This is graded quiz #1. It contains two problems, 20 points total. You can type/paste your answers directly in the textbox on ELMS or upload scanned copies of your answers. If the latter, before uploading your work to ELMS please make sure all scanned/photocopied material has good resolution and is readable both on your computer and in ELMS. If the uploaded material is unreadable it will not be graded.

Problem 1. Consider a hypothetic reaction A $\rightleftarrows$ B that takes place at 25°C. The reaction started with 250 mM of compound A and no B. Five minutes after the reaction started, the molar concentration of A dropped to 100 mM, and the ΔG for the forward reaction at this time point was -3 kJ/mol. Answer the following questions.

(A) (3 points) Determine the value of ΔG^o for the forward reaction.
Concentrations at the 5 min point: [A] = 0.1 M, [B] = 0.25M - 0.1M = 0.15 M. Since we know ΔG at this point, we can calculate $\Delta G^o = \Delta G - RT \times \ln([B]/[A])$ = **- 4.004 kJ/mol**

(don't worry about the decimal digit precision, - 4 kJ/mol should work)

(B) (3 points) Determine the equilibrium constant for the forward reaction.

$K_{eq} = \exp(-\Delta G^o/RT)$ = **5.036**

(again, don't worry about the decimal digit precision, 5.0 should work, too)

(C) (3 points) Determine the final molar concentration of B.

The final point in the reaction is where it reached the equilibrium (because it's where it stops). Assuming the equilibrium concentration of B is $[B]_{eq}$, using the equation that relates the equilibrium constant to the ratio of concentrations at equilibrium, $K_{eq} = [B]_{eq}/(0.25-[B]_{eq})=5.036$; and solving it for $[B]_{eq}$ we get $[B]_{eq} \times 6.036 = 0.25 \times 5.036$ → $[B]_{eq} = 0.25 \times 5.036/(6.036)$ = **0.2086 M**.

Problem 2. (11 points) You need to prepare 200 mL of 50 mM acetate buffer with pH 5.2. You do this by mixing pre-calculated amounts/volumes of acetic acid and sodium acetate with pure water. Calculate how many milliliters of 1M acetic acid and 1M sodium acetate you need for this.

The final concentrations of CH_3COOH and CH_3COO^- are related through the Henderson-Hasselbalch equation: $[CH_3COO^-]/[CH_3COOH] = 10^{pH-pKa} = 10^{5.2-4.76} \approx 2.75$. This gives

$[CH_3COO^-] = 2.75 \times [CH_3COOH]$, and because $[CH_3COO^-] + [CH_3COOH] = (1+2.75) \times [CH_3COOH] = 50$ mM, we obtain $[CH_3COOH] = 50$ mM /3.75 = 13.3 mM and $[CH_3COO^-]$ = 36.7 mM.

Now let's determine the volumes of the initial 1000 mM stock solutions needed to have 200 mL of the final mixture with these concentrations.

Volume $_{[CH3COOH]}$ × 1000 mmol/L = 200 mL × 13.3 mmol/L ➔ Volume $_{[CH3COOH]}$ = (13.3/1000) ×200 mL = **2.66 mL**

Volume $_{[CH3COO^-]}$ × 1000 mmol/L = 200 mL × 37.6 mmol/L ➔ Volume $_{[CH3COO^-]}$ = (36.7/1000) ×200 mL = **7.34 mL**