Section 5.1 Classification of Elements

2. Krypton was not discovered until 1898 (see Figure 3.7).

4. Plutonium was not discovered until 1940 (see Figure 3.7).

Section 5.2 The Periodic Law Concept

6. After Moseley’s discovery in 1913, the periodic law states that physical and chemical properties tend to repeat periodically when elements are arranged according to increasing atomic number.

8. Note that Te precedes I in the periodic table, even though the atomic mass of Te (127.60) is greater than I (126.90).

Section 5.3 Groups and Periods of Elements

10. Horizontal rows in the periodic table are referred to as periods or series.

12. The term for the elements that belong to Groups 3–12 is the transition elements.

14. The elements in the series that follow element 89 are called the actinides.

16. The elements Sc, Y, and La are rare earth elements, but not lanthanides.

18. The elements on the right side of the periodic table are nonmetals.

20. The appearance of B, Si, Ge, As, Sb, and Te resembles that of metals, and these nonradioactive elements are referred to as semimetals, or metalloids.
22. **Family** | **Group Number**
--- | ---
(a) boron group | IIIA/13
(b) oxygen group | VIA/16
(c) nickel group | VIII/10
(d) copper group | IB/11

24. **IUPAC** | **American** | **IUPAC** | **American**
--- | --- | --- | ---
(a) Group 2 | IIA | (b) Group 4 | IVB
(c) Group 6 | VIB | (d) Group 8 | VIII
(e) Group 11 | IB | (f) Group 12 | IIB
(g) Group 16 | VIA | (h) Group 18 | VIIIA

26. **Element** | **Element**
--- | ---
(a) Ge | (b) Na
(c) I | (d) Pm

28. **Element** | **Element**
--- | ---
(a) Se | (b) Pt
(c) Sc | (d) Rn

**Section 5.4 Periodic Trends**

30. Proceeding up a group in the periodic table, the metallic character of an element generally decreases.

32. Proceeding up a group of elements in the periodic table, the metallic character of an element generally decreases.

34. **Metallic Character** | **Metallic Character**
--- | ---
(a) K > Ca | (b) Mg > Al
(c) Fe > Cu | (d) S > Ar

(Note: The element with the greater metallic character is in **bold**.)

36. **Atomic Radius** | **Atomic Radius**
--- | ---
(a) Rb > Sr | (b) As > Se
(c) Pb > Bi | (d) I > Xe

(Note: The element with the larger atomic radius is in **bold**.)
Section 5.5 Properties of Elements

38. Predicted melting point of Cr: \( 2617 \, ^\circ C - (3410 \, ^\circ C - 2617 \, ^\circ C) = 1824 \, ^\circ C \)

Predicted atomic radius of Mo: \( \frac{0.125 \, \text{nm} + 0.137 \, \text{nm}}{2} = 0.131 \, \text{nm} \)

Predicted density of W: \( 10.28 \, \text{g/mL} + (10.28 \, \text{g/mL} - 7.14 \, \text{g/mL}) = 13.42 \, \text{g/mL} \)

40. Predicted boiling point of Ar: \( -152 \, ^\circ C + [-152 \, ^\circ C - (-107 \, ^\circ C)] = -197 \, ^\circ C \)

Predicted atomic radius of Kr: \( \frac{0.180 \, \text{nm} + 0.210 \, \text{nm}}{2} = 0.195 \, \text{nm} \)

Predicted density of Xe: \( 3.74 \, \text{g/L} + (3.74 \, \text{g/L} - 1.78 \, \text{g/L}) = 5.70 \, \text{g/L} \)

42. | Compound       | Formula | Compound       | Formula |
    |----------------|---------|----------------|---------|
    | (a) lithium oxide | Li₂O    | (b) barium oxide | BaO     |
    | (c) gallium oxide | Ga₂O₃    | (d) tin oxide | SnO₂     |

44. | Compound       | Formula  | Compound       | Formula  |
    |----------------|----------|----------------|----------|
    | (a) cadmium oxide | CdO     | (b) cadmium sulfide | CdS       |
    | (c) cadmium selenide | CdSe    | (d) cadmium telluride | CdTe     |

