RLP-CHEMA · RLP Chemistry A — Atoms, Bonding, Reactions, Gases and Solutions

# Unit 1: Atoms, Electrons and the Periodic Table

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

## Lesson 1.1 — Lead in Missouri: What Is an Atom of an Element?

### FLUENCY

1. How many protons, neutrons and electrons are in a neutral atom of lead-206?

2. How many protons, neutrons and electrons are in a neutral atom of copper-65?

3. A lead-208 ion has 80 electrons. Give its charge and symbol.

4. An ion has 17 protons, 18 neutrons and 18 electrons. Give its symbol with charge and its mass number.

5. Soil at 400 ppm lead contains how many milligrams of lead per kilogram, and what percent of the soil's mass is that?

6. Using NIST isotope data, compute the average atomic mass of lithium: Li-6 is 6.0151 u (7.59%) and Li-7 is 7.0160 u (92.41%).

## APPLICATION

7. Boron has two natural isotopes: B-10 (10.0129 u, 19.9%) and B-11 (11.0093 u, 80.1%). Compute the average atomic mass and say which isotope is more abundant and how the answer shows it.

8. EPA's 2009 sampling found 129 of 372 properties had soil above the action level, and 104 of those 129 had been cleaned up before. What percent of sampled properties were above the level, and what percent of those had been cleaned up before? (Report each to one decimal place.)

9. Using atomic weights Pb = 207.2 and S = 32.06, find the mass percent of lead in galena, PbS.

## CHALLENGE

10. Copper has two natural isotopes, Cu-63 (62.9296 u) and Cu-65 (64.9278 u), and an average atomic mass of 63.546 u. Find the percent abundance of Cu-63.

11. Soil contains 400 ppm lead. (a) How many grams of lead are in 1.00 kg of this soil? (b) How many kilograms of soil contain 1.00 g of lead?

## REVIEW

12. Round the computed average mass of lead, 207.217 u, to four significant figures, and say why NIST's value is written 207.2(1).

13. Using the NIST table, what percent of natural lead atoms are Pb-204 or Pb-206 (the two lighter isotopes)?

## Lesson 1.2 — Metals, Nonmetals and Reactivity Patterns

### FLUENCY

1. How many valence electrons do Na (Group 1), Mg (Group 2), Al (Group 13), C (Group 14) and Cl (Group 17) have?

2. A trial scores 3 at 30 s, 3 at 2 min and 2 at 5 min. What is the activity index?

3. Three trials of one metal have activity indexes 5, 5.5 and 4.5. Find the mean.

4. Classify each as metal or nonmetal from its position and properties: sulfur, copper, magnesium, graphite.

5. In the vinegar test, name the independent variable, the dependent variable and two controlled variables.

6. Does the periodic table predict that sulfur conducts electricity? What did the recorded data show?

## APPLICATION

7. Using the reading's means, compute zinc's reactivity relative to magnesium: zinc's mean index 5.00, magnesium's 8.17. Give the answer as a percent to one decimal place.

8. Rank the five metals in the reading from highest to lowest mean activity index.

9. Aluminum has a lower first ionization energy than magnesium, yet it scores lower in vinegar. Give one reason, and say whether this disproves the periodic-table model.

## CHALLENGE

10. Rank Al, Mg, Cu, Fe and Zn by first ionization energy (low to high; NIST: Al 5.986 eV, Mg 7.646 eV, Cu 7.726 eV, Fe 7.902 eV, Zn 9.394 eV), then compare with the reactivity ranking. Which metal's reactivity rank differs most from its ionization-energy rank, and by how many places?

11. A student runs only one trial of each metal and reports a ranking. Explain two ways repeating the test three times improves the claim, and compute how the mean of 5, 5.5 and 4.5 compares with the single value 5.5.

## REVIEW

12. How many protons, neutrons and electrons are in a neutral zinc-64 atom?

13. A soil sample has 400 ppm lead. How many milligrams of lead are in 250 g of this soil?

## Lesson 1.3 — Arguing from Periodic Trends

### FLUENCY

1. Convert sodium's first ionization energy, 5.139 eV per atom, to kJ/mol (1 eV per atom = 96.485 kJ/mol).

2. Which has the lower first ionization energy, lithium (5.392 eV) or cesium (3.894 eV), and what does that predict about which is more reactive?

3. How much lower is potassium's first ionization energy (4.341 eV) than sodium's (5.139 eV), in eV and as a percent of sodium's?

4. Core charge = Z minus inner electrons. Find the core charge for sodium (Z = 11, 10 inner electrons) and chlorine (Z = 17, 10 inner electrons).

5. Sodium's first and second ionization energies are 5.139 and 47.286 eV. Find the ratio second ÷ first and say how many valence electrons it indicates.

6. Across period 3, sodium's value is 5.139 eV and argon's is 15.760 eV. By how many eV does it rise, and what causes the increase?

## APPLICATION

7. Magnesium's first three ionization energies are 7.646, 15.035 and 80.144 eV. Compute the ratios 2nd ÷ 1st and 3rd ÷ 2nd and state its number of valence electrons.

