Problem Set 1
Question 4

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Radius of spherical cell $r = 0.06\ mm$

Specific membrane capacitance $c_m = 10\ nF/mm^2$

Only potassium channel in the cell

Concentration of potassium outside the cell $C_{out} = 4.8\ mM$

Concentration of potassium inside the cell $C_{in} = 186\ mM$

Initial voltage $V_0 = 0\ mV$

Time at which channels suddenly opened $= t_0$

1

Initial number of moles of potassium ions in the cell

$$\begin{aligned} N_0^{inside} &= \text{Volume of cell } \times C_{in} \\ &= \frac{4}{3}\pi r^3 \times C_{in} \\ &= \frac{4}{3}\pi \frac{(0.06)^3}{10^{-6}} \times \frac{186}{10^3} \end{aligned}$$

$$\boxed{N_0^{inside} = 53.568\pi\ moles}$$

2

Steady state membrane potential is the potassium nernst potential as calculated in question 3

$$\boxed{V_\infty = -97.8298\ mV}$$

3

Charge accumulated $q = CV$

From question 2 we get C as $144\pi \times 10^{-12}F$

On substituting,

$$\boxed{q = -44.26289 \times 10^{-12}\ C}$$

4

As the steady state potential is negative, it implies more K^+ on ions inside. Hence the ions flow from intracelluar space to extracellular space.

The number of potassium ions is given as the $\dfrac{q}{\text{charge on one monovalent ion}}$

Hence no. of K^+ ions finally is $\dfrac{44.26289 \times 10^{-12}}{1.6 \times 10^{-19}} = \boxed{27.664 \times 10^7 \text{ ions}}$

5

The potassium concentration inside the neuron decreases.