Practice MC Test H.1 (Ch 6 & 7) Electrons & Periodicity

Name___________________Per___

- ***This is practice - Do NOT cheat yourself of finding out what you are capable of doing. Be sure you follow the testing conditions outlined below.***
- ***DO NOT USE A CALCULATOR. You may use ONLY the green periodic table.***
- ***Try to work at a pace of 1.2 min per question. Time yourself. It is important that you practice working for speed.***
- ***Then when time is up, continue working and finish as necessary.***

1. Which of the following contains only atoms that are diamagnetic in their ground state?
   a. Kr, Ca, and P
   b. Cl, Mg, and Cd
   c. Ar, K, and Ba
   d. He, Sr, and C
   e. Ne, Be, and Zn

2. Calcium reacts with element X to form an ionic compound. If the state electron configuration of X is $1s^2 2s^2 2p^4$, what us the simplest formula for this compound?
   a. CaX
   b. CaX_2
   c. Ca_4X_2
   d. Ca_2X_2
   e. Ca_2X_3

3. The ground-state configuration of Fe^{2+} is which of the following?
   a. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$
   b. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$
   c. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$
   d. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$
   e. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4 4s^2$

The next four questions refer to the following orbital diagrams.

(A) 1s ↑↓ 2s ↑

(B) 1s ↑↓ 2s ↑↓ 2p ↑↓ ↑↓ ↑↓ 3s ↑

(C) [Kr]5s ↑↓ 4d ↑ ↑ ↑ ___ ___

(D) [Ne] 3s ↑ 3p ↑ ↑ ↑

(E) 1s ↑↓ 2s ↑↓ 2p ↑↓ ↑↓ ↑↓

4. The least reactive element is represented by:

5. The transition metal is represented by:

6. The most chemically reactive element is represented by:

7. The element in an excited state is represented by:

Use the following ground-state electron configurations for the following four questions.

(A) $1s^2 1p^6 2s^2 2p^3$

(B) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^1$

(C) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$

(D) $1s^2 2s^2 2p^5$

(E) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$

8. The electron configuration of a halogen is:

9. This is a possible configuration for a transition metal *atom*.

10. This electron configuration is not possible.

11. This is a possible configuration of a transition metal ion.

The following answers are to be used for the following four questions:

(A) Pauli exclusion principle

(B) electron shielding

(C) the wave properties matter

(D) Heisenberg uncertainty principle

(E) Hund's rule

12. The exact position of an electron is not known.

13. Oxygen atoms, in their ground state, are paramagnetic.

14. An atomic orbital can hold no more than two electrons.

15. The reason the 4s orbital fills before the 3d.

(Note: It is highly unlikely that you would have to know the terms listed in A, D, and E, however, I would be remiss if they didn't get mentioned. You know the concepts, we just never named them as such.)

16. The element with the ground state electron configuration of [Ar] $3d^7 4s^2$ is
    a. Mg
    b. K
    c. Ar
    d. Co
    e. Ni

17. The electron configuration for the element antimony, ${}_{51}Sb$, is
    a. [Na] $3s^2 2d^{10} 3p^3$
    b. [Ar] $4s^2 3d^{10} 4p^5$
    c. [Ar] $4s^2 3d^{10} 4p^3$
    d. [Kr] $5s^2 4d^{10} 5p^3$
    e. [Kr] $5s^2 4d^{10} 5p^5$

18. Atomic radii decrease from left to right across a period because of
    a. an increase in effective nuclear charge
    b. an increase in energy level (n)
    c. an increase in sub-level (L)
    d. an increase in shielding
    e. more electrons

19. The number of unpaired electrons in the chromium atom is
    a. 1
    b. 2
    c. 4
    d. 5
    e. 6

20. The correct ordering of atoms in progressively decreasing ionization energy is
    a. F > O > C > Li > Na
    b. Na > Li > C > O > F
    c. F > O > C > Na > Li
    d. C > O > F > Li > Na
    e. O > F > C > Na > Li

21. Electron affinity is the
    a. energy required to remove an electron from an atom in the gaseous state.
    b. energy gained or released when an electron is gained by an atom in it's standard state.
    c. maximum energy required to remove an electron from an atom in its standard state.
    d. energy gained or released when an electron is gained by an atom in the gaseous state.
    e. energy gained by an electron when it is absorbed by another electron.

