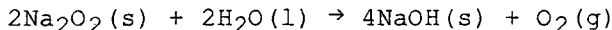


1. The value of  $\Delta H^\circ$  for the reaction below is  $-126 \text{ kJ}$ . How much heat (in kJ) is evolved when 2.00 mol of NaOH is formed in the reaction?



- a) 252  
 b) 63  
 c) 3.9  
 d) 7.8  
 e) -126

$$\frac{2.00 \text{ mol NaOH} \mid 126 \text{ kJ}}{4 \text{ mol NaOH}} = 63 \text{ kJ}$$

2. What are the spectator ions in the reaction between  $\text{KOH}(\text{aq})$  and  $\text{HNO}_3(\text{aq})$ ?

- a)  $\text{K}^+$  and  $\text{H}^+$   
 b)  $\text{H}^+$  and  $\text{OH}^-$   
 c)  $\text{K}^+$  and  $\text{NO}_3^-$   
 d)  $\text{H}^+$  and  $\text{NO}_3^-$   
 e)  $\text{OH}^-$  only



3. Which of the following is an exothermic process?

- a) ice melting  
 b) water evaporating  
 c) heating soup  
 d) condensation of water vapor  
 e) Ammonium thiocyanate and barium hydroxide are mixed at  $25^\circ\text{C}$ : the temperature drops.

4. The first law of thermodynamics states that \_\_\_\_\_.

- a) all spontaneous processes are accompanied by an increase in disorder  
 b) energy is conserved during any process  
 c) the entropy of a pure, crystalline substance at absolute zero is zero  
 d) the amount of work done during a change is independent of the pathway of that change  
 e) none of these

5.  $4\text{Al}(\text{s}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{Al}_2\text{O}_3(\text{s}) \quad \Delta H^\circ = -3351 \text{ kJ}$

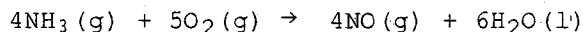
The reaction shown above is \_\_\_\_\_ and therefore heat is \_\_\_\_\_ by the reaction.

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

6. Substance |  $\Delta H^\circ_f$  (kJ/mol)

|                                |      |
|--------------------------------|------|
| $\text{H}_2\text{O}(\text{l})$ | -286 |
| $\text{NO}(\text{g})$          | 90   |
| $\text{NO}_2(\text{g})$        | 34   |
| $\text{HNO}_3(\text{aq})$      | -207 |
| $\text{NH}_3(\text{g})$        | -46  |

Calculate  $\Delta H_{\text{rxn}}^\circ$  (in kJ) for the reaction:



- a) -1172  
 b) -150  
 c) -1540  
 d) -1892  
 e) The  $\Delta H^\circ_f$  of  $\text{O}_2(\text{g})$  is needed for the calculation.

$$\Delta H = \sum \Delta H_{\text{prod}} - \sum \Delta H_{\text{react}}$$

$$\begin{matrix} 4\text{NO} & 6\text{H}_2\text{O} & & 4\text{NH}_3 & 5\text{O}_2 \\ [4(90) + 6(-286)] & - & [4(-46) + 5(0)] & = & -1172 \text{ kJ} \end{matrix}$$

7. What is the concentration (M) of NaCl in a solution made by mixing 25.0 mL of 0.100 M NaCl with 50.0 mL of 0.100 M NaCl?

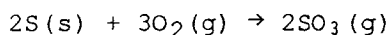
- a) 0.100
- b) 0.0500
- c) 0.0333
- d) 0.0250
- e) 125

Same conc.

8. A strong electrolyte is one that \_\_\_\_\_ completely in solution.

- a) reacts
- b) dissolves
- c) decomposes
- d) disappears
- e) ionizes

9. The value of  $\Delta H^\circ$  for the reaction below is -790 kJ. The enthalpy change accompanying the reaction of 0.95 g of S is \_\_\_\_\_ kJ.



- a) 23
- b) -23
- c) -12
- d) 12
- e) -790

$$\frac{0.95 \text{ g S} \left| \frac{1 \text{ mol}}{32.06 \text{ g}} \right|}{32.06 \text{ g}} \left| \frac{-790 \text{ kJ}}{2 \text{ mol S}} \right| = -11.7$$

10. Which hydroxides are strong bases?

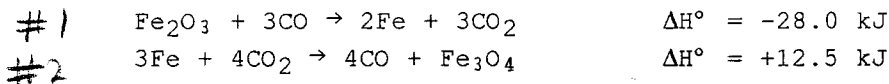
- 1. Sr(OH)<sub>2</sub>
- 2. KOH
- ✓ 3. NaOH
- 4. Ba(OH)<sub>2</sub>

- a) 2 & 4
- b) 2 & 3
- c) 2, 3, & 4
- d) 1, 2, 3, & 4
- e) none of these is a strong base

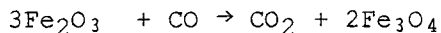
11. A chemical reaction that absorbs heat from the surroundings is said to be Endo and has a + value of  $\Delta H$  at constant pressure.

