Inversion of Sucrose

A. Reaction and Kinetics

1. $S + H^+ + H_2O \rightarrow F + G + H^+$ (*i.e.*, acid-catalyzed)
2. *Rate Law*: $r = -d[S]/dt = k_H [H^+] [S] \equiv k_{eff} [S]$

   (*pseudo-first order* — because $[H^+]$ doesn't change)
3. *Integrate*: $-d[S]/[S] = k_{eff}\, dt \rightarrow \ln [S] = \text{const} - k_{eff}\, t$
4. *Boundary Condition*: @ $t = 0$, $[S] = [S]_0 \rightarrow \text{const} = \ln [S]_0$

   $\rightarrow [S] = [S]_0 \exp(-k_{eff}\, t)$ (first-order decay law)

B. Experiment

1. Measure α with polarimeter. But all 3 sugars are optically active, so α doesn't vanish when S is 100% converted.
2. Rather, $\alpha = A \exp(-k_{eff}\, t) + B$ (exponential + background)
3. $t = 0$: $\alpha\ (\equiv \alpha_0) = A + B$; $t = \infty$: $\alpha = B$ (α for F + G)

4. *Specific rotation*: $\alpha = [\alpha]^T_\lambda [\ ] \ell$

   units of $[\alpha]^T_\lambda$: degree L g^{-1} dm^{-1}

5. Need one "completion" run to get α .

C. Temperature Dependence

1. *Arrhenius*: $k = A \exp(-E_a/RT)$ $\Rightarrow$ $\ln k = \ln A - E_a/RT$

2. *Typical*: Have k at two Ts $\Rightarrow$ $k_2/k_1 = \exp[(E_a/R)(1/T_1 - 1/T_2)]$

   $\ln(k_2/k_1) = (E_a/R)(1/T_1 - 1/T_2)$ (don't need A)

3. ***Note***: This is our second encounter with $\ln(\ ) = a + b/T$. We will see it again in analyzing the T dependence of equilibrium constants (Expt. 5) and vapor pressure (Expt. 6).

   In all such thermodynamic applications, T is in K.

Statistical Error Propagation

A. **Statistics Notes 3**

B. **Statistics Problems 11-17**

C. **Partial Differentiation**

Exercises available at

http://www.vanderbilt.edu/AnS/Chemistry/Tellinghuisen/Chem236/PDExer.pdf

and solutions at

http://www.vanderbilt.edu/AnS/Chemistry/Tellinghuisen/Chem236/PDSoln.pdf

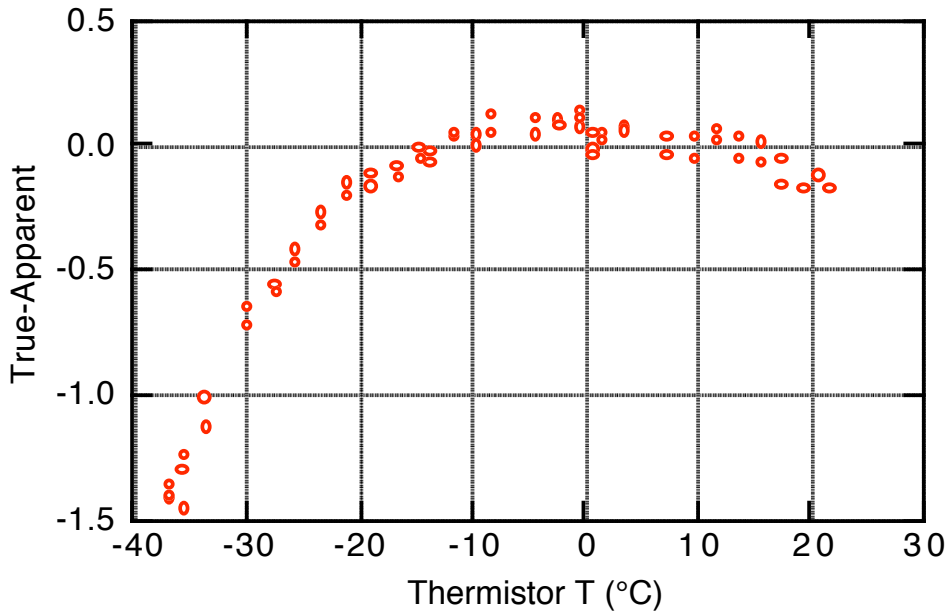
Today's Practice Quiz !

1. A quantity is known to follow a linear relationship, $y = a + bx$. If $y = -1.5$ when $x = 0.2$ and $y = 111.7$ when $x = 8.9$, what are the values of a and b?

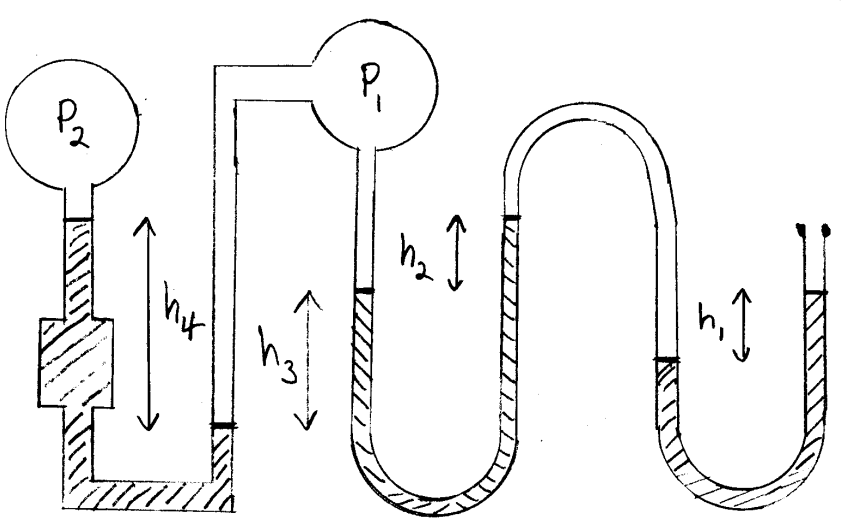
   a. $a = -2.5$; $b = 5.0$ b. $a = -3.5$; $b = 10.0$ c. $a = -4.0$; $b = 12.7$
   d. $a = -4.1$; $b = 13.0$ e. none of these

2. Student records a data point on the sublimation curve of ice, where the thermistor reads –24.1°C. If the calibration data are as shown in the accompanying graph, what is the corrected T?

   a. –24.5°C b. –23.7°C
   c. 0.4°C d. –0.5°C
   e. This cannot be determined w/o additional information.



3. Refer to the accompanying figure of three connected Hg manometers. If atmospheric pressure is 754 torr, h_1 = 111 mm, h_2 = 83 mm, h_3 = 192 mm, and h_4 = 289 mm, what are the pressures P_1 and P_2 (in Torr)?



a. 865 & 948 b. 948 & 659
c. 948 & 851 d. 560 & 849
e. P_1 = 948 Torr; P_2 cannot be determined.

4. If barometers used water as the operating fluid, a weather barometer would need to be about how tall? [1.00 m = 39.37 in.]

a. 5 ft b. 15 ft c. 40 ft d. 100 ft e. none of these

5. Besides the size problem, can you think of any other reason why water might be an unwise choice for a barometer?

a. It is transparent. b. It has significant vapor pressure.
c. Mosquitoes can breed in H_2O but not in Hg. d. All of the above
e. None of the above