1 atm = 0.1 MPa (megapascals)

\[ 2\text{ atm} \times (0.1) = 0.2 \text{ MPa} \rightarrow \text{ it will take 3 atm to raise the water 70 cm.} \]

2. **Gravity is not taken into account** (see other numbers)
   (to overcome resistance)

3. **To = concentration outside the cell**
   \[ RT = 2.5 \text{ m} \text{ol} \] (constant \( \rightarrow \) NEVER CHANGES)

\[
\begin{align*}
500 \text{ mM} & \quad 500 \text{ mM} = 1 \text{ M} = 0.5 \text{ M} \\
100 \text{ mM} & \quad 10^3 \text{ mM} \\
200 \text{ mM} & \quad 10^3 \text{ mM} = 0.2 \text{ M}
\end{align*}
\]

\[ \ln: \text{RT (0.5)} \rightarrow -2.5 (0.5 \text{ M}) \rightarrow -1.25 \text{ MPa} \]

\[ \text{OUT: RT (0.7)} \rightarrow -2.5 (0.2 \text{ M}) = -1.5 \text{ MPa} \]

\[ \text{OUT - INSIDE} = -1.5 + (1.25 \text{ MPa}) = 0.75 \text{ MPa} = 0.75 \text{ atm} \]

4. **Ca}^{2+} \text{ in cytoplasm cannot increase.}**

   C1+ channels don't open
   K+ isn't lost
   stomata can't close

5. **Adhesion**
   **Surface Tension**

   The smaller the radius, the greater the negative pressure and the big pressure pulls the column of water up the tube against the force of gravity.
- $RT(y_o - y_i) = turgor \ pressure$

Diagram:

- Opening
- Closing
- Completely closed

$K^+, Cl^-, H^+, Ca^{2+}$

Lower concentrations:
- $K^+, Cl^-, H_2O, Ca^{2+}$

Inside cell

Deciduous trees move water in the winter when they don’t have leaves by not moving water at all.

(ends of xylem tubes are sealed)

Pulling force on the water $\rightarrow$ leaf pulls the water

No leaf, no pulling force, water would fall back down to roots if xylem was not sealed.
(4) 1 atm supports column of water 35 ft high

\[ 70 \div 35 = 2 \text{ atm} \]

It will take 2 atm to raise water 70 ft

\[ 2 \text{ atm} \times \frac{1 \text{ atm}}{1 \text{ atm}} = 2 \text{ atm} \]

(5) Water must rise to the top of the tree, but it must also flow to meet the water needs and the loss by evaporation. To flow through the xylem, it requires pressure to overcome resistance and gravity.

(6) \[ \psi_z = 50 \text{ cm} \times \frac{1 \text{ atm}}{10^3 \text{ atm}} = 0.05 \text{ atm} \]

\[ \psi_0 = 200 \text{ mm} \times \frac{1 \text{ atm}}{10^3 \text{ atm}} = 0.2 \text{ atm} \]

\[ \text{turgor} = -2.5 \times \frac{2 \text{ atm} \text{ atm}}{12 \text{ atm} - 0.5 \text{ atm}} \]

\[ = -2.5 \times \frac{2 \text{ atm} \text{ atm}}{11.5} \]

\[ = 4.3 \text{ atm} \times \frac{1 \text{ atm}}{1 \text{ atm}} = 4.3 \text{ atm} \]

(7) If \( Ca^{2+} \) is blocking the \( Ca^{2+} \) channels, then \( Ca^{2+} \) cannot increase in the cytoplasm. If there is no increase in calcium, the \( Ca^{2+} \) channels won't open and \( H^+ \) is not lost from inside the cell. As a result, the stomata cannot close.

(10) They don't! The ends of the xylem tubes are sealed off across the leaf separates from the branch to prevent the water column from collapsing.
Useful things to know:

\[ \log(a/b) = -\log(b/a) \]
\[ \log(1) = 0 \]
\[ \log(10) = 1 \]
\[ \log(100) = 2 \]
\[ \log(1000) = 3 \]
\[ \log(10000) = 4 \]

Problem set 3

1. \[ -87 mV = \frac{58}{2} \log \left( \frac{1 M}{x} \right) \]

2. \[ -87 mV = \frac{29}{2} \log \left( \frac{1 M}{x} \right) \]

3. \[ -87 mV = \frac{29}{2} \log \left( \frac{10^3 M}{10^{-7}} \right) \]

4. Cystolic concentration = 1000 mM or 1 M

5. \[ \frac{100 \text{ mM}}{1} \times \frac{1 \text{ M}}{10^3 \text{ mM}} \times \frac{1000 \text{ mM}}{1 \text{ M}} = 1 \times 10^5 \text{ mM} \text{ or } 1 \times 10^7 \text{ M} \]

6. \[ \frac{58}{2} \log \left( \frac{10^3 M}{10^{-7}} \right) \]

7. \[ 29 \log \left( \frac{10^3}{10^{-7}} \right) = 29 \log (10^4) = 29 \log (10000) \]

8. \[ \log (10000) = 4 \]

9. \[ 29 \times 4 = 116 \text{ mV} \]

10. \[ -87 - 116 = -203 \text{ mV} \]

11. 203 mV from equilibrium