Concept Review Questions

Lecture 2 | Atomic structure

Directions: Choose the one alternative that best completes the statement or answers the questions.

Topic 1.1A | Early atomic structure (Dalton, Thomson, Rutherford)

Learning objectives

- ❑ *To learn about the internal parts of an atom*
- ❑ *To understand Rutherford's experiment*
- ❑ *To describe some important features of subatomic particles*
- ❑ *To learn about the terms isotope, atomic number, and mass number*
- ❑ *To* give examples of isotopes.
- ❑ *To understand the use of the symbol*
- ❑ *To indicate the number of electrons, protons, and neutrons in atoms and ions.*

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1) an atom is___.
   a. the smallest unit of matter that maintains it chemical identity
   b. the smallest unit of a compound
   c. always made of carbon
   d. smaller than an electron

2) Which of the following was one of Dalton's improvements over Democritus's ideas?
   a.)Matter consists of tiny particles called atoms
   b.)Atoms are indestructible
   c.)Atoms can retain their identity in a chemical reaction
   d.)Atoms are indivisible
   e) all of these are correct.

3) Which of the following was originally a tenet of Dalton's atomic theory, but had to be revised about a century ago?
   a.) The atoms of any element are different from those of any other element
   b.) Compounds are made up by combining atoms
   c.) Atoms are tiny indestructible particles
   d.) Atoms of different elements can combine with one another in simple whole number ratios
   e.) none of these are correct.

4) According to the law of conservation of mass, when sodium, hydrogen, and oxygen react to form a compound, the mass of the compound is ____ the sum of the masses of the individual elements
   a. equal to b. greater than c. less than
   d. either greater than or less than

5) J. J. Thomson studied cathode ray particles (electrons) and was able to measure the mass/charge ratio. His results showed that
   A) the mass/charge ratio varied with as the cathode material was changed.
   B) the charge was always a whole-number multiple of some minimum charge.
   C) matter included particles much smaller than the atom.
   D) atoms contained dense areas of positive charge.
   E) atoms are largely empty space.

6) When an electrical current passed through a glass tube, it caused the surface of the tube directly across from the cathode to glow. Scientists concluded that____.
   a. a magmatic field was produced
   b. the particles of the beam were negatively charged
   c. there was gas int he tube
   d. atoms were indivisible
   e. all of these are correct.

7) Experiments with cathode rays led to the discovery of the___.
   a. proton b. nucleus c. neutron
   d. electron e. mass of atom

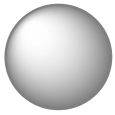
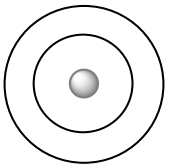
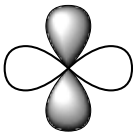
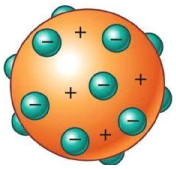
8) When J. J. Thomson discovered the electron, what physical property of the electron did he measure?
   A. its charge, e
   B. its charge-to-mass ratio, e/m
   C. its temperature, T
   D. its mass, m
   E. its atomic number, Z

9) Who is credited with measuring the charge/mass ratio of the electron?
   A. Dalton B. Chadwick C. Thomson
   D. Millikan E. Rutherford

10) Millikan's oil-drop experiment
   A. established the charge on an electron.
   B. showed that all oil drops carried the same charge.
   C. provided support for the nuclear model of the atom.
   D. suggested that some oil drops carried fractional numbers of electrons.
   E. suggested the presence of a neutral particle in the atom.

11) The scientist who determined the magnitude of the electric charge of the electron was
A. John Dalton. B. Robert Millikan. C. J. J. Thomson.
D. Henry Moseley. E. R. Chang.

12) Which of the following diagram represents Thomson's Atomic model?

1. 
2. 
3. 
4 

13) Who is credited with discovering the atomic nucleus?
A. Dalton B. Gay-Lussac C. Thomson
D. Chadwick E. Rutherford

14) Rutherford's 'alpha (α) particles scattering experiment' resulted in to discovery of__.
A) Electron B) Proton C) Nucleus in the atom
D) Atomic mass E) Neutron

15) Rutherford's experiment with alpha particle scattering by gold foil established that
A. protons are not evenly distributed throughout an atom.
B. electrons have a negative charge.
C. electrons have a positive charge.
D. atoms are made of protons, neutrons, and electrons.
E. protons are 1840 times heavier than electrons.

