

**Appendix D****ANSWERS TO  
END-OF-CHAPTER PROBLEMS****Chapter 34**

- FTTFT
- TTFTT
- b and e
- a. 38.00 kJ      b. 33.9 kJ
- a. 0.33 kJ      b. 1.52 kJ      c. 1.6 kJ      d. 4.72 kJ      e. 8.2 kJ
- 24.5 kJ

**Chapter 35**

- TTTTTF
- TTFFFF
- 61%, 24%
- 0.019 g
- 0.70 g

**Chapter 36**

- FTTF
- 0.0278 g
- 1.79 Torr
- 7.9%

**Chapter 37**

- FTFFFF
- FFFFTF
- a. dispersion      b. dispersion      c. dispersion, dipole-dipole      d. dispersion, dipole-dipole
- a. dispersion (strongest), dipole-dipole hydrogen bonding (strongest)      b. dispersion      c. dispersion, dipole-dipole,      d. dispersion
- a. HF, H<sub>3</sub>CNH<sub>2</sub>      b. all      c. HF      d. PBr<sub>3</sub>
- HCl < HBr < Br<sub>2</sub>
- a. H<sub>2</sub>CBr<sub>2</sub>      b. C<sub>2</sub>H<sub>6</sub>      c. C<sub>2</sub>H<sub>6</sub>
- SiCl<sub>4</sub>
- HCl, PH<sub>3</sub>, CH<sub>4</sub>

**Chapter 38**

- FTTFFT
- bcc: 2      fcc: 4
- 4
- four anions, eight cations
- a. covalent network      b. molecular      c. molecular      d. ionic network      e. metallic  
network      f. ionic network

**Chapter 39**

- TTTTT
- FTFFF
- a. ion-dipole induced dipole      b. dispersion, hydrogen bonding, dipole-dipole      c. dispersion, dipole-induced dipole
- a. dispersion, dipole-dipole hydrogen bonding, dipole-dipole      b. dispersion, dipole-induced dipole      c. dispersion,
- MgO
- a. 2      b. 3      c. 1
- a. 33.9 kJ      b. -39.8 kJ
- $\text{ZnCl}_2(s) \rightleftharpoons \text{Zn}^{2+}(aq) + 2 \text{Cl}^{-}(aq)$        $\Delta H_{\text{soln}}^{\circ} = -73.16 \text{ kJ}$       exothermic

**Chapter 40**

- TFFFF
- a. disfavored      b. disfavored      c. can be favored or disfavored
- a.  $\text{CH}_3\text{OH}(l)$       b.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3(g)$
- a.  $\text{H}_2\text{O}_2$ ,  $\text{HNO}_3$       b.  $\text{CH}_2\text{Cl}_2$       c.  $\text{C}_8\text{H}_{18}$
- $\text{CH}_3\text{CO}_2\text{H}$  (miscible)
- a. hydrophobic      b. amphiphilic      c. hydrophilic

**Chapter 41**

- TFFFF
- 0.019 atm
- 0.79 g

**Chapter 42**

- $1.8 \times 10^{-3} \text{ mol}$
- 0.455
- 47.2%  $\text{C}_6\text{H}_6$ , 33.7%  $\text{C}_5\text{H}_{12}$ , 19.1%  $\text{C}_2\text{Cl}_6$
- 3.08 g
- 0.893 m
- a. 4.3 M      b. 4.8 m      c. 8.0 mol%

**Chapter 43**

- FFTT
- 1.20 °C
- 95.2 g/mol
- 17,000 g/mol

**Chapter 44**

- FFFTTTF
- a.  $\text{Br}_2(g)$       b.  $\text{CH}_3\text{OH}(g)$
- a.  $\text{PF}_5(g)$       b.  $\text{AsH}_3(g)$
- 287.51 J/K

5. -723.5 J/K  
 6. a. 4      b. 5

**Chapter 45**

1. T T T F T F  
 2. F T T F T T  
 3. Ne(g), H<sup>+</sup>(aq), Al(s)  
 4. a. -1104.14 kJ      b. -143.21 J/K      c. -1061.44 kJ  
 5. a. -507.45 kJ      b. 29.55 J/K      c. -516.26 kJ  
 6. a. -620.6 kJ      b. -203.4 J/K      c. -560.0 kJ  
 7. a  
 8. -9.10 kJ  
 9. -92.34 kJ  
 10. -606.60 kJ

