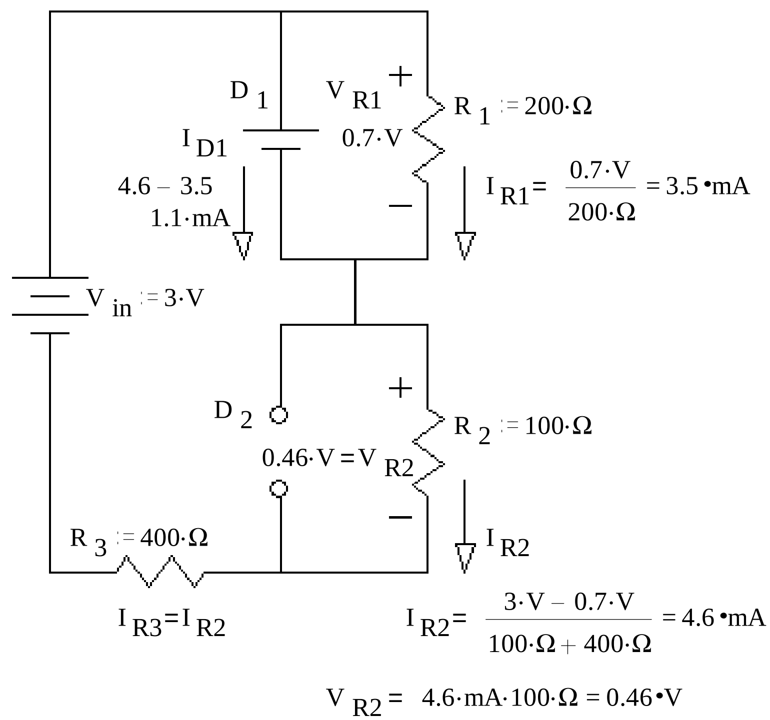
$I_{R1} := \frac{V_{R1}}{R_1}$ $\quad I_{R1} = 3.5 \cdot mA$

$I_{R3} := \frac{V_{in} - 0.7 \cdot V}{R_2 + R_3}$ $\quad I_{R3} = 4.6 \cdot mA$

$I_{D1} := I_{R3} - I_{R1}$ $\quad I_{D1} = 1.1 \cdot mA$

$I_{R2} := I_{R3}$

$V_{R2} := I_{R2} \cdot R_2$ $\quad V_{R2} = 0.46 \cdot V$



b) Was the assumption about D_1 correct? (circle one) yes no

How do you know? (Specifically show a value which is or is not within a correct range.)

yes $\quad I_{D1} = 1.1 \cdot mA > 0$

c) Was the assumption about D_2 correct? (circle one) yes no

How do you know?

yes $\quad V_{D2} = V_{R2} = 0.46 \cdot V < 0.7V$

d) Based on your answers to b) and c), which (if any) of the following was not correctly calculated in part a.

V_{R1} $\quad I_{R1}$ $\quad I_{R3}$ $\quad I_{D2}$ $\quad V_{R2}$

(circle any number of answers)

Circle none in this case

Assume that diode D_1 does **NOT** conduct.

Assume that diodes D_2 and D_3 **DO conduct.**

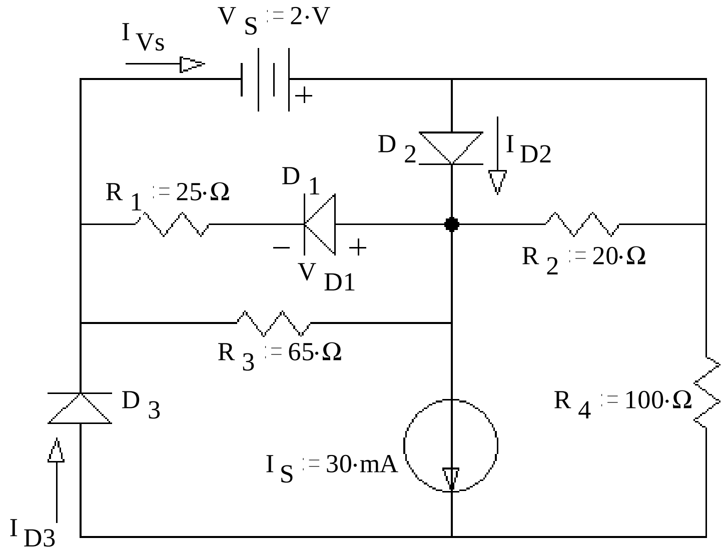
a) Stick with these assumptions even if your answers come out absurd.
Find the following:

