

Chapter 3: Thermochemistry

- Which is a unit of energy?
 - pascal
 - newton
 - joule
 - watt
 - ampere
- For a chemical reaction, where the internal energy is given the symbol E , the correct statement is:
 - E_{final} signifies the internal energy of the reactants.
 - E_{initial} signifies the internal energy of the products.
 - $\Delta E = E_{\text{products}} - E_{\text{reactants}}$
 - ΔE is positive if energy is released to the surroundings.
 - ΔE is positive if energy is released by the chemical reaction.
- A 500.0 gram sample of aluminum is initially at 25.0°C . It absorbs 32.60 kJ of heat from its surroundings. What is its final temperature, in $^{\circ}\text{C}$? (specific heat = $0.9930\text{ J g}^{-1}\text{ }^{\circ}\text{C}^{-1}$ for aluminum)
 - 40.4°C
 - 64.7°C
 - 65.7°C
 - 89.7°C
 - 90.7°C
- A 113.25 gram sample of gold is initially at 100.0°C . It loses 20.00 J of heat to its surroundings. What is its final temperature? (specific heat of gold = $0.129\text{ J g}^{-1}\text{ }^{\circ}\text{C}^{-1}$)
 - 98.6°C
 - -98.6°C
 - 94.6°C
 - -94.6°C
 - 96.6°C
- During an **endothermic** chemical reaction,
 - a system becomes warmer, and the chemical substances undergo an increase in potential energy.
 - a system becomes warmer, and the chemical substances undergo a decrease in potential energy.
 - a system becomes cooler, and the chemical substances undergo an increase in potential energy.

d. a system becomes cooler, and the chemical substances undergo a decrease in potential energy.

e. a system becomes warmer, and additional heat is gained from the surroundings.

6. A bomb calorimeter consists of metal parts with a heat capacity of $925.0 \text{ J } ^\circ\text{C}^{-1}$ and 1.100×10^3 grams of oil with a specific heat of $2.814 \text{ J g}^{-1} ^\circ\text{C}^{-1}$. What is the heat capacity, in joules per degree, of the *entire* calorimeter?

a. $1321 \text{ J } ^\circ\text{C}^{-1}$

b. $2028 \text{ J } ^\circ\text{C}^{-1}$

c. $3703 \text{ J } ^\circ\text{C}^{-1}$

d. $4020 \text{ J } ^\circ\text{C}^{-1}$

e. $5698 \text{ J } ^\circ\text{C}^{-1}$

7. A closed, uninsulated system was fitted with a movable piston. Introduction of 483 J of heat caused the system to expand, doing 320 J of work in the process against a constant pressure of 101 kPa (kilopascals). What is the value of ΔE for this process?

a. $(483 + 320)$ joules

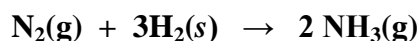
b. $(483 - 320)$ joules

c. $(320 - 483)$ joules

d. 483 joules

e. $(-320 - 483)$ joules

8. When nitrogen gas reacts with hydrogen gas to form ammonia, 92.38 kJ of heat are given off for each mole of nitrogen gas consumed, under constant pressure and standard conditions. What is the correct value for the standard enthalpy of reaction in the thermochemical equation below when 0.750 mol of hydrogen reacts?



a. +34.5 kJ

b. -98.3 kJ

c. +59.2 kJ

d. -59.2 kJ

e. -23.1 kJ

9. The thermochemical equation which is associated with ΔH_f° , the standard enthalpy of formation for $\text{HCl}(\text{g})$, is

a. $\text{H}(\text{g}) + \text{Cl}(\text{g}) \rightarrow \text{HCl}(\text{g})$

b. $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$

c. $\frac{1}{2}\text{H}_2(\text{g}) + \frac{1}{2}\text{Cl}_2(\text{g}) \rightarrow \text{HCl}(\text{g})$

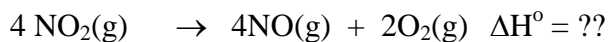
d. $\text{H}_2(\text{g}) + \text{Cl}_2(\text{l}) \rightarrow 2\text{HCl}(\text{g})$

e. $\frac{1}{2}\text{H}_2(\text{g}) + \frac{1}{2}\text{Cl}_2(\text{l}) \rightarrow \text{HCl}(\text{g})$

10. Consider the following thermochemical equation:

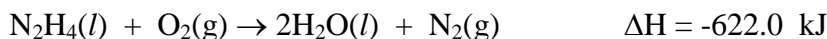


Calculate ΔH° for the reaction below:



