

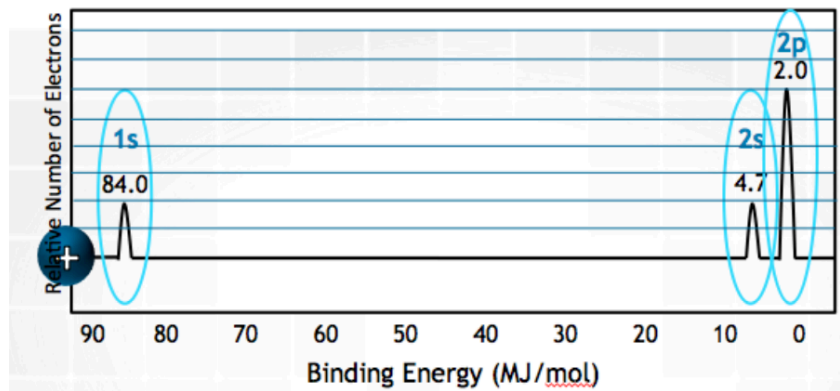
Chapter 7 – Atomic Structure and Periodicity

1. What is the frequency of light having a wavelength of 4.50×10^{-6} cm?
 - A. $2.84 \times 10^{-12} \text{ s}^{-1}$
 - B. $2.10 \times 10^4 \text{ s}^{-1}$
 - C. $6.67 \times 10^{15} \text{ s}^{-1}$
 - D. $1.06 \times 10^{22} \text{ s}^{-1}$
2. The energy in joules of a photon of radiation of wavelength 1.23×10^{-5} m is
 - A. $(6.63 \times 10^{-34})(3.00 \times 10^8) \div (1.23 \times 10^{-5})$
 - B. $(3.00 \times 10^8) \div (1.23 \times 10^{-5})$
 - C. $(1.23 \times 10^{-5}) \div (6.63 \times 10^{-34})$
 - D. $(6.63 \times 10^{-34})(1.23 \times 10^{-5}) \div (3.00 \times 10^8)$
3. The emission spectrum of gold shows a line of wavelength 2.676×10^{-7} m. How much energy is emitted as the excited electron falls to the lower energy level?
 - A. $7.43 \times 10^{-19} \text{ J}$
 - B. $5.30 \times 10^{-20} \text{ J}$
 - C. $6.05 \times 10^{-19} \text{ J}$
 - D. $3.60 \times 10^{-20} \text{ J}$
4. Which of the following correctly lists electromagnetic waves in order from longest to shortest wavelength?
 - A. gamma rays, ultraviolet, infrared, microwaves
 - B. microwaves, ultraviolet, visible light, gamma rays
 - C. radio waves, infrared, gamma rays, ultraviolet
 - D. radio waves, infrared, visible light, X-rays
5. What frequency are 20 mm microwaves? (1GHz = 10^9 Hz; 1MHz = 10^6 Hz)
 - A. 100 MHz
 - B. 400 MHz
 - C. 15 GHz
 - D. 73 GHz
6. If 480 kJ/mol of energy is supplied to an electron with a binding energy of 222 kJ/mol, with what kinetic energy will the electron be launched?
 - A. 222 kJ/mol
 - B. 702 kJ/mol
 - C. 924 kJ/mol
 - D. 258 kJ/mol

7. The threshold wavelength for photoelectric emission in Tungsten is 240 nm. What is the approximate threshold energy in, kJ/mol, required to in order for an electron to be emitted from the surface of Tungsten?