22. What is the most likely electron configuration for a sodium ion in its ground state?
    a. $1s^2 2s^2 2p^5$
    b. $1s^2 2s^2 2p^6$
    c. $1s^2 2s^2 2p^6 3s^1$
    d. $1s^2 2s^2 2p^5 3s^2$
    e. $1s^2 2s^2 2p^6 3s^2$

23. Which of the following statements is true regarding sodium and chlorine?
    a. Sodium has greater electronegativity and a larger first ionization energy.
    b. Sodium has a larger first ionization energy and a larger atomic radius.
    c. Chlorine has a larger atomic radius and a greater electronegativity.
    d. Chlorine has a greater electronegativity and a larger first ionization energy.
    e. Chlorine has a larger atomic radius and a larger first ionization energy.

The following choices refer to the following four questions.

(A) C

(B) N

(C) O

(D) F

(E) Ne

24. This is the most electronegative element.

25. The nuclear decay of an isotope of this element is used to measure the age of archaeological artifacts.

26. All of the electrons in this element are spin-paired.

27. This element, present as a diatomic gas, makes up most of the earth's atmosphere.

28. Which of the following elements is diamagnetic?
    a. H
    b. Li
    c. Be
    d. B
    e. C

The following choices refer to the following 3 questions.

(A) Hg

(B) Si

(C) Cu

(D) Zn

(E) Ag

29. This element is commonly used in the manufacturing of semiconductors.

30. This element is liquid at room temperature.

31. After oxygen, this is by far the most common element in the earth's crust.

32. Which of the following is true of the alkali metal elements?
    a. They usually take the +2 oxidation state.
    b. They have oxides that act as acid anhydrides.
    c. They form covalent bonds with oxygen.
    d. They are generally found in nature in compounds.
    e. They have relatively large first ionization energies

33. Which of the following ions has the smallest ionic radius?
    a. O^{2-}
    b. F^{-}
    c. Na^{+}
    d. Mg^{2+}
    e. Al^{3+}

34. The ionization energies listed in the table below would represent which one of the following elements:

first	second	third	fourth	fifth
8eV	15eV	80eV	109eV	141eV

    a. sodium
    b. magnesium
    c. aluminum
    d. silicon
    e. phosphorus

35. A researcher listed the first five ionization energies (in kJ mol^{-1}) for a silicon atom in order from first to fifth. Which of the following lists corresponds to the ionization energies for silicon?
    a. 780 13,675 14,110 15,650 16,100
    b. 780 1,575 14,110 15,650 16,100
    c. 780 1,575 3,220 15,650 16,100
    d. 780 1,575 3,220 4,350 16,100
    e. 780 1,575 3,220 4,350 5,340

36. The photoelectric effect shows that a minimum energy is needed to eject an electron from a piece of metal. This supports the idea of quantized energy because:
    a. increasing the brightness of the light makes the electrons move faster.
    b. changing the color, or wavelength, of the light keeps the electrons quantized at the same level.
    c. quantized energy is the only way that energy can be explained at the time of its discovery.
    d. it is shown that a minimum frequency of light is needed. Making the light brighter doesn't help.
    e. all changes in brightness (intensity) and color (frequency) have no effect on the ejection of electrons from a metal.

37. What is the energy (in Joules) if a photon that has a frequency of 4.0×10^{10} s^{-1} ? Planks constant has a value of 6.6×10^{-34} J/s.
    a. 2.0×10^{-25}
    b. 2.6×10^{-23}
    c. 7.5×10^{-3}
    d. 1.6×10^{-44}
    e. 6.1×10^{43}

38. Which of the following is the ground state electron configuration of an oxide ion?
    a. $1s^22s^22p^4$
    b. $1s^22s^22p^5$
    c. $1s^22s^22p^6$
    d. $1s^22s^22p^63s^1$
    e. $1s^22s^22p^63s^2$

39. Phosphorus (−72) has a less negative electron affinity than silicon (−134). This is explained by the fact that an electron added to phosphorus is added to:
    a. a filled orbital.
    b. a new subshell.
    c. an empty orbital.
    d. a half- filled orbital.
    e. a new valence shell.

40. Which atom has the largest covalent radius?
    a. Argon
    b. Arsenic
    c. Phosphorus
    d. Selenium
    e. Sulfur

41. Position on the Periodic Table gives information regarding an element’s electron configuration. Which is the same as the period number and the group number?