- a) endothermic, positive
- b) endothermic, negative
- c) exothermic, negative
- d) exothermic, positive
- e) exothermic, neutral

12. Consider the following thermochemical equations:



Calculate the value of  $\Delta H^\circ$  (in kJ) for:



- a) -59.0
- b) 40.5
- c) -15.5
- d) -109
- e) +109

$$\begin{array}{l} 3Fe_2O_3 : \#1 \times 3 \\ CO : \text{skip} \\ CO_2 : \text{skip} \\ 2Fe_3O_4 : \#2 \times 2 \end{array} \quad \begin{array}{l} 3Fe_2O_3 + 9CO \rightarrow 6Fe + 9CO_2 \quad -84.0 \\ 6Fe + 8CO_2 \rightarrow 8CO + 2Fe_3O_4 \quad 25.0 \\ \hline 3Fe_2O_3 + CO \rightarrow CO_2 + 2Fe_3O_4 \quad -59.0 \text{ kJ} \end{array}$$

13. How many grams of NaOH (MW = 40.0) are there in 500.0 mL of a 0.175 M NaOH solution?

- a)  $2.19 \times 10^{-3}$
- b) 114
- c) 14.0
- d) 3.50
- e)  $3.50 \times 10^3$

$$\frac{500.0 \text{ mL} \times 0.175 \text{ mol NaOH}}{1000 \text{ mL}} \times \frac{40.0 \text{ g}}{\text{mol}} = 3.50 \text{ g NaOH}$$

14. Which of the following are strong acids?

- 1. HI
  - 2. HNO<sub>3</sub>
  - 3. HF
  - 4. HBr
- 
- a) 3 & 4
  - b) 1, 2, 3, & 4
  - c) 1, 3, & 4
  - d) 2, 3, & 4
  - e) 1, 2, & 4

15. Which one of the following is a weak acid?

- a) HNO<sub>3</sub>
- b) HCl
- c) HI
- d) HF
- e) HClO<sub>4</sub>

16. What volume (mL) of a concentrated solution of sodium hydroxide (6.00 M) must be diluted to 200 mL to make a 0.88 M solution of sodium hydroxide?

- a) 2.64
- b) 176
- c) 26.4
- d) 29.3
- e) 50.0

$$M_1 V_1 = M_2 V_2$$
$$(6.00 \text{ M})(V_1) = (0.88 \text{ M})(200 \text{ mL})$$
$$V_1 = 29.3 \text{ mL}$$

17. When a sample of aluminum absorbed 9.86 J of heat, its temperature increased from 23.2°C to 30.5°C. Since the specific heat of aluminum is 0.90 J/g-K, the mass of the sample was \_\_\_\_\_ g.

- a) 72
- b) 1.5
- c) 65
- d) 8.1
- e) 6.6

$$\frac{9.86 \text{ J}}{0.90 \text{ J/g} \cdot \text{K}} = 11.0 \text{ g}$$
$$\frac{11.0 \text{ g}}{7.3 \text{ K}} = 1.5 \text{ g}$$

18. Which one of the following processes is endothermic?

- a)  $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$  Combustion = Exo
- b)  $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$  Condensation = Exo
- c)  $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$  Combustion = Exo
- d)  $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l})$  melting = Endo
- e)  $2\text{Al}(\text{s}) + \text{Fe}_2\text{O}_3(\text{s}) \rightarrow \text{Al}_2\text{O}_3(\text{s}) + 2\text{Fe}(\text{l})$  liquid = Exo

19. An aqueous ethanol solution (400 mL) was diluted to 4.00 L, giving a concentration of 0.0400 M. The concentration of the original solution was \_\_\_\_\_ M.

- a) 0.400
- b) 0.200
- c) 2.00
- d) 1.60
- e) 4.00

$$M_1 V_1 = M_2 V_2$$
$$M_1 (0.400 \text{ L}) = (0.0400 \text{ M})(4.00 \text{ L})$$

$$M_1 = 0.400 \text{ M}$$

20. When 72 g of a metal at 97.0°C is added to 100.0 g of water at 25.0°C, the final temperature is 29.1°C. What is the heat capacity (in J/g-K) of the metal? The specific heat of H<sub>2</sub>O(l) is 4.18 J/g-K.