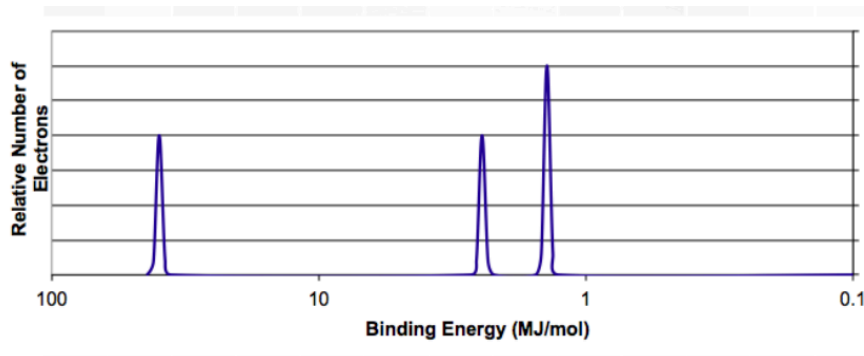
- A. 200
- B. 499
- C. 350
- D. 240

8. Which of the following elements might this spectrum represent?



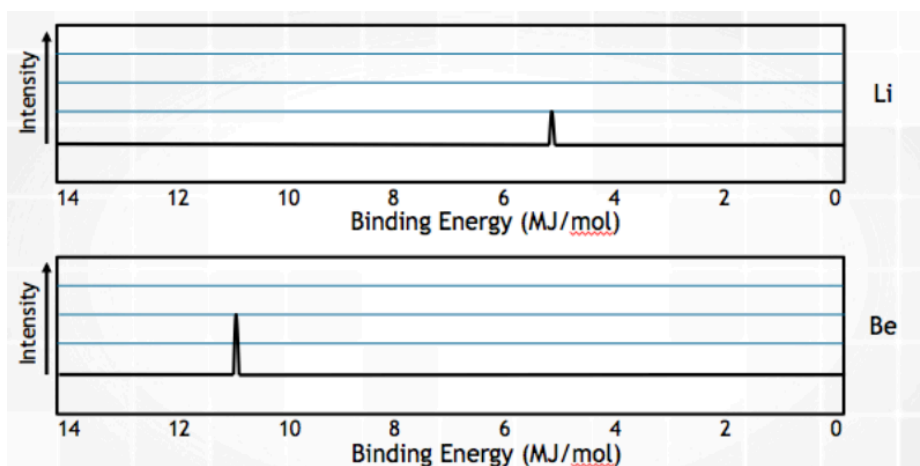
- A. He
- B. N
- C. Ne
- D. Ar

9. Which element could be represented by the complete spectrum above? Label the peaks.



- A) Li
- B) N
- C) O
- D) Ne

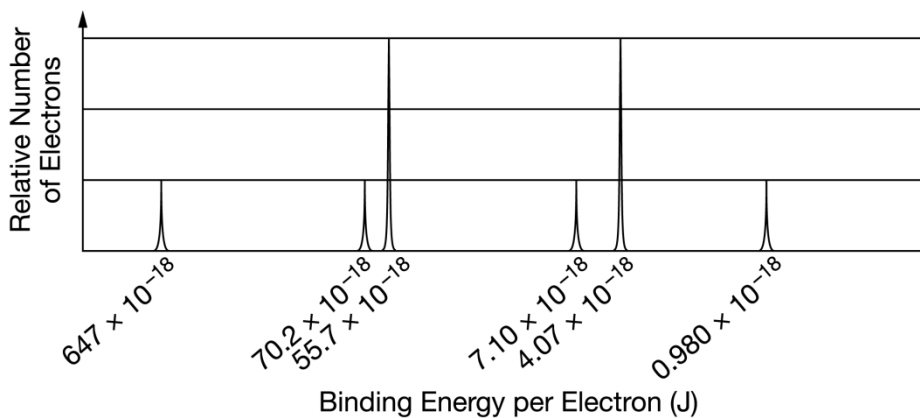
10. Which of the following best explains the relative positioning and intensity of the 2s peaks in the following spectra?



- A. Be has a greater nuclear charge than Li and more electrons in the 2s orbital
- B. Be electrons experience greater electron-electron repulsions than Li electrons
- C. Li has a greater pull from the nucleus on the 2s electrons, so they are harder to remove
- D. Li has greater electron shielding by the 1s orbital, so the 2s electrons are easier to remove