**Chapter 46**

1. T T F T  
 2. -113 kJ  
 3. 336.3 K  
 4. a.

$$Q = \frac{[\text{H}^+]^2 [\text{NO}_3^-]^2}{P(\text{N}_2\text{O}_5)}$$

b.

$$Q = \frac{[\text{Mg}^{2+}] P(\text{CO}_2)}{[\text{H}^+]^2}$$

5. 0.00764  
 6. 544  
 7. 4.20 kJ  
 8. 5.05 kJ

**Chapter 47**

1. T F T  
 2. b  
 3.  $2.127 \times 10^{-4}$   
 4.  $2.61 \times 10^{-10}$   
 5.  $1.64 \times 10^{-3}$   
 6.  $4.122 \times 10^{-4}$   
 7. 6.81 kJ

**Chapter 48**

1. F T T F F  
 2. a. speed =  $-\frac{1}{2} \frac{\Delta[\text{NO}]}{\Delta t} = -\frac{\Delta[\text{O}_2]}{\Delta t} = \frac{1}{2} \frac{\Delta[\text{NO}_2]}{\Delta t}$   
 b. speed =  $-\frac{\Delta[(\text{NH}_2)_2\text{CO}]}{\Delta t} = -\frac{1}{2} \frac{\Delta[\text{OH}^-]}{\Delta t} = \frac{\Delta[\text{CO}_3^{2-}]}{\Delta t} = \frac{1}{2} \frac{\Delta[\text{NH}_3]}{\Delta t}$

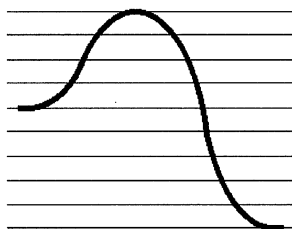
$$c. \text{ speed} = -\frac{\Delta[\text{CH}_2\text{Cl}_2]}{\Delta t} = -\frac{1}{2} \frac{\Delta[\text{H}_2\text{O}]}{\Delta t} = \frac{\Delta[\text{CO}_2]}{\Delta t} = \frac{1}{2} \frac{\Delta[\text{HCl}]}{\Delta t} = \frac{1}{2} \frac{\Delta[\text{H}_2]}{\Delta t}$$

**Chapter 49**

- FTTFFTT
- TFFFT
- TTFT
- a. rate =  $k [\text{C}_2\text{H}_5\text{Cl}]$     b. 0.42 (mol/L)/s    c. 0.15 s
- a. rate =  $k [\text{H}_2\text{O}] [\text{N}_2\text{O}_4]$     b. 5.92 (mol/L)/s
- a.  $2.2 \times 10^{-4}$  mol/L    b.  $1.1 \times 10^{-4}$  mol/L    c. 33%
- a. 21 s    b. 0.00901 mol/L    c. 0.0127 mol/L    d. 73.8%
- a. 0.016 mol/L    b. 0.020 mol/L    c. 38%
- 20,600 (L/mol)/s
- 2.7

**Chapter 50**

- FFFFT
- FTTTT
- 



- a. D    b. B - C    c. D - C    d. endothermic    e. endothermic
220. kJ
- Very high  $E_a$  in the first step

**Chapter 51**

- FTTTT
- TTTTT
- a.  $2.92 \times 10^{-6}$     b.  $1.71 \times 10^{-3}$
- 3.19
- 4.12
- $6.5 \times 10^{-8}$
- 314

**Chapter 52**

- $P(\text{Cl}_2) = 0.53$  atm;  $P(\text{SCl}_2) = 1.93$  atm or 1.94 atm
- $P(\text{C}_2\text{H}_5\text{Cl}) = 0.481$  atm;  $P(\text{C}_2\text{H}_4) = 8.50 \times 10^{-4}$  atm
- $P(\text{Cl}_2) = 0.83$  atm;  $P(\text{BrCl}) = 1.34$  atm
- $[\text{CO}_2] = 0.028$  M;  $[\text{F}^-] = 0.017$  M;  $[\text{CO}_3^{2-}] = 4.4 \times 10^{-6}$  M;  $[\text{HF}] = 8.8 \times 10^{-6}$  M
- a. -10.13 kJ    b. 59.7    c.  $[\text{NH}_3(aq)] = 0.0462$  M;  $P(\text{NH}_3(g)) = 7.70 \times 10^{-4}$  atm