16) Rutherford bombarded gold foil with alpha (α) particles and found that a small percentage of the particles were deflected. Which of the following was not accounted for by the model he proposed for the structure of the atom?
A. the small size of the nucleus
B. the charge on the nucleus
C. the total mass of the atom
D. the existence of protons
E. the presence of electrons outside the nucleus

17) Which one of the following statements about atoms and subatomic particles is correct?
A. Rutherford discovered the atomic nucleus by bombarding gold foil with electrons
B. The proton and the neutron have identical masses.
C. The neutron's mass is equal to that of a proton plus an electron.
D. A neutral atom contains equal numbers of protons and electrons.
E. An atomic nucleus contains equal numbers of protons and neutrons.

18) What is the term for the number of protons in the nucleus of each atom of an element? It also indicates the number of electrons in the atom.

A. Isotope number B. Mass number C. Mass-to-charge ratio
D. Atomic number E. Atomic mass units

19) What is the term for the total number of neutrons and protons in the nucleus of each atom of an element?

A. Isotope number B. Atomic mass C. Mass-to-charge ratio
D. Atomic number E. amu

20) When an atom is represented by the symbol ${}^{A}_{Z}X$, the value of A is the

A) number of neutrons in the atom.
B) number of protons in the atom.
C) atomic mass of the element.
D) total number of electrons and neutrons in the atom.
E) total number of protons and neutrons in the atom.

21) The number of electrons in an element X is 15 and the number of neutrons is 16. Which of the following is the correct representation of the element?

1. ${}^{31}_{15}X$ 2. ${}^{30}_{16}X$ 3. ${}^{16}_{15}X$ 4. ${}^{30}_{15}X$ 5. ${}^{31}_{16}X$

22) How do isotopes of an element differ?

A. the isotopes of an element have different number of proton.
B. the isotopes of an element have different number of neutron.
C. the isotopes of an element have different number of electron.
D. the isotopes of an element have different number of atomic number.
E. the isotopes of an element have different number of atom.

23) Atoms of the same element with different mass numbers are called ___.

A. ions. B. neutrons. C. chemical groups.
D. chemical families. E. isotopes.

24) Bromine is the only nonmetal that is a liquid at room temperature. Consider the isotope bromine-81, ${}^{81}_{35}Br$. Select the combination which lists the correct atomic number, number of neutrons, and mass number, respectively.

A. 35, 46, 81 B. 35, 81, 46 C. 81, 46, 35
D. 46, 81, 35 E. 35, 81, 116

25) An atom of the isotope sulfur-31, ${}^{31}_{16}S$, consists of how many protons, neutrons, and electrons? (p = proton, n = neutron, e = electron)

A. 15 p, 16 n, 15 e B. 16 p, 15 n, 16 e C. 16 p, 31 n, 16 e
D. 32 p, 31 n, 32 e E. 16 p, 16 n, 15 e

26) Give the number of protons (p), electrons (e), and neutrons (n) in one atom of chlorine-37.

A. 37 p, 37 e, 17 n

B. 17 p, 17 e, 37 n

C. 17 p, 17 e, 20 n

D. 37 p, 17 e, 20 n

E. 17 p, 37 e, 17 n

27) Atoms X, Y, Z, and R have the following nuclear compositions:

$^{410}_{186}X$	$^{410}_{183}Y$	$^{412}_{186}Z$	$^{412}_{185}R$
(I)	(II)	(III)	(IV)

Which of the following are isotopes of the same element?

A. I & II B. I & IV C. II & IV

D. III & IV E. I & III

28) Which isotope is not possible?

A. $^{1}_{1}H$ B. $^{2}_{1}H$ C. $^{52}_{24}Cr$

D. $^{25}_{54}Mn$ E. All of these isotopes are possible.

Topic 1.1B | Bohr Model, Schrödinger atom, Atomic orbital, Electron configurations

Learning objectives

- ❑ *To explore the nature of electromagnetic radiation*
- ❑ *To see how atoms emit light*
- ❑ *To understand how the emission spectrum of hydrogen demonstrates the quantized nature of energy*
- ❑ *To learn about Bohr's model of the hydrogen atom*
- ❑ *To understand how the electron's position is represented in the wave mechanical model*
- ❑ *To learn about the shapes of the s, p and d orbitals*
- ❑ *To review the energy levels and orbitals of the wave mechanical model of the atom*
- ❑ *To understand how the principal energy levels fill with electrons in atoms beyond hydrogen*
- ❑ *To learn about valence electrons and core electrons*
- ❑ *To learn about the electron configurations of atoms*

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29) Select the arrangement of electromagnetic radiation which starts with the lowest energy and increases to greatest energy.

