Project Advance Chemistry 106 Sample Questions
on Material in *General Chemistry*, Brown, LeMay, and Bursten, 6th ed.

Chapter 5. Energy Relationships in Chemistry: Thermochemistry

1. Calculate the kinetic energy in joules of an electron moving at 6.00×10^6 m/s.

   (a) 4.98×10^{-48}
   (b) 3.28×10^{-14}
   (c) 1.64×10^{-14}
   (d) 2.49×10^{-48}
   (e) 6.56×10^{-14}

2. Calculate the value of ΔE for a system which performs 213 kJ of work on its surroundings and loses 79 kJ of heat?

   (a) +292 kJ
   (b) -292 kJ
   (c) +134 kJ
   (d) -134 kJ
   (e) -213 kJ

3. Which statement is *incorrect* about an endothermic change in a chemical reaction?

   (a) The potential energy of the reacting chemicals increases.
   (b) The reaction mixture becomes cool.
   (c) Heat is absorbed by the reacting chemicals.
   (d) The law of conservation of mass is observed.
   (e) The surroundings absorb heat from the reaction mixture.

4. Which of the following statements is false?

   (a) Enthalpy is not a state function.
   (b) Work is not a state function.
   (c) In a reaction run at constant pressure, the enthalpy change is equal to the energy flow as heat.
   (d) Under most conditions, ΔH is close to ΔE.
   (e) If ΔE = w the process is adiabatic.

5. Which one of the following processes is endothermic?

   (a) $2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O$
   (b) $H_2O(g) \rightarrow H_2O(l)$
   (c) $CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(g)$
   (d) $H_2O(s) \rightarrow H_2O(l)$
   (e) none of these.

6. Which one of the following reactions has a negative value for $\Delta H°$?

   (a) $CO_2(s) + CO_2(g)$

   (b) $C(s) + O_2(g) \rightarrow CO_2(g)$

   (c) $2\ H_2O(l) \rightarrow 2\ H_2(g) + O_2(g)$

   (d) $NH_3(l) \rightarrow 2\ H_2(g) + O_2(g)$

   (e) none of these.

7. The value of $\Delta H°$ for the following reaction is -126 kJ. Determine the amount of heat (in kJ) that would be evolved by the reaction of 25.0 g of sodium peroxide, Na_2O_2, with water.

   $$2\ Na_2O_2(s) + 2\ H_2O(l) \rightarrow 4\ NaOH(s) + O_2(g)$$

   (a) 20.2 (b) 40.4
   (c) 67.5 (d) 80.8
   (e) none of these.

8. The value of $\Delta H°$ for the reaction below is -6535 kJ. How many kJ of heat will be evolved during the combustion of 16.0 g of $C_6H_6(l)$?

   $$2\ C_5H_6(l) + 15\ O_2(g) \rightarrow 12\ CO_2(g) + 6\ H_2O(l)$$

   (a) 1.34×10^3 (b) 5.23×10^4
   (c) 6.70×10^2 (d) 2.68×10^3
   (e) none of these.

9. The value of $\Delta H°$ for the following reaction is -186 kJ. Calculate the value of $\Delta H_f°$ (in kJ/mol) for $HCl(g)$.

   $$H_2(g) + Cl_2(g) \rightarrow 2\ HCl(g)$$

   (a) -3.72×10^2 (b) -1.27×10^2
   (c) -186 (d) -93.0
   (e) none of these.

10. The reaction: $2\ Al(s) + 3\ O_2(g) \rightarrow 2\ Al_2O_3(s)$ has a $\Delta H° = -3351$ kJ. The reaction is _____ and therefore heat is _____ by the reaction.

    (a) endothermic, evolved (b) endothermic, absorbed
    (c) exothermic, evolved (d) exothermic, absorbed

11. Given the values of $\Delta H°$ for the two reactions below, what is $\Delta H°$ in kJ for the reaction: $IF_5(g) \rightarrow IF_3(g) + F_2(g)$?