**Chapter 53**

1. T F F F
2. a. left    b. left    c. right    d. no effect
3. a. no effect    b. left    c. no effect    d. right
4. a. left    b. left    c. no effect    d. no effect
5. a and c

**Chapter 54**

1. T T F F T
2. T T F T F
3. F F T F T
4. T T T T T
5.  $\Delta G^\circ = 80.9 \text{ kJ}$ ;  $K_w = 2.33 \times 10^{-14}$ ; pH 6.82
6. a.  $\text{F}^-$     b.  $\text{H}_2\text{CO}_3$     c.  $\text{H}_2\text{PO}_4^-$
7. a.  $\text{ClO}_2^-$     b.  $\text{HCN}$     c.  $\text{NH}_3$
8. water, hydrogen oxalate ion, dihydrogen arsenate ion
9. a. 0.0334 M    b. 1.48    c. 12.52
10. a. 0.00850 M    b. 2.07    c. 11.93
11. 2.03
12. 12.26
13. 0.21 g
14. 0.038 L

**Chapter 55**

1. T F T T T
2. a.  $\text{HBrO}(aq) \rightleftharpoons \text{H}^+(aq) + \text{BrO}^-(aq)$      $K_a = \frac{[\text{H}^+][\text{BrO}^-]}{[\text{HBrO}]}$   
 b.  $\text{HCN}(aq) \rightleftharpoons \text{H}^+(aq) + \text{CN}^-(aq)$      $K_a = \frac{[\text{H}^+][\text{CN}^-]}{[\text{HCN}]}$
3. a.  $\text{HO}_2\text{CCH}_2\text{CO}_2\text{H}(aq) \rightleftharpoons \text{H}^+(aq) + \text{HO}_2\text{CCH}_2\text{CO}_2^-(aq)$   
 $\text{HO}_2\text{CCH}_2\text{CO}_2^-(aq) \rightleftharpoons \text{H}^+(aq) + ^-\text{O}_2\text{CCH}_2\text{CO}_2^-(aq)$   
 b.  $\text{H}_3\text{AsO}_4(aq) \rightleftharpoons \text{H}^+(aq) + \text{H}_2\text{AsO}_4^-(aq)$   
 $\text{H}_2\text{AsO}_4^-(aq) \rightleftharpoons \text{H}^+(aq) + \text{HAsO}_4^{2-}(aq)$   
 $\text{HAsO}_4^{2-}(aq) \rightleftharpoons \text{H}^+(aq) + \text{AsO}_4^{3-}(aq)$
4. nitric acid, chlorous acid
5.  $\text{HP}_2\text{O}_7^{3-}(aq) \rightleftharpoons \text{H}^+(aq) + \text{P}_2\text{O}_7^{4-}(aq)$      $K_{a4} = \frac{[\text{H}^+][\text{P}_2\text{O}_7^{4-}]}{[\text{HP}_2\text{O}_7^{3-}]}$
6.  $[\text{C}_3\text{H}_7\text{CO}_2\text{H}] = 0.131 \text{ M}$ ;  $[\text{H}^+] = 0.0014 \text{ M}$ ;  $[\text{C}_3\text{H}_7\text{CO}_2^-] = 0.0014 \text{ M}$ ; pH 2.85; 1.1% diss
7.  $[\text{ClCH}_2\text{CO}_2\text{H}] = 0.0273 \text{ M}$ ;  $[\text{H}^+] = 0.0062 \text{ M}$ ;  $[\text{ClCH}_2\text{CO}_2^-] = 0.0062 \text{ M}$ ; pH 2.21; 19% diss
8. 2.41
9.  $[\text{H}_2\text{C}_2\text{O}_4] = 0.065 \text{ M}$ ;  $[\text{H}^+] = 0.059 \text{ M}$ ;  $[\text{HC}_2\text{O}_4^-] = 0.059 \text{ M}$ ; 48% diss;  $[\text{C}_2\text{O}_4^{2-}] = 5.4 \times 10^{-5} \text{ M}$
10. 1.33

