



Chapter 5 Answers

Practice Examples

1a. 0.540 M Cl^-

1b. (a) 7.9×10^{-5} M F^- ; (b) 3.1 kg CaF_2

2a. (a) $\text{Al}^{3+}(\text{aq}) + 3 \text{OH}^-(\text{aq}) \rightarrow \text{Al}(\text{OH})_3(\text{s})$

(b) No reaction occurs.

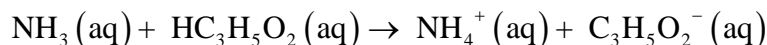
(c) $\text{Pb}^{2+}(\text{aq}) + 2 \text{I}^-(\text{aq}) \rightarrow \text{PbI}_2(\text{s})$

2b. (a) $\text{Al}^{3+}(\text{aq}) + \text{PO}_4^{3-}(\text{aq}) \rightarrow \text{AlPO}_4(\text{s})$

(b) $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$

(c) $\text{Pb}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{PbCO}_3(\text{s})$

3a. The acid and base react to form a salt solution of ammonium propionate.



3b. $\text{CaCO}_3(\text{s}) + 2 \text{HC}_2\text{H}_3\text{O}_2(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + \text{Ca}^{2+}(\text{aq}) + 2 \text{C}_2\text{H}_3\text{O}_2^-(\text{aq})$

4a. (a) It is not an oxidation–reduction reaction; (b) This is an oxidation–reduction reaction.

4b. Vanadium is oxidized, manganese is reduced.

5a. *Oxidation*: $\{\text{Al}(\text{s}) \rightarrow \text{Al}^{3+}(\text{aq}) + 3 \text{e}^-\} \times 2$

Reduction: $\{2 \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow \text{H}_2(\text{g})\} \times 3$

Net equation: $2 \text{Al}(\text{s}) + 6 \text{H}^+(\text{aq}) \rightarrow 2 \text{Al}^{3+}(\text{aq}) + 3 \text{H}_2(\text{g})$

5b. *Oxidation*: $2 \text{Br}^-(\text{aq}) \rightarrow \text{Br}_2(\text{l}) + 2 \text{e}^-$

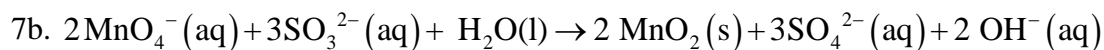
Reduction: $\text{Cl}_2(\text{g}) + 2 \text{e}^- \rightarrow 2 \text{Cl}^-(\text{aq})$

Net equation: $2 \text{Br}^-(\text{aq}) + \text{Cl}_2(\text{g}) \rightarrow \text{Br}_2(\text{l}) + 2 \text{Cl}^-(\text{aq})$

6a. $\text{MnO}_4^-(\text{aq}) + 8 \text{H}^+(\text{aq}) + 5 \text{Fe}^{2+}(\text{aq}) \rightarrow \text{Mn}^{2+}(\text{aq}) + 4 \text{H}_2\text{O}(\text{l}) + 5 \text{Fe}^{3+}(\text{aq})$

6b. $3 \text{UO}^{2+}(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 8 \text{H}^+(\text{aq}) \rightarrow 3 \text{UO}_2^{2+}(\text{aq}) + 2 \text{Cr}^{3+}(\text{aq}) + 4 \text{H}_2\text{O}(\text{l})$

7a. $\text{S}(\text{s}) + 2 \text{OH}^-(\text{aq}) + 2 \text{OCl}^-(\text{aq}) \rightarrow \text{SO}_3^{2-}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + 2 \text{Cl}^-(\text{aq})$



8a. Since the oxidation state of H is 0 in $\text{H}_2 (\text{g})$ and is +1 in both $\text{NH}_3 (\text{g})$ and $\text{H}_2\text{O} (\text{g})$, hydrogen is oxidized. A substance that is oxidized is called a reducing agent. The oxidation state of the element N decreases during this reaction, meaning that $\text{NO}_2 (\text{g})$ is reduced. The substance that is reduced is called the oxidizing agent.

