

Name _____

AP Chemistry

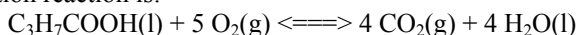
_ / _ / _

Chapter 6 Collected AP Exam Free Response Questions 1980 - 2010

1984 - #3

| Substance | Standard Heat of Formation, ΔH_f° , in kJ mol^{-1} |
|---------------------------------------|---|
| C(s) | 0.00 |
| CO ₂ (g) | -393.5 |
| H ₂ (g) | 0.00 |
| H ₂ O(l) | -285.85 |
| O ₂ (g) | 0.00 |
| C ₃ H ₇ COOH(l) | ? |

The enthalpy change for the combustion of butyric acid at 25°C, $\Delta H^\circ_{\text{comb}}$, is -2,183.5 kilojoules per mole. The combustion reaction is:



- (a) From the data above, calculate the standard heat of formation, ΔH_f° , for butyric acid at 25 °C.
 (b) Write a correctly balanced equation for the formation of butyric acid from its elements.

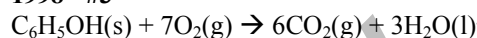
1984 - #4c

Give a scientific explanation for the following observations. Use equations or diagrams if they are relevant.
 (c) Perspiring is a mechanism for cooling the body.

1995 - #2

- (a) Write a balanced equation for the complete combustion of propane gas, which yields CO₂(g) and H₂O(l)
 (b) Calculate the volume of air at 30°C and 1.00 atmosphere that is needed to burn completely 10.0 grams of propane. Assume that air is 21.0 percent O₂ by volume.
 (c) The heat of combustion of propane is -2,220.1 kJ/mol. Calculate the heat of formation, ΔH_f° , of propane given that ΔH_f° of H₂O(l) = -285.3 kJ/mol and ΔH_f° of CO₂(g) = -393.5 kJ/mol.
 (d) Assuming that all of the heat evolved in burning 30.0 grams of propane is transferred to 8.00 kilograms of water (specific heat = 4.18 J/g × K), calculate the increase in temperature of the water.

1998 - #3

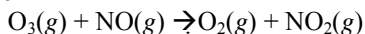


When a 2.000-gram sample of pure phenol, C₆H₅OH(s), is completely burned according to the equation above, 64.98 kilojoules of heat is released.

Use the information in the table below to answer the questions that follow.

| Substance | Standard Heat of Formation, ΔH_f° , at 25°C (kJ/mol) |
|--------------------------------------|--|
| C (graphite) | 0.00 |
| CO ₂ (g) | -395.5 |
| H ₂ (g) | 0.00 |
| H ₂ O(l) | -285.85 |
| O ₂ (g) | 0.00 |
| C ₆ H ₅ OH (s) | ? |

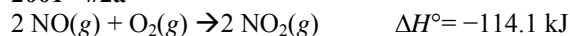
- (a) Calculate the molar heat of combustion of phenol in kilojoules per mole at 25°C.
 (b) Calculate the standard heat of formation, ΔH_f° , of phenol in kilojoules per mole at 25°C.
 (d) If the volume of the combustion container is 10.0 liters, calculate the final pressure in the container when the temperature is changed to 110°C. (Assume no oxygen remains unreacted and that all products are gaseous.)

2000 - #6

Consider the reaction represented above.

(a) Referring to the data in the table below, calculate the standard enthalpy change, ΔH° , for the reaction at 25°C. Be sure to show your work.

| | O₃(g) | NO(g) | NO₂(g) |
|--|-------------------------|--------------|--------------------------|
| Standard enthalpy of formation, ΔH_f° , at 25°C (kJ mol ⁻¹) | 143 | 90. | 33 |

2001 - #2a

The reaction represented above is one that contributes significantly to the formation of photochemical smog. Calculate the quantity of heat released when 73.1 g of NO(g) is converted to NO₂(g).

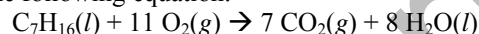
2002 - #3

Consider the hydrocarbon pentane, C₅H₁₂ (molar mass 72.15 g).