- Strongest,  $\text{HClO}_3$ ; weakest,  $\text{HIO}$
- $[\text{H}^+] = 2.4 \times 10^{-4} \text{ M}$ ; pH 3.62

**Chapter 56**

- T T T F F T
- $\text{CH}_3\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{OH}^-(\text{aq}) + \text{CH}_3\text{NH}_3^+(\text{aq})$   $K_b = \frac{[\text{OH}^-][\text{CH}_3\text{NH}_3^+]}{[\text{CH}_3\text{NH}_2]}$
  - $\text{C}_6\text{H}_5\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{OH}^-(\text{aq}) + \text{C}_6\text{H}_5\text{NH}_3^+(\text{aq})$   $K_b = \frac{[\text{OH}^-][\text{C}_6\text{H}_5\text{NH}_3^+]}{[\text{C}_6\text{H}_5\text{NH}_2]}$
- $[\text{C}_5\text{H}_5\text{N}] = 0.0143 \text{ M}$ ;  $[\text{OH}^-] = 4.9 \times 10^{-6} \text{ M}$ ;  $[\text{C}_5\text{H}_5\text{NH}^+] = 4.9 \times 10^{-6} \text{ M}$ ; pOH = 5.31; pH = 8.69
- $[(\text{C}_2\text{H}_5)_3\text{N}] = 0.0267 \text{ M}$ ;  $[\text{OH}^-] = 0.0037 \text{ M}$ ;  $[(\text{C}_2\text{H}_5)_3\text{NH}^+] = 0.0037 \text{ M}$ ; pH = 11.57; 12% diss
- 6.7 g
- $\text{HONH}_3^+(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{HONH}_2(\text{aq})$   $K_a = \frac{[\text{H}^+][\text{HONH}_2]}{[\text{HONH}_3^+]}$
  - $\text{CN}^-(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{OH}^-(\text{aq}) + \text{HCN}(\text{aq})$   $K_b = \frac{[\text{OH}^-][\text{HCN}]}{[\text{CN}^-]}$
- $1.4 \times 10^{-11}$
  - $1.0 \times 10^{-12}$
  - $2.3 \times 10^{-11}$
  - $7.7 \times 10^{-12}$
- $K_a = 3.2 \times 10^{-12}$ ;  $K_b = 1.1 \times 10^{-7}$
  - $K_a = 4.8 \times 10^{-9}$ ;  $K_b = 4.2 \times 10^{-12}$
- $[\text{ClO}^-] = 0.0241 \text{ M}$ ;  $[\text{OH}^-] = 8.9 \times 10^{-5} \text{ M}$ ;  $[\text{HClO}] = 8.9 \times 10^{-5} \text{ M}$ ; pOH = 4.05; pH = 9.95
- $[\text{CH}_3\text{NH}_3^+] = 0.0669 \text{ M}$ ;  $[\text{H}^+] = 1.2 \times 10^{-6} \text{ M}$ ;  $[\text{CH}_3\text{NH}_2] = 1.2 \times 10^{-6} \text{ M}$ ; pH = 5.92
- 0.0027 atm
- neutral
  - acidic
  - basic
  - basic
  - acidic
- neutral
  - basic
  - acidic
  - neutral
  - acidic
- acidic
  - basic
  - acidic
  - acidic

**Chapter 57**

- T T T F F
- 2.82
- 10.76
- 9.85
- $\text{C}_6\text{H}_5\text{CO}_2\text{H}$
- 4.89
  - 4.84
  - 4.99
- 6.87
  - 6.50
  - 7.21

**Chapter 58**

- T T F T F
- 16.17 mL
  - 1.14
  - 1.62
  - 7.00
  - 12.00
- 1.50
  - 1.81
  - 7.00
  - 11.70
- 41.44 mL
  - 2.42
  - 3.69
  - 8.11
  - 11.59
- 4.39
  - 8.40
  - 11.84
  - 12.14

