

A. (8) Bomb Calorimetry — practical.

1. (3) A 0.893 g tablet of phenol ($\text{C}_6\text{H}_5\text{OH}$, $M = 94.12$) is completely burned in a bomb calorimeter having $C_K = 13.22 \text{ kJ K}^{-1}$, producing a temperature increase of 2.192°C . Calculate (a) the combustion heat, and (b) the specific and molar heats of combustion of phenol.
- (a) 28.98 kJ (b) 32.45 kJ/g (c) 3054 kJ/mol
2. (5) Write a balanced reaction for the complete combustion of phenol at room T . Use this to calculate $H^\circ - E^\circ$ for this reaction at 25°C [$R = 8.3145 \text{ J mol}^{-1} \text{ K}^{-1}$.]
- $\text{C}_6\text{H}_5\text{OH}(s) + 7 \text{ O}_2(g) \rightarrow 6 \text{ CO}_2(g) + 3 \text{ H}_2\text{O}(l)$ $g = -1$ $H^\circ - E^\circ = -RT = -2479 \text{ J/mol}$

B. (7) Bomb Calorimetry — conceptual.

1. (3) Combustion of 1.170 g of substance A raises the temperature of 0.931 kg of water by 2.44 K. Therefore, combustion of 1.510 g of A will raise the T of 1.190 kg of water by how much?
- 2.464 K
2. (4) Taking the first two masses and the first T given above as exact, and the 3rd and 4th masses (1.510 g and 1.190 kg) as uncertain by 0.026 g and 0.033 kg, respectively, calculate (a) the % uncertainty, and (b) the absolute uncertainty in your computed T . (c) Use the latter to state your result correctly.
- (a) 3.26% (b) $s_T = 0.0803 \text{ K}$ (c) $T = 2.46(8) \text{ K}$

C. (12) Phase Equilibria and the Triple Point.

1. (5) For water near its triple point, I. B. Allwette determines $H_{m,\text{fus}} = 6.2 \pm 0.7 \text{ kJ mol}^{-1}$ and $H_{m,\text{vap}} = 44.9 \pm 0.5 \text{ kJ mol}^{-1}$. Calculate H_m for the sublimation process, $\text{H}_2\text{O}(s) \rightarrow \text{H}_2\text{O}(g)$, and its uncertainty, and report the result correctly.
- $s = 0.86 \text{ kJ/mol}$ $H_{m,\text{sub}} = 51.1(9) \text{ kJ/mol}$
2. (7) Consider the accompanying figure, which shows the natural log of the vapor pressure of Br_2 as a function of $1/T$, for both solid and liquid phases. Using this figure, estimate (a) the triple point T and P ; (b) the normal boiling point T ; and (c) $H_{m,\text{vap}}$. (R is on p. 1)
- (a) $262 \pm 2 \text{ K}$; $34 \pm 3 \text{ torr}$ (b) $331 \pm 2 \text{ K}$ (c) $32 \pm 1 \text{ kJ/mol}$
- [\pm indicates reasonable ranges for reading the graph]