Thermochemistry

NChO 1999

Reaction	ΔH
$Mg(s) + 2\ HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$	-467 kJ mol^{-1}
$MgO(s) + 2\ HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$	-151 kJ mol^{-1}

27. According to this information, and given the fact that for water, $\Delta H_f = -286$ kJ mol^{-1}, what is ΔH_f for MgO(s)?
(A) -904 kJ mol^{-1} (C) -334 k J mol^{-1}
(B) -602 kJ mol^{-1} (D) -30 kJ mol^{-1}

NChO 1998

22. Carbon reacts with oxygen according to this equation. $2C(s) + O_2(g) \rightarrow 2CO(g)$
$\Delta H = -220$ kJ
Which statements are true?
1. The reaction is exothermic.
2. The combustion of 0.50 mol of carbon produces 55 kJ of heat energy
(A) 1 only (C) both 1 and 2
(B) 2 only (D) neither 1 nor 2

24. Use these data to calculate ΔH° for this reaction. $NO(g) + ½\ O_2(g) \rightarrow NO_2(g)$

Reaction	ΔH°, kJ mol^{-1}
$½\ N_2(g) + ½\ O_2(g) \rightarrow NO(g)$	90.2 kJ mol^{-1}
$½\ N_2(g) + O_2(g) \rightarrow NO_2(g)$	33.2 kJ mol^{-1}

(A) -57.0 (C) +28.5
(B) -28.5 (D) +57.0

25. A 1.0 g sample of substance A at 100 °C is added to 100 ml of H_2O at 25 °C. Using separate 100 mL portions of H_2O, the procedure is repeated with substance B and then with substance C. How will the final temperatures of the water compare?

Substance	Specific Heat
A	0.60 J g^{-1} $°C^{-1}$
B	0.40 J g^{-1} $°C^{-1}$
C	0.20 J g^{-1} $°C^{-1}$

(A) $T_c > T_b > T_a$ (C) $T_a > T_b > T_c$
(B) $T_b > T_a > T_c$ (D) $T_a = T_b = T_c$

26. How many grams of benzene, $C_6H_6(l)$, must be burned in a bomb calorimeter to raise its temperature by 1.5 °C? Given: The calorimeter constant is 12.59 kJ C^{-1} and the $\Delta H°_{combustion}$ for C_6H_6 = -41.9 kJ g^{-1}
(A) 0.45 g (C) 3.3 g
(B) 2.8 g (D) 8.4 g

NChO 1997

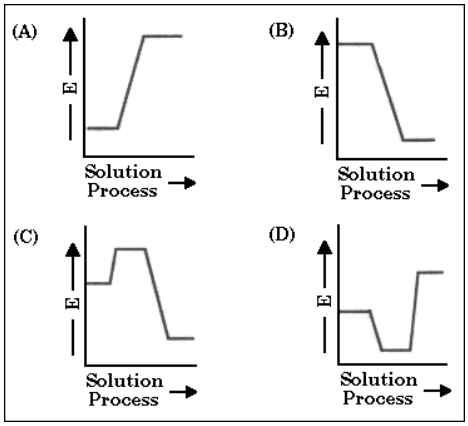
19. 30.0 mL of water at 10. °C is mixed with 50.0 mL of water at 60. °C. What is the final temperature of the mixture?
(A) 31 °C (C) 41 °C
(B) 35 °C (D) 46 °C

24. What is the value of ΔH° for this reaction?
$Fe_2O_3(s) + 3H_2O(l) \rightarrow 2Fe(OH)_3(s)$

Substance	$\Delta H°_f$ (kJ mol^{-1})
$Fe_2O_3(s)$	-824.2
$Fe(OH)_3(s)$	-823.0
$H_2O(l)$	-285.8

(A) 35.6 kJ (C) 858.6 kJ
(B) 286 kJ (D) -536 kJ

25. When $Na_2S_2O_3 \cdot 3H_2O$ dissolves in water, the solution gets cold. Which energy diagram best represents the behavior of this solution process?