**Chapter 59**

- T T F F

2. a.  $\text{Fe}(\text{OH})_3(\text{s}) \rightleftharpoons \text{Fe}^{3+}(\text{aq}) + 3 \text{OH}^{-}(\text{aq})$   $K_{\text{sp}} = [\text{Fe}^{3+}] [\text{OH}^{-}]^3$   
 b.  $\text{Hg}_2\text{SO}_4(\text{s}) \rightleftharpoons \text{Hg}_2^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$   $K_{\text{sp}} = [\text{Hg}_2^{2+}] [\text{SO}_4^{2-}]$
3. a.  $\text{PbBr}_2(\text{s}) \rightleftharpoons \text{Pb}^{2+}(\text{aq}) + 2 \text{Br}^{-}(\text{aq})$   $K_{\text{sp}} = [\text{Pb}^{2+}] [\text{Br}^{-}]^2$   
 b.  $\text{Ni}_3(\text{PO}_4)_2(\text{s}) \rightleftharpoons 3 \text{Ni}^{2+}(\text{aq}) + 2 \text{PO}_4^{3-}(\text{aq})$   $K_{\text{sp}} = [\text{Ni}^{2+}]^3 [\text{PO}_4^{3-}]^2$
4.  $\text{MX} < \text{MX}_2 < \text{MX}_3$
5.  $\Delta G^\circ = 64.4 \text{ kJ}$   $K_{\text{sp}} = 5.1 \times 10^{-12}$
6.  $\text{Ag}_2\text{C}_2\text{O}_4(\text{s}) \rightleftharpoons 2 \text{Ag}^{+}(\text{aq}) + \text{C}_2\text{O}_4^{2-}(\text{aq})$   
 $\text{C}_2\text{O}_4^{2-}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{HC}_2\text{O}_4^{-}(\text{aq}) + \text{OH}^{-}(\text{aq})$   
 $\text{Ag}_2\text{C}_2\text{O}_4(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons 2 \text{Ag}^{+}(\text{aq}) + \text{HC}_2\text{O}_4^{-}(\text{aq}) + \text{OH}^{-}(\text{aq})$   $K = 1.0 \times 10^{-21}$

### Chapter 60

1. F F F T
2. a.  $5.3 \times 10^{-7} \text{ M}$  b.  $1.3 \times 10^{-4} \text{ M}$
3. a.  $3.5 \times 10^{-8} \text{ M}$  b.  $2.6 \times 10^{-6} \text{ M}$
4.  $[\text{Pb}^{2+}] = 5.3 \times 10^{-5} \text{ M}$ ;  $[\text{SO}_4^{2-}] = 4.70 \times 10^{-4} \text{ M}$
5.  $2.0 \times 10^{-7} \text{ M}$
6.  $0.01 \text{ M HNO}_3$
7. a.  $\text{Cd}^{2+}(\text{aq}) + 4 \text{OH}^{-}(\text{aq}) \rightleftharpoons \text{Cd}(\text{OH})_4^{2-}(\text{aq})$   $K_{\text{f}} = \frac{[\text{Cd}(\text{OH})_4^{2-}]}{[\text{Cd}^{2+}] [\text{OH}^{-}]^4}$   
 b.  $\text{Ni}^{2+}(\text{aq}) + 6 \text{NH}_3(\text{aq}) \rightleftharpoons \text{Ni}(\text{NH}_3)_6^{2+}(\text{aq})$   $K_{\text{f}} = \frac{[\text{Ni}(\text{NH}_3)_6^{2+}]}{[\text{Ni}^{2+}] [\text{NH}_3]^6}$
8. a.  $[\text{Cu}^{2+}] = 2.3 \times 10^{-4} \text{ M}$ ;  $[\text{NH}_3] = 9.2 \times 10^{-4} \text{ M}$ ;  $[\text{Cu}(\text{NH}_3)_4^{2+}] = 0.00342 \text{ M}$   
 b.  $[\text{Cu}^{2+}] = 8.4 \times 10^{-9} \text{ M}$ ;  $[\text{NH}_3] = 0.0120 \text{ M}$ ;  $[\text{Cu}(\text{NH}_3)_4^{2+}] = 0.00365 \text{ M}$
9.  $[\text{Al}^{3+}] = 5.9 \times 10^{-10} \text{ M}$ ;  $[\text{F}^{-}] = 0.0064 \text{ M}$ ;  $[\text{AlF}_6^{3-}] = 0.00280 \text{ M}$
10.  $\text{CuCl}(\text{s}) \rightleftharpoons \text{Cu}^{+}(\text{aq}) + \text{Cl}^{-}(\text{aq})$   
 $\text{Cu}^{+}(\text{aq}) + 4 \text{CN}^{-}(\text{aq}) \rightleftharpoons \text{Cu}(\text{CN})_4^{3-}(\text{aq})$   
 $\text{CuCl}(\text{s}) + 4 \text{CN}^{-}(\text{aq}) \rightleftharpoons \text{Cu}(\text{CN})_4^{3-}(\text{aq}) + \text{Cl}^{-}(\text{aq})$   $K = 3.4 \times 10^{23}$