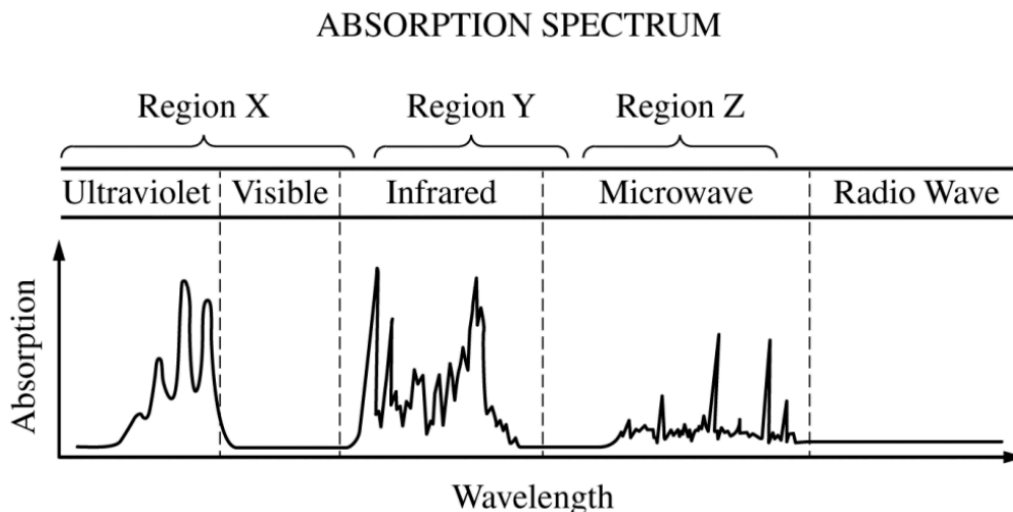
11. Based on the PES diagram below, identify the element.

The complete photoelectron spectrum of an element in its ground state is represented below.



- A. Na
- B. Ca
- C. Mg
- D. K

The diagram below represents the absorption spectrum for a pure molecular substance.

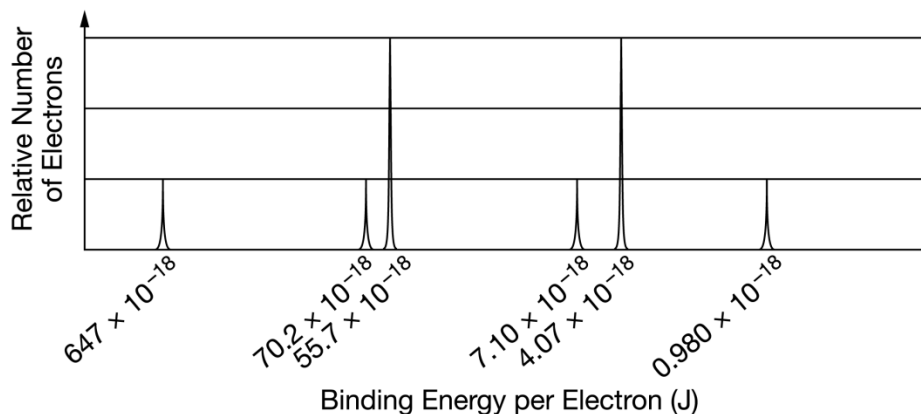


12. Which of the following correctly indicates the type of transition observed for the substance in each of the regions of the absorption spectrum?

Region X	Region Y	Region Z
A. molecular vibration;	molecular rotation;	electronic transition
B. electronic transition;	molecular rotation;	molecular vibration
C. molecular rotation;	molecular vibration;	electronic transition
D. electronic transition;	molecular vibration;	molecular rotation

13. Based on the PES diagram below, Calculate the approximate wavelength, in meters, of electromagnetic radiation needed to remove an electron from the valence shell of an atom of the element

The complete photoelectron spectrum of an element in its ground state is represented below.



A. 2.03×10^{-7} m B. 4.93×10^6 m C. 4.06×10^{-7} m D. 9.43×10^{-2} m

14. The atom that contains only one electron in the highest occupied energy sublevel in the ground state.

A. S B. Ca C. Ga D. Sb

15. The atom that contains exactly two unpaired electrons in the ground state.

A. S B. Ca C. Ga D. Sb

16. Which of the following ground-state electron configurations represents the atom that has the lowest first-ionization energy?

