Periodic Table AP Practice Questions

1997 D
Explain each of the following observations using principles of atomic structure and/or bonding.

(a) Potassium has a lower first-ionization energy than lithium.

$4s^1$ vs. $\boxed{2s^1}$

Closer to nucleus so positive protons effectively hold onto electrons more effectively

(b) The ionic radius of N^{3-} is larger than that of O^{2-}.

N^{3-} 7 protons
        10 electrons   ← fewer protons holding onto same # of electrons.

O^{2-} 8 protons
        10 electrons

(c) A calcium atom is larger than a zinc atom.

Ca^0 20 protons
        20 electrons

Zn^0 30 protons
        30 electrons

Both atoms have electrons in the first four energy levels. Zn has more protons that effectively pull the electrons closer to the nucleus.

(d) Boron has a lower first-ionization energy than beryllium.

B $1s^2 2s^2 \boxed{2p^1}$ ← easier to lose this electron because it is located farther away from the nucleus.

Be $1s^2 2s^2$

2006

Suppose that a stable element with atomic number 119, symbol **Q**, has been discovered.

(a) Write the ground state electron configuration for **Q**, showing only the valence shell electrons.

Q would have a valence electron $8s^1$ (must look, count over @ periodic table)

(b) Would **Q** be a metal or a nonmetal? Explain in terms of electron configuration.

Q would be an Alkali metal because it only has one valence electron

(c) On the basis of periodic trends, would **Q** have the largest atomic radius in its group or would it have the smallest? Explain in terms of electronic structure.

Q would have the largest atomic radius because it has the most # of energy levels of electrons.

(d) What would be the most likely charge of the **Q** ion in stable ionic compounds?

Q would likely form +1 ions by losing the one valence electron is has

(e) Assume that **Q** reacts to form a carbonate compound.

(i) Write the formula of the compound formed between **Q** and the carbonate ion, CO_3^{2-}.

Q_2CO_3

(ii) Predict whether or not the compound would be soluble in water. Explain your reasoning.

All group IA compounds are soluble in water, so I would predict Q_2CO_3 to be soluble as well.

Element	First Ionization Energy (kJ/mole)	Second Ionization Energy (kJ/mole)	Third Ionization Energy (kJ/mole)
Unknown 1	1,251	2,300	3,820
Unknown 2	496	4,560	6,910
Unknown 3	738	1,450	7,730
Unknown 4	1,000	2,250	3,360

The table above shows the first three ionization energies for atoms of four elements from the third period of the periodic table. The elements are numbered randomly. Use the information in the table to answer the following questions.

(a) Which element is most metallic in character? Explain your reasoning.

Most metallic = most able to give up an electron so element #2 with its lowest first ionization energy is the most metallic

(b) Identify unknown element 3. Explain your reasoning.

unknown #3 shows a large jump in energy for its 3rd ionization energy. This would be consistent with cracking into a full valence shell, and Mg° would be the most likely element.

(c) Write the complete electron configuration for an atom of unknown element 3.

$1s^2 2s^2 2p^6 3s^2$

(d) What is the expected oxidation state for the most common ion of unknown element 2?

+1 is predicted because of the large increase in ionization energy as the second electron is lost.

(e) A neutral atom of which of the four elements has the smallest radius?

within a period, the atoms get smaller as we move to the right in the periodic table. Based on unknown 2 being in group IA and unknown 3 being in group IIA, the first ionization energy gets larger as we move to the right. Thus element #1 would be the farthest to the right and have the smallest radius.