$IF(g) + F_2(g) \rightarrow IF_3(g)$; $\Delta H_1° = -390$ kJ

$IF(g) + 2\ F_2(g) \rightarrow IF_5(g)$; $\Delta H_2° = -745$ kJ

(a) +355 (b) -1135
(c) +1135 (d) +35
(e) -35

12. Given the following thermochemical equations

$N_2(g) + 2\ O_2(g) \rightarrow 2\ NO_2(g)$; $\Delta H° = 66.4$ kJ
$2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$; $\Delta H° = -114.2$ kJ

What is the value of $\Delta H°$ for the reaction shown below?

$N_2(g) + O_2(g) \rightarrow 2\ NO(g)$

(a) 181 kJ (b) -47.8 kJ
(c) 47.8 kJ (d) 90.3 kJ
(e) none of these.

13. For which species below would $\Delta H_f°$ be zero?

$Ni(s) + 2\ CO(g) + 2\ PF_3(g) \rightarrow Ni(CO)_2(PF_3)_2(l)$

(a) $Ni(s)$ (b) $CO(g)$
(c) $PF_3(g)$ (d) $Ni(CO)_2(PF_3)_2(l)$
(e) both $CO(g)$ and $PF_3(g)$

14. Select the equation(s) shown below for which the enthalpy change is the heat of formation.

I. $H_2(g) + O_2(g) \rightarrow H_2O_2(l)$
II. $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$
III. $H_2(g) + Br_2(l) \rightarrow 2\ HBr(g)$
IV. $O_2(g) + 2\ F_2(g) \rightarrow 2\ OF_2(g)$

(a) II only (b) I and III
(c) I, II, and III (d) I only
(e) All of them I, II, III, and IV.

15. Calculate the value of $\Delta H°$ (in kJ) for the following reaction:

$$4\ NH_3(g) + 5\ O_2(g) \rightarrow 4\ NO(g) + 6\ H_2O(l)$$

(a) -1172
(b) -150
(c) -1540
(d) -1892
(e) none of these.

16. What is the value of $\Delta H_f°$ for the following reaction?

$$IF_5(g) + F_2(g) \rightarrow IF_7(g)$$

(a) 1801 kJ
(b) -1801 kJ
(c) 121 kJ
(d) -121 kJ
(e) none of these.

17. The enthalpy change, $\Delta Hf°$ for the following reaction is -390 kJ. What is the value of $\Delta H_f°$ (in kJ/mol) for IF_3?

$$IF(g) + F_2(g) \rightarrow IF_3(g)$$

(a) 295
(b) -485
(c) -295
(d) 485
(e) none of these.

18. Determine the value of $\Delta H°$ for the following reaction:

$$C_2H_5OH(l) + O_2(g) \rightarrow CH_3CO_2H(l) + H_2O(l)$$

(a) -79.0
(b) -476.4
(c) -492.6
(d) -1048.0
(e) none of these.

19. The value of $\Delta H°$ for the following reaction is -137.0 kJ. What is the value of $\Delta H_f°$ for $C_2H_6(g)$?

$$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$$

(a) 189.3
(b) -189.3
(c) -84.7
(d) 84.7
(e) none of these.

20. Determine the value of $\Delta H°$ (in kJ) for the following reaction.

$$2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g)$$

(a) -99
(b) 99
(c) 198
(d) -198
(e) none of these.

21. Calculate the quantity of heat (in kJ) evolved when 7.5 g of SO_2 reacts according to the following equation.

$$SO_2(g) + Cl_2(g) \rightarrow SO_2Cl_2(g)$$

(a) 77
(b) 5.7×10^2
(c) 19
(d) 7.9
(e) none of these.

22. An iron sphere of diameter 4.00 cm and density 7.86 g/cm^3 at 20.0°C is dropped into a perfectly insulated beaker containing 90.0 g of H_2O at 50.0°C. [$V = (4/3)\pi r^3$] The respective specific heats of Fe and H_2O are 0.45 and 4.18 J/g · °C. What is the final temperature (in °C) of the iron sphere?

(a) 7
(b) 73
(c) 29
(d) 48
(e) 43

23. Determine the heat capacity per gram (C_g) for metal X from the following information: 95 g of metal at 75°C are placed in 50 g of water ($C_g = 4.184$) at 18°C. The final temperature of the water is 23°C.

(a) 23
(b) 0.21
(c) 0.76
(d) 3.6
(e) none of these.