8b. Au has been oxidized and, thus, $\text{Au} (\text{s})$ (oxidization state = 0), is the reducing agent. O has been reduced and thus, $\text{O}_2 (\text{g})$ (oxidation state = 0) is the oxidizing agent.

9a. 0.1019 M

9b. 0.130 M

10a. 65.4% Fe

10b. 0.03129 M

Integrative Example

A. 49.89%

B. 1.32%

Exercises

1a. Weak electrolyte

1b. Strong electrolyte

1c. Strong electrolyte

1d. Nonelectrolyte.

1e. Strong electrolyte

3. HCl is practically 100% dissociated into ions. The apparatus should light up brightly. A solution of both HCl and $\text{HC}_2\text{H}_3\text{O}_2$ will yield similar results.

5a. Barium bromide: strong electrolyte

5b. Propionic acid: weak electrolyte

5c. Ammonia: weak electrolyte

7a. 0.238 M K^+

7b. 0.334 M NO_3^-

7c. 0.166 M Al^{3+}

7d. 0.627 M Na^+

9. $3.04 \times 10^{-3} \text{ M OH}^-$

11a. $3.54 \times 10^{-4} \text{ M Ca}^{2+}$

11b. $8.39 \times 10^{-3} \text{ M K}^+$

11c. $3.44 \times 10^{-3} \text{ M Zn}^{2+}$

13. The solution containing 8.1 mg K^+ per mL gives the largest K^+ of the three solutions.

15. $4.3 \times 10^2 \text{ mg MgI}_2$

17. 0.732 M

19a. $\text{Pb}^{2+}(\text{aq}) + 2 \text{ Br}^-(\text{aq}) \rightarrow \text{PbBr}_2(\text{s})$

19b. No reaction occurs (all are spectator ions).

19c. $\text{Fe}^{3+}(\text{aq}) + 3 \text{ OH}^-(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s})$

21a. No reaction occurs.

21b. $\text{Cu}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{CuCO}_3(\text{s})$

21c. $3\text{Cu}^{2+}(\text{aq}) + 2\text{PO}_4^{3-}(\text{aq}) \rightarrow \text{Cu}_3(\text{PO}_4)_2(\text{s})$

23a. Add $\text{K}_2\text{SO}_4(\text{aq})$; $\text{BaSO}_4(\text{s})$ will form and MgSO_4 will not precipitate.

23b. $\text{H}_2\text{O}(\text{l})$; $\text{Na}_2\text{CO}_3(\text{s})$ dissolves, but $\text{MgCO}_3(\text{s})$ will not dissolve (appreciably).

23c. Add $\text{KCl}(\text{aq})$; $\text{AgCl}(\text{s})$ will form, while $\text{Cu}(\text{NO}_3)_2(\text{s})$ will dissolve.

25a. $\text{Sr}(\text{NO}_3)_2(\text{aq}) + \text{K}_2\text{SO}_4(\text{aq})$: $\text{Sr}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{SrSO}_4(\text{s})$

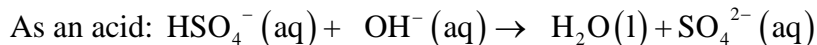
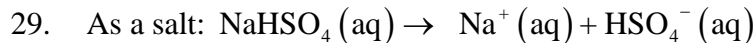
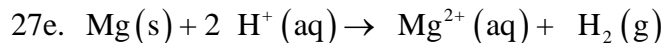
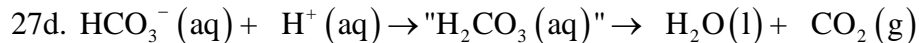
25b. $\text{Mg}(\text{NO}_3)_2(\text{aq}) + \text{NaOH}(\text{aq})$: $\text{Mg}^{2+}(\text{aq}) + 2 \text{ OH}^-(\text{aq}) \rightarrow \text{Mg}(\text{OH})_2(\text{s})$

25c. $\text{BaCl}_2(\text{aq}) + \text{K}_2\text{SO}_4(\text{aq})$: $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$

27a. $\text{OH}^-(\text{aq}) + \text{HC}_2\text{H}_3\text{O}_2(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{C}_2\text{H}_3\text{O}_2^-(\text{aq})$

27b. No reaction occurs. This is the physical mixing of two acids.