	Period number is the:	Group number is the:
a	number of p orbitals	number of elements in the group
b	number of shells of electrons in the atom	number of valence electrons
c	total number of electrons in the outer shell	total number of electrons in the atom
d	number of subshells in the last energy level	number of metal atoms in the group
e	number of electrons in the outer subshell (s, p, d, or f)	charge on the most stable ion

42. How many electrons in an atom can possess the a principal quantum number of n = 3
    a. 3
    b. 6
    c. 8
    d. 10
    e. 18

43. How many p-orbitals are filled in a Kr atom?
    a. 3
    b. 6
    c. 9
    d. 18
    e. 27

44. How many unpaired electrons are in the iron atom
    a. 0
    b. 2
    c. 3
    d. 4
    e. 8

45. $[Ar]4s^2 3d^{10} 4p^3$ is the electron configuration of a(n) ______ atom.
    a. As
    b. V
    c. P
    d. Sb
    e. Sn

46. How many unpaired electrons are in the Ni^{2+} ion?
    a. 0
    b. 2
    c. 3
    d. 4
    e. 6

47. Of the following transitions in the Bohr hydrogen atom, the _________ transition results in the emission of the shortest wavelength photon.
    f. n = 1 to n =6
    g. n = 6 to n = 1
    h. n = 6 to n = 3
    i. n = 2 to n = 1
    j. n = 1 to n = 4

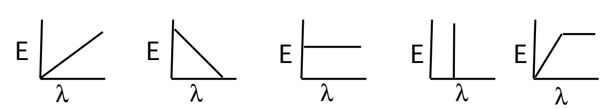
48. In a p_x orbital, the subscript x denotes the _______ of the electron.
    a. energy
    b. spin of the electrons
    c. probability of the shell
    d. size of the orbital
    e. axis along which the orbital is aligned

49. List the following species in order from smaller to larger size (radii).
    a. $Se^{2-} < Kr < Rb^+$
    b. $Kr < Se^{2-} < Rb^+$
    c. $Rb^+ < Kr < Se^{2-}$
    d. $Rb^+ < Se^{-2} < Kr$
    e. They are all the same size.

50. All of the ________ have a valence shell electron configuration of ns^2
    a. noble gases
    b. halogens
    c. chalcogens
    d. alkali metals
    e. alkaline earth metals

51. The elements in the ______ period of the periodic table have an inner core-electron configuration that is the same as the electron configuration of neon.
    a. first
    b. second
    c. third
    d. fourth
    e. fifth

52. Pick the graph below that best represents the relationship between energy and wavelength of light.



a b c d e

Use the choices below to answer the next 6 questions

a. $1s^22s^22p^63s^23p^64s^23d^{10}4p^65s^1$

b. $1s^22s^22p^63s^23p^5$

c. $1s^22s^22p^63s^23p^64s^23d^8$

d. $1s^22s^22p^63s^23p^64s^23d^{10}4p^6$

e. $1s^22s^22p^33s^1$

53. The ground state electron configuration of a transition metal is

54. An electron configuration of an excited atom is

55. The ground state electron configuration of an element with the smallest number of valence electrons is

56. The ground state electron configuration of a chemically un-reactive element is

57. The ground state electron configuration of an element that forms a −1 ion is

58. The ground state electron configuration of a highly reactive metal is

59. The largest principle quantum number in the ground state electron configuration of iodine is _______
    a. 1
    b. 4
    c. 5
    d. 6
    e. 7

60. Identify the element whose 3+ ion has the following electron configuration: [Xe] $4f^{14}$ $5d^3$
    a. W
    b. Lu
    c. Ta
    d. Nb
    e. Y

61. To remove which electron from gallium would you expect an extraordinarily high increase in successive ionization energy?
    a. 2nd
    b. 3rd
    c. 4th
    d. 5th
    e. none, all successive ionization energies increase steadily

62. To remove the second electron from which would you expect an extraordinarily high increase in the second successive ionization energy?
    a. Ca
    b. K
    c. Ga
    d. Ge
    e. Se

63. Which of the following correctly represents the <u>second</u> ionization of phosphorus?
    a. $P + e^- \rightarrow P^-$
    b. $P + P^- \rightarrow e^-$
    c. $P + P^+ \rightarrow e^-$
    d. $P^+ \rightarrow P^{2+} + e^-$
    e. $P^+ + e^- \rightarrow P$

