

Name _____

AP Chemistry

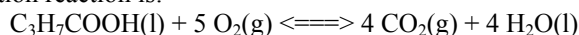
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Chapter 6 Collected AP Exam Free Response Answers 1980 - 2010

1984 - #3

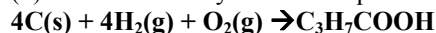
Substance	Standard Heat of Formation, ΔH_f° , in kJ mol^{-1}
C(s)	0.00
CO ₂ (g)	-393.5
H ₂ (g)	0.00
H ₂ O(l)	-285.85
O ₂ (g)	0.00
C ₃ H ₇ COOH(l)	?

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. **-533.8 kJ**

(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.

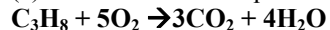
(c) Perspiring is a mechanism for cooling the body.

Vaporization or evaporation of sweat from the skin.

These processes are endothermic and so cool the skin.

1995 - #2

(a) Write a balanced equation for the complete combustion of propane gas, which yields CO₂(g) and H₂O(l).

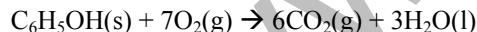


(b) Calculate the volume of air at 30°C and 1.00 atmosphere that is needed to burn completely 10.0 grams of propane. Assume that air is 21.0 percent O₂ by volume. **134 L air**

(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. **-101.6 kJ = ΔH_f° (C₃H₈)**

(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. **45.1 K**

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.

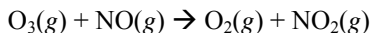
Substance	Standard Heat of Formation, ΔH_f° , at 25°C (kJ/mol)
C (graphite)	0.00
CO ₂ (g)	-395.5
H ₂ (g)	0.00
H ₂ O(l)	-285.85
O ₂ (g)	0.00
C ₆ H ₅ OH (s)	?

(a) Calculate the molar heat of combustion of phenol in kilojoules per mole at 25°C. **$\Delta H_{\text{comb}} = -3,058 \text{ kJ/mol}$**

(b) Calculate the standard heat of formation, ΔH_f° , of phenol in kilojoules per mole at 25°C. **$\Delta H_f^\circ \text{ phenol} = -173 \text{ kJ}$**

(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.)
0.601 atm

2000 - #6a



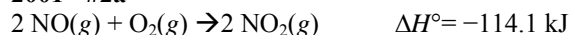
Consider the reaction represented above.

(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

$$\Delta H^\circ = 33 - (90. + 143) \text{ kJ} = -200 \text{ kJ}$$

2001 - #2a



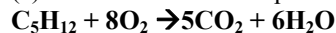
The reaction represented above is one that contributes significantly to the formation of photochemical smog.

Calculate the quantity of heat released when 73.1 g of NO(g) is converted to NO₂(g). **139 kJ of energy are released**

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.



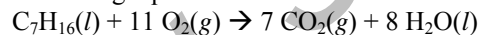
(b) What volume of dry carbon dioxide, measured at 25°C and 785 mm Hg, will result from the complete combustion of 2.50 g of pentane? **4.11 L**

(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. $\Delta H = -3.50 \times 10^3 \text{ kJ}$

(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. **18.0 g/mol**

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 $-4.85 \times 10^3 \text{ kJ}$.

(c) Using the information in the table below, calculate the value of ΔH_f° for C₇H₁₆(l) in kJ mol⁻¹. **-190 kJ/mol**

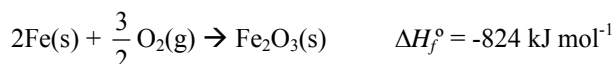
Compound	ΔH_f°, at 25°C (kJ mol⁻¹)
CO ₂ (g)	-393.5
H ₂ O(l)	-285.8

(d) A 0.0108 mol sample of C₇H₁₆(l) is combusted in a bomb calorimeter.

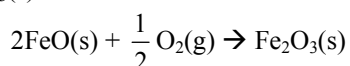
(i) Calculate the amount of heat released to the calorimeter. **52.4 kJ**

(ii) Given that the total heat capacity of the calorimeter is 9.273 kJ °C⁻¹, calculate the temperature change of the calorimeter. **5.65°C**

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) **-272 kJ/mol**

2005B - #7

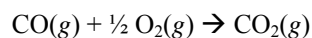
Substance	Combustion Reaction	Enthalpy of Combustion, ΔH_{comb}° , at 298 K (kJ mol ⁻¹)
H ₂ (g)	H ₂ (g) + $\frac{1}{2}$ O ₂ (g) → H ₂ O(l)	-290
C(s)	C(s) + O ₂ (g) → CO ₂ (g)	-390
CH ₃ OH(l)		-730

(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. **CH₃OH + $\frac{3}{2}$ O₂ → CO₂ + 2H₂O**

(b) On the basis of your answer to part (a) and the information in the table, determine the enthalpy change for the reaction C(s) + H₂(g) + H₂O(l) → CH₃OH(l). **50. kJ**

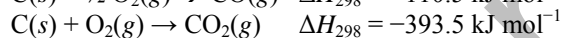
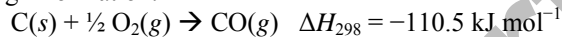
(c) Write the balanced chemical equation that shows the reaction that is used to determine the enthalpy of formation for one mole of CH₃OH(l). **C + $\frac{1}{2}$ O₂ + 2H₂ → CH₃OH**

2006 - #2a



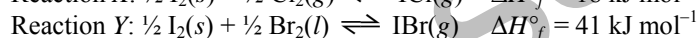
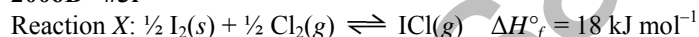
The combustion of carbon monoxide is represented by the equation above.

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

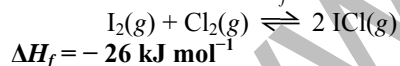


- 283.0 kJ mol⁻¹

2006B - #3f



(f) For the vaporization of solid iodine, I₂(s) → I₂(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.



$\Delta H_f^{\circ} = -26 \text{ kJ mol}^{-1}$

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. **-33.8 kJ**