### Chapter 61

1. a.  $\text{S}_2\text{O}_3^{2-}/\text{SO}_4^{2-}$  and  $\text{HBrO}/\text{Br}^{-}$   
 b.  $\text{S}_2\text{O}_3^{2-} + 5 \text{H}_2\text{O} \rightarrow 2 \text{SO}_4^{2-} + 10 \text{H}^{+} + 8 \text{e}^{-}$   
 $\text{HBrO} + \text{H}^{+} + 2 \text{e}^{-} \rightarrow \text{Br}^{-} + \text{H}_2\text{O}$   
 c.  $\text{S}_2\text{O}_3^{2-} + 4 \text{HBrO} + \text{H}_2\text{O} \rightarrow 2 \text{SO}_4^{2-} + 6 \text{H}^{+} + 4 \text{Br}^{-}$   
 d.  $\text{S}_2\text{O}_3^{2-}$  is oxidized.  $\text{HBrO}$  is reduced.
2. a.  $\text{Cd}/\text{Cd}(\text{OH})_2$  and  $\text{NiO}(\text{OH})/\text{Ni}(\text{OH})_2$   
 b.  $\text{Cd} + 2 \text{OH}^{-} \rightarrow \text{Cd}(\text{OH})_2 + 2 \text{e}^{-}$   
 $\text{NiO}(\text{OH}) + \text{e}^{-} + \text{H}_2\text{O} \rightarrow \text{Ni}(\text{OH})_2 + \text{OH}^{-}$   
 c.  $\text{Cd} + 2 \text{NiO}(\text{OH}) + 2 \text{H}_2\text{O} \rightarrow \text{Cd}(\text{OH})_2 + 2 \text{Ni}(\text{OH})_2$   
 d.  $\text{Cd}$  is oxidized.  $\text{NiO}(\text{OH})$  is reduced.
3. a.  $\text{N}_2\text{O} + 3 \text{H}_2\text{O} \rightarrow 2 \text{HNO}_2 + 4 \text{H}^{+} + 4 \text{e}^{-}$   
 $\text{Co}^{3+} + \text{e}^{-} \rightarrow \text{Co}^{2+}$   
 b.  $\text{N}_2\text{O} + 3 \text{H}_2\text{O} + 4 \text{Co}^{3+} \rightarrow 2 \text{HNO}_2 + 4 \text{H}^{+} + 4 \text{Co}^{2+}$   
 c.  $\text{Co}^{3+}$  is the oxidizing agent.  $\text{N}_2\text{O}$  is the reducing agent.
4. a.  $3 \text{PO}_4^{3-} + 2 \text{Cr} + 2 \text{H}_2\text{O} \rightarrow 2 \text{CrO}_2^{-} + 3 \text{HPO}_3^{2-} + \text{OH}^{-}$

b.  $\text{PO}_4^{3-}$  is the oxidizing agent. Cr is the reducing agent.