- (a) Write the balanced equation for the combustion of pentane to yield carbon dioxide and water.
 (b) What volume of dry carbon dioxide, measured at 25°C and 785 mm Hg, will result from the complete combustion of 2.50 g of pentane?
 (c) The complete combustion of 5.00 g of pentane releases 243 kJ of heat. On the basis of this information, calculate the value of ΔH for the complete combustion of one mole of pentane.
 (d) Under identical conditions, a sample of an unknown gas effuses into a vacuum at twice the rate that a sample of pentane gas effuses. Calculate the molar mass of the unknown gas.

2003B - #3 c & d

In another experiment, liquid heptane, C₇H₁₆(l), is completely combusted to produce CO₂(g) and H₂O(l), as represented by the following equation.

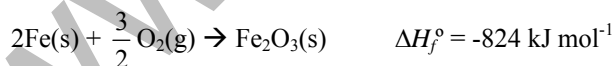


The heat of combustion, $\Delta H_{\text{comb}}^\circ$, for one mole of C₇H₁₆(l) is -4.85×10^3 kJ.

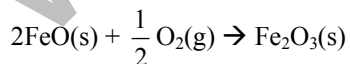
(c) Using the information in the table below, calculate the value of ΔH_f° for C₇H₁₆(l) in kJ mol⁻¹.

| Compound | ΔH_f°, at 25°C (kJ mol⁻¹) |
|---------------------|---|
| CO ₂ (g) | -393.5 |
| H ₂ O(l) | -285.8 |

- (d) A 0.0108 mol sample of C₇H₁₆(l) is combusted in a bomb calorimeter.
 (i) Calculate the amount of heat released to the calorimeter.
 (ii) Given that the total heat capacity of the calorimeter is 9.273 kJ °C⁻¹, calculate the temperature change of the calorimeter.

2004 - #2e

The reaction represented below also produces iron(III) oxide. The value of ΔH° for the reaction is -280. kJ per mole of Fe₂O₃(s) formed.



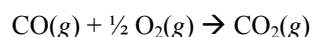
Calculate the standard enthalpy of formation ΔH_f° of FeO(s)

2005B - #7

| Substance | Combustion Reaction | Enthalpy of Combustion, ΔH_{comb}° , at 298 K (kJ mol ⁻¹) |
|-----------------------|---|---|
| H ₂ (g) | $\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$ | -290 |
| C(s) | $\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$ | -390 |
| CH ₃ OH(l) | | -730 |

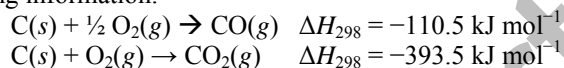
- (a) In the empty box in the table above, write a balanced chemical equation for the complete combustion of one mole of CH₃OH(l). Assume products are in their standard states at 298 K. Coefficients do not need to be whole numbers.
- (b) On the basis of your answer to part (a) and the information in the table, determine the enthalpy change for the reaction $\text{C}(\text{s}) + \text{H}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{CH}_3\text{OH}(\text{l})$.
- (c) Write the balanced chemical equation that shows the reaction that is used to determine the enthalpy of formation for one mole of CH₃OH(l).

2006 - #2a

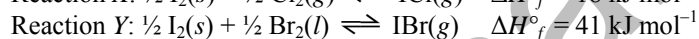
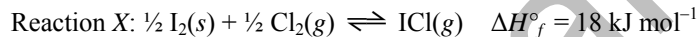


The combustion of carbon monoxide is represented by the equation above.

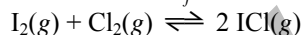
- (a) Determine the value of the standard enthalpy change, ΔH_{rxn}° , for the combustion of CO(g) at 298 K using the following information.



2006B - #3f



- (f) For the vaporization of solid iodine, $\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{g})$, the value of ΔH_{298}° is 62 kJ mol⁻¹. Using this information, calculate the value of ΔH_f° for the reaction represented below.



2007 - #2c



- (c) Calculate the standard enthalpy change, ΔH° , that occurs when a 0.256 mol sample of NF₃(g) is formed from N₂(g) and F₂(g) at 1.00 atm and 298 K.