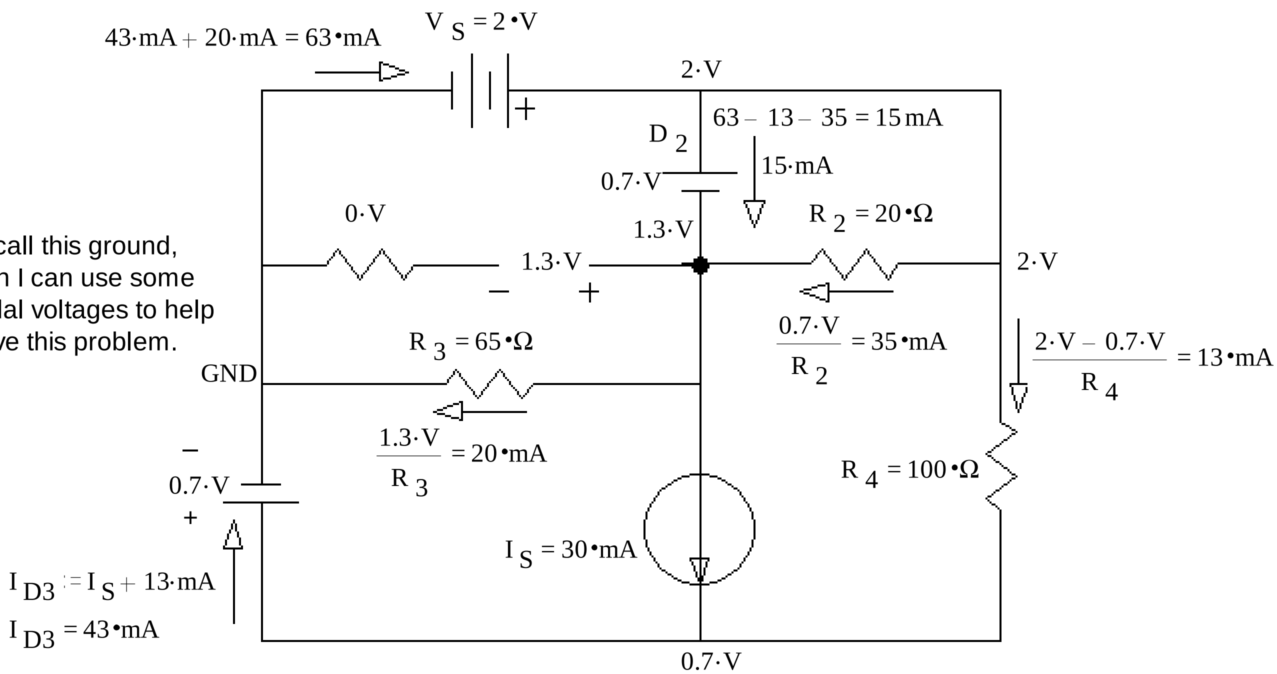
V_{D1} = ________

I_{D2} = ________

I_{D3} = ________

I_{Vs} = ________





If I call this ground, then I can use some nodal voltages to help solve this problem.

Alternate way to find: $I_{D2} := 20\cdot mA + I_S - \frac{0.7\cdot V}{R_2}$ $\quad I_{D2} = 15\cdot mA$

b) Based on the numbers above, was the assumption about D_1 correct? Circle one: yes no

How do you know? (Specifically show a value which is or is not within a correct range.) $V_{D1} = 1.3 > 0.7V$ no

c) Based on the numbers above, was the assumption about D_2 correct? Circle one: yes no
How do you know? (Show a value & range.)
$I_{D2} = 15\cdot mA > 0$ yes

d) Based on the numbers above, was the assumption about D_3 correct? Circle one: yes no
How do you know? (Show a value & range.)
$I_{D3} = 43\cdot mA > 0$ yes

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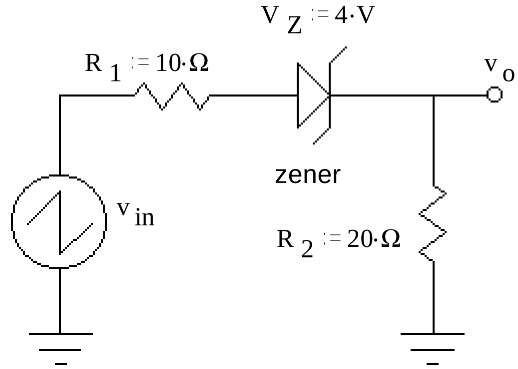
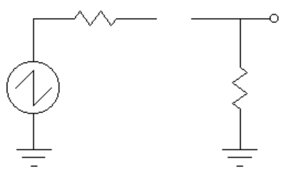
A voltage waveform (dotted line) is applied to the circuit shown.
Accurately draw the output waveform (v_o) you expect to see.
Label important times **and** voltage levels.