### Chapter 62

- T F T T T F
- $\text{Fe}/\text{Fe}^{3+}$  and  $\text{Ag}^+/\text{Ag}$
  - $$\text{Fe}(s) \rightarrow \text{Fe}^{3+}(aq) + 3 e^- \quad \text{---anode}$$

$$\text{Ag}^+(aq) + e^- \rightarrow \text{Ag}(s) \quad \text{---cathode}$$
 Fe is oxidized;  $\text{Ag}^+$  is reduced.
  - $\text{Fe}(s) + 3 \text{Ag}^+(aq) \rightarrow \text{Fe}^{3+}(aq) + 3 \text{Ag}(s)$
- $$\text{Cu}(s) \rightarrow \text{Cu}^{2+}(aq) + 2 e^- \quad \text{---anode}$$

$$2 \text{HClO}_2(aq) + 6 \text{H}^+(aq) + 6 e^- \rightarrow \text{Cl}_2(g) + 4 \text{H}_2\text{O}(l) \quad \text{---cathode}$$
 Cu is oxidized;  $\text{HClO}_2$  is reduced.
  - $3 \text{Cu}(s) + 2 \text{HClO}_2(aq) + 6 \text{H}^+(aq) \rightarrow 3 \text{Cu}^{2+}(aq) + \text{Cl}_2(g) + 4 \text{H}_2\text{O}(l)$
- $$\text{SO}_3^{2-}(aq) + 2 \text{OH}^-(aq) \rightarrow \text{SO}_4^{2-}(aq) + \text{H}_2\text{O}(l) + 2 e^- \quad \text{---anode}$$

$$\text{HSnO}_2^-(aq) + \text{H}_2\text{O}(l) + 2 e^- \rightarrow \text{Sn}(s) + 3 \text{OH}^-(aq) \quad \text{---cathode}$$
 $\text{SO}_3^{2-}$  is oxidized;  $\text{HSnO}_2^-$  is reduced.
  - $\text{SO}_3^{2-}(aq) + \text{HSnO}_2^-(aq) \rightarrow \text{SO}_4^{2-}(aq) + \text{Sn}(s) + \text{OH}^-(aq)$
- $\text{Ni}(s) | \text{Ni}^{2+}(aq) || \text{H}^+(aq) | \text{H}_2(g) | \text{Pt}(s)$
- $2 \text{CrO}_4^{2-}(aq) + 8 \text{H}_2\text{O}(l) + 3 \text{Zn}(s) + 2 \text{OH}^-(aq) \rightarrow 2 \text{Cr}(\text{OH})_3(s) + 3 \text{Zn}(\text{OH})_4^{2-}(aq)$
  - $\text{Zn}(s) | \text{OH}^-(aq), \text{Zn}(\text{OH})_4^{2-}(aq) || \text{OH}^-(aq), \text{CrO}_4^{2-}(aq) | \text{Cr}(\text{OH})_3(s) | \text{Pt}(s)$
- $$\text{ClO}_2(g) + 3 \text{H}^+(aq) + 3 e^- \rightarrow \text{HClO}(aq) + \text{H}_2\text{O}(l) \quad \text{---cathode}$$

$$\text{Hg}(l) \rightarrow \text{Hg}^{2+}(aq) + 2 e^- \quad \text{---anode}$$
  - $\text{Hg}(l) | \text{Hg}^{2+}(aq) || \text{H}^+(aq), \text{HClO}(aq) | \text{ClO}_2(g) | \text{Pt}(s)$
- T F F F
- $\Delta G_{1/2}^\circ = -207.92 \text{ kJ}; E_{1/2}^\circ = 1.0775 \text{ V}$

### Chapter 63

- 0.43 V      b. 0.45 V      c. 0.81 V
- 0.24 V      b. 2.73 V      c. 0.27 V
- b or d
- 2 mol      b. 12 mol      c. 6 mol
- $E^\circ = 0.38 \text{ V}$  and  $\Delta G^\circ = -73 \text{ kJ}$
- 1.50 V
- $$\frac{\text{MnO}_4^-(aq) + 8 \text{H}^+(aq) + 5 e^- \rightleftharpoons \text{Mn}^{2+}(aq) + 4 \text{H}_2\text{O}(l)}{\text{Mn}^{2+}(aq) + 2 \text{H}_2\text{O}(l) \rightleftharpoons \text{MnO}_2(s) + 4 \text{H}^+(aq) + 2 e^-}$$

$$\text{MnO}_4^-(aq) + 4 \text{H}^+(aq) + 3 e^- \rightleftharpoons \text{MnO}_2(s) + 2 \text{H}_2\text{O}(l) \quad E_{1/2}^\circ = 1.70 \text{ V}$$