8. Write a claim, evidence and reasoning statement (2-3 sentences) arguing whether rubidium (4.177 eV) or sodium (5.139 eV) loses its outer electron more easily.

9. Use the toy model IE ≈ 13.598 × (core charge)$^2$ ÷ $n^2$ for potassium (core charge 1, $n$ = 4) and compare it with the NIST value 4.341 eV. By what factor is the model low?

## CHALLENGE

10. Aluminum's first four ionization energies are 5.986, 18.829, 28.448 and 119.992 eV. How much energy (in eV) removes its three valence electrons, and how many kJ/mol is that?

11. Lead's four ionization energies are 7.417, 15.032, 31.937 and 42.333 eV. Compute the energy to make $Pb^{2+}$ and to make $Pb^{4+}$, their ratio, and use it to argue why $Pb^{2+}$ is the lead ion present in the ore galena.

## REVIEW

12. How many protons, neutrons and electrons are in the ion $Pb^{2+}$ for lead-206?

13. Magnesium scored a mean activity index of 8.17 in vinegar and zinc scored 5.00 (Lesson 1.2's reading). Compute zinc's reactivity as a percent of magnesium's.

## Lesson 1.4 — Modeling Electrons: Configurations and Line Spectra

### FLUENCY

1. Write the electron configuration of sodium (Z = 11) and state its number of valence electrons.

2. Write the electron configuration of sulfur (Z = 16) and state its number of valence electrons.

3. How many unpaired electrons does a nitrogen atom ($2p^3$) have?

4. Use $hc$ = 1239.84 eV·nm. Find the energy of a photon of wavelength 486.135 nm.

5. Find the frequency of light with wavelength 410.1734 nm ($c = 2.998 \times 10^8$ m/s).

6. A photon has an energy of 2.00 eV. What is its wavelength?

## APPLICATION

7. Write iron's configuration (Z = 26) and count its unpaired electrons.

8. Explain how copper's real configuration differs from the filling-order prediction, and give its number of 4s electrons.

9. Using the model energy $13.5984 \times (1/4 - 1/16)$ eV for the $4 \to 2$ transition, find the predicted wavelength ($hc$ = 1239.84 eV·nm) and compare with NIST's 486.135 nm as a percent difference.

## CHALLENGE

10. Hydrogen's $2 \to 1$ transition releases 10.1988 eV. Compute its wavelength and say whether it is visible (about 380–700 nm).

11. An electron is removed from hydrogen's level 2, which takes 3.3996 eV. What is the longest-wavelength photon that can do it, and how does it compare with the 656.279 nm red line's energy of 1.8892 eV?

### REVIEW

12. Magnesium's second and third ionization energies are 15.035 and 80.144 eV. What ratio shows how many valence electrons it has, and what is the number?

13. Chlorine has two isotopes, Cl-35 (34.9689 u, 75.76%) and Cl-37 (36.9659 u, 24.24%). Find the average atomic mass.

## Unit 1 checkpoint

1. A neutral atom has 82 protons and 126 neutrons. What is its mass number?
   A. 82
   B. 126
   C. 208
   D. 290

2. Which pair are isotopes?
   A. Pb and Pb<sup>2+</sup>
   B. Pb-206 and Pb-208
   C. Pb-208 and Bi-208
   D. Sn-118 and Pb-118

3. Using the NIST values in Lesson 1.3's reading, which of lithium, sodium, potassium or magnesium has the lowest first ionization energy?
   A. Lithium
   B. Sodium
   C. Potassium
   D. Magnesium

4. Magnesium bubbled vigorously in vinegar and copper did not. The best explanation is that
   A. copper is heavier
   B. magnesium gives up its outer electrons much more easily
   C. copper is a nonmetal
   D. the copper sample was bigger

5. An element's successive ionization energies are 5.99, 18.83, 28.45 and 119.99 eV. How many valence electrons does it have?
   A. 1
   B. 2
   C. 3
   D. 4

6. Which hydrogen photon carries more energy, the 410.1734 nm violet line or the 656.279 nm red line, and why?
   A. Red, because it has the longer wavelength
   B. Violet, because E = hc/λ is larger for a shorter wavelength
   C. They are equal
   D. Red, because it has lower frequency

7. Which statement is a criterion, not a constraint, for a yard-soil lead check?
   A. The sampling step must not bring lead dust into the home
   B. The method reports lead in mg/kg so it can be compared with 400 mg/kg
   C. The kit must cost less than a set limit
   D. Samples must be collected without skin contact

8. The sum of lead's first two ionization energies is _____ eV (one decimal place, using the NIST values in Lesson 1.3's reading).

9. Iron's neutral-atom configuration is [Ar] 3d<sup>_____</sup> 4s<sup>_____</sup>.

10. True or false: 400 ppm of lead in soil means 400 mg of lead per kilogram of soil.

11. True or false: Isotopes of an element differ in their number of protons.

12. True or false: Copper's ground configuration is [Ar] 3d<sup>9</sup> 4s<sup>2</sup>.

13. True or false: Because aluminum's ionization energy is lower than magnesium's, aluminum must bubble faster in vinegar than magnesium.