A) radio, visible, infrared, ultraviolet

B) infrared, visible, ultraviolet, microwave

C) visible, ultraviolet, infrared, gamma rays

D) X-radiation, visible, infrared, microwave

E) microwave, infrared, visible, ultraviolet

30) Electromagnetic radiation of 500 nm wavelength lies in the _____ region of the spectrum.

A) infrared B) visible C) ultraviolet D) X-ray E) γ-ray

31) What is the wavelength of radiation that has a frequency of 6.912×10^{14} s^{-1}?

A. 1.447×10^{-15} nm B. 4.337×10^{2} nm C. 2.304×10^{6} nm
D. 2.074×10^{23} nm E. 4.337×10^{-7} nm

32) What is the wavelength of radiation that has a frequency of 2.10×10^{14} s^{-1}?

A. 6.30×10^{22} m B. 7.00×10^{2} nm C. 7.00×10^{5} m
D. 1.43×10^{-6} m E. 3.00×10^{8} m

33) Calculate the frequency of visible light having a wavelength of 486 nm.

A. 2.06×10^{14} /s B. 2.06×10^{6} /s C. 6.17×10^{14} /s
D. 1.20×10^{-15} /s E. 4.86×10^{-7} /s

34) What is the energy in joules of one photon of microwave radiation with a wavelength 0.122 m? (*hint:* $E = h\frac{c}{\lambda}$)

A. 2.70×10^{-43} J B. 5.43×10^{-33} J C. 1.63×10^{-24} J
D. 4.07×10^{-10} J E. 2.46×10^{9} J

35) What is the energy in joules of a mole of photons associated with visible light of wavelength 486 nm?

A. 6.46×10^{-16} J B. 6.46×10^{-25} J C. 2.46×10^{-4} J
D. 12.4 kJ E. 246 kJ

36) What is the energy in joules of a mole of photons associated with red light of wavelength 7.00×10^{2} nm?

A. 256 kJ B. 1.71×10^{5} J C. 4.72×10^{-43} J
D. 12.4 kJ E. 2.12×10^{42} J

37) Which scientist first proposed that the electron in the hydrogen atom can have only certain energies?

A) Planck B) Einstein C) Bohr D) Rydberg E) Heisenberg

38) Which of the following is **true** about Bohr's interpretation of the atomic emission spectrum of hydrogen?

a) He concluded that electrons behave as waves.

b) He concluded that atoms can absorb or emit any amount of energy.

c) He concluded that only certain energies are available to electrons in atoms.

d) He concluded that electrons are emitted only when intensity of light is increased.

e) He observed a continuous spectrum of light when hydrogen gas was supplied with energy.

39) Which statement accurately represents the arrangement of electrons in Bohr's atomic model?
A. Electrons vibrate in fixed locations around the nucleolus.
B. Electrons travel around the nucleolus in fixed energy levels with energy's that vary from level to level.
C. electrons travel around the nucleolus in fixed energy levels with equal amounts of energy.
D. Electrons travel randomly in the relatively large space outside the nucleolus.
E. all of these are correct.

40) Complete this sentence: Atoms emit visible and ultraviolet light____.
A. as electrons jump from lower energy levels to higher levels.
B. as the atoms condense from a gas to a liquid.
C. as electrons jump from higher energy levels to lower levels.
D. as they are heated and the solid melts to form a liquid.
E. as the electrons move about the atom within an orbit.

41) The lines in the emission spectrum of hydrogen result from _____.
A) electrons given off by hydrogen as it cools
B) decomposing hydrogen atoms
C) electrons given off by hydrogen when it burns
D) energy given off in the form of visible light when an electron moves from a higher energy state to a lower energy state
E) protons given off when hydrogen burns

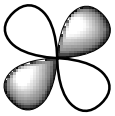
42) How was Bohr's atomic model similar to Rutherford's model?
A. It assigned energy levels to electrons.
B. It described electron positioning in terms of the electron cloud model.
C. It described how electrons gain or lose energy.
D. It described a nucleus surrounded by a large volume of space.
E. Choice A and C are correct.

43) Which of the following subshells does not exist?
A) 6s B) 3f C) 3p D) 2s E) 4d

44) Which of the following subshell notation for electron occupancy is an **impossibility**?
a) $4d^9$ b) $6s^2$ c) $5f^{12}$ d) $2d^1$ e) $3p^6$

45) _____-orbitals are spherically symmetrical.
A) d B) g C) p D) f E) s

46) Which of the following is a representation of a d-orbital?

