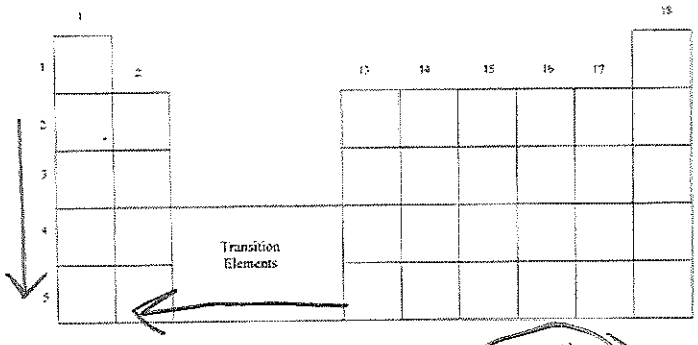
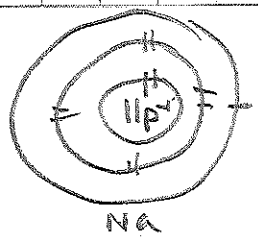
Atomic structure: Trends of the periodic table.

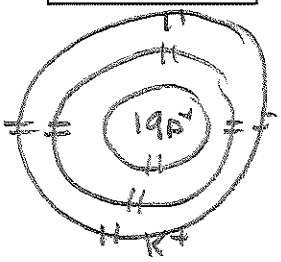


Video answers

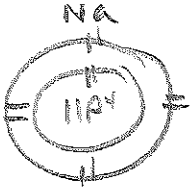
1. Create a Bohr diagram for the sodium atom.



2. Create a Bohr diagram of a potassium atom.



3. Create a Bohr diagram of the sodium ion.



Isoelectric: meaning same # of electrons

4. Which atom is sodium ion isoelectric with? Ne

5. How do the size of the sodium atom and the potassium atom compare? Why the difference?

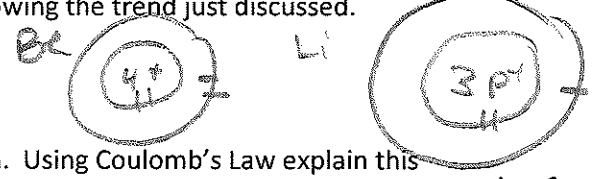
Na < K more energy levels

6. How do the size of the sodium ion and the sodium atom compare? Why the difference?

$Na^+ < Na$ more energy levels

7. On the periodic table above, draw an arrow showing the trend just discussed.

8. Draw a Bohr diagram of the Be and Li atoms.



   a. The Be atom is smaller then the Li atom. Using Coulomb's Law explain this phenomenon.? True, more p^+ causes more Coulombic attraction to e^- pulling them closer.

   b. Write out the electron configurations for:
      i. Be: $1s^2 2s^2$
      ii. B: $1s^2 2s^2 2p^1$

   c. The radius of B does increase a slightly from Be, but then C continues to get smaller then B and Nitrogen is smaller yet.
      i. Why is there a slight bump in size between the Be and B?

addition of P orbital

ii. Why does this row of atoms get smaller as we add protons/electron combination? more Coulombic attraction

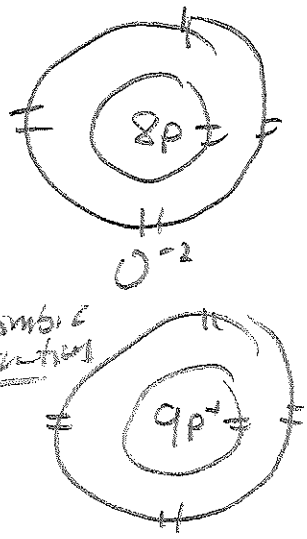
d. Describe the term effective nuclear charge. ↑ at a given energy level

9. On the periodic table above, add an arrow showing how atomic radius generally changes over a row?

10. According the trends listed, which atom might be the largest atom?

Francium

11. The Draw a Bohr diagram of Oxide and the Aluminum ion.



a. How many energy levels are composed in each of these atoms?