A. $1s^22s^1$ B. $1s^22s^22p^2$ C. $1s^22s^22p^6$ D. $1s^22s^22p^63s^1$

17. Which of the following is the ground-state electron configurations of the **Cl⁻** ion ?

A. $1s^22s^22p^4$ B. $1s^22s^22p^5$ C. $1s^22s^22p^6$ D. $1s^22s^22p^63s^23p^6$

18. Which of the following best represents the ground-state electron configuration for an atom of arsenic?

A. $[\text{Ar}]4s^23d^{10}4p^3$
B. $[\text{Ne}]3s^23p^4$
C. $[\text{Ar}]4s^23d^{10}4p^4$
D. $[\text{Ne}]3s^23p^3$

19. Of the following electron configurations of neutral atoms, which represents an atom in an excited state?

A. $1s^22s^22p^5$ B. $1s^22s^22p^53s^2$ C. $1s^22s^22p^63s^1$ D. $1s^22s^22p^63s^23p^2$

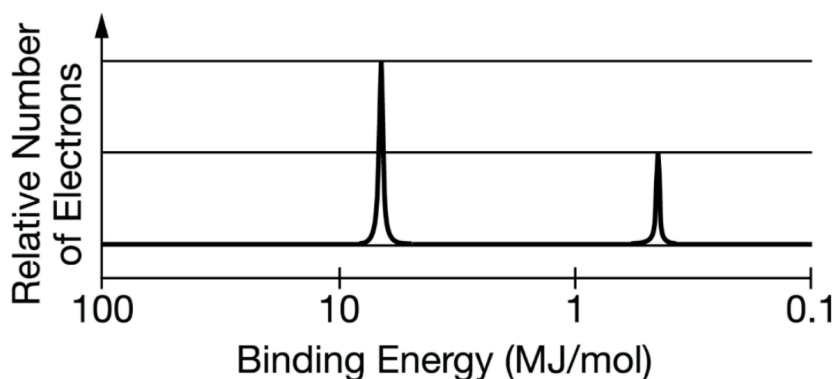
20. Which of the following represents the ground state electron configuration for the **Mn³⁺** ion? (Atomic number Mn = 25)

A. $1s^22s^22p^63s^23p^63d^4$
B. $1s^22s^22p^63s^23p^63d^54s^2$
C. $1s^22s^22p^63s^23p^63d^24s^2$
D. $1s^22s^22p^63s^23p^63d^34s^1$

21. Which of the following represents an electron configuration that corresponds to the valence electrons of an element for which there is an especially large jump between the second and third ionization energies? (Note: n represents a principal quantum number equal to or greater than 2.)

- A. ns^2
- B. ns^2np^1
- C. ns^2np^2
- D. ns^2np^3

The complete photoelectron spectrum for an element is shown below.



22. Which of the following observations would provide evidence that the spectrum is consistent with the atomic model of the element?

- A. A neutral atom of the element contains exactly two electrons.
- B. The element does not react with other elements to form compounds.
- C. In its compounds, the element tends to form ions with a charge of +1.
- D. In its compounds, the element tends to form ions with a charge of +3.

23. Which of the following electron configurations is correct for nickel?

- A. $[\text{Ar}] 4s^1 3d^8$
- B. $[\text{Kr}] 4s^1 4d^8$
- C. $[\text{Kr}] 4s^1 3d^8$
- D. $[\text{Ar}] 4s^2 3d^8$

24. The outer electronic configuration ns^2np^4 corresponds to which one of the following elements in its ground state?

- A. As
- B. Ca
- C. Cr
- D. S

25. A neutral atom of an element has 2 electrons in the first energy level, 8 in the second energy level and 8 in the third energy level. This information does **not** necessarily tell us:

- A. the number of neutrons in the nucleus of an atom of the element.
- B. anything about the element's chemical properties.
- C. the total number of electrons in s orbitals.
- D. the total number of electrons in p orbitals.

26. How many total **p** sublevel electrons are there in an atom of rubidium?

- A. 12
- B. 18
- C. 24
- D. 16

27. The emission spectrum of gold shows a line of wavelength 2.676×10^{-7} m. How much energy is emitted as the excited electron falls to the lower energy level?

- A. 7.43×10^{-19} J
- B. 5.30×10^{-20} J
- C. 6.05×10^{-19} J
- D. 3.60×10^{-20} J

28. The Heisenberg Principle states that _____.

- A. no two electrons in the same atom can have the same set of four quantum numbers.
- B. two atoms of the same element must have the same number of protons.
- C. it is impossible to determine accurately both the position and momentum of an electron simultaneously.
- D. electrons of atoms in their ground states enter energetically equivalent sets of orbitals singly before they pair up in any orbital of the set.

29. Which of the responses contains all the statements that are consistent with the Bohr theory of the atom (and no others)?

