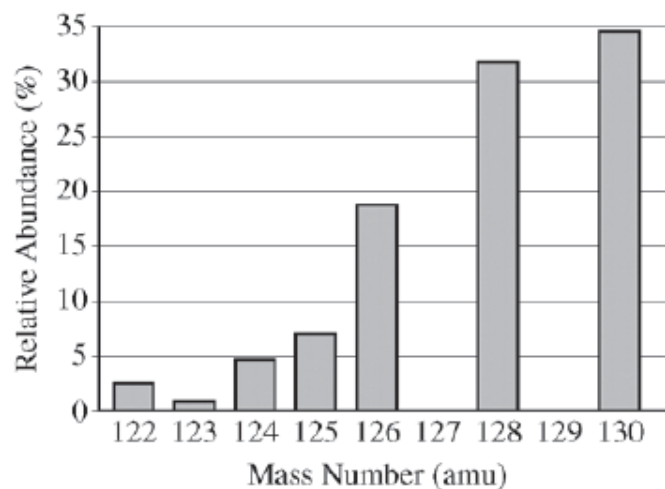


PES & Atomic Sample AP Problems from Recent AP (& Mock) Exams

2014 Released & Mock AP Exam

3. Which of the following correctly identifies which has the higher first-ionization energy, Cl or Ar, and supplies the best justification?
- (A) Cl, because of its higher electronegativity
 (B) Cl, because of its higher electron affinity
 (C) Ar, because of its completely filled valence shell
 (D) Ar, because of its higher effective nuclear charge



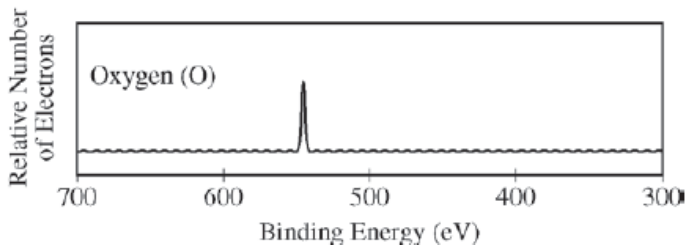
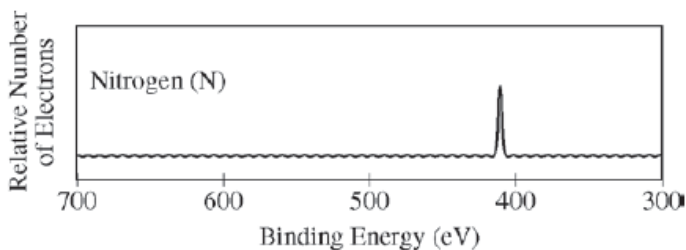
10. The elements I and Te have similar average atomic masses. A sample that was believed to be a mixture of I and Te was run through a mass spectrometer, resulting in the data above. All of the following statements are true. Which one would be the best basis for concluding that the sample was pure Te?
- (A) Te forms ions with a -2 charge, whereas I forms ions with a -1 charge.
 (B) Te is more abundant than I in the universe.
 (C) I consists of only one naturally occurring isotope with 74 neutrons, whereas Te has more than one isotope.
 (D) I has a higher first ionization energy than Te does.

Element	Atomic Radius	First Ionization Energy
Calcium	194 pm	590 kJ/mol
Potassium	—	—

58. Based on periodic trends and the data in the table above, which of the following are the most probable values of the atomic radius and the first ionization energy for potassium, respectively?
- (A) 242 pm, 633 kJ/mol
 (B) 242 pm, 419 kJ/mol
 (C) 120 pm, 633 kJ/mol
 (D) 120 pm, 419 kJ/mol

Element	First Ionization Energy (kJ/mol)	Atomic Radius (pm)
B	801	85
C	1086	77
N	1400	75
O	1314	73
F	1680	72
Ne	2080	70

12. The table above shows the first ionization energy and atomic radius of several elements. Which of the following best helps to explain the deviation of the first ionization energy of oxygen from the overall trend?
- (A) The atomic radius of oxygen is greater than the atomic radius of fluorine.
 (B) The atomic radius of oxygen is less than the atomic radius of nitrogen.
 (C) There is repulsion between paired electrons in oxygen's $2p$ orbitals.
 (D) There is attraction between paired electrons in oxygen's $2p$ orbitals.



	NaF	MgO
Boiling Point (°C)	1695	3600

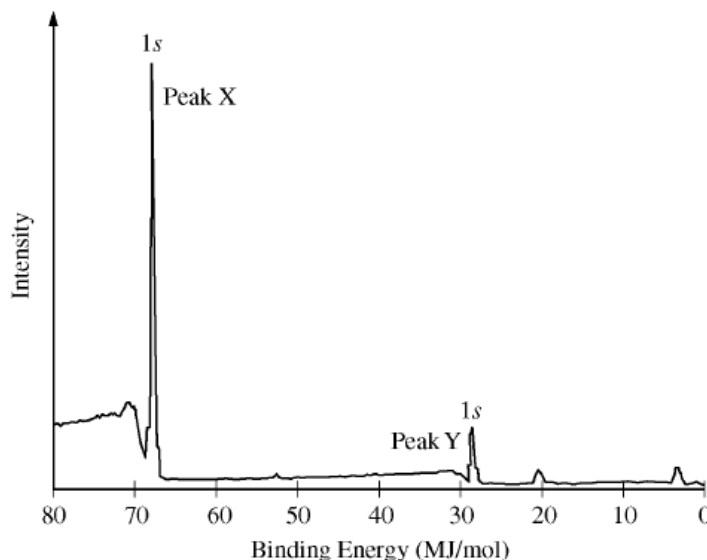
	Na ⁺	Mg ²⁺	F ⁻	Cl ⁻	O ²⁻
Ionic Radius (pm)	76	72	133	181	140