2

b. How many protons does each atom have?

8 , 9

c. ~~Which atom is bigger or smaller?~~ F is smaller, more p+, Coulombic attraction

d. ~~Compare the two atoms of Fluorine and Fluoride?~~

Size

How many energy levels are composed in each of these atoms?

e. How many protons does each atom have?

f. Which atom has more electrons?

g. The fluoride ~~atom~~ ion is bigger than the fluorine atom. Using coulombs law, why might this be? e- Repulsion (Coulombic Repulsion)

Investigating Atomic radius
1. Which row of the periodic table is the atom residing? (energy levels)
2. How many protons does an atom have? (Effective nuclear charge, to atoms same energy level)
3. How many electrons does an atom have.

12. For the following atoms, use energy levels and Coulombs law to predict and justify the following questions (Use the following symbols to express size difference, < or <<< for a significant size difference as might be seen with energy levels.

a. F << Cl Justify Energy levels

b. F << Ar Justify Energy levels

c. Br < Br^{+1} Justify electron Repulsion

~~d. I < I^{+1}~~ Justify

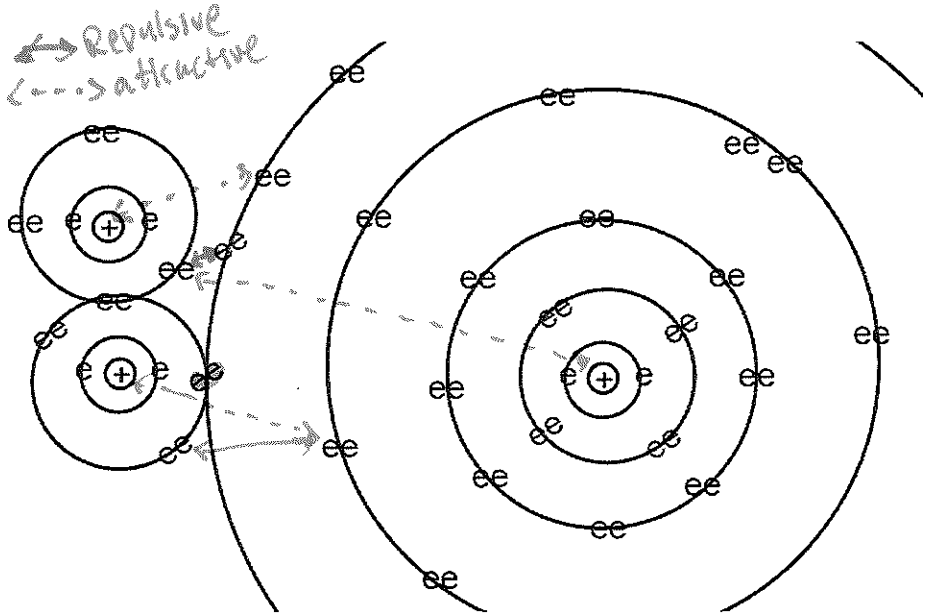
Ca^{+2} < Ca energy levels

Ca^{+2} > Al^{+3} more protons, Coulombic attraction

Application of atomic radius

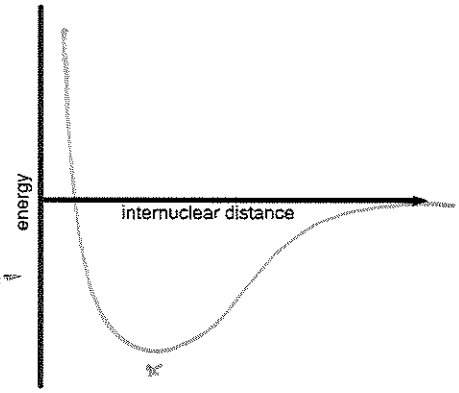
How is atomic radius utilized in chemistry? It is mostly utilized in conjunction with coulombs law in the formation of an ionic bulk crystal. The most prominent factor affecting the attraction (melting point) of cations and anions in a ionic crystal is the size of charge. The secondary factor is atomic radius.