46. | Compound       | Formulas | Compound       | Formulas |
    |----------------|----------|----------------|----------|
    | (a) arsenic sulfide and arsenic selenide | As₂S₃ and As₂S₅ | (b) antimony sulfide and antimony selenide | Sb₂S₃ and Sb₂S₅ |

Section 5.6 Blocks of Elements

48. The elements in Groups IIIA/3 through VIIIA/18 are filling \( p \) sublevels.

50. The inner transition elements are filling \( f \) sublevels.

52. The elements in the actinide series are filling a \( 5f \) sublevel.

54. | Element | Highest Sublevel | Element | Highest Sublevel |
    |---------|-----------------|---------|-----------------|
    | (a) He  | 1s              | (b) K   | 4s              |
    | (c) U   | 5f              | (d) Pd  | 4d              |
    | (e) Be  | 2s              | (f) Co  | 3d              |
    | (g) Si  | 3p              | (h) Pt  | 5d              |

2014 © Pearson Education, Inc. The Periodic Table 29
56.  | Element | Electron Configuration | Core Notation |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>B</td>
<td>1s(^2) 2s(^2) 2p(^1)</td>
<td>[He] 2s(^2) 2p(^1)</td>
</tr>
<tr>
<td>(b)</td>
<td>Ti</td>
<td>1s(^2) 2s(^2) 2p(^6) 3s(^2) 3p(^6) 4s(^2) 3d(^2)</td>
<td>[Ar] 4s(^2) 3d(^2)</td>
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<tr>
<td>(c)</td>
<td>Na</td>
<td>1s(^2) 2s(^2) 2p(^6) 3s(^1)</td>
<td>[Ne] 3s(^1)</td>
</tr>
<tr>
<td>(d)</td>
<td>O</td>
<td>1s(^2) 2s(^2) 2p(^4)</td>
<td>[He] 2s(^2) 2p(^4)</td>
</tr>
<tr>
<td>(e)</td>
<td>Ge</td>
<td>1s(^2) 2s(^2) 2p(^6) 3s(^2) 3p(^6) 4s(^2) 3d(^{10}) 4p(^2)</td>
<td>[Ar] 4s(^2) 3d(^{10}) 4p(^2)</td>
</tr>
<tr>
<td>(f)</td>
<td>Ba</td>
<td>1s(^2) 2s(^2) 2p(^6) 3s(^2) 3p(^6) 4s(^2) 3d(^{10}) 4p(^6) 5s(^2) 4d(^{10})</td>
<td>[Xe] 6s(^2)</td>
</tr>
<tr>
<td>(g)</td>
<td>Pd</td>
<td>1s(^2) 2s(^2) 2p(^6) 3s(^2) 3p(^6) 4s(^2) 3d(^{10}) 4p(^6) 5p(^{6}) 6s(^{2})</td>
<td></td>
</tr>
<tr>
<td>(h)</td>
<td>Kr</td>
<td>1s(^2) 2s(^2) 2p(^6) 3s(^2) 3p(^6) 4s(^2) 3d(^{10}) 4p(^6)</td>
<td>[Kr] 5s(^2) 4d(^{8})</td>
</tr>
</tbody>
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\[\text{Section 5.7 Valence Electrons}\]

58.  | Group  | Valence Electrons | Group  | Valence Electrons |
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<tr>
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<td>(b)</td>
<td>IVA/14</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(d)</td>
<td>VIIIA/18</td>
</tr>
</tbody>
</table>

60.  | Element | Valence Electrons | Element | Valence Electrons |
<table>
<thead>
<tr>
<th></th>
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<th></th>
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<tbody>
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<td>Se</td>
<td>6</td>
<td>(d)</td>
<td>Ne</td>
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<tr>
<td>(e)</td>
<td>Cs</td>
<td>1</td>
<td>(f)</td>
<td>Ga</td>
</tr>
<tr>
<td>(g)</td>
<td>Sb</td>
<td>5</td>
<td>(h)</td>
<td>Br</td>
</tr>
</tbody>
</table>

\[\text{Section 5.8 Electron Dot Formulas}\]