1.  2.  3.  4.  5. 

47) An orbital is best described as__.

A) the pathway for an electron.

B) a region of probability of finding an electron.

C) the space in which only valence electrons exist.

D) a physical structure which holds the electrons.

E) all of these are correct.

48) Which statement about orbitals is INCORRECT?

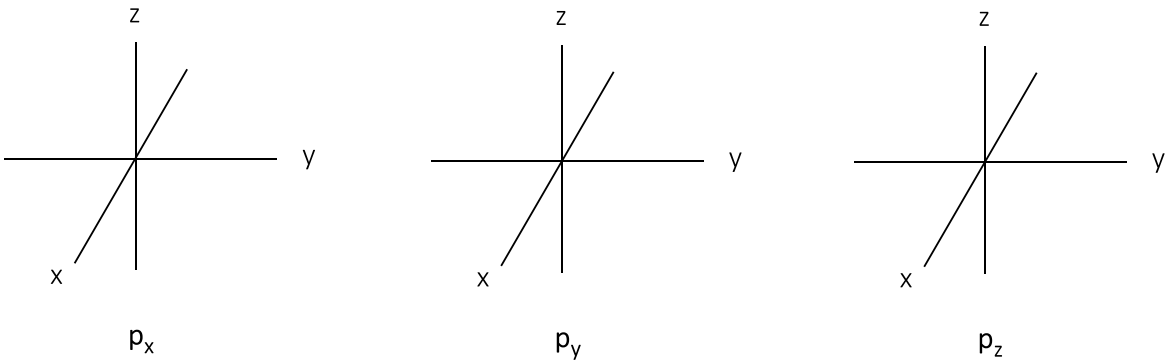
a) Different subshells have different shapes.

b) Two electrons can occupy each lobe of a *p*-orbital.

c) s-orbitals can hold 2 electrons

d) An orbital is a region of space where an electron is most likely to be found

49) On the axes below, draw the general shape of the following orbitals.



p_x p_y p_z

50) How many orbitals are found in a *p* sublevel?

A) 1 B) 2 C) 3 D) 5 E) 7

51) How many orbitals are found in a d sublevel?

A) 1 B) 2 C) 3 D) 5 E) 7

52) What is the maximum number of electrons in a *s* sublevel?

A) 2 B) 6 C) 10 D) 14 E) 18

53) What is the maximum number of electrons in a *d* sublevel?

A) 2 B) 6 C) 10 D) 14 E) 18

54) Select the correct electron configuration for sulfur (Z = 16).

1. $1s^2\ 1p^6\ 2s^2\ 2p^6$ 2. $1s^2\ 2s^2\ 2p^8\ 3s^2\ 3p^4$ 3. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

4. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3d^4$ 5. $1s^2\ 2s^2\ 2p^8\ 3s^2\ 3p^2$

55) Select the correct electron configuration for Cu (Z = 29).

A) [Ar]$4s^2\,3d^9$ D) [Ar]$4s^2\,4d^9$

B) [Ar] $4s^1\,3d^{10}$ E) [Ar]$5s^2\,4d^9$

C) [Ar]$4s^2\,4p^6\,3d^3$

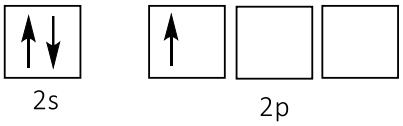
56) The electronic structure $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^8$ refers to the ground state of

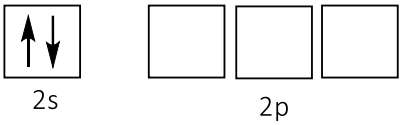
A) Kr. B) Ni. C) Fe. D) Pd. E) none of the above.

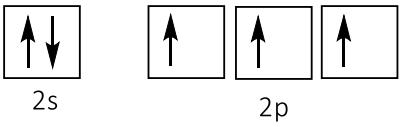
57) Select the correct electron configuration for Zn (Z = 30).

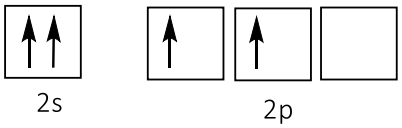
1. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^9\,4p^1$
2. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^9$
3. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^1\,3d^{10}$
4. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}$
5. None of these are correct.

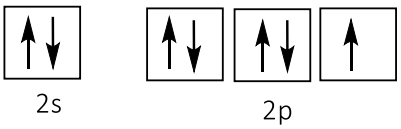
58) Which electron configuration represents a violation of the Pauli Exclusion Principle?

