Chemistry 236 -- Quiz 2

Lab Day ____

February 4, 2014 — Experiments 1 and 2

A. (3) Calibration functions. A Baratron pressure gauge gives a reading of −0.27 V when P = 0, and 8.51 V when P = 761 torr. What is the apparent P when this gauge reads 4.33 V?

$P = a + bV$ → $P(4.33\text{V}) = 398._7$ torr

B. (3) P calibration — away from mercury. An oil manometer charged with dibutyl phthalate (ρ = 1.046 g/mL) yields a level difference h = 42.3 mm in a system where the reference arm is held at a pressure of P = 1.06 torr. What is the pressure of the gas sample? (ρ_{Hg} = 13.595 g/mL)

ΔP = 42.3 torr × 1.046/13.595 = 3.25_5 torr → P = 4.31 torr

C. (6) Calibration — Fitting the data. You obtain the illustrated results upon fitting your thermistor calibration data (true − thermistor *vs.* thermistor), obtained over the region 19-32°C.

1. Properly state the correction and its statistical error at 25°C. ΔT = 0.0509(12) °
2. If there are 24 data points, what is the estimated standard deviation (s_y) of these data?

   s_y^2 = Chisq/ν = 2.3765×10^{-5} → s_y = 0.004875 °
3. If the thermistor reads 30.47°C, what is the corrected temperature? 30.52°C

D. (15) Pickanose^{-1}.

1. (3) The acid-catalyzed inversion of pickanose has a rate constant of 0.0324 L mol^{-1} min^{-1}. A reaction is initiated by mixing 10.00 mL of 4.0 M HCl with 20.0 mL of a solution of pickanose. Assuming that volumes are additive, calculate the effective rate constant for this mixture; or indicate if you think that this cannot be done.

   k_{eff} = 0.0432 min^{-1}

2. (3) This reaction is monitored by polarimetry. The optical rotation is initially 18.0° and is −8.0° when the reaction has gone to completion. Calculate the rotation (a) after one half-life, and (b) after two half-lives; or indicate if you think there is insufficient information to determine these quantities.

   Rx is 1/2 completed after 1 half-life, 3/4 completed after 2. (1) 5.0° (2) −1.5°

3. (6) The reaction is studied at 20.0°C and at 45.0°C. Suppose that the $k_{H,20}$ and $k_{H,45}$ values are each uncertain by 8%, and their ratio is 4.5.

   (a) Calculate the % uncertainty in their ratio; use this result to state this ratio and its uncertainty.

   $(8^2 + 8^2)^{1/2}$ % = 11.3 % r = 4.5(5)

   (b) Calculate the uncertainty in $\ln(k_{H,45}/k_{H,20})$. $s(\ln r) = s_r/r = 0.113$

   (c) Use the last result to calculate the uncertainty in the activation energy E_a. (Take temperatures as error-free; R = 8.3145 J mol^{-1} K^{-1})

   $\ln r = E_a/R\,(1/T_1 - 1/T_2)$ → $s_{E_a} = s(\ln r)\,R/(1/T_1 - 1/T_2)$ = 3.51 kJ/mol

4. (3) A solution of a different sugar, bashanose, is prepared by dissolving 23.71 g of bashanose in water and bringing the volume to 0.100 L in a volumetric flask. The optical rotation observed at λ_D for this solution in a 0.200-m polarimetry cell at 25°C is 14.7°. Calculate the specific rotation of bashanose (units deg mL g^{-1} dm^{-1}) at this wavelength and T.

   31.0 deg mL g^{-1} dm^{-1}