24. The density of gold is 19.3 g/cm^3. The heat capacity of gold is 0.13 J/g · °C. A cube of gold at 75.0°C is dropped into 150 g of water at 25.0°C. The final temperature of the mixture is 27.5°C. What is the length of an edge of the gold cube? Heat capacity of water is 4.184 J/g · °C.

(a) 13 cm
(b) 6.3 cm
(c) 2.4 cm
(d) 0.42 cm
(e) none of these.

25. Which of the following statements abut energy usage in the United States is *false*?

    (a) Fossil fuels are our major energy source.
    (b) Nuclear power accounts for about 35% of all electricity generated in the U.S.
    (c) Coal is our most abundant fossil fuel.
    (d) Solar energy falling on 0.1% of the land area of the U.S. is equivalent to current national energy use.
    (e) Photovoltaic solar power cells are not yet practical on a large scale.

26. Which one of the following samples would require the least amount of thermal energy to bring its temperature to 80.0°C?

    (a) 200.0 g of H_2O at 40.0 K
    (b) 100.0 g of H_2O at 20.0 K
    (c) 200.0 g of H_2O at 40.0 K
    (d) 100.0 g of H_2O at 20.0 K
    (e) 200.0 g of H_2O at 20.0 K

27. If 100 J of heat is removed from a mixture of 100 g of ice and 100 g of water at 0°C, then

    (a) the temperature will rise.
    (b) some of the water will freeze.
    (c) the temperature will decrease.
    (d) some of the ice melts.
    (e) some of the water vaporizes.

28. A calorimeter was calibrated using a heater rated at 35.0 W. When the heater was on for 128 s, the temperature rose 4.216 K. The calibration relation for the calorimeter is

    (a) 1.06 kJ per 4.216 K
    (b) 3.65 kJ per 4.216 K
    (c) 4.48 kJ per 4.216 K
    (d) 35.0 J per 4.216 K
    (e) 35.0 kJ per 30.4 $s \cdot K^{-1}$

29. To which of the following reactions does ΔH_f° for HCl(*g*) refer?

    (a) $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$
    (b) $NaCl(s) + H_2SO_4(l) \rightarrow NaHSO_4(s) + HCl(g)$
    (c) $\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) \rightarrow HCl(g)$
    (d) $H_2(g) + Cl_2(l) \rightarrow HCl(l)$
    (e) $H(g) + Cl(g) \rightarrow HCl(g)$

30. The equation that represents the standard enthalpy of formation of solid ammonium nitrate is

(a) $4N(g) + 8H(g) + 6O(g) \rightarrow 2NH_4NO_3(s)$
(b) $2N_2(g) + 4H_2(g) + 3O_2(g) \rightarrow 2NH_4NO_3(s)$
(c) $N_2(g) + 2H_2(g) + 3/2O_2(g) \rightarrow NH_4NO_3(s)$
(d) $2N(g) + 4H(g) + 3O(g) \rightarrow NH_4NO_3(s)$
(e) $N_2O(g) + 2H_2O(g) \rightarrow NH_4NO_3(s)$

Standard Heats of Formation for Selected Substances

Substance	Formula	ΔH_f° (kJ/mole)
acetic acid	$CH_3CO_2H(l)$	-484.5
ammonia	$NH_3(g)$	-46
calcium carbonate	$CaCO_3(s)$	-1207
carbon dioxide	$CO_2(g)$	-193.7
carbon monoxide	$CO(g)$	-110.5
ethyl alcohol	$C_2H_5OH(l)$	-277.7
ethylene	$C_2H_4(g)$	52.3
hydrogen sulfide	$H_2S(g)$	-20.6
iodine hepatfluoride	$IF_7(g)$	-941
iodine fluoride	$IF(g)$	-95
iodine pentafluoride	$IF_5(g)$	-840
nitric acid	$HNO_3(g)$	-207
nitrogen oxide	$NO(g)$	90
nitrous oxide	$NO_2(g)$	34
silver(I) sulfide	$Ag_2S(s)$	-32.6
silver(I) oxide	$Ag_2O(s)$	-31.0
sulfur dioxide	$SO_2(g)$	-297
sulfur trioxide	$SO_3(g)$	-396
sulfuric acid	$H_2SO_4(l)$	-814
thionyl chloride	$SO_2Cl_2(g)$	-364
water	$H_2O(l)$	-285.8