

LECTURE NOTES FOR GENERAL CHEMISTRY © 2007 MM  
CHAPTER 6 THERMOCHEMISTRY

ENDOTHERMIC:  $\Delta H$  POSITIVE:  $H_{\text{PRODUCTS}} > H_{\text{REACTANTS}}$

EXOTHERMIC:  $\Delta H$  NEGATIVE:  $H_{\text{PRODUCTS}} < H_{\text{REACTANTS}}$

$H$  IS ENTHALPY

AT CONSTANT PRESSURE, HEAT FLOW:  $Q_p =$

$$Q_p = H_{\text{PRODUCTS}} - H_{\text{REACTANTS}} = \Delta H$$

ENTHALPY IS A STATE FUNCTION

ENTHALPY IS FIXED WHEN "STATE" ( $T, P$ ) IS SPECIFIED

ENTHALPY OF A SUBSTANCE CHANGES WITH TEMP

$$H \text{ OF } 1 \text{ g } H_2O(l) \text{ AT } 100^\circ\text{C} - H \text{ OF } 1 \text{ g } H_2O(l) \text{ AT } 0^\circ\text{C} = 418 \text{ J}$$

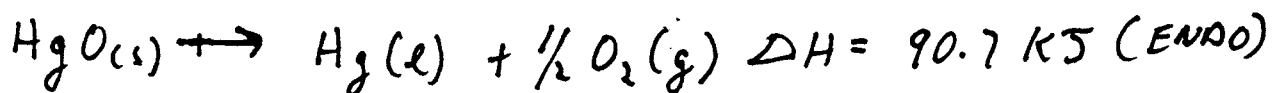
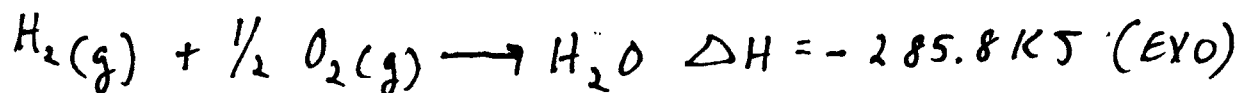
ALSO, PHASE CHANGES

$$H \text{ OF } 1 \text{ g } H_2O(l) \text{ AT } 0^\circ\text{C} - H \text{ OF } 1 \text{ g } H_2O(s) \text{ AT } 0^\circ\text{C} = 333 \text{ J}$$

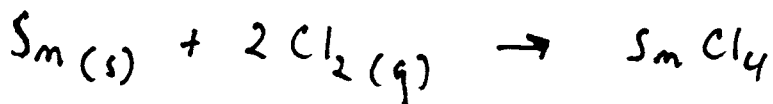
$$H \text{ OF } 1 \text{ g } H_2O(g) \text{ AT } 100^\circ\text{C} - H \text{ OF } 1 \text{ g } H_2O(l) \text{ AT } 0^\circ\text{C} = 2257 \text{ J}$$

1 MOL (18g)  $H_2O$  HAS 18X  $H$  OF 1g  $H_2O$  (EXTENSIVE)

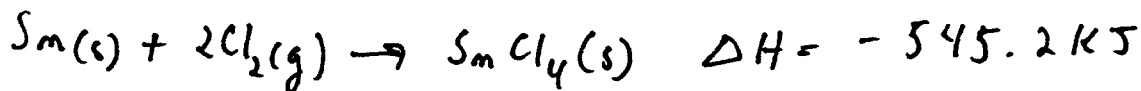
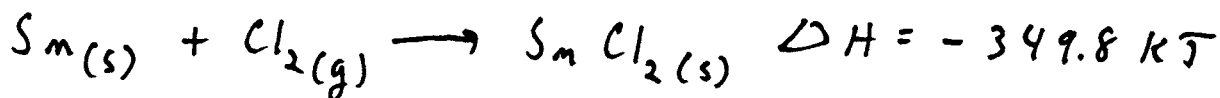
THERMOCHEMICAL EQUATIONS



- 1) (DOUBLE THESE COEFFICIENTS, MUST DOUBLE  $\Delta H$ )
- 2)  $\Delta H$  FOR REVERSE REACTION IS EQUAL, BUT OPPOSITE SIGN OF FORWARD REACTION
- 3)  $\Delta H$  IS INDEPENDENT OF # OF STEPS OVERALL (STATE FUNCTION)