If diode doesn't conduct:

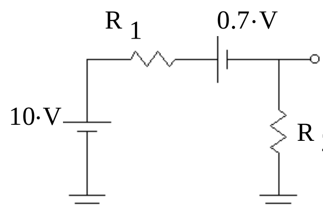


$v_o := 0$

Positive half

Diode conducts at: $0.7 \cdot V$ input   at time: $\frac{0.7 \cdot V}{10 \cdot V} \cdot 10 \cdot ms = 0.7 \cdot ms$

Maximum:

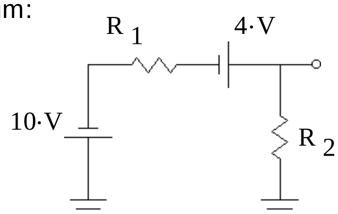


$v_o := (10 \cdot V - 0.7 \cdot V) \cdot \frac{R_2}{R_1 + R_2}$ $v_o = 6.2 \cdot V$

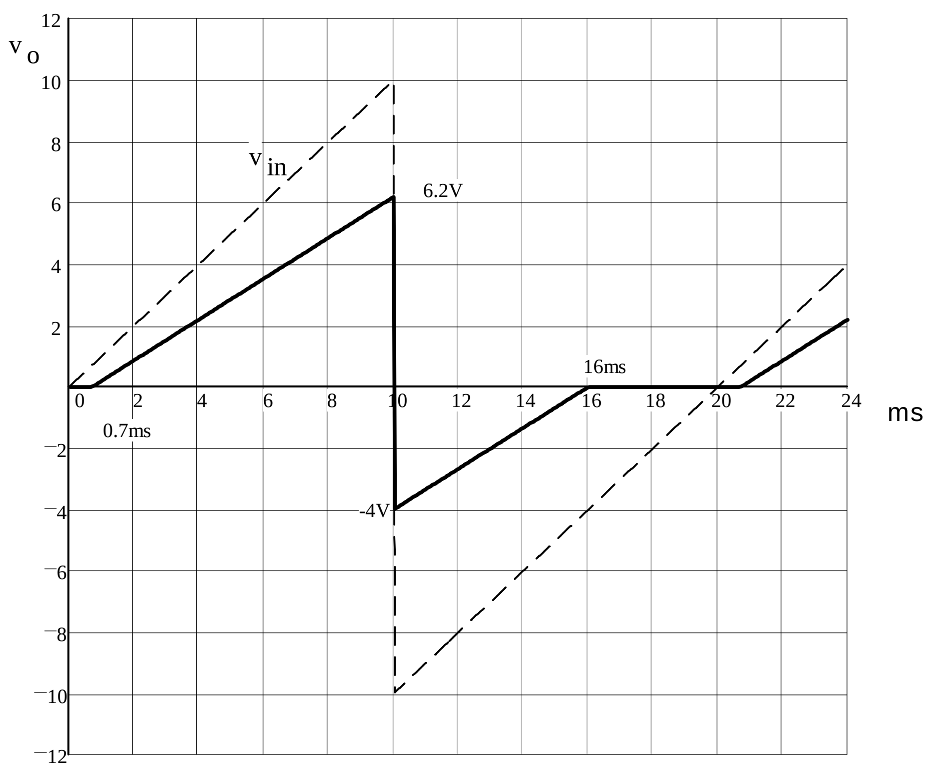
Negative half

Diode conducts at: $-4 \cdot V$ input   at time: $20 \cdot ms - \frac{4 \cdot V}{10 \cdot V} \cdot 10 \cdot ms = 16 \cdot ms$

Maximum:



$v_o := -(10 \cdot V - 4 \cdot V) \cdot \frac{R_2}{R_1 + R_2}$ $v_o = -4 \cdot V$



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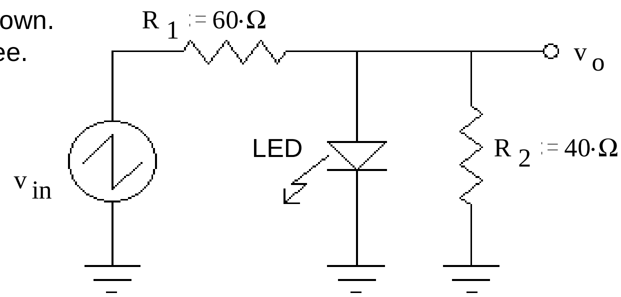

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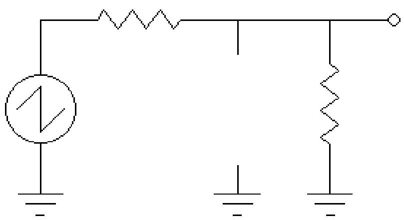
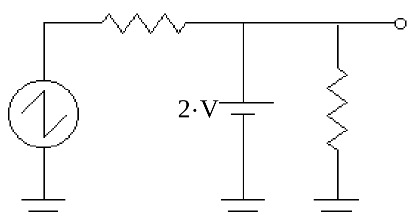


$$v_o = \frac{R_2}{R_1 + R_2} \cdot v_{in}$$

$$\frac{R_2}{R_1 + R_2} \cdot 10 \cdot V = 4 \cdot V$$

When: $v_{in} := \frac{R_1 + R_2}{R_2} \cdot 2 \cdot V$ $\quad v_{in} = 5 \cdot V$ at: $5 \cdot ms$ Diode begins to conduct

When diode conducts:



$$v_o = 2 \cdot V$$