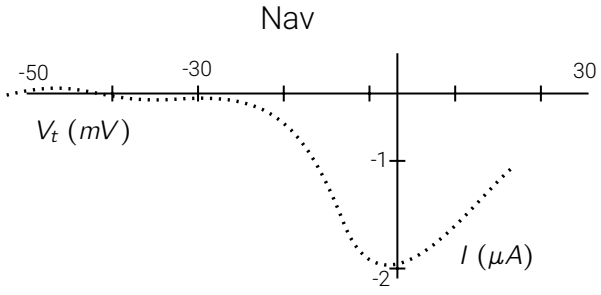
Sensory and Motor Systems — Problem Set 1

1. What is the membrane potential at steady state in a cell with a membrane that is only permeable to calcium (Calcium out = 1.9mM, Calcium in= 0.0002mM)?

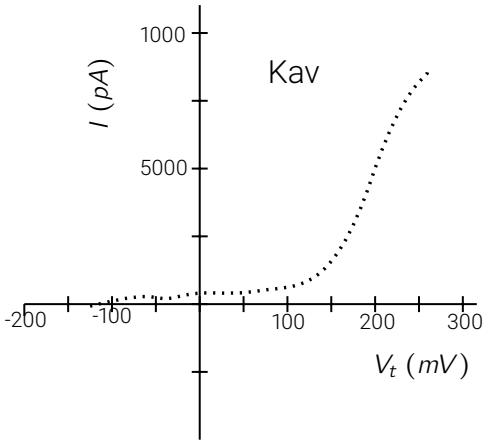
2. Define equilibrium for an ion (within the context of the neuronal membrane). Your answer should mention forces.

3. If Vm is -70mV and external sodium is 145mM and internal is 10 mM. Calculate the driving force for sodium ions after Nav channels open.

4. Please explain the shape of the current voltage relationship for both voltage gated sodium and potassium ion channels.

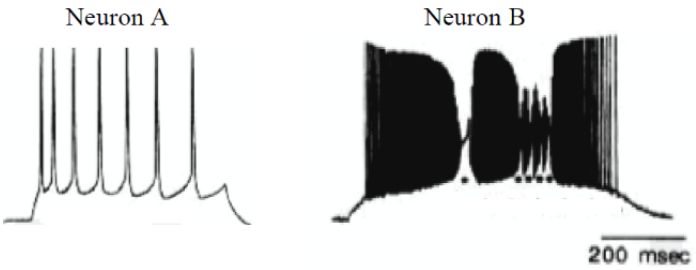


Explanation:



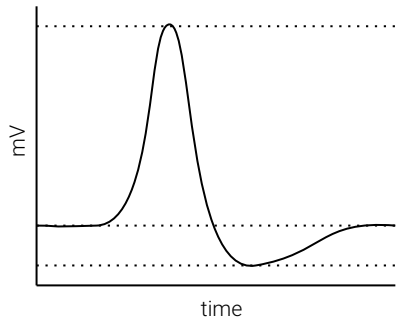
Explanation:

5. Neurons A and B are able to fire at different frequencies. Neuron A's maximum firing rate is shown below at left; Neuron B's maximum firing rate is shown at right. Note that in both cases, the vertical lines represent spikes, or individual action potentials. Suggest one specific difference in Na+ or K+ channel properties between these 2 neurons that could explain the different firing rates. Be as specific as you can.



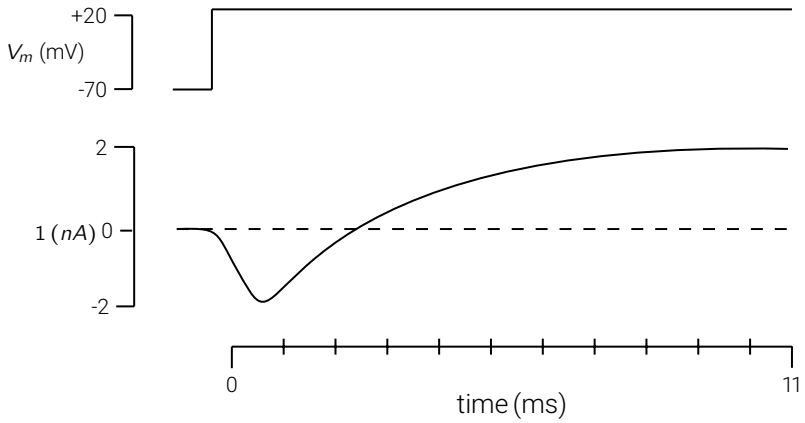
Explanation:

6. Imagine that a mutation causes faster inactivation of sodium channels compared to those that help produced the APs bellow. Draw and explain how the AP shape would change.