NChO 1996

22. The standard enthalpy of formation ($\Delta H°_f$) for sodium bromide is the enthalpy change for the reaction
(A) $Na^+(g) + Br^-(g) \rightarrow NaBr(g)$
(B) $Na^+(g) + Br^-(g) \rightarrow NaBr(s)$
(C) $2\ Na(s) + Br_2(g) \rightarrow 2\ NaBr(s)$
(D) $Na(s) + ½\ Br_2(l) \rightarrow NaBr(s)$

23. Use the standard enthalpies of formation in the table to calculate $\Delta H°$ for this reaction:

$2\ CrO_4^{2-}(aq) + 2\ H^+(aq) \rightarrow Cr_2O_7^{2-}(aq) + H_2O(l)$

Substance	$\Delta H°_f$, kJ mol^{-1}
$CrO_4^{2-}(aq)$	- 881.2
$Cr_2O_7^{2-}(aq)$	- 1490.3
$H^+(aq)$	0
$H_2O(l)$	- 285.8

(A) 272.1 kJ (C) -13.7 kJ
(B) 13.7 kJ (D) -272.1 kJ

NChO 1995

21. For which of these processes is the sign of the enthalpy change different from the others?
(A) $Al_2O_3(s) \rightarrow 2\ Al(s) + 3/2\ O_2(g)$
(B) $H_2O(s) \rightarrow H_2O(l)$
(C) $Cl_2(g) \rightarrow 2Cl(g)$
(D) $Cl(g) + e^- \rightarrow Cl^-(g)$

22. The standard enthalpy of formation ($\Delta H°$) for nitrogen(IV) oxide is the enthalpy change for the reaction
(A) $N(g) + 2O(g) \rightarrow NO_2(g)$
(B) $½\ N_2(g) + O_2(g) \rightarrow NO_2(g)$
(C) $½\ N_2O_4(g) \rightarrow NO_2(g)$
(D) $NO(g) + ½\ O_2 \rightarrow NO_2(g)$

23. In a bomb calorimeter, reactions are carried out at
(A) constant volume.
(B) constant pressure.
(C) 1 atm pressure and 25 °C.
(D) 1 atm pressure and 0 °C.

26. Consider the reaction
$Hg(l) + 2\ Ag^+(aq) \rightarrow Hg^{2+}(aq) + 2\ Ag(s)$
What is the enthalpy change for this reaction if $\Delta H°_f$ for Ag^+ (aq) is +105.6 kJ mol^{-1} and for Hg^{2+} (aq) is +171.1 kJ mol^{-1}?
(A) 65.5 kJ are evolved per mole of Hg.
(B) 65.5 lK are absorbed per mole of Hg.
(C) 40.1 kJ are evolved per mole of Hg.
(D) 40.1 kJ are absorbed per mole of Hg.

NChO 1994

24. A student mixes 100 mL of 0.50 M NaOH with 100 mL of 0.50 M HCl in a styrofoam cup and observes a temperature increase of ΔT_1. When she repeats this experiment using 200mL of each solution, she observes a temperature change of ΔT_2. If no heat is lost to the surroundings or absorbed by the styrofoam cup, what is true about ΔT_1 and $\Delta\ T_2$?
(A) $\Delta T_2 = \Delta T_1$ (C) $\Delta T_2 = 2\ \Delta T_1$
(B) $\Delta T_2 = 0.5\ \Delta T_1$ (D) $\Delta T_2 = 4\ \Delta T_1$

27) Given these values of $\Delta H°$: $\Delta H°$

$CS_2(l) + 3O_2(g) \rightarrow CO_2(g) + 2SO_2(g)$ - 1077 kJ

$H_2(g) + O_2(g) \rightarrow H_2O_2(l)$ - 188 kJ

$H_2(g) + (1/2)\ O_2(g) \rightarrow H_2O(l)$ - 286 kJ

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

$CS_2(l) + 6\ H_2O_2(l) \rightarrow CO_2(g) + 6\ H_2O(l) + 2\ SO_2(g)$

(A) -1175 kJ (C) -1665 kJ
(B) -1551 kJ (D) -3921 kJ

NChO 1993

13. Which process or reaction has a positive ΔH?
(A) $H_2O(l) \rightarrow H_2O(s)$
(B) $2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(l)$
(C) $CO_2(s) \rightarrow CO_2(g)$
(D) $2\ Na(s) + Cl_2(g) \rightarrow 2\ NaCl\ (s)$

15. For the reaction
$H_2(g) + I_2(s) \rightarrow 2\ HI(g)$ $\Delta H_{rxn} = 53.0$ kJ
What will be the value of ΔH_{rxn} (in kJ) for this rxn ?
$HI(g) \rightarrow ½\ H_2(g) + ½\ I_2(s)$
(A) 26.5 (C) -26.5
(B) 7.3 (D) -53.0