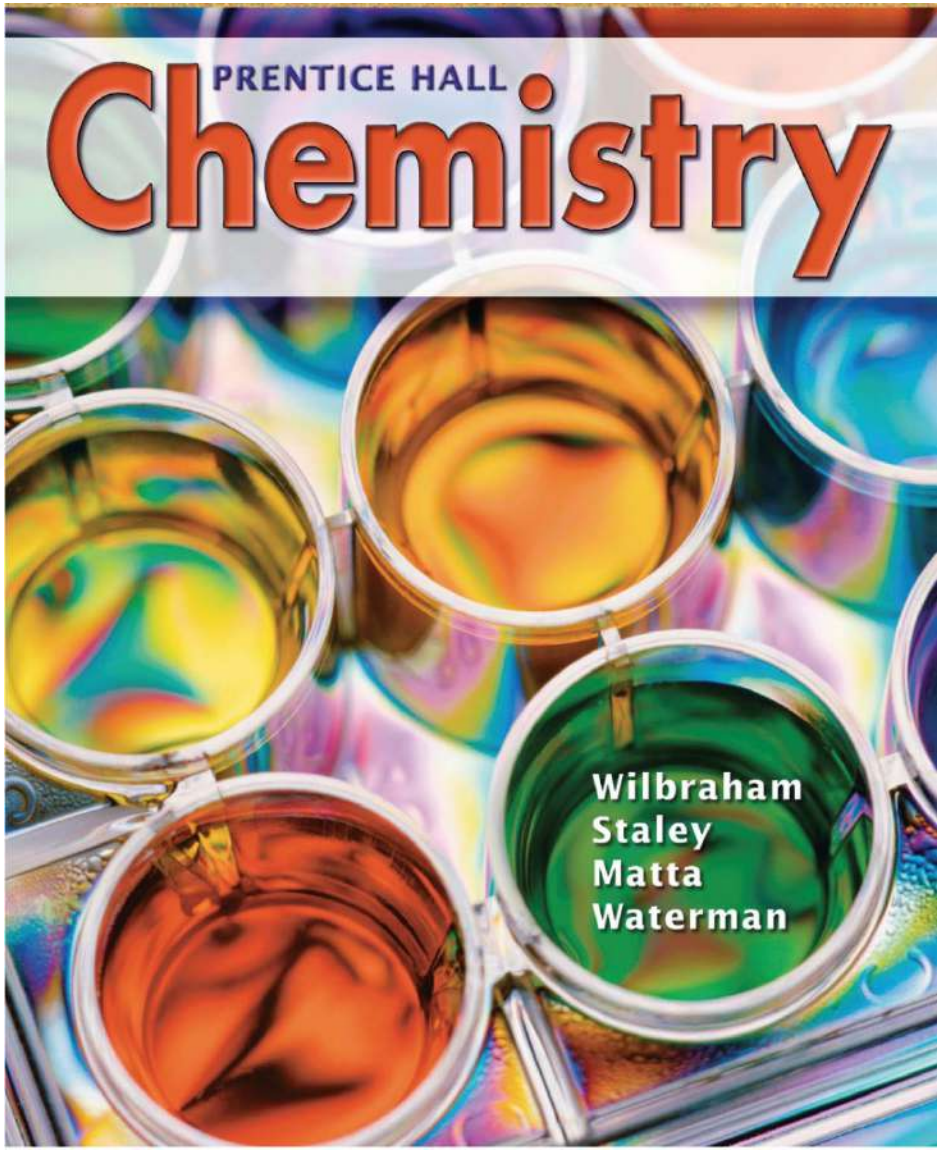
PRENTICE HALL
Chemistry
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