Chemistry 236 — Quiz 2
November 1, 2006 — Tellinghuisen

Honor Code Pledge: I have neither given nor received aid on this exam. _____

(Signature)

I. (11) Bombs Away.

A. (8) Strangelove uses a bomb calorimeter to estimate the heat of combustion of an unknown. The calorimeter is calibrated with benzoic acid (BA, $q_{specific}$ = –26.413 kJ/g); both the BA and the unknown are ignited with iron fuse wire ($q_{specific}$ = –6.68 kJ/g).

In experiments run at ~25°C, 1.038 g of BA and 57 mg of fuse wire yield a temperature rise of 1.119 K. Then 1.372 g of unknown and 48 mg of fuse wire produce a ΔT of 1.322 K. In each case the calorimeter pail is filled with the same volume of water. Calculate **(1)** the calorimeter constant, and **(2)** $q_{specific}$ for the unknown.

(1) C_K = 24.84 kJ/K (2) $q_{spec,unk}$ = –23.70 kJ/g

B. (3) Calculate the value of $\Delta H° - \Delta E°$ for the combustion of cyclohexane [$C_6H_{12}(\ell)$] at 40.0°C. [R = 8.3145 J mol^{-1} K^{-1}].

$\Delta H° - \Delta E°$ = –7.811 kJ/mol

II. (14) Smucrose^{-1}.

A. (4) Getting Started. Polarimetry is used to study the inversion process for a newly discovered sugar, smucrose. Initially a 20.0-cm polarimeter tube is charged with a solution of smucrose and HCl(*aq*) prepared by mixing 25.0 mL of a stock smucrose solution with 15.0 mL of 4.0 M HCl. At the start of the inversion reaction, the measured rotation of the polarimeter is 11.3°, and after a very long time, the rotation is measured to be –14.2°. The specific rotation $[\alpha]_{\lambda}^{T}$ for smucrose is 46.4 degree dm^{-1} mL g^{-1} at the temperature and wavelength used in the experiment. Calculate **(1)** the initial concentration of smucrose, and **(2)** the initial concentration of HCl in the polarimeter tube.

(1) [smucrose] = 0.122 g/mL (2) [HCl] = 1.5 M

B. (6) Inverting. The reaction is found to reach the inversion point after 33 min. Calculate **(1)** the effective rate constant k_{eff} and **(2)** the rate constant k_{H}.

(1) k_{eff} = 0.0177 min^{-1} (2) k_{H} = 0.0118 L mol^{-1} min^{-1}

C. (4) Getting Warmer. The rate constant is found to increase by a factor of 2.35 when the temperature is increased from 20.0°C to 40.0°C. Calculate the activation energy E_a. [R = 8.3145 J mol^{-1} K^{-1}].

E_a = 32.6 kJ/mol

III. (8) Triple Trouble.

A. (6) I. B. Alwette and U. B. Water run the TP experiment and analyze their data to obtain ΔH_{vap} = 45.74±0.13 kJ/mol and ΔH_{sub} = 52.09±0.08 kJ/mol. Calculate from these results ΔH_{fus} and its uncertainty. State the results with the proper numbers of significant figures.

6.35(15) kJ/mol

B. (2) Morely Smartt does very careful vapor pressure measurements on water near 25°C and obtains ΔH_{vap} = 44.001(3) kJ/mol, while Bud Wizer breezes through and gets 44.8(9) kJ/mol. The literature value is 44.012 kJ/mol. Which determination — Smartt's or Wizer's — is the greater cause for "concern"? Explain briefly.

Wizer's result is much further from the accepted value, but it is nonetheless within 1 σ . On the other hand, Smartt's value is off by 3.7 σ, which has a very small probability of occurring randomly. Thus, Smartt's result could mean that the literature value is, in fact, wrong. This makes Smartt's a greater source of concern.

IV. (6) Percent Error.

Suppose that x, y, and z are obtained from measured values of t, u, and v, which have % uncertainties of 3.0%, 5.0%, and 2.0%, respectively. If $x = 5v^{-3/2}$, $y = 9\,u\,/v$, and $z = 13\,t^3\,u/v^2$, what are the % uncertainties in x, y, and z?

x: 3.0%

y: 5.4%

z: 11.0%