Key to Homework #3

1. The first step is to calculate the concentrations of the components:

   [NaCl] = 5.8 g ÷ 0.1 liter ÷ 58.44 g/mole = **1 M**

   <u>total</u> [MES] = 9.75 g ÷ 0.1 liter ÷ 195 g/mole = **0.5 M**

   [NaOH] = (3.5 ml)(1 M)/100 ml = **0.035 M**

2. MES is a weak acid and the ratio of the amount of MES in the acid form and the amount of ionized MES (i.e., the conjugate base) will determine the pH as defined by the following:

   $MES \leftrightarrow MES^- + H^+$

   The amount of MES^- is equal to the [NaOH] since each mole equivalent of strong base will convert MES to the deprotonated, or ionized, form. The MES will now be represented by this value subtracted from the total MES, or:

   pH = 6.15 + log0.035/(0.5-0.035) = 5.0

3. The two factors which probably contribute most to the difference in calculated pH vs. measured pH are the pH being > 1 pH unit from the pK_a and the high ionic composition of the buffer (i.e., 0.5 M MES and 1 M NaCl). Temperature could also play a role since there was no mention of temperature. The low pH would tend to exclude the Na^+ effect (i.e., electrode error) since this is most prominent at high pH. It might be advisable to switch to a buffer with a pK_a closer to 5, especially if the H^+ would have a tendency to increase during the experiment.