Unless otherwise noted, assume below that:

 T=25°C

R= 1.99 cal mol^-1 deg^-1

Faraday’s Constant= 23,062 cal volt^-1 equiv ^-1

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Problem:

1. In skeletal muscle the Ca+2 concentration is controlled by the SR (sarcoplasmic reticulum). At rest, the Ca+2 pump of the SR can maintain a concentration gradient of

0.5 mM inside SR / 0.1 µM cytoplasm (aka, outside the SR). How much energy is stored in this gradient; ignore the effects of charge.

1. The pump can be summarized by these two equations:

2 Ca+2 outside $\rightarrow $ 2 Ca+2 inside

ATP$\rightarrow $ ADP + Pi

Given the resting concentration of Ca+2 above and ATP= 2.5mM, ADP= 0.5 mM and Pi= 0.5 mM, how much energy is required to move the 2 Ca+2 ions into the SR per cycle and how much energy is released by ATP hydrolysis. (G’ ATP = -7,700 cal/mol)

1. The SR also contains a Ca+2 binding protein “calsequestrin” which reduces the actual SR free [Ca+2] from 20 mM, which it would be without the presence of the protein, to 0.5 mM; the figure given above. From the info given, total SR Ca+2 and free SR Ca+2, and an estimate of 90% saturation of binding sites under these conditions, estimate the Ka of calsequestrin for Ca+2.