

Pledge and signature:

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A. (14) Bombs Away.

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

In experiments run at $\sim 25^\circ\text{C}$, 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 T of 1.322 K. In each case the calorimeter pail is filled with the same volume of water. Calculate (a) the calorimeter constant, and (b) q_{specific} for the unknown.

(a) $C_K = 24.84_1$ kJ/K (b) $q_{\text{specific,unk}} = -23.70_2$ kJ/g

2. (3) Give a balanced equation for the complete combustion of cyclohexane [$\text{C}_6\text{H}_{12}(\ell)$]. Then calculate the value of $H^\circ - E^\circ$ for this process at 40.0°C . [$R = 8.3145$ J mol $^{-1}$ K $^{-1}$].

-7.811 kJ/mol

3. (3) What quantities do you measure when you run a single experiment with the bomb calorimeter? Give reasonable uncertainties (absolute) for each of these. Hence what is likely to be the dominant source of experimental uncertainty.

See Study Problem 9 for Expt. 3.

B. (12) Triple Trouble.

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

6.35 ± 0.15 kJ/mol

2. (2) Morely Smartt does very careful vapor pressure measurements on water near 25°C and obtains $H_{\text{vap}} = 44.001(3)$ 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.

Smartt's result is 3.7 below the literature value, hence a source of concern.

3. (4) In the standard derivation of the integrated Clausius-Clapeyron (CC) Equation (which we employed), H_m is assumed to be constant with respect to changes in T . Over an extended range of T , this becomes inadequate. Suppose we assume instead that C_P is independent of T , whereupon we obtain $H_m(T) = H_0 + C_P(T - T_0)$, where T_0 is the triple point T . Use this expression for $H_m(T)$ in the differential form of the CC Equation, and integrate to obtain the more accurate expression for the integrated CC Equation.

See Study Problem 9 for Expt. 4.