- a) 0.46  
 b) 2.8  
 c) 0.35  
 d) 2.0  
 e) 4.18

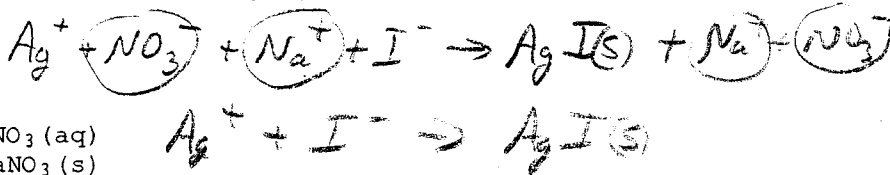
Heat lost Metal = Heat gained H<sub>2</sub>O  

$$\text{Heat (H}_2\text{O)} : \frac{4.18 \text{ J/g-K} \times 100.0 \text{ g} \times 4.1 \text{ K}}{8 \text{ K}} = 1713.8 \text{ J}$$

$$\text{Sp. Ht. metal} : \frac{1713.8 \text{ J}}{72 \text{ g} \times 67.9 \text{ K}} = 0.35 \frac{\text{J}}{\text{g K}}$$

21. When aqueous solutions of AgNO<sub>3</sub> and NaI are mixed, AgI precipitates. The balanced net ionic equation is \_\_\_\_\_.

- a) Ag<sup>+</sup>(aq) + I<sup>-</sup>(aq) → AgI(s)  
 b) Ag<sup>+</sup>(aq) + NO<sub>3</sub><sup>-</sup>(aq) → AgNO<sub>3</sub>(s)  
 c) Ag<sup>+</sup>(aq) + NO<sub>3</sub><sup>-</sup>(aq) → AgNO<sub>3</sub>(aq)  
 d) AgNO<sub>3</sub>(aq) + NaI(aq) → AgI(s) + NaNO<sub>3</sub>(aq)  
 e) AgNO<sub>3</sub>(aq) + NaI(aq) → AgI(aq) + NaNO<sub>3</sub>(s)



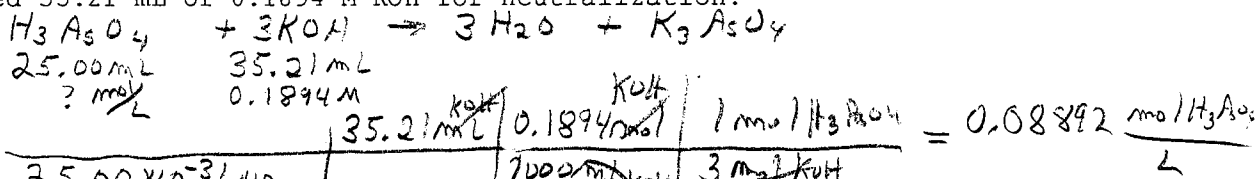
22. What is the concentration (M) of sodium ions in 4.57 L of a 0.847 M Na<sub>3</sub>P solution?

- a) 0.847  
 b) 3.87  
 c) 0.185  
 d) 2.54  
 e) 0.282

$$3 \times 0.847 = 2.54 \text{ M Na}^+$$

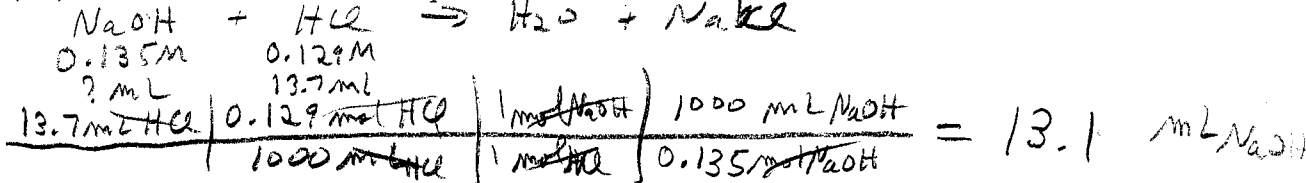
23. Calculate the concentration (M) of arsenic acid (H<sub>3</sub>AsO<sub>4</sub>) in a solution if 25.00 mL of that solution required 35.21 mL of 0.1894 M KOH for neutralization.

- a) 0.2668  
 b) 0.8003  
 c) 0.08892  
 d) 0.1345  
 e) 0.1894



24. What volume (mL) of 0.135 M NaOH is required to neutralize 13.7 mL of 0.129 M HCl?

- a) 13.1  
 b) 0.24  
 c) 14.3  
 d) 0.076  
 e) 6.55



25. What is the concentration (M) of CH<sub>3</sub>OH in a solution prepared by dissolving 11.7 g of CH<sub>3</sub>OH in sufficient water to give 230 mL of solution?

- a) 11.9  
 b) 1.59 × 10<sup>-3</sup>  
 c) 0.0841  
 d) 1.59  
 e) 11.9 × 10<sup>-3</sup>

$$\frac{11.7 \text{ g CH}_3\text{OH}}{32.04 \text{ g}} \times \frac{1 \text{ mol}}{32.04 \text{ g}} = \frac{0.230 \text{ L}}{0.230 \text{ L}} = 1.59 \frac{\text{mol}}{\text{L}}$$