Action Potential

A. The resting membrane potential is characterized by sodium wanting to enter the axoplasm due an electrochemical gradient, but fails to due so because of the impermeability of the membrane to sodium (Na+). Potassium, on the other hand has a concentration gradient for diffusion out of the axoplasm, but fails to do so as the force of diffusion is countered by the negative charge within the axoplasm due to proteins and phosphates.

B. Here a depolarization occurs due to an inward net movement of sodium ions into an adjacent portion of the axon. However, threshold is not reached; and action potential in not generated. Ions are redistributed by Na/K exchange pumps and again reach the resting membrane potential.

C. Depolarization again occurs due to an inward movement of sodium ions into the neuron. But this time threshold is reached (D) by nearby voltage sensitive gates.

E. Having reached threshold, the sodium "activation gate" opens fast, allowing sodium (Na+) to rush into the axoplasm. As this is happening the slower moving "inactivation gate" is closing, and the potassium (K+) gate is slowly opening.

F. Sodium continues to rush in during (E), but once the "inactivation gate" closes, sodium can no longer enter and the voltage plateaus (F). The charge within the axoplasm is now positive (+), i.e. +30 mV. This polarity change gives potassium a temporary electro-chemical gradiant

G. As the "inactivation gate" closes, the Potassium gate has concurrently opened. And the negative charge that was previously holding the potassium back is no longer present. Rather, potassium is momentarily experiencing an electrochemical gradient, as the voltage is now +30 mV. Potassium now rushes out of the axoplasm and the voltage becomes negative (G).

H. The voltage again passes through threshold, and the sodium activation gate closes fast. Since the slow moving inactivation gate is already closed, there will be no net movement of sodium ions. Potassium (I) will continue to leave the axoplasm as it too is a slow closing gate.

J. As the potassium gate is slow closing, potassium continues to leave causing the membrane to hyperpolarize (the charge is negative of l resting membrane threshold).

K. Once the potassium gate does close, the voltage again plateaus, as these ions can no longer pass through the membrane.

L. The continuous activity of the Na/K exchage pumps redistribute the ions, and they eventaully return to the resting membrane potential as the original equaibrium between potassium and the negatively charged molecules within the axoplasm is reestablished.