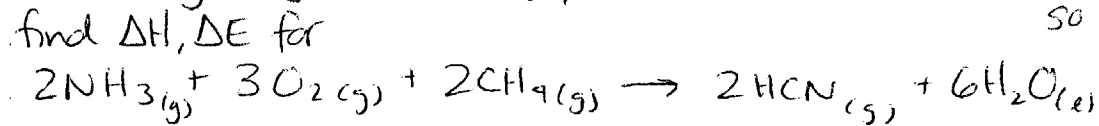


## Answers - Calorimetry Practice Problems

1. 5.000g  $\text{NH}_3$  + excess  $\text{O}_2$ ,  $\text{CH}_4$

bomb - constant V  
so  $\Delta E$  will be obtained

find  $\Delta H$ ,  $\Delta E$  for



$$\frac{q_v}{x \text{ mol LR}} = \Delta E$$

$$q_{\text{cal}} = C \Delta T$$

$$\Delta T = 33.90 - 19.77 =$$

$$q_{\text{cal}} = (15.48 \text{ kJ}/^\circ\text{C})(14.13^\circ\text{C}) \quad \Delta T = 14.13^\circ\text{C}$$

$$q_{\text{cal}} = 218.7324 \text{ kJ}$$

$$q_{\text{rxn}} = -q_{\text{cal}} = -218.7324 \text{ kJ}$$

We want: energy per 2 mol  $\text{NH}_3$ . ( $\Delta E$ )

$$(5.000 \text{ g NH}_3) \left( \frac{1 \text{ mol NH}_3}{17.034 \text{ g NH}_3} \right) = 0.293530585 \text{ mol NH}_3$$

$$\frac{-218.7324 \text{ kJ}}{0.293530585 \text{ mol NH}_3} = -745.1775 \frac{\text{kJ}}{\text{mol NH}_3} \times \frac{2}{2} = \frac{-1490. \text{ kJ}}{2 \text{ mol NH}_3}$$

$$\text{So... } \Delta E = -1490. \text{ kJ}$$

to find  $\Delta H$ , need  $w_p$

$$\Delta E = q + w \quad \Delta E = \Delta H + w_p$$

$$w_p = -\Delta n_{\text{gas}} RT$$

$$\Delta n_{\text{gas}} = (\text{prod} - \text{react}) = (2) - (2 + 3 + 2) = -5 \text{ mol gas}$$

$$w_p = -(-5 \text{ mol})(8.314 \text{ J/mol}\cdot\text{K})(307.05 \text{ K}) = +12764 \text{ J}$$

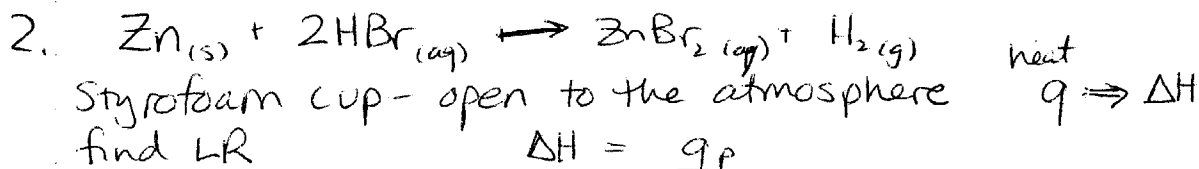
$w$  is  $\oplus$   
compression: more  $\rightarrow$  less gas

$$\text{final } T \uparrow +273.15$$

$$\text{or } \div 1000 \rightarrow 12.764 \text{ kJ } w_p$$

$$\Delta H = \Delta E - w_p = -1490. \text{ kJ} - 12.764 \text{ kJ} = -1502.76 \text{ kJ}$$

$$\Delta H = -1503 \text{ kJ}$$



$$\Delta H = \frac{q_p}{x \text{ moles LR}}$$

$$(0.7240 \text{ g Zn}) \left( \frac{1 \text{ mol Zn}}{65.39 \text{ g Zn}} \right) = 0.011072 \text{ mol Zn}$$

$$(0.07500 \text{ L}) \left( \frac{0.8000 \text{ mol HBr}}{1 \text{ L}} \right) = 0.06000 \text{ mol HBr}$$

Need:  $\frac{2 \text{ HBr}}{1 \text{ Zn}}$

Have:  $\frac{0.06000 \text{ mol HBr}}{0.011072 \text{ mol Zn}} = 5.4 \frac{\text{HBr}}{1 \text{ Zn}}$

extra HBr  
so Zn is LR

$$q_{rxn} = -q_{solution}$$

$$q_{solution} = C_m \Delta T$$

$$\Delta T = 25.08 - 19.81 = 5.27^\circ\text{C}$$

assume  $d_{solution} = d_{water}$  and  
 $C_{solution} = C_{water}$

$$q_{solution} = (4.184 \text{ J/g}^\circ\text{C}) \left( \underset{\text{solution}}{75.00 \text{ g}} + \underset{\text{Zn}}{0.7240 \text{ g}} \right) (5.27^\circ\text{C})$$

$$q_{solution} = 1669.69 \text{ J}$$

$$q_{rxn} = -1669.69 \text{ J}$$

$$\Delta H = \frac{q_{rxn}}{x \text{ moles LR}} = \frac{-1669.69 \text{ J}}{0.011072 \text{ mol Zn}} = -150802.9 \text{ J/mol Zn}$$

$$\Delta H = -151 \text{ kJ/mol Zn}$$

$$\text{so } \Delta H = -151 \text{ kJ}$$

to get  $\Delta E$ , we need  $w$ .

$$\Delta E = q + w = \Delta H + w_p$$

$$w = -\Delta n_{gas} RT \quad \Delta n_{gas} = (1 - 0) = 1 \text{ mol}$$

$$w = -(1 \text{ mol}) (8.314 \text{ J/mol}\cdot\text{K}) (298.23 \text{ K}) = -2479.484 \text{ J}$$

$$25.08 + 273.15$$

$$\text{or } -2479.484 \text{ J}$$

$w$  is  $\ominus$   
 gas is produced - expansion

$$w = -2.479 \text{ kJ}$$

$$\Delta E = \Delta H + w_p = -150.8 \text{ kJ} - 2.479 \text{ kJ} = -153.279 \text{ kJ}$$

$$\Delta E = -153 \text{ kJ}$$