Chapter 1 Investigations

Investigation 1.4.1: The Nuts and Bolts of Atomic Mass, page 42

Analyze and Evaluate

(a) The total mass of the sample is found by subtracting the mass of the empty cup from the mass of the boltium sample in the cup. Actual values will depend on the materials used.

(b) $$\%\text{ abundance of boltium } -1 = \frac{5}{20} \times 100$$
$$\%\text{ abundance of boltium } -1 = 25\ \%$$

$$\%\text{ abundance of boltium } -2 = \frac{10}{20} \times 100$$
$$\%\text{ abundance of boltium } -2 = 50\ \%$$

$$\%\text{ abundance of boltium } -3 = \frac{5}{20} \times 100$$
$$\%\text{ abundance of boltium } -3 = 25\ \%$$

(c) Answers are determined from experimental data. Multiply the atomic mass by 20.
(d) Answers may vary. Students' answers should include a discussion of isotopic abundance. Sample answer: The measured mass of the sample does not take into account the abundance of each particular boltium in the sample.

Apply and Extend

(e) Answers are determined from experimental data. Multiply the isotopic abundance calculated in (b) with the total mass of each boltium.
(f) Neon-19 has 9 neutrons, neon-20 has 10 neutrons, and neon-22 has 12 neutrons.
(g) An isotope is a form of an element in which the atoms have the same number of protons as all other forms of that element, but a different number of neutrons. Isotopic abundance is the percentage of a given isotope in a sample of an element. Atomic mass is the weighted average of the masses of all the naturally occurring isotopes of an element.
(h) Answers may vary. Sample answer: This analogy of nuts and bolts for isotopes of atoms is helpful because the isotopes are large enough to separate easily and to make finding the mass and abundance of each isotope simple. This analogy does not represent actual isotopes well because the number of models used is very small compared with the actual numbers of atoms in a sample. In addition, although protons and neutrons have roughly the same mass, a bolt and nut do not.

Investigation 1.5.1: The Search for Patterns, pages 44–45

Analyze and Evaluate

(a) The elements tested in Part A from least reactive to most reactive are copper, magnesium, calcium, lithium, and sodium.
(b) Sodium and lithium are in a group. Calcium and magnesium are in a second group. The reactivity increases as one proceeds down a group.
(c) Sodium and magnesium are in a period, as are calcium and copper. Reactivity decreases as you move across a period from left to right.
(d) The solution formed is basic.
(e) The gas produced is hydrogen.
(f) The elements tested in Part B from least reactive to most reactive are iron, zinc, aluminum, and magnesium.
(g) Reactivity decreases as one moves across a period from left to right.
(h) The gas produced is hydrogen.
(i) Reactivity decreases as one moves down a group.
(j) Students' answers should show an understanding of the limitation of using so few metals and that using more metals would help you to get a clearer picture of reactivity trends.

Apply and Extend

(k) Answers may vary. Sample answer: If you were to drop a piece of potassium into a beaker of water, the potassium would produce bubbles of hydrogen gas and a basic solution.
(l) Answers may vary. Students' answers should include references to the following: Atomic radius increases moving down a group and decreases across a period. The valence electrons experience weaker forces of attraction in larger atoms. Thus, ionization energy and electron affinity tend to decrease as atoms become larger. Metal atoms tend to lose electrons when they react, so the largest metal atoms, which have the lowest ionization and electron affinity, tend to be more reactive.

Investigation 1.7.1: Graphing Periodic Trends, page 45

Analyze and Evaluate

(a) As atomic number increases, the atomic radius decreases across a period from left to right, but increases as you move down a group.
(b) The alkali metals have the largest radii as you move across a period.
(c) The noble gases have the smallest radii as you move across a period.
(d) Sample answer: As atomic number increases, the first ionization energy increases across a period from left to right, but decreases as you move down a group.
(e) The noble gases have the greatest first ionization energy as you move across a period.
(f) The alkali metals have the smallest first ionization energy as you move across a period.
(g) The trend for atomic radius is the opposite of the trend for first ionization energy. The first ionization energy depends on how tightly held the valence electrons are. Thus, the larger the atom, the less energy that is needed to remove an electron.
(h) Scandium: atomic radius (184); ionization energy (632 kJ/mol)
Titanium: atomic radius (176); ionization energy (657 kJ/mol)

Apply and Extend

(i) In general, electron affinity increases across a period, so electron affinity will tend to increase from elements 3 to 10 and from elements 11 to 18. You should see large positive values as the atomic number increases across each period.