27c. $\text{FeS}(\text{s}) + 2 \text{ H}^+(\text{aq}) \rightarrow \text{H}_2\text{S}(\text{g}) + \text{Fe}^{2+}(\text{aq})$



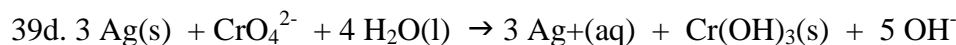
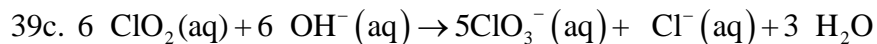
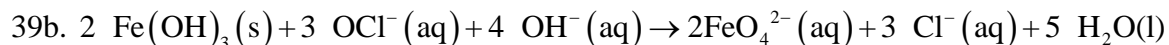
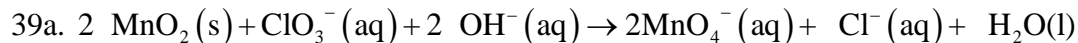
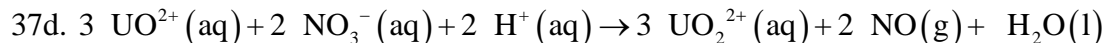
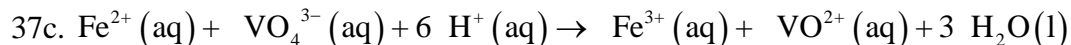
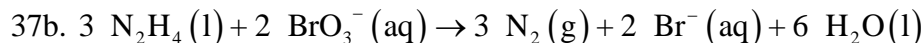
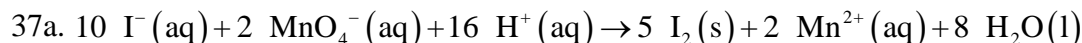
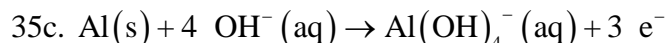
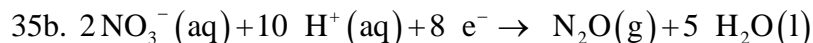
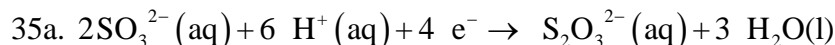
31. Use (b), $\text{NH}_3 (\text{aq})$. NH_3 affords the OH^- ions necessary to form $\text{Mg}(\text{OH})_2 (\text{s})$.

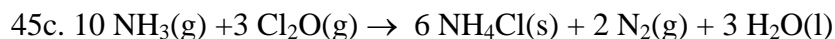
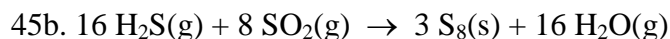
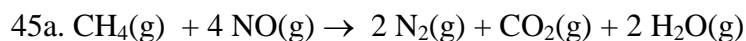
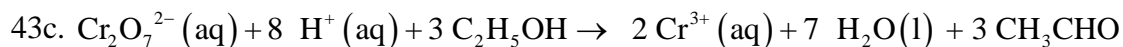
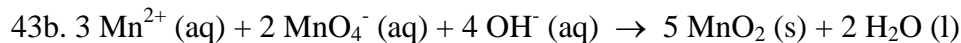
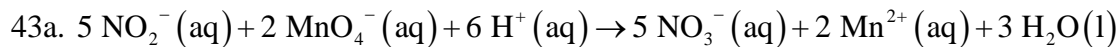
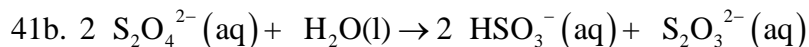
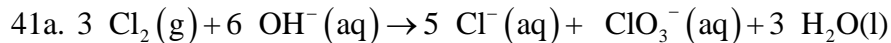
33a. The O.S. of H is +1, that of O is -2, that of C is +4, and that of Mg is +2 on each side of this equation. This is not a redox equation.

