Exercise # 1

1)
What is the voltage at site 1? \( V \) volts
What is the voltage at site 2? 0 volts
What is the current at site 1? \( \frac{V}{R} \) amps
What is the current at site 2? \( \frac{V}{R} \) amps

All the voltage is “dropped” across the resistor. Current only splits in parallel so in this case, it is the same current that flows at sites 1 and 2.

2)
What is the voltage at site 1? \( V \) volts
What is the voltage at site 2? \( V \) volts
How much current flows down the R1 resistor? \( \frac{V}{R_1} \) amps
How much current flows down the R2 resistor? \( \frac{V}{R_2} \) amps
How much current flows at site 1? \[
\frac{V}{R_1} + \frac{V}{R_2} = V\left(\frac{g_1 + g_2}{R_1 + R_2}\right)
\]

Voltage is constant in parallel, so it is the same at sites 1 and 2. Then you can calculate the individual currents that flow down each resistor from Ohm’s law. At any one point, the current flow in must equal the current flow out. So the current at site 1 must equal the sum of the currents that flow down the two resistors.
3) Draw the I-V curve of an ohmic device

Draw the I-V curve of a rectified device

The red curves are fine examples of the I-V relationship of ohmic devices. A device that has rectification has a non-linear I-V relationship as seen in the green curve.

4) Imagine this represents one piece of dendrite. If you injected a voltage $V_o$ at site 1, how much voltage remains at site 2? How much voltage is “dropped” via the leak current out of the membrane? What might be a way to drop less voltage? Biologically, what would this mean? Can you think of another way to lessen the attenuation of the voltage at site 2? What would that entail, biologically?

![Diagram](https://via.placeholder.com/150)

$V_2 = V_o \left( \frac{R_m}{R_a + R_m} \right)$

This is in fact, the voltage “dropped” across the membrane via the leak current. Imagine if the extracellular space is set to ground, the voltage difference between the inside and outside of the membrane is the voltage drop across the membrane resistance. Also remember that voltage is constant in parallel so the voltage at site 2 is the voltage difference between the top of the membrane resistor. But I should say here that I probably asked the rest of the question wrongly. What I wanted you to think about a bit was how to keep $V_2$ high. From the above equation, you can see that $V_2$ can stay relatively near $V_o$ if $R_a$ is low (maybe a dendrite with a large diameter) or if $R_m$ is high (maybe there are very few ion channels in the membrane). You could have answered...
something about how to drop the least amount of voltage across the membrane and that would have just meant minimizing $V_2$, either by having a really high $R_a$ (a very thin dendrite) or a nonexistent $R_m$ – essentially connecting site 2 to the extracellular space. I guess this could happen if your membrane had more channel proteins than lipid bilayer.