64. The electron configuration of the ground state for the Ag atom is an *exception* to the electron-filling rules. Which configuration below is most likely to represent Ag.
    a. [Ar] $4s^24d^9$
    b. [Kr] $5s^14d^{10}$
    c. [Kr] $5s^23d^9$
    d. [Ar] $4s^14d^{10}$
    e. [Kr] $5s^24d^{10}$

65. Which equation correctly represents the electron affinity of sulfur?
    a. $S + e^- \rightarrow S^- + EA$
    b. $S + EA \rightarrow S^{+1} + e^-$
    c. $S \rightarrow S^- + e^- + EA$
    d. $S^- + EA \rightarrow S + e^-$
    e. $S^+ + e^- \rightarrow S + EA$

Use the choices below to answer the next 4 questions

a. [Kr] $5s^1$

b. [Ne] $3s^23p^1$

c. [Ar] $4s^23d^{10}4p^4$

d. [Ne] $3s^23p^6$

e. [Ar] $4s^1$

66. The atom with the largest atomic radius is ________

67. The electron configuration of the atom that is expected to have the highest first ionization energy is _______

68. The electron configuration of the atom that is expected to form a stable 2− ion is ______

69. The electron configuration of the atom that is the most reactive.

70. Which of the following sets contains species that are isoelectronic?
   a. Br, Kr, Rb
   b. O^{2-}, S^{2-}, Se^{2-}
   c. Al^{3-}, S^{2-}, Ar
   d. Cl^{+}, Ar, K^{-}
   e. F^{-}, Ne, Na^{+}

71. In general, as you go across a period in the periodic table from left to right: the atomic radius ______, the electron affinity becomes ______ negative, and the first ionization energy ______.
   a. decreases, decreasingly, increases
   b. increases, increasingly, decreases
   c. increases, increasingly, increases
   d. decreases, increasingly, increases
   e. decreases, decreasingly, decreases

72. Isotopes of the same element are nuclides with
   a. the same number of protons and the same atomic number (Z).
   b. the same number of protons and the same number of neutrons.
   c. the same mass number (A) and the same number of electrons.
   d. the same mass number (A) and the same number of protons.
   e. the same sum of protons and neutrons as well as the same mass number (A).

73. Which species contains the most neutrons?
   a. ${}^{59}_{26}Fe^{3+}$
   b. ${}^{56}_{26}Fe$
   c. ${}^{60}_{29}Cu$
   d. ${}^{61}_{30}Zn$
   e. ${}^{60}_{30}Zn^{+2}$

74. Which represents the ${}^{235}U$ atom?

	Protons	Electrons	Neutrons
(A)	46	46	143
(B)	46	46	92
(C)	92	92	143
(D)	92	92	146
(E)	92	92	235

Kinetics review for first order radioactive decay.

75. If 75% of a sample of pure ${}^{3}_{1}H$ decays in 24.6 years, what is the half- life of ${}^{3}_{1}H$
   a. 24.6 years
   b. 18.4 years
   c. 12.3 years
   d. 6.15 years
   e. 3.07 years

76. Strontium–90 decays through the emission of beta particles. It has a half- life of 29 years. How long does it take for 80 percent of a sample of strontium–90 to decay?
   a. 9.3 years
   b. 21 years
   c. 38 years
   d. 67 years
   e. 96 years

77. After 44 minutes, a sample of ${}^{44}_{19}K$ is found to have decayed to 25 percent of the original amount present. What is the half–life of ${}^{44}_{19}K$?
   a. 11 minutes
   b. 22 minutes
   c. 44 minutes
   d. 66 minutes
   e. 88 minutes

78. How many nuclear particles are in an atom of lead-210, ${}^{210}Pb$?
   a. 0
   b. 82
   c. 128
   d. 210
   e. 292

79. ${}^{131}I$ has a half-life of 3.5 days. Assuming you start with an 8.0 g sample, what mass will remain after two weeks?
   a. 4.0 g
   b. 2.4 g
   c. 2.0 g
   d. 1.0 g
   e. 0.5 g

80. A sample of radioactive cadmium has a half life of 15 days. If you have a sample that originally weighed 40 g and later weighs 2.5 g. How much time elapsed between the initial and final masses?
   a. 600 days
   b. 100 days
   c. 60 days
   d. 45 days
   e. 37.5 days