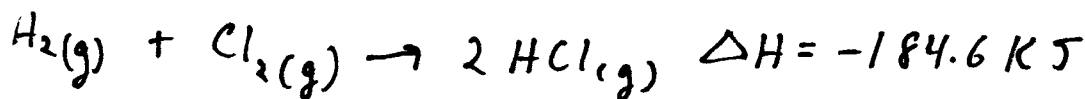
THIS REACTION MIGHT TAKE 2 STEPS



HESS'S LAW

$\Delta H$  FOR A REACTION IS THE SAME NO MATTER HOW MANY STEPS IT TAKES

$\Delta H$  IN STOICHIOMETRY



UNIT RELATIONSHIPS

$$1 \text{ MOL H}_2 = -184.6 \text{ kJ}$$

$$1 \text{ MOL Cl}_2 = -184.6 \text{ kJ}$$

$$2 \text{ MOL HCl} = -184.6 \text{ kJ}$$

WHAT IS THE ENTHALPY CHANGE WHEN 75.0 g HCl IS FORMED?

$$75.0 \text{ g HCl} \times \frac{1 \text{ MOL HCl}}{36.46 \text{ g HCl}} \times \frac{-184.6 \text{ kJ}}{2 \text{ MOL HCl}} = 380 \text{ kJ}$$

CALORIMETRY

THE HEAT CAPACITY (C) OF A SYSTEM IS THE QUANTITY OF HEAT REQUIRED TO CHANGE THE TEMP OF A SYSTEM BY  $1^\circ\text{C}$

UNITS ARE  $\text{J}/^\circ\text{C}$  OR  $\text{J}/\text{K}$

# HEAT CAPACITY

CALCULATE THE HEAT CAPACITY OF AN IRON BLOCK THAT REQUIRES 1015 J TO WARM FROM 25°C TO 100°C.

$$J = 1015$$
$$^{\circ}C = 100^{\circ} - 25^{\circ} = 75^{\circ}C$$

$$C = \frac{1015 J}{75^{\circ}C} = 14 J/^{\circ}C$$

MORE USEFUL IS THE SPECIFIC HEAT

SPECIFIC HEAT IS THE HEAT CAPACITY OF 1g OF SUBSTANCE

$$\text{THE SPECIFIC HEAT OF } H_2O = 4.18 \frac{J}{g \cdot ^{\circ}C}$$

IF THE IRON BLOCK ABOVE HAD

A MASS OF 31g, SPECIFIC HEAT =

$$\frac{14 J}{31 g \cdot ^{\circ}C} = 0.45 \frac{J}{g \cdot ^{\circ}C}$$

MEASURING HEATS OF REACTION

A 1.23 g SAMPLE OF FUEL IS BURNED IN A BOMB CALORIMETER WITH A HEAT CAPACITY OF 7.45 kJ/°C. THE TEMP RISES FROM 21.80 TO 24.30 °C.

WHAT IS THE HEAT OF COMBUSTION OF FUEL IN kJ/g?

$$\begin{array}{r} 24.30^{\circ}C \\ - 21.80^{\circ}C \\ \hline 2.50^{\circ}C \end{array}$$

SO, WATER TEMP GOES UP BY 2.50°C

$$7.45 \frac{kJ}{^{\circ}C} \times 2.50^{\circ}C = 18.6 kJ \text{ NEEDED}$$

$$\frac{18.6 kJ}{1.23 g \text{ FUEL}} = 15.1 kJ/g \text{ FUEL}$$

# CHAPTER 6

## TOPICS

## QUESTIONS

CONSERVATION OF ENERGY  
AND THE FIRST LAW

WORK WITH EXOTHERMIC AND  
ENDOTHERMIC:  $\Delta H +$  AND  $\Delta H -$

25, 27, 29

USE ENTHALPY IN STOICHIOMETRIC  
CALCULATIONS

33, 35

WORK WITH HEAT CAPACITY

43, 45

WORK WITH SPECIFIC HEAT

51, 53

DO CALORIMETRIC CALCULATIONS

55, 57

WORK WITH HESS'S LAW,  
SUMMING  $\Delta H$  FOR MULTISTEP  
REACTIONS

65, 67