### Chapter 64

- F T F T T T
- 1.07 V      b. 2      c. 1.27 V
- 0.92 V      b. 3      c. 0.90 V
- 0.43 V      b. 0.30 V      c.  $1.2 \times 10^{29}$
- 0.28 V      b. 0.47 V      c.  $2.5 \times 10^{28}$
- 0.014 M
- decrease      b. increase      c. increase      d. same



8. a. same    b. increase    c. decrease    d. increase    e. decrease  
 9. a. increase    b. increase    c. increase    d. decrease  
 10.  $\Delta G^\circ = -373.34 \text{ kJ}$  and  $E^\circ = 1.9347 \text{ V}$

**Chapter 65**

1. F F T F T  
 2. a. exergonic    b. exergonic    c. endergonic    d. endergonic    e. exergonic  
 3. a.  $-0.45 \text{ V}$     b.  $-0.35 \text{ V}$     c.  $2.4 \times 10^{-46}$   
 4. a.  $-0.04 \text{ V}$ , endergonic    b.  $0.06 \text{ V}$ , exergonic  
 5.  $0.126 \text{ g}$   
 6.  $12.2 \text{ min}$

**Chapter 66**

1. T T T F F  
 2. F F T T F  
 3. a.  ${}_{14}^{26}\text{Si} \rightarrow {}_{13}^{26}\text{Al} + {}_1^0\beta$   
 b.  ${}_{84}^{212}\text{Po} \rightarrow {}_{82}^{208}\text{Pb} + {}_2^4\alpha$   
 c.  ${}_{31}^{67}\text{Ga} + {}_{-1}^0\text{e} \rightarrow {}_{30}^{67}\text{Zn}$   
 d.  ${}_{16}^{35}\text{S} \rightarrow {}_{17}^{35}\text{Cl} + {}_{-1}^0\beta$   
 e.  ${}_{44}^{93\text{m}}\text{Ru} \rightarrow {}_{44}^{93}\text{Ru} + \gamma$   
 4. a.  ${}^{217}\text{Rn}$     b.  ${}^{119}\text{Sn}$     c.  ${}^{209}\text{Pb}$     d.  ${}^{25}\text{Al}$   
 5. a.  $\beta^-$     b.  $\alpha$     c.  $\beta^+$  or EC  
 6. a.  ${}^{228}\text{Ra}$ ,  ${}^{224}\text{Ra}$     b.  ${}^{208}\text{Pb}$

**Chapter 67**

1. a.  $2.35 \times 10^{12} \text{ Bq}$     b.  $63.5 \text{ Ci}$   
 2.  $3.09 \times 10^{12} \text{ dis/min}$   
 3. a.  $0.214 \text{ mol}$     b.  $49.6 \text{ g}$   
 4.  $5.06 \times 10^{-5} \text{ g}$   
 5. a.  $115 \text{ Ci}$     b.  $1.32 \text{ Ci}$   
 6.  $1.42 \mu\text{g}$   
 7.  $4.86 \text{ MBq}$   
 8.  $4.04 \times 10^9 \text{ y}$

**Chapter 68**

1. T F T F  
 2. a.  ${}_{86}^{222}\text{Rn} \rightarrow {}_{84}^{218}\text{Po} + {}_2^4\alpha$     b.  $540. \text{ GJ}$     c.  $5.591 \text{ MeV}$   
 3. a.  ${}_{6}^{14}\text{C} \rightarrow {}_{7}^{14}\text{N} + {}_{-1}^0\beta$     b.  $15.1 \text{ GJ}$     c.  $0.156 \text{ MeV}$   
 4. a.  ${}_{74}^{178}\text{W} + {}_{-1}^0\text{e} \rightarrow {}_{73}^{178}\text{Ta}$     b.  $8.8 \text{ GJ}$     c.  $0.091 \text{ MeV}$   
 5. a.  ${}_{35}^{79\text{m}}\text{Br} \rightarrow {}_{35}^{79}\text{Br} + \gamma$     b.  $20.0 \text{ GJ}$     c.  $0.207 \text{ MeV}$   
 6. EC,  $1.504 \text{ MeV}$ ;  $\beta^-$ ,  $1.311 \text{ MeV}$