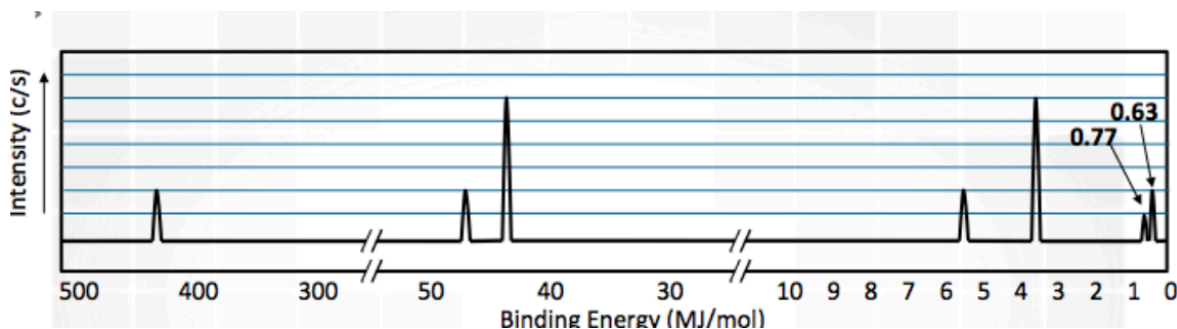
- (1) An electron can remain in a particular orbit as long as it continually absorbs radiation of a definite frequency.
- (2) The lowest energy orbits are those closest to the nucleus.
- (3) An electron can jump from the $n = 1$ energy level to the $n = 3$ energy level by emitting radiation of a definite frequency.

- (a) 1,2,3
- (b) 2 only

(c) 3 only

(d) 1,2

Given the PES diagram below for scandium:



30. Choose the **best** explanation for why Sc commonly makes a **+3** ion as opposed to a **+2** ion.

- A. Removing 3 electrons releases more energy than removing 2 electrons.
- B. Scandium is in Group 3, and atoms only lose the number of electrons that will result in a noble gas electron configuration.
- C. The amount of energy required to remove an electron from the 3d sublevel is close to that for the 4s sublevel, but significantly more energy is needed to remove electrons from the 3p sublevel.
- D. Removing 2 electrons alleviates the spin-pairing repulsions in the 4s sublevel, so it is not as energetically favorable as emptying the 4s sublevel completely.

31. Which of the following best helps to explain why the electron affinity of Br has a greater magnitude than that of I ?

- A. Br has a lower electronegativity than I does.
- B. Br has a lower ionization energy than I does.
- C. An added electron would go into a new shell in Br but not in I.
- D. There is a greater attraction between an added electron and the nucleus in Br than in I.

32. Which of the following elements has the highest electronegativity?

- A. Cs
- B. Sr
- C. Pb
- D. Br

33. Which of the following elements has the largest atomic radius?

- A. Cs
- B. Pd
- C. Pb
- D. Cl

34. Which of the following elements has the lowest first-ionization energy?

- A. Cd
- B. Ba
- C. Ge
- D. F

35. Which atomic orbital is spherical in shape?

- (a) 2s
- (b) 3p
- (c) 4d
- (d) 5f

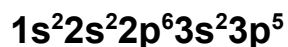
The ionization energies for element X are listed in the table below.

Ionization Energies for element X (kJ mol^{-1})				
First	Second	Third	Fourth	Fifth
580	1,815	2,740	11,600	14,800

36. On the basis of the data, element X is most likely to be

- A. Ge B. Si C. Ga D. P

37. Atoms of an element, X, have the electronic configuration shown below.



The compound most likely formed with magnesium, Al, is

- A. Al_3X_5
- B. AlX_3
- C. Al_3X
- D. Al_5X_3

38. Atoms of Ca combine with atoms of Br to form a compound. Atoms of which of the following elements combine with atoms of Br in the same ratio?

- A. Li B. Ag C. Al D. Sr

39. In the ground state of a cobalt atom there are _____ unpaired electrons and the atom is _____.

- A. 3, paramagnetic
- B. 5, paramagnetic
- C. 2, diamagnetic

D. 0, diamagnetic

All the chlorides of the alkaline earth metals have similar empirical formulas, as shown in the table below.