62.  | Element | Electron Dot Formula | Element | Electron Dot Formula |
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<th></th>
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<tbody>
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<td>He:\</td>
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<td>(c)</td>
<td>Se</td>
<td>\cdot Se:\</td>
<td>(d)</td>
<td>Ne\cdot</td>
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<tr>
<td>(e)</td>
<td>Cs</td>
<td>Cs\cdot</td>
<td>(f)</td>
<td>Ga\cdot</td>
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<tr>
<td>(g)</td>
<td>Sb</td>
<td>\cdot Sb:\</td>
<td>(h)</td>
<td>Br\cdot</td>
</tr>
</tbody>
</table>

\[\text{Section 5.9 Ionization Energy}\]

64.  Proceeding from left to right in the periodic table, the ionization energy increases.

66.  The Group VIIIA/18 elements have the highest ionization energy.
68. **Ionization Energy**

(a) Ga < Ge
(b) Si < P
(c) Br < Cl
(d) As > Sb

(Note: The element with the higher ionization energy is in **bold**.)

---

70. **Ionization Energy**

(a) Mg < Si
(b) Pb < Bi
(c) Ca < Ga
(d) P < Cl

(Note: The element with the lower ionization energy is in **bold**.)

---

### Section 5.10 Ionic Charges

72. **Group** | **Ionic Charge** | **Group** | **Ionic Charge**
--- | --- | --- | ---
(a) IVA/14 | 4– | (b) VA/15 | 3–
(c) VIA/16 | 2– | (d) VIIA/17 | 1–

74. **Ion** | **Ionic Charge** | **Ion** | **Ionic Charge**
--- | --- | --- | ---
(a) Be ion | 2+ | (b) Sn ion | 4+
(c) P ion | 3– | (d) S ion | 2–

76. **Ion** | **Isolelectronic** | **Ion** | **Isolelectronic**
--- | --- | --- | ---
(a) K⁺ | Ar | (b) Sr²⁺ | Kr
(c) Cl⁻ | Ar | (d) Se²⁻ | Kr

78. **Ion** | **Electron Configuration – Core Notation**
---
(a) Ti²⁺ | [Ar] 3d²
(b) Zn²⁺ | [Ar] 3d¹⁰
(c) Y³⁺ | [Kr]
(d) Cs⁺ | [Xe]

80. **Ion** | **Electron Configuration – Core Notation**
---
(a) Br⁻ | [Ar] 4s² 3d¹⁰ 4p⁶, or [Kr]
(b) Te²⁻ | [Kr] 5s² 4d¹⁰ 5p⁶, or [Xe]
(c) As³⁻ | [Ar] 4s² 3d¹⁰ 4p⁶, or [Kr]
(d) O²⁻ | [He] 2s² 2p⁶, or [Ne]
General Exercises

82. European IUPAC (a) Group IIA Group 2 (b) Group IIB Group 12 (c) Group IVA Group 14 (d) Group IVB Group 4

84. Predicted atomic radius of Ra: 0.217 nm + (0.217 – 0.215) nm = 0.219 nm
Predicted density of Ra: 3.65 g/mL + (3.65 – 2.63) g/mL = 4.67 g/mL
Predicted melting point of Ra: 725 °C – (769 – 725) °C = 681 °C

86. Element Electron Configuration
(a) W [Xe] 6s² 4f¹⁴ 5d⁴
(b) Bi [Xe] 6s² 4f¹⁴ 5d¹⁰ 6p³
(c) Ra [Rn] 7s²
(d) Ac [Rn] 7s² 6d¹

88. Ionic Charges of Hydrogen Ions
H⁺ Hydrogen loses an electron similar to the Group IA/1 elements.
H⁻ Hydrogen gains an electron similar to the Group VIIA/17 elements.

Challenge Exercises

90. Mendeleev predicted the element gallium (Ga), which was not discovered until 1875.

92. Magnesium has two valence electrons in a filled s sublevel. Aluminum has one electron in an unfilled p sublevel. The ionization energy for aluminum is less than that of magnesium because of the single electron in a p sublevel.

Online Exercises

94. Element 104 was named rutherfordium (Rf) for an English physicist.

96. Soluble compounds containing barium are poisonous to humans. Barium sulfate is highly insoluble, thus elemental barium is not free to enter the blood.