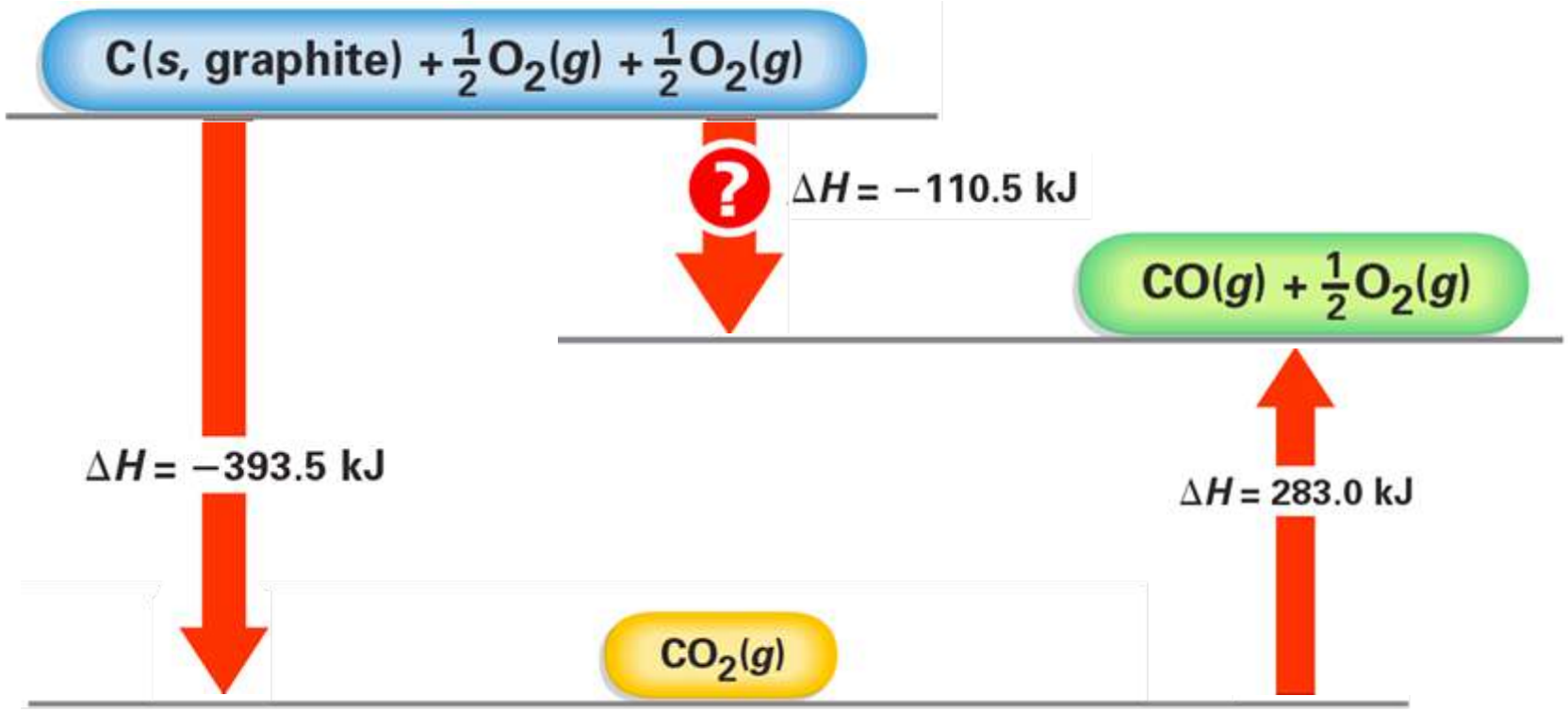
How much heat is released when 100.0 g of Calcium Oxide reacts with excess water? (CaO = -65.2kJ/mol)