Metal	Be	Mg	Ca	Sr	Ba	Ra
Formula of Metal Chloride	BeCl ₂	MgCl ₂	CaCl ₂	SrCl ₂	BaCl ₂	RaCl ₂

40. Which of the following best helps to explain this observation?

- A. Cl₂(g) reacts with metal atoms to form strong, covalent double bonds.
- B. Cl has a much greater electronegativity than any of the alkaline earth metals.
- C. The two valence electrons of alkaline earth metal atoms are relatively easy to remove.
- D. The radii of atoms of alkaline earth metals increase moving down the group from Be to Ra.

41. Which of the following ions has the same number of electrons as **Br⁻** ion?

- A. Ca²⁺ B. Sr²⁺ C. Ba²⁺ D. I⁻

42. Which of the following best explains why oxygen has a smaller first ionization energy than nitrogen?

- A. Oxygen is less electronegative than nitrogen.
- B. Oxygen atoms are bigger than nitrogen atoms.
- C. The electron ionized from oxygen is a 2p electron, while the electron ionized from nitrogen is a 2s electron.
- D. The electron ionized from oxygen experiences more electron-electron repulsion than the electron ionized from nitrogen.

43. Of the following statements, which is **incorrect**?

- A. The most stable Ca ion is Ca⁺².
- B. Cl has a less negative electron affinity than F.
- C. C atoms are smaller than a Si atoms.
- D. The Mg cation is smaller than the Mg atom.

44. When electrons are consecutively removed from an atom, why does IE increase?

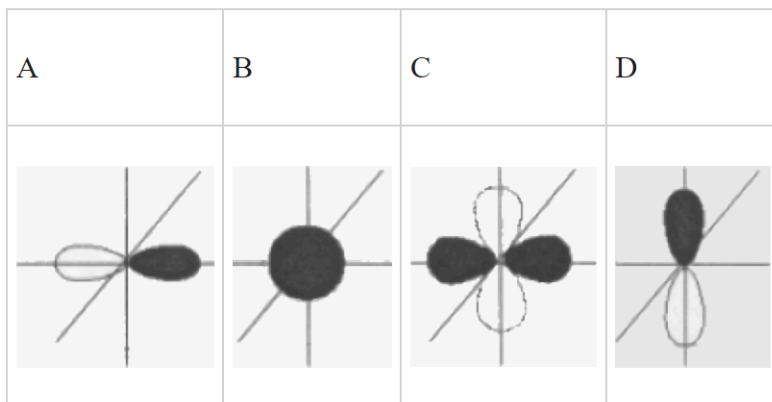
- A. The atomic radius is decreasing.
- B. The remaining electrons are held more strongly.
- C. The outermost electron experiences a higher effective nuclear charge.

D. All of the above

45. How many valence electrons are in one ion of thiosulfate, $\text{S}_2\text{O}_3^{-2}$?

- A. 32
- B. 28
- C. 30
- D. 28

Examine the set of four orbitals below:



46. For orbital A, what is the best label?

- A. 1s
- B. 2s
- C. 2p
- D. 3d

Consider the following comparisons in regard to atomic and ionic radii.

- I. $\text{Br} < \text{Br}^-$
- II. $\text{P} < \text{N}$
- III. $\text{S}^{2-} < \text{Cl}^-$
- IV. $\text{Li}^+ < \text{Li}$

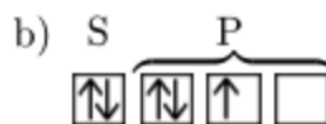
47. Which of the options below are **incorrect**?

- A. I and IV only
- B. III and IV only
- C. II and IV only
- D. I and III only

48. The first ionization energy of a certain element is equal to 495.9 kJ/mol. Determine the approximate wavelength of light that could remove an electron from an atom of this element.

- A. 2.41×10^{-7} m
- B. 2.41×10^{-4} m
- C. 4.14 m
- D. 4.14×10^3 m

49. Which orbital notation below correctly represents the outermost principal energy level of a nitrogen atom in the ground state?



- A. A
- B. B
- C. C
- D. D

The diagram below represents the bright-line spectra of four elements, A, B, C, and D, and the spectrum of an unknown gaseous sample.



50. Based on comparisons of these spectra, which two elements are found in the unknown sample?

- A. A and B
- B. A and D
- C. B and C
- D. C and D