33b. The O.S. of Cl is 0 on the left and -1 on the right side of this equation. The O.S. of Br is -1 on the left and 0 on the right side of this equation. This is a redox reaction.

33c. The O.S. of Ag is 0 on the left and +1 on the right side of this equation. The O.S. of N is +5 on the left and +4 on the right side of this equation. This is a redox reaction.

33d. On both sides of the equation the O.S. of O is -2, that of Ag is +1, and that of Cr is +6. Thus, this is not a redox equation.





47a. $\text{SO}_3^{2-}(\text{aq})$ is the reducing agent; $\text{MnO}_4^-(\text{aq})$ is the oxidizing agent.

47b. $\text{H}_2(\text{g})$ is the reducing agent; $\text{NO}_2(\text{g})$ is the oxidizing agent.

47c. $[\text{Fe}(\text{CN})_6]^{4-}(\text{aq})$ is the reducing agent; $\text{H}_2\text{O}_2(\text{aq})$ is the oxidizing agent.

49. 13.3 mL NaOH(aq) soln

51. 3.546 mL KOH solution

53. 0.1230 M NaOH

55. 0.077 M NaOH

57. Acidic

59. 34 mL base

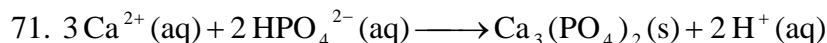
61. Answer is (d).

63. 1.968×10^{-2} M

65. 53.23% Fe

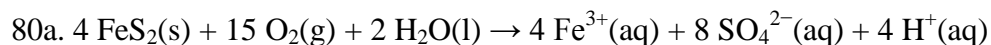
67. 37.0 g $\text{Na}_2\text{C}_2\text{O}_4$

Integrative and Advanced Exercises



74. 108 ppm Mg

75. 0.0874 L



80b. 23.4 g CaCO_3

83. 44.6 g Cl_2

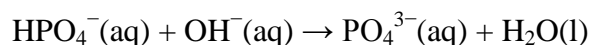
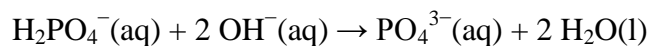
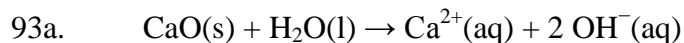
85. 5.0×10^2 g $\text{ClO}_2(g)$

88a. 45.9 g

88b. 1.00 L

89. % $\text{Mg}(\text{OH})_2 = 21.6$; % $\text{Al}(\text{OH})_3 = 78.4$.

91. 0.4346 %



93b. 0.302 kg

Feature Problems

94. $x = 1.03$

95. 91.0% MnO_2

97. Before the breath test: 8×10^{-4} M; After the breath test 3×10^{-4} mol/L.

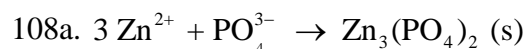
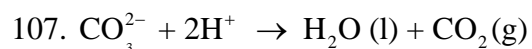
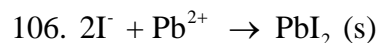
Self-Assessment Exercises

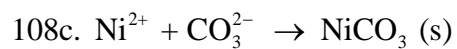
102. The answer is (b).

103. The answer is (d).

104. The answer is (c).

105. The answer is (a).





109a. Species oxidized: N in NO

109b. Species reduced: O_2

109c. Oxidizing agent: O_2

109d. Reducing agent: NO

109e. Gains electrons: O_2

109f. Loses electrons: NO

110. The answer is (b).

111. The answer is (d).

112. The answer is (a).

113a. False

113b. True

113c. False

113d. False

113e. True

114a. No

114b. Yes

114c. Yes

114d. No