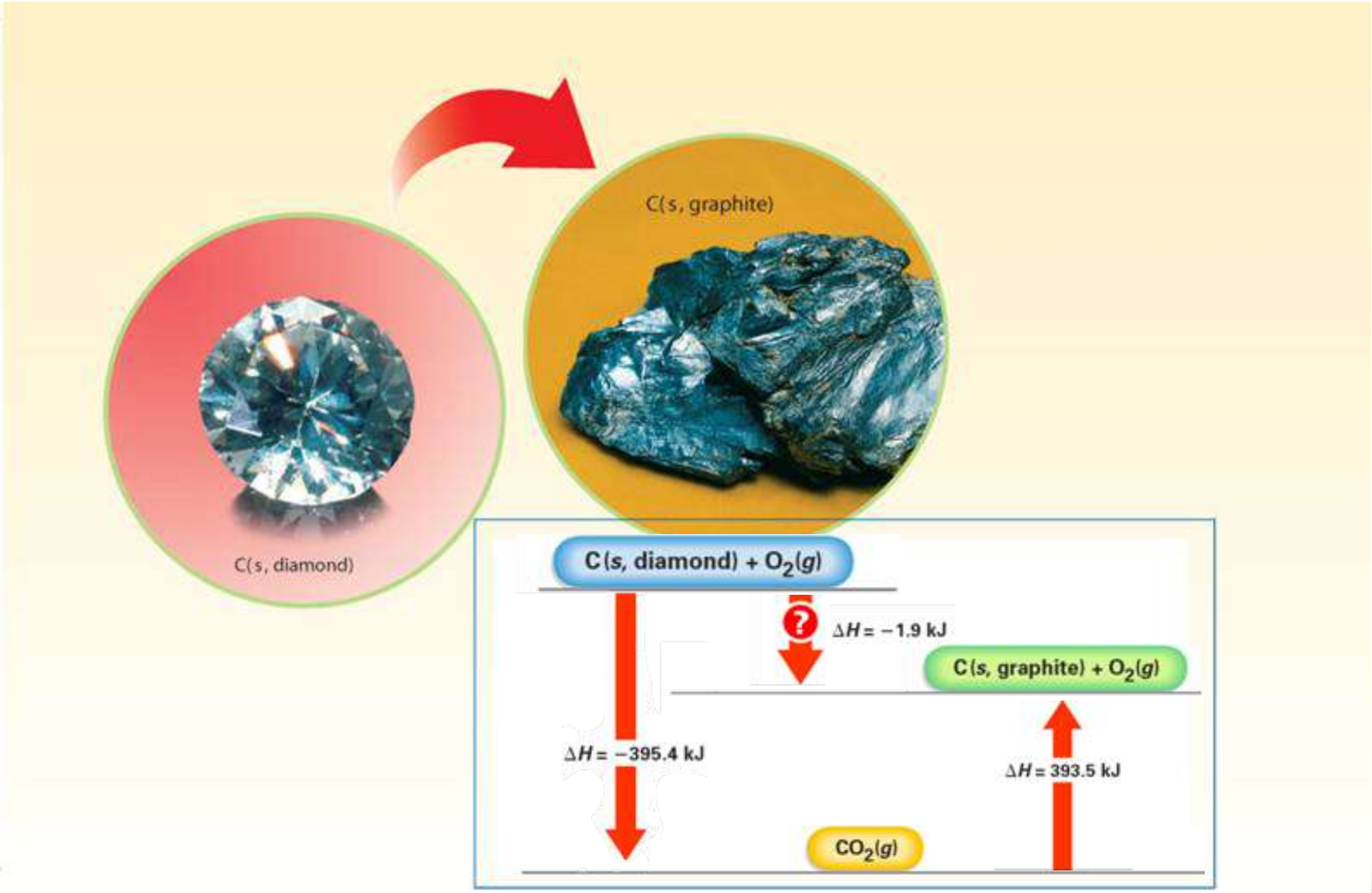
Hess's Law

–What are two ways that you can determine the heat of reaction when it cannot be directly measured?

Hess's law allows you to determine the heat of reaction indirectly.

Hess's law of heat summation states that if you add two or more thermochemical equations to give a final equation, then you can also add the heats of reaction to give the final heat of reaction.





Standard Heats of Formation

–For a reaction that occurs at standard conditions, you can calculate the heat of reaction by using standard heats of formation.

The **standard heat of formation** (ΔH_f^0) of a compound is the change in enthalpy that accompanies the formation of one mole of a compound from its elements with all substances in their standard states at 25°C.