43. The photoelectron spectra above show the energy required to remove a $1s$ electron from a nitrogen atom and from an oxygen atom. Which of the following statements best accounts for the peak in the upper spectrum being to the right of the peak in the lower spectrum?

- (A) Nitrogen atoms have a half-filled p subshell.
- (B) There are more electron-electron repulsions in oxygen atoms than in nitrogen atoms.
- (C) Electrons in the p subshell of oxygen atoms provide more shielding than electrons in the p subshell of nitrogen atoms.
- (D) Nitrogen atoms have a smaller nuclear charge than oxygen atoms.

54. Based on the data in the tables above, which of the following statements provides the best prediction for the boiling point of NaCl?

- (A) NaCl will have a lower boiling point than NaF because the coulombic attractions are weaker in NaCl than in NaF.
- (B) NaCl will have a boiling point between that of NaF and MgO because the covalent character of the bonds in NaCl is intermediate between that of MgO and NaF.
- (C) NaCl will have a higher boiling point than MgO because the ions are spaced farther apart in NaCl.
- (D) NaCl will have a higher boiling point than MgO because the energy required to transfer electrons from the anion to the cation is larger in NaCl than in MgO.



31. A sample containing atoms of C and F was analyzed using x-ray photoelectron spectroscopy. The portion of the spectrum showing the $1s$ peaks for atoms of the two elements is shown above. Which of the following correctly identifies the $1s$ peak for the F atoms and provides an appropriate explanation?

- (A) Peak X, because F has a smaller first ionization energy than C has.
- (B) Peak X, because F has a greater nuclear charge than C has.
- (C) Peak Y, because F is more electronegative than C is.
- (D) Peak Y, because F has a smaller atomic radius than C has.

2008 Released Exam

5. Using principles of atomic and molecular structure and the information in the table below, answer the following questions about atomic fluorine, oxygen, and xenon, as well as some of their compounds.

Atom	First Ionization Energy (kJ mol ⁻¹)
F	1,681.0
O	1,313.9
Xe	?

- (a) Write the equation for the ionization of atomic fluorine that requires 1,681.0 kJ mol⁻¹.
- (b) Account for the fact that the first ionization energy of atomic fluorine is greater than that of atomic oxygen. (You must discuss both atoms in your response.)
- (c) Predict whether the first ionization energy of atomic xenon is greater than, less than, or equal to the first ionization energy of atomic fluorine. Justify your prediction.

2007 B Released Exam

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

6. 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.
- (b) Identify element 3. Explain your reasoning.
- (c) Write the complete electron configuration for an atom of element 3.
- (d) What is the expected oxidation state for the most common ion of element 2 ?
- (e) What is the chemical symbol for element 2 ?
- (f) A neutral atom of which of the four elements has the smallest radius?

Additional AP Chemistry Practice Exam (Flinn)

1. The following are experimentally-determined values, in kJ/mol, of successive ionization energies for a third period element: $IE_1 = 578$, $IE_2 = 1820$, $IE_3 = 2750$, $IE_4 = 11600$. That is, 578 kJ of energy are required to remove the outermost electron from 1 mole of atoms of the element, 1820 kJ of energy are required to remove the next (of the remaining electrons) valence electron, and so on.
- To which element do these successive ionization energies correspond? Justify your answer.
 - Explain why IE_2 is larger than IE_1 .
 - Estimate a value for IE_5 . Justify your answer.

Other Sample Problems

1. Based upon the ionization energy data presented below, element Z is most likely to be

Ionization Energies for Element Z (kJ mol ⁻¹)				
First	Second	Third	Fourth	Fifth
580	1,815	2,740	11,600	14,800

- Na
- Mg
- Al
- Si

2. The effective nuclear charge experienced by the outermost electron of Na is different than the effective nuclear charge experienced by the outermost electron of Ne. This difference best accounts for which of the following?

- Na has a greater density at standard conditions than Ne.
- Na has a lower first ionization energy than Ne.
- Na has a higher neutron-to-proton ratio than Ne.
- Na has fewer naturally occurring isotopes than Ne.

3. Based upon the ionization energy data presented below, what is the most likely formula for the product of the combustion of W in excess oxygen?

Ionization Energies for Element W (kJ mol ⁻¹)		
First	Second	Third
520	7,298	11,815

- WO
- W₂O
- W₂O₃
- WO₂