13. In the following model below draw arrows showing the attractive forces and arrows showing repulsive forces. Distinguish between repulsive and attractive arrows.



14. Complete below is a energy/internuclear distance diagram. (How does this diagram explain the previous question?)

x is a balance between attractive Repulsive forces

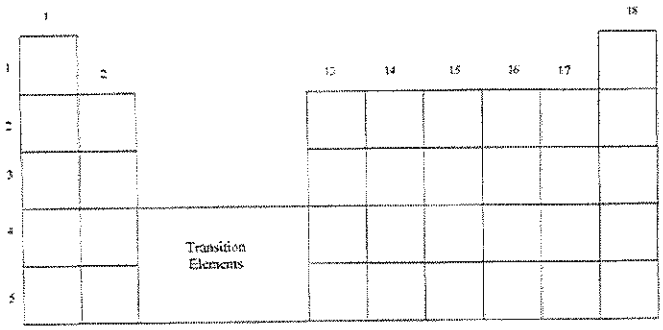


15. Ionization energy: Energy needed to remove $1e^-$
16. Second ionization energy: ENERGY needed to remove 2nd e^-
17. Write the chemical reaction for the ionization of Na.

Energy + $Na \rightarrow Na^+ + 1e^-$

18. The 1st ionization energy of sodium is much smaller then the 2nd ionization energy of sodium. Based upon your Bohr diagram above, justify.

2nd e^- is much closer, ↑ coulombic attraction



19. Statement A: The Ba atom has more protons then Be so it should be harder to remove its outer electron? e^- is much farther away, so easier

Statement B: The Ba atom is easier to remove the outer most electron then Be due to the electron being farther away. True, more p^+ ← New answer

Question Changed

Are these statements true or false?

$$F = \frac{q^+ q^-}{d^2}$$

Notice the distance is squared, causing greater distances to have a larger effect.

Investigating Atomic radius

1. Which row of the periodic table is the atom residing? (energy levels)
2. How many protons does an atom have? (more p^+ makes smaller) (Effective nuclear charge, to atoms same energy level)
3. How many electrons does an atom have. (more e^- makes bigger)

All justification of ionization energy should be referenced to Coulombs law, both attraction and distance play a role. If you discuss distance, then relate that to force of attraction at that distance. A complete answer will eventually circle back to force of attraction and how the factors at hand affect that force.

20. Using your knowledge of atomic structure and coulombs law indicate how the two substances below differ relative to ionization energy.

a. Na > K Justify Larger distance

b. Na > Na^+ Justify Shorter dist

c. F < F^{-1} Justify Larger distance

d. Ne < ~~Ar~~ Na^+ Justify more p^+

e. F^{-1} < Ne Justify more p^+

21. Statement: The ionization energy of O^{-2} is larger then the ionization energy of O since oxide(O^{-2}) has a full energy shell. It is therefore more stable making it harder to remove an electron. Justify or nullify. Nullify, common misconception

electron Repulsion causes ↑ distance, easier to remove e⁻ from O^{-2}

22. Unknown substance X has the following ionization energies.

    1st ionization energy = x kJ/mol
    2nd Ionization energy = 10x kJ/mol
    3rd ionization energy = 100x kJ/mol

    Justify or nullify the following statements.

    a. The 2nd ionization energy is larger due to having a ~~larger effective nuclear charge.~~ false, e⁻ is closer to same p+

    b. The 3rd ionization energy is larger due to loss of an energy level. True

Interrelating properties relative to the periodic table has become common in recent tests. Here are a few examples.

23. Chlorine is used in swimming pools, what might be another substance from the periodic table that could replace Chlorine if needed? Br_2 F_2 I_2 Same family on Periodic table

24. Silicon is commonly used to make microprocessors what other materials could possibly be used to make these substances?

C, Ge