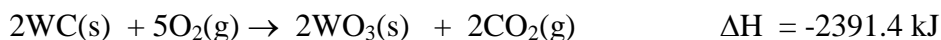
- a. +334.5 kJ
- b. -146.19 kJ
- c. +226.4 kJ
- d. -509.2 kJ
- e. +192.38 kJ

11. Determine the enthalpy change, ΔH , for the reaction, $\text{N}_2(\text{g}) + 2\text{H}_2(\text{g}) \rightarrow \text{N}_2\text{H}_4(\text{l})$, given the following thermochemical equations:



- a. -151.7 kJ
- b. -236.2 kJ
- c. +106.1 kJ
- d. +50.2 kJ
- e. +567.4 kJ

12. Determine the enthalpy change, ΔH , for the reaction, $\text{W}(\text{s}) + \text{C}(\text{s}) \rightarrow \text{WC}(\text{s})$, given the following thermochemical equations:

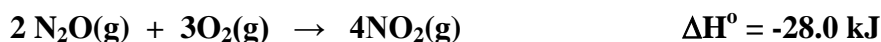


- a. +33.3 kJ
- b. -38.2 kJ
- c. +106.1 kJ
- d. -52.9 kJ
- e. +177.4 kJ

13. The mathematical equation which expresses the first law of thermodynamics is

- a. $\Delta H = \Delta E + p\Delta V$
- b. $\Delta H = \Delta E - p\Delta V$
- c. $\Delta H = q + w$
- d. $\Delta E = q + w$
- e. $\Delta H = q + \Delta E$

14. The thermochemical equation for the reaction between dinitrogen monoxide and oxygen to produce nitrogen dioxide is shown below. Write the thermochemical equation for the reaction when 1.00 mole of nitrogen dioxide is formed.



- a. $\text{N}_2\text{O}(\text{g}) + 3 \text{O}_2(\text{g}) \rightarrow \text{NO}_2(\text{g}) \quad \Delta H^\circ = -28.0 \text{ kJ}$
- b. $\text{N}_2\text{O}(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{NO}_2(\text{g}) \quad \Delta H^\circ = -28.0 \text{ kJ}$
- c. $2 \text{N}_2\text{O}(\text{g}) + 3 \text{O}_2(\text{g}) \rightarrow 4 \text{NO}_2(\text{g}) \quad \Delta H^\circ = -56.0 \text{ kJ}$
- d. $\frac{1}{2} \text{N}_2\text{O}(\text{g}) + \frac{3}{4} \text{O}_2(\text{g}) \rightarrow \text{NO}_2(\text{g}) \quad \Delta H^\circ = -7.00 \text{ kJ}$
- e. $\frac{1}{2} \text{N}_2\text{O}(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{NO}_2(\text{g}) \quad \Delta H^\circ = -14.0 \text{ kJ}$

15. Given the equation for a hypothetical reaction, $3\text{A} + 4\text{B} \rightarrow 4\text{C} + 7\text{D}$, and the following standard enthalpies of formation, ΔH_f° :

A: $+15.7 \text{ kJ mol}^{-1}$ B: $-86.4 \text{ kJ mol}^{-1}$ C: $-52.7 \text{ kJ mol}^{-1}$ D: $-71.6 \text{ kJ mol}^{-1}$

calculate the standard enthalpy of reaction, in kJ, for the reaction shown.

- a. -53.6 kJ
- b. -413.5 kJ
- c. -515.6 kJ
- d. -853.6 kJ
- e. -908.4 kJ

16. The standard enthalpy of combustion for xylene, $\text{C}_8\text{H}_{10}(\text{l})$, is $-3908 \text{ kJ mol}^{-1}$. Using this information and the standard enthalpies of formation of the following, ΔH_f° : $\text{H}_2\text{O}(\text{l}) = -285.9 \text{ kJ mol}^{-1}$; $\text{CO}_2(\text{g}) = -393.5 \text{ kJ mol}^{-1}$, calculate the standard enthalpy of formation of $\text{C}_8\text{H}_{10}(\text{l})$, in kJ mol^{-1} .

- a. -669.5 kJ
- b. $+3228.6 \text{ kJ}$
- c. -3228.6 kJ
- d. $+4587.4 \text{ kJ}$
- e. $+8485.5 \text{ kJ}$

17. The standard enthalpy of reaction, $\Delta H_{\text{rxn}}^\circ$ for



is $-311.5 \text{ kJ mol}^{-1}$. Determine the value of $\Delta E_{\text{rxn}}^\circ$ for this reaction.

- a. $-306.5 \text{ kJ mol}^{-1}$
- b. $-309.0 \text{ kJ mol}^{-1}$
- c. $-314.0 \text{ kJ mol}^{-1}$
- d. $-316.46 \text{ kJ mol}^{-1}$
- e. $+4646 \text{ kJ mol}^{-1}$