20.E: Periodic Trends and the s-Block Elements (Exercises)

A general chemistry Libretexts Textmap organized around the textbook

Chemistry: Principles, Patterns, and Applications

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These are homework exercises to accompany the Textmap created for "Chemistry: Principles, Patterns, and Applications" by Bruce A. Averill and Patricia Eldredge. Complementary General Chemistry question banks can be found for other Textmaps and can be accessed here. In addition to these publicly available questions, access to private problems bank for use in exams and homework is available to faculty only on an individual basis; please contact Delmar Larsen for an account with access permission.

21.1: Overview of Periodic Trends

Problems

1. List three physical properties that are important in describing the behavior of the main group elements.
2. Arrange K, Cs, Sr, Ca, Ba, and Li in order of
    a. increasing ionization energy.
    b. increasing atomic size.
    c. increasing electronegativity.
3. Arrange Rb, H, Be, Na, Cs, and Ca in order of
    a. decreasing atomic size.
    b. decreasing magnitude of electron affinity.
4. Which periodic trends are affected by Z_{eff}? Based on the positions of the elements in the periodic table, which element would you expect to have the highest Z_{eff}? the lowest Z_{eff}?
5. Compare the properties of the metals and nonmetals with regard to their electronegativities and preferred oxidation states.
6. Of Ca, Br, Li, N, Zr, Ar, Sr, and S, which elements have a greater tendency to form positive ions than negative ions?
7. Arrange As, O, Ca, Sn, Be, and Sb in order of decreasing metallic character.
8. Give three reasons the chemistry of the second-period elements is generally not representative of their groups as a whole.
9. Compare the second-period elements and their heavier congeners with regard to
    a. magnitude of electron affinity.
    b. coordination number.
    c. the solubility of the halides in nonpolar solvents.
10. The heavier main group elements tend to form extended sigma-bonded structures rather than multiple bonds to other atoms. Give a reasonable explanation for this tendency.
11. What is the diagonal effect? How does it explain the similarity in chemistry between, for example, boron and silicon?
12. Although many of the properties of the second- and third-period elements in a group are quite different, one property is similar. Which one?
13. Two elements are effective additives to solid rocket propellant: beryllium and one other element that has similar chemistry. Based on the position of beryllium in the periodic table, identify the second element.
14. Give two reasons for the inert-pair effect. How would this phenomenon explain why Sn^{2+} is a better reducing agent than Pb^{2+}?

15. Explain the following trend in electron affinities: Al (−41.8 kJ/mol), Si (−134.1 kJ/mol), P (−72.0 kJ/mol), and S (−200.4 kJ/mol).
16. Using orbital energy arguments, explain why electron configurations with more than four electron pairs around the central atom are not observed for second-period elements.

Answers

3.
    a. Cs > Rb > Ca > Na > Be > H
    b. H > Na > Rb > Cs > Ca > Be
7. Ca > Be > Sn > Sb > As > O
13. aluminum
15. The magnitude of electron affinity increases from left to right in a period due to the increase in Z_{eff}; P has a lower electron affinity than expected due to its half-filled 3p shell, which requires the added electron to enter an already occupied 3p orbital.

Structure and Reactivity

1. The following table lists the valences, coordination numbers, and ionic radii for a series of cations. Which would you substitute for K^+ in a crystalline lattice? Explain your answer.

Metal	Charge	Coordination Number	Ionic Radius (pm)
Li	+1	4	76
Na	+1	6	102
K	+1	6	138
Mg	+2	6	72
Ca	+2	6	100
Sr	+2	6	118

Answer

1. Sr^{2+}; it is the ion with the radius closest to that of K^+.

21.2: The Chemistry of Hydrogen

21.3: The Alkali Metals (Group 1)

22.4: The Alkaline Earth Metals (Group 2)