Ch. 6 Study Questions

(*) I assumed 3 s.f. for each problem

1. a) $\frac{500\text{ J}}{10.9°C} = \boxed{\frac{45.9\text{ J}}{°C}}$ or $\frac{45.9\text{ J}}{K}$

b) $\frac{500\text{ J}}{(50.0\text{ g})(10.9°C)} = \boxed{\frac{0.917\text{ J}}{g°C}}$ or $\frac{0.917\text{ J}}{g \cdot K}$

2. $q = (1000\text{ g})(0.451 \frac{J}{°C g})(975°C) = 439{,}725\text{ J} = \boxed{4.40 \times 10^5\text{ J}}$

3. $-q_{copper} = +q_{H_2O}$

$-(40\text{ g})(0.385 \frac{J}{g°C})(T_f - 100°C) = (100\text{ g})(4.184 \frac{J}{g°C})(T_f - 25°C)$

$-15.4\, T_f + 1540 = 418.4\, T_f - 10460$

$T_f =$ [illegible] $\boxed{27.7°C}$

4. $27.0\text{ g } H_2O \times \frac{1\text{ mol } H_2O}{18.016\text{ g } H_2O} \times \frac{6.009\text{ kJ}}{1\text{ mol}} = \boxed{9.01\text{ kJ}}$

5. Heat to melt: 27.0 g @ 0°C → 9.01 kJ or 9010 J

$+(q_{fus} + q_{ice}) = -q_{H_2O}$

$9010\text{ J} + (27.0\text{ g})(4.184 \frac{J}{°C \cdot g})(T_f - 0°C) = -(123\text{ g})(4.184 \frac{J}{g°C})(T_f - 100°C)$

$9010\text{ J} + 112.968\, T_f = -514.632\, T_f + 51463.2$

$T_f = \boxed{67.6°C}$

6. $10.5\text{ g } H_2O \times \frac{1\text{ mol } H_2O}{18.016\text{ g } H_2O} \times \frac{6.009\text{ kJ}}{1\text{ mol}} = 3.50\text{ kJ} = 3{,}500\text{ J}$

$q_{metal} = mC\Delta T$

$-3{,}500\text{ J} = (50\text{ g})(c)(0°C - 100°C)$

$c = \boxed{0.700 \frac{J}{g°C}}$

7. $1\,kg\,C_3H_8 \times \frac{1000\,g}{1\,kg} \times \frac{1\,mol\,C_3H_8}{44.094\,g} \times \frac{-2220\,kJ}{1\,mol\,C_3H_8} = \boxed{-50{,}300\,kJ}$

8. $2CH_{4(g)} + 3O_{2(g)} \rightarrow 2CO_{(g)} + 4H_2O_{(l)}$ $\Delta H° = -1215\,kJ$

$(\times\tfrac{1}{2})$ $CH_{4(g)} + \tfrac{3}{2}O_{2(g)} \rightarrow CO_{(g)} + 2H_2O_{(l)}$ $\Delta H° = -607.5\,kJ$

$(\times -\tfrac{1}{2})$ $CO_{(g)} \rightarrow C_{(s)} + \tfrac{1}{2}O_{2(g)}$ $\Delta H° = +221/2\,kJ$

(no change) $C_{(s)} + \tfrac{1}{2}O_{2(g)} \rightarrow CO_{2(g)}$ $\Delta H° = -394\,kJ$

$CH_4 + 2O_{2(g)} \rightarrow CO_2 + 2H_2O_{(l)}$ $\Delta H° = \boxed{-891\,kJ}$

9. $\Delta H_{rxn} = [\Delta H_f CO_2 + 2(\Delta H_f H_2O)] - [\Delta H_f CH_4 + 2\Delta H_f O_2]$

$-891 = -394 + 2(-286) - x + 0$

$x = \Delta H°_f CH_4 = \boxed{-75\,kJ/mol}$

10. $\Delta H°_{rxn} = 2(\Delta H_f NO_2) + 3(\Delta H_f H_2O) - 2(\Delta H_f NH_3) - 0$

$-698 = 2(33) + 3(-286) - 2x$

$2x = -94$

$x = \boxed{-47\,kJ/mol} = \Delta H_f NH_3$

11. $q_{soln} = -q_{rxn}$

$= -m_{H_2O} C \Delta T$

$= -(100\,g)(4.184\,J/g°C)(-22.4°C)$

$= 9372.16\,J$

$\Delta H_{soln} = \dfrac{9.37216\,kJ}{\left(40\,g \times \frac{1\,mol\,NH_4NO_3}{80.052\,g}\right)} = \boxed{18.8\,\frac{kJ}{mol}}$

Culver City H.S. • AP Chemistry

Name KEY
Period ___ Date ___/___/___

6 • Thermochemistry

PRACTICE FRQ

$$C_2H_2(g) + 2\ H_2(g) \rightarrow C_2H_6(g)$$

Information about the substances involved in the reaction represented above is summarized in the following tables.

Substance	$\Delta H°_f$ (kJ/mol)
$C_2H_2(g)$	226.7
$C_2H_6(g)$	-84.7

(a) Write the equation for the heat of formation of $C_2H_6(g)$

$2C_{(graphite)} + 3H_{2(g)} \rightarrow C_2H_{6(g)}$

(b) Use the above information to determine the enthalpy of reaction for the equation given.

$\Delta H°_{rxn} = \Delta H°_f\ C_2H_6 - (\Delta H°_f\ C_2H_2 + 2\Delta H°_f\ H_2)$

$= -84.7 - (+226.7 + 0)$

$=$ ~~112.0~~ $-311.4\ \frac{kJ}{mol}$

$$C_6H_5OH(s) + 7\ O_2(g) \rightarrow 6\ CO_2(g) + 3\ H_2O(l) \quad \Delta H_{rxn} = ?$$

When a 2.000-gram sample of pure phenol, $C_6H_5OH(s)$, is completely burned according to the equation above, 64.98 kilojoules of heat is released. Use the information in the table below to answer the questions that follow.

Substance	Standard Heat of Formation, $\Delta H°_f$, at 25°C (kJ/mol)
$CO_2(g)$	-393.5
$H_2O(l)$	-285.85
$C_6H_5OH(s)$	?

(a) Calculate the **molar** heat of combustion of phenol in kilojoules per mole at 25°C.

$2.000g\ C_6H_5OH \times \frac{1\ mol\ C_6H_5OH}{94.108\ g} = 0.02125\ mol\ C_6H_5OH$

$\Delta H_{combustion} = \frac{-64.98\ kJ}{0.02125\ mol} = -3058\ \frac{kJ}{mol}$

(b) Calculate the standard heat of formation, $\Delta H°_f$, of phenol in kilojoules per mole at 25°C.

$\Delta H_{combustion} = 6(\Delta H°_f\ CO_2) + 3(\Delta H°_f\ H_2O) - \Delta H°_f\ C_6H_5OH$

$-3058 = 6(-393.5) + 3(-285.85) - x$

$x = -160.55\ kJ/mol$