1. 

2. 

3. 

4. 

5. 

59) In the electron configuration [Ar] $4s^2\,3d^{10}\,4p^4$, which are valence electrons?

A) all of the electrons after the [Ar] D) only the $4p^4$ electrons

B) only the $4s^2$ electrons E) both the $4s^2$ and the $4p^4$ electrons

C) only the $3d^{10}$ electrons

60) Which of the following sets of elements have the $ns^2\,np^2$ valence electron configuration?

A) O, S, Se, Te, Po D) C, Si, Ge, Sn, Pb

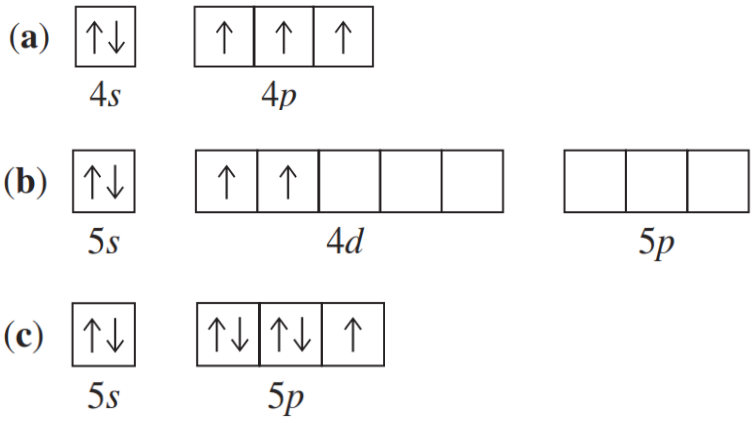
B) N, P, As, Sb, Bi E) Ti, Zr, Hf

C) F, Cl, Br, I, At

61) How many valence electrons does a carbon atom have?

A. 1 B. 2 C. 3 D. 4 E. 6

62) From each partial orbital diagram (valence electrons only), identify the element and give its full and condensed electron configuration and the number of inner electrons.



Solution

Topic 1.1C | Periodic Table Trend and Atomic Properties

Learning objectives

Students should be able to;

- ❑ *Predict the trends from left to right and top to bottom of the periodic table for each of the following: atomic radius, ionization energy, metallic character*
- ❑ *Describe why the first ionization energy is always smaller than the second ionization energy of a given atom.*
- ❑ *Identify the metals, nonmetal, and metalloids of Group 4A.*

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63) In the modern periodic table, the order in which the elements are placed is based on
A) atomic mass.
B) mass number.
C) atomic number.
D) atomic size.
E) chemical reactivity.

64) A column of the periodic table is called a
A) group.
B) period.
C) isotopic mixture.
D) pillar.
E) shell.

65) A row of the periodic table is called a
A) group.
B) period.
C) isotopic mixture.
D) family.
E) subshell.

66) What is the chemical symbol for the group 6A (16) element that lies in period 4?
A) Cr B) HF C) W D) Ti E) Se

67) Which of the following fourth-period elements has the smallest atomic radius?
A) K B) Ti C) Cu D) Ge E) Kr

68) Which of the following elements has the largest atomic size?
A) S B) Ca C) Ba D) Po E) Rn

69) Which of the following elements has the smallest atomic size?
A) Na B) Ar C) K D) Ca E) Kr

70) Which of the following elements has the smallest atomic radius?
A) Li B) Ne C) Rb D) Sr E) Xe

71) Which of the following elements has the greatest atomic radius?
A) Li B) Ne C) Rb D) Sr E) Xe

72) Which one of the following equations correctly represents the process relating to the ionization energy of X?
A) $X(s) \rightarrow X^+(g) + e^-$
B) $X_2(g) \rightarrow X^+(g) + X^-(g)$
C) $X(g) + e^- \rightarrow X^-(g)$
D) $X^-(g) \rightarrow X(g) + e^-$
E) $X(g) \rightarrow X^+(g) + e^-$

73) Which of the following elements has the largest first ionization energy?
A) Na B) Cl C) Ca D) Te E) Br

74) Which of the following elements has the smallest first ionization energy?
A) Rb B) Mg C) I D) As E) F

75) When comparing the successive ionization energies of an element, an unusually big increase in ionization energy is seen when
A) the first valence electron is removed.
B) the second valence electron is removed.
C) the eighth electron of is removed.
D) the first core electron is removed.
E) the last valence electron is removed.

76) Elements with the highest first ionization energies are found in the _____ region of the periodic table.
A) lower left B) upper left C) center
D) lower right E) upper right

77) Identify the element of Period 2 which has the following successive ionization energies, in kJ/mol.

IE1	IE2	IE3	IE4	IE5	IE6	IE7	IE8
1314	3389	5298	7471	10992	13,329	71,345	84,087

A) Li B) B C) O D) Ne E) none of the above

78) *Which of the following elements has the largest second ionization energy (IE_2)? [Difficulty: Hard]

A) Li B) B C) O D) F E) Na

79) Which of the following is a non-metal?

A) lithium, Li, Z = 3
B) bromine, Br, Z = 35
C) mercury, Hg, Z = 80
D) bismuth, Bi, Z = 83
E) sodium, Na, Z = 11

80) Which of the following is a metal?

A) nitrogen, N, Z = 7
B) phosphorus, P, Z = 15
C) arsenic, Z = 33
D) thallium, Tl, Z = 81
E) silicon, Si, Z = 14

81) Which of the following is a metalloid?

A) carbon, C, Z = 6
B) sulfur, S, Z = 16
C) germanium, Ge, Z = 32
D) F (Z = 9)
E) Iodine

82) Select the element with the greatest metallic character.

A) Li B) Ca C) Al D) Pb E) Cs

83) Select the element with the least metallic character.

A) Sn B) Sr C) Tl D) Ge E) Ga

84) Which of these elements has the greatest metallic character?

A. Br B. F C. Ge D. Mn E. Sc

85) Which of these elements has the greatest metallic character?

A. Br B. Se C. Ni D. As E. Si

86) Metallic behavior is generally associated with

A) elements with very negative electron affinities.
B) elements with low ionization energies.
C) elements with small atomic radii.
D) elements with unpaired electrons.
E) elements with partially filled p orbitals.

87) Which of these choices is the electron configuration for the aluminum ion?
A. $1s^2\ 2s^2\ 2p^6\ 3s^2$ B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$
C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$ D. $1s^2\ 2s^2\ 2p^6$
E. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

88) Which of these choices is the electron configuration for the chloride ion?
A. [Ne] $3s^2\ 3p^4$ B. [Ne] $3s^2\ 3p^7$ C. [Ar]
D. [Ar] $4s^1$ E. [Ne] $3s^2\ 3p^5$

89) Which of these choices is the electron configuration of a sulfide ion?
A. [Ne] $3s^2\ 3p^4$ B. [Ne] C. [Ne] $3s^2\ 3p^1$
D. [Ar] E. [Ne] $3s^2\ 3p^2$

90) Which of these choices is the electron configuration of the iron(III) ion?
A. [Ar] $3d^5$ B. [Ar] $4s^1\ 3d^5$ C. [Ar] $4s^2\ 3d^3$
D. [Ar] $3d^6$ E. [Ar] $4s^2\ 3d^9$

91) The electron configuration of a cobalt(III) ion is
A. [Ar] $3d^5$. B. [Ar] $4s^1\ 3d^5$. C. [Ar]$4s^2\ 3d^4$.
D. [Ar] $3d^6$. E. [Ar] $4s^2\ 3d^9$.

92) The cobalt(III) ion, Co^{3+}, has how many 3d electrons?
A. 0 B. 7 C. 6 D. 5 E. 4

93) How many 3d electrons does the copper(I) ion, Cu^+, have?
A. 10 B. 9 C. 8 D. 7 E. 6

94) How many 3d electrons does an Fe^{3+} ion have?
A. 9 B. 6 C. 5 D. 4 E. 3

95) Consider the set of isoelectronic atoms and ions A^{2-}, B^-, C, D^+, and E^{2+}. Which arrangement of relative radii is correct?
A) $A^{2-} > B^- > C > D^+ > E^{2+}$ D) $A^{2-} < B^- < C > D^+ > E^{2+}$
B) $E^{2+} > D^+ > C > B^- > A^{2-}$ E) None of the above is correct.
C) $A^{2-} > B^- > C < D^+ < E^{2+}$

96) What is the correct order of decreasing size of the following ions?
A) $P^{3-} > Cl^- > K^+ > Ca^{2+}$ D) $K^+ > Cl^- > P^{3-} > Ca^{2+}$
B) $Ca^{2+} > K^+ > Cl^- > P^{3-}$ E) None of the above is correct.
C) $K^+ > Cl^- > Ca^{2+} > P^{3-}$