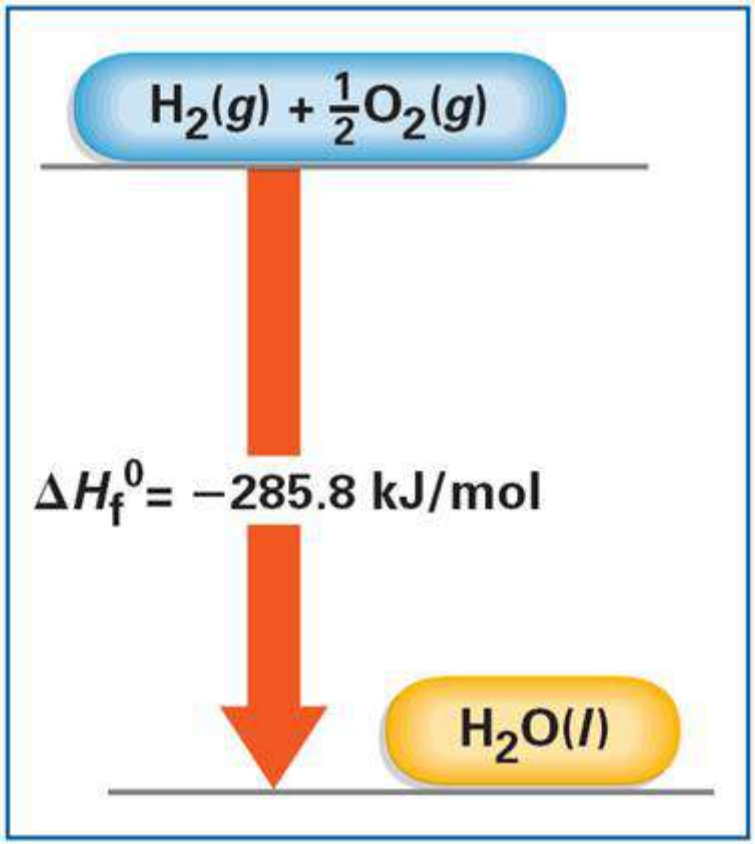
$$\Delta H^0 = \Delta H_f^0(\text{products}) - \Delta H_f^0(\text{reactants})$$

Table 17.4

Standard Heats of Formation (ΔH_f^0) at 25°C and 101.3 kPa

Substance	ΔH_f^0 (kJ/mol)	Substance	ΔH_f^0 (kJ/mol)
$Al_2O_3(s)$	−1676.0	$H_2O_2(l)$	−187.8
$Br_2(g)$	30.91	$I_2(g)$	62.4
$Br_2(l)$	0.0	$I_2(s)$	0.0
C(*s*, diamond)	1.9	$N_2(g)$	0.0
C(*s*, graphite)	0.0	$NH_3(g)$	−46.19
$CH_4(g)$	−74.86	$NO(g)$	90.37
$CO(g)$	−110.5	$NO_2(g)$	33.85
$CO_2(g)$	−393.5	$NaCl(s)$	−411.2
$CaCO_3(s)$	−1207.0	$O_2(g)$	0.0
$CaO(s)$	−635.1	$O_3(g)$	142.0
$Cl_2(g)$	0.0	P(*s*, white)	0.0
$Fe(s)$	0.0	P(*s*, red)	−18.4
$Fe_2O_3(s)$	−822.1	S(*s*, rhombic)	0.0
$H_2(g)$	0.0	S(*s*, monoclinic)	0.30
$H_2O(g)$	−241.8	$SO_2(g)$	−296.8
$H_2O(l)$	−285.8	$SO_3(g)$	−395.7

The Standard Heat of Formation of Water



SAMPLE PROBLEM 17.7

Calculating the Standard Heat of Reaction

What is the standard heat of reaction (ΔH^0) for the reaction of $CO(g)$ with $O_2(g)$ to form $CO_2(g)$?

Carbon Monoxide Detector

PEARSON Prentice Hall

SAMPLE PROBLEM 17.7

Analyze ***List the knowns and the unknown.***

Knowns

(from Table 17.4)

- $\Delta H_f^0 O_2(g) = 0$ kJ/mol (free element)
- $\Delta H_f^0 CO(g) = -110.5$ kJ/mol
- $\Delta H_f^0 CO_2(g) = -393.5$ kJ/mol

Unknown

- $\Delta H^0 = ?$ kJ

Balance the equation of the reaction of $CO(g)$ with $O_2(g)$ to form $CO_2(g)$. Then determine ΔH^0 using the standard heats of formation of the reactants and products.

SAMPLE PROBLEM 17.7

Calculate ***Solve for the unknown.***

First, write the balanced equation.

$$2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$$

Next, find and add the ΔH_f^0 of all of the reactants, taking into account the number of moles of each.

$$\Delta H_f^0(\text{reactants}) = 2\ \cancel{\text{mol CO}(g)} = \frac{-110.5\ \text{kJ}}{1\ \cancel{\text{mol CO}(g)}} + 0\ \text{kJ}$$

$$= -221.0\ \text{kJ}$$

Then, find the ΔH_f^0 of the product in a similar way.

$$\Delta H_f^0(\text{product}) = 2\ \cancel{\text{mol CO}_2(g)} \times \frac{-393.5\ \text{kJ}}{1\ \cancel{\text{mol CO}_2(g)}}$$

$$= -787.0\ \text{kJ}$$

Finally, solve for the unknown

$$\Delta H^0 = \Delta H_f^0(\text{products}) - \Delta H_f^0(\text{reactants})$$

$$\Delta H^0 = (-787.0\ \text{kJ}) - (-221.0\ \text{kJ})$$

$$\Delta H^0 = -566.0\ \text{kJ}$$

SAMPLE PROBLEM 17.7

Evaluate ***Does the result make sense?***

The ΔH^0 is negative. Therefore, the reaction is exothermic. This makes sense because combustion reactions always release heat.

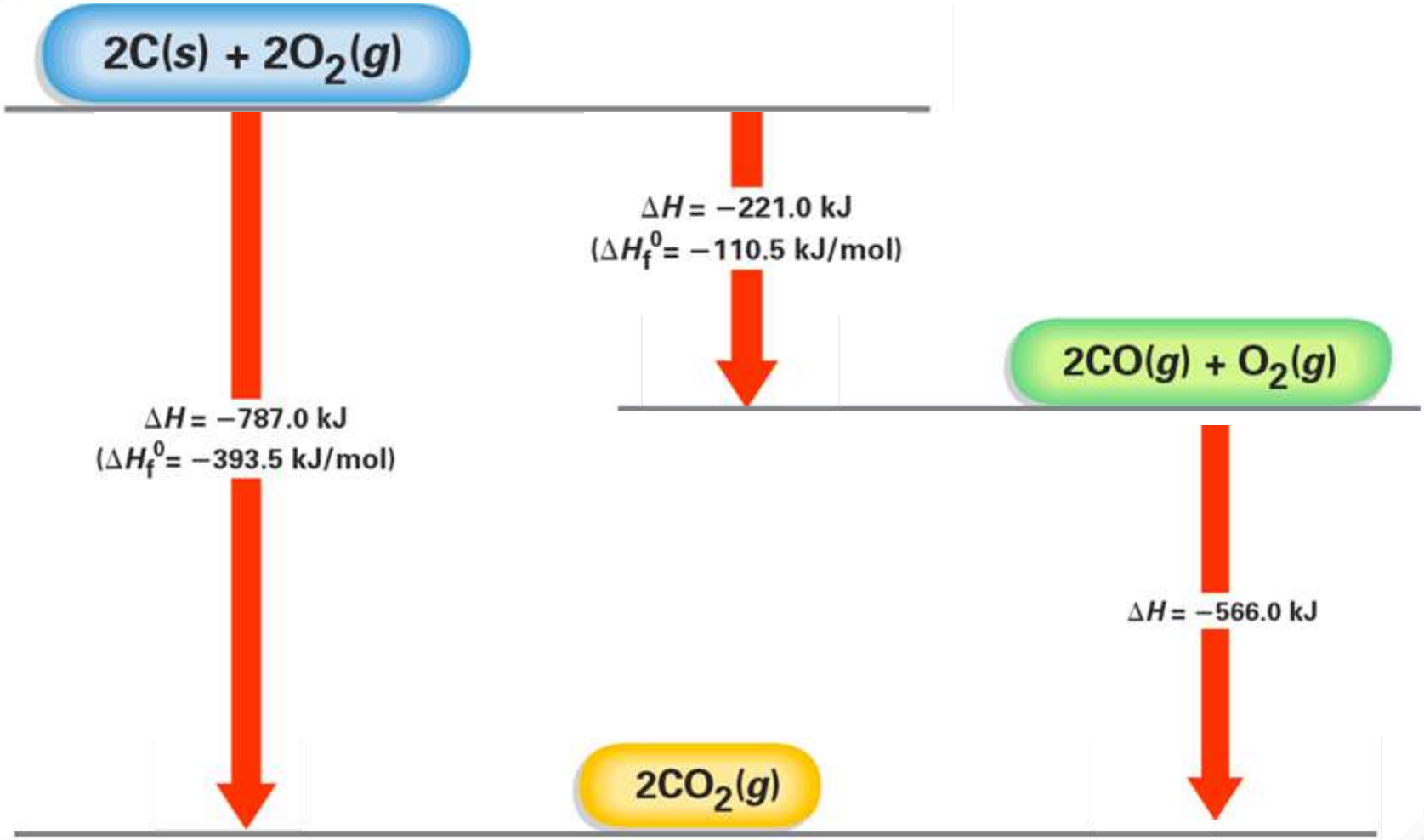
32. Calculate ΔH^0 for the following reactions.

a. $Br_2(g) \longrightarrow Br_2(l)$

b. $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$

c. $2NO(g) + O_2(g) \longrightarrow 2NO_2(g)$

Problem Solving 17.32 Solve Problem 32 with the help of an interactive guided tutorial.



17.4 Section Quiz.

Assess students' understanding of the concepts in Section 17.4.

Continue to:

Section Quiz

-or-

Launch:

ExamView® QuickTake

17.4 Section Quiz.

– 1. According to Hess's law, it is possible to calculate an unknown heat of reaction by using

- heats of fusion for each of the compounds in the reaction.
- two other reactions with known heats of reaction.
- specific heat capacities for each compound in the reaction.
- density for each compound in the reaction.

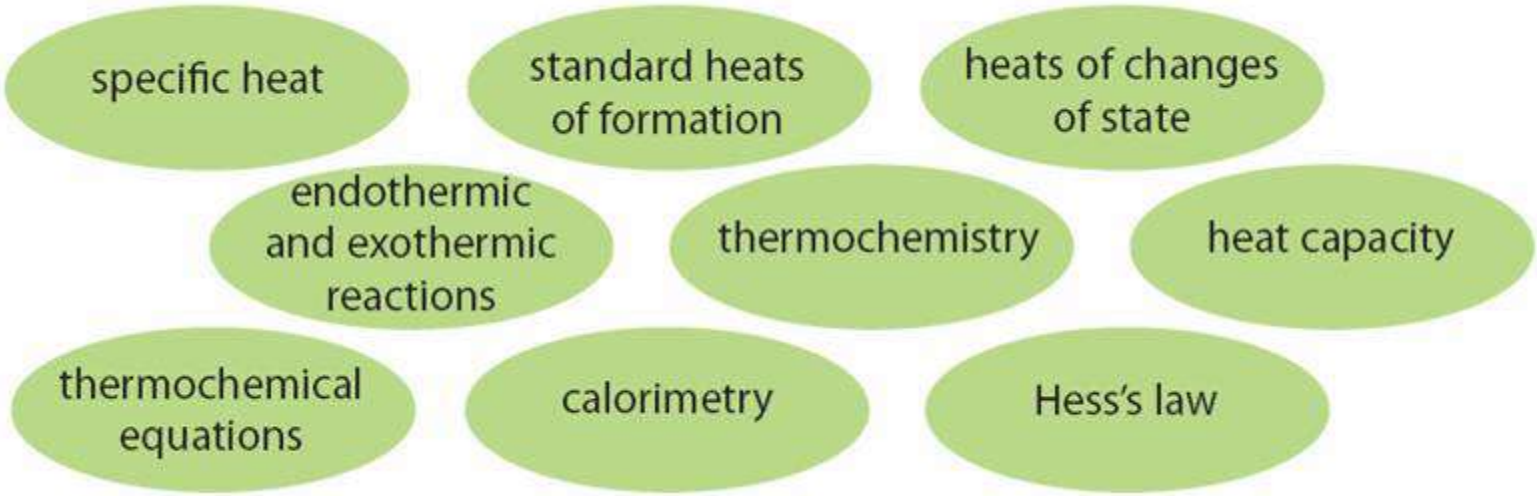
17.4 Section Quiz.

– 2. The heat of formation of $Cl_2(g)$ at 25°C is
  - the same as that of H_2O at 25°C.
  - larger than that of Fe(*s*) at 25°C.
  - undefined.
  - zero.

17.4 Section Quiz.

- 3.Calculate ΔH^0 for $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$. Standard heats of formation: $NH_3(g) = -45.9$ kJ/mol, $HCl(g) = -92.3$ kJ/mol, $NH_4Cl(s) = -314.4$ kJ/mol
- 176.2 kJ
  - –360.8 kJ
  - –176.2 kJ
  - –268 kJ.

–Solve the Concept Map with the help of an interactive guided tutorial.



END OF SHOW