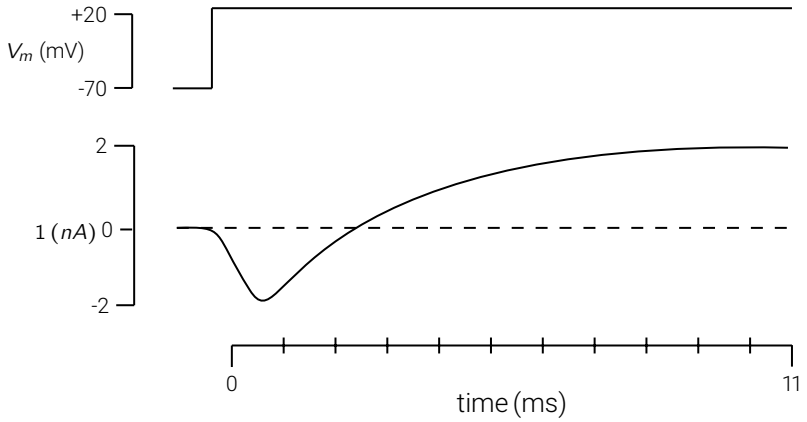
Explanation:

7. When a normal, healthy squid axon is voltage-clamped in artificial seawater, one obtains the following current (I) record in response to a step change in V_m from –70 mV to 20 mV.



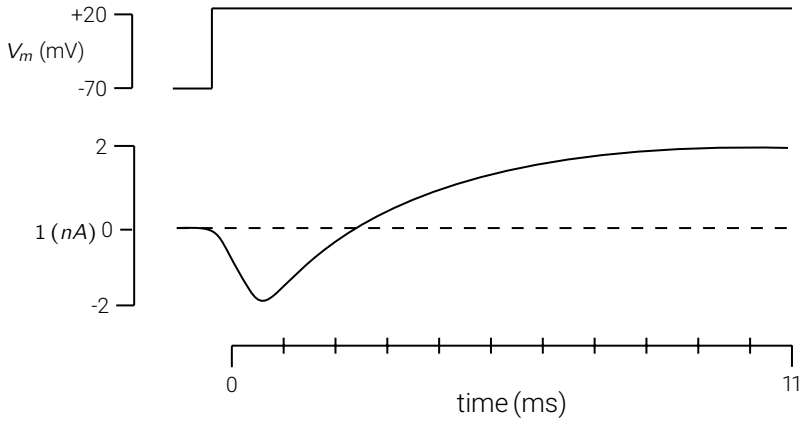
Draw plots of current vs. time when the recordings are made under each of the following experimental conditions. For each (questions a–d, on next page), overlay the new response on the control plot. Briefly explain your reasoning next to each plot. Note that a dashed line is provided at 0 nA.

a. TEA, a voltage gated K+ channel blocker is added:



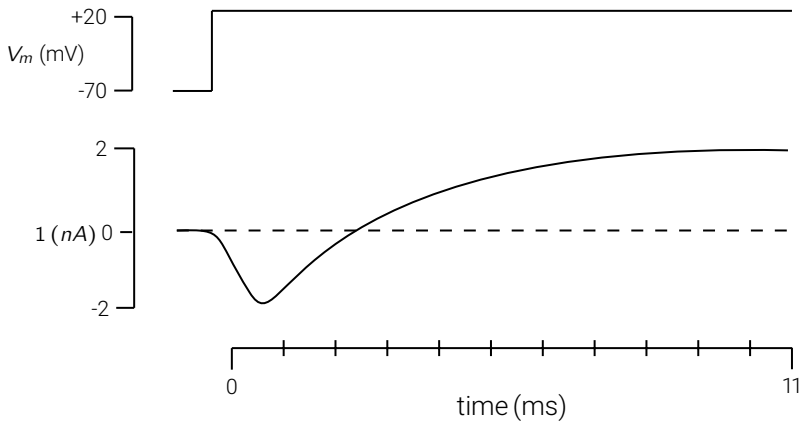
Explanation:

b. TTX, a voltage gated Na+ channel blocker is added:



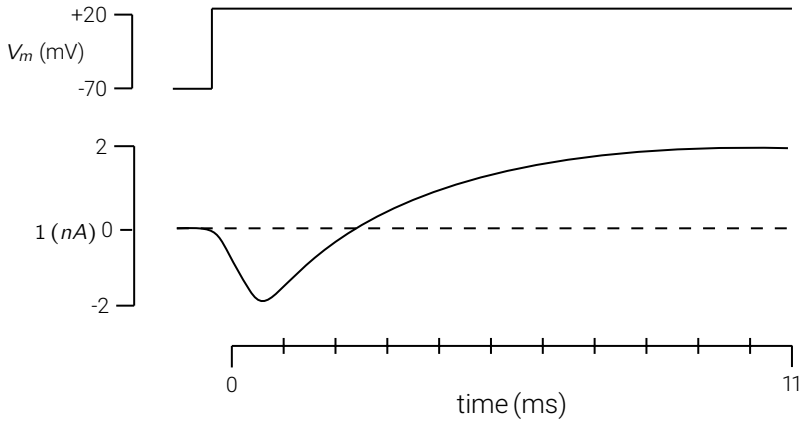
Explanation:

c. Na concentration out= Na concentration in:



Explanation:

d. K^+ concentration out= K concentration in:



Explanation: