# Chemistry 236 -- Quiz 2

Lab Day ____

February 5, 2013 — Experiments 1 and 2

## A. (12) Calibration.

1. (3) A Baratron gauge (capacitance manometer) gives a reading of –0.27 V when $P$ = 0, and 7.08 V when $P$ = 760 Torr. What is the apparent $P$ when the gauge reads 4.44 V?

   487 torr

2. (2) Calibration data for a thermistor are as shown in the accompanying graph. If the thermistor reads –27.0°C, what is the true temperature?

   −27.5 (±0.1) °C

3. (4) A thermistor has a resistance of 11.27 kΩ at 10.0°C and 1.257 kΩ at 50.0°C. If the thermistor behaves in accord with the simplest theoretical relationship between temperature and resistance, what should its resistance be when the temperature is 30.0° C?

   3.501 kΩ

4. (3) A J-tube experiment (pictured to right) is carried out under a constant atmospheric pressure of 732 torr and a constant temperature of 25°C. Initially (diagram **A**) a 52.1-cm$^3$ sample of gas is trapped in the closed end, such that the difference of the mercury column heights on the two sides is $h$ = 80.0 mm. Then additional mercury is added, reducing the volume to 40.0 cm$^3$ (**B**). Neglecting temperature corrections for the density of Hg, what is $h$ in **B**? $325._6$ mm

## B. (16) Pickanose$^{-1}$.

1. (6) Polarimetry is used to study the inversion process for a newly discovered sugar, pickanose. Like sucrose, this sugar changes the sign of its optical rotation as it undergoes acid-catalyzed hydrolysis (*i.e.*, it "inverts").

   (a) Write the general equation for the time dependence of the rotation $\alpha(t)$, as a sum of a constant ($B$) and an exponentially decaying term of initial magnitude $A$ with effective rate constant $k_{eff}$.

   $\alpha(t) = A \exp(-k_{eff}\, t) + B$

   (b) Re-express this equation in terms of the rotations $\alpha_0$ and $\alpha_\infty$ for $t$ = 0 and $t$ = ∞, respectively.

   $\alpha(t) = (\alpha_0 - \alpha_\infty) \exp(-k_{eff}\, t) + \alpha_\infty$

   (c) Suppose the inversion point is reached at time $t_{inv}$. Obtain an expression for $k_{eff}$ in terms of $t_{inv}$, $\alpha_0$, and $\alpha_\infty$ (or $A$ and $B$ if you are unsure of your results for $\alpha_0$ and $\alpha_\infty$).

   $k_{eff} = t_{inv}^{-1} \ln[(\alpha_\infty - \alpha_0)/\alpha_\infty]$

2. (4) Initially a 20.0-cm polarimeter tube is charged with a solution of pickanose and HCl(*aq*) prepared by mixing 25.0 mL of the stock sugar solution with 15.0 mL of 4.0 M HCl. At the start of the inversion reaction, the measured rotation of the polarimeter is −12.4°. The specific rotation $[\alpha]_\lambda^T$ for pickanose is −26.4 degree dm$^{-1}$ mL g$^{-1}$ at the temperature and wavelength used in the experiment. Calculate the initial concentrations in the polarimeter tube, of (a) pickanose, and (b) HCl. [Assume volumes are additive.]

   (a) 0.235 g/ml (b) 1.5 M

3. (4) The reaction is found to reach the inversion point in 23 min; after 15 hours, the rotation is found to be 19.2°. Calculate (a) the effective rate constant $k_{eff}$ and (b) the rate constant $k_H$.

   (a) 0.217/min (b) 0.0144 l mol$^{-1}$ min$^{-1}$

4. (2) Having trouble with her error propagation, Honey Sweetwater decides to follow the suggestion in the writeup — to use weighted nonlinear LS fitting in KG to obtain her activation energy and uncertainty from estimates of $k_H$ at 22° and 40°C. She finds that KG won't work with just her two points, so she copies each entry line again in the data sheet, giving 4 points total and success with KG. What must she then do to correct her results for the $E_a$ uncertainty, and why?

   Multiply by $\sqrt{2}$. When data are simply repeated $n$ times in a weighted KG fit, the parameter standard errors go as $1/\sqrt{n}$, so this is needed to correct for this "false" $n$ dependence.