81. For a first order reaction that has a half-life of 69 s at 80°C, the value of the rate constant, k, is closest to?
   a. 0.01 s^{-1}
   b. 0.1 s^{-1}
   c. 1 s^{-1}
   d. 10 s^{-1}
   e. 100 s^{-1}

82. If the half-life of a reaction is independent of concentration, what is the order of the reaction?
    a. zero
    b. first
    c. second
    d. half-life is unrelated to the order of the reaction
    e. unable to be determined without knowing starting concentrations

83. A particular nuclear decay has a rate constant of 0.00346 min^{-1} What is the half-life?
    a. 3.3 hours
    b. 1.6 hours
    c. 0.0012 min
    d. 0.0024 min
    e. 0.0050 min

84. The half-life of ^{14}C is 5570 years. How many years will it take for 90% of a sample to decompose?
    a. 5,013 years
    b. 11,000 years
    c. 18,600 years
    d. 23,000 years
    e. 50,130 years

85. The half-life of ^{99}Tc is 6.00 hours. If it takes exactly 12.00 hours for the manufacturer to deliver a ^{99}Tc sample to a hospital, how much must be shipped in order for the hospital to receive 10.0 mg?
    a. 40.0 mg
    b. 30.0 mg
    c. 20.0 mg
    d. 15.0 mg
    e. 4.0 mg

ANSWERS

1. e Substances are diamagnetic, no response to a magnetic field, if they have all paired electrons. This means that they must be elements in columns headed by Be−s^2, Zn−s^2d^{10}, and He−s^2(and all the other noble gases, s^2p^6)
2. a The electron configuration given, tells you it is oxygen and would have a charge of 2−, thus Ca^{2+} and O^{2-} = CaO or CaX.
3. a Fe^{2+} has lost 2 electrons, it would be the $4s^2$ valence electrons that would be ripped off because, while they are not the last electrons in (highest energy) they are the most exposed in the outermost energy level, thus they are the first electrons out. The paired electron in the d set of orbitals would move to the 4s orbital. The energy expended in moving the e^- further from the nucleus would be recovered in less repulsion and the “special stability” achieved by a half-full sub-set of “d” orbitals.
4. e Least reactive means you are looking for a Noble gas.
5. c Looking for an element with unfinished d orbitals (or d^{10}).
6. b Most reactive means you are looking for an alkali metal. Both a and b meet that requirement, and since b is lower in the column, with electrons further from the nucleus, it is more reactive because the electrons can be stolen more easily when they are further from the attractive force of the nucleus.
7. d Excited state means you are looking for a configuration in which a lower orbital is unfilled while some other electrons are in higher energy orbitals.
8. d Halogens are always ns^2 np^5
9. b “c” does not meet the criteria because it is missing its $4s^2$ electrons, thus it is a transition metal ion, Zn^{2+}
10. a the 1p orbital in “a” is impossible.
11. c As described in #11, c would be the answer. For all transition metals, the outermost “s” orbitals loose their electrons first before loosing any d electrons.
12. d The dual nature of matter (quantum particles exhibit both particle and wave properties) places limitations on how precisely we can know both the location and momentum of any objects. In other words the more precisely one property is measured, the less precisely the other can be controlled, determined, or known. For objects that surround us on a daily basis, this is unimportant, but for subatomic particles such as the electron, this principle is very important. This is what has lead to the fact that we can precisely describe and electron’s energy, but we must describe its location inside an atom in terms of probabilities not exact locations.
13. e Paramagnetism refers to a substances response to a magnetic field which is due to its unpaired electrons with spin all in the same direction. Hund’s rule says that for electrons in *degenerate* orbitals (all the same subset, i.e. all the same energy) the lowest energy is attained if the number of electrons with the same spin is maximized. This can be accomplished when degenerate electrons spread out with in its subset of orbitals. It is not likely that you will need to know the term “Hund’s Rule” on the AP exam, but you will need to apply the concept.
14. a The Pauli exclusion principle states that no two electrons in an atom can have the same set of orbital numbers: n, L, m_L, m_s. Thus if we want to put more than one electron in any orbital *and* satisfy the Pauli exclusion principle, the only option would be to assign two different m_s quantum numbers, and since there are only 2 choices for m_s: +½ and −½, the conclusion is that any orbital can hold a maximum of two electrons with opposite spin.

15. b The 3d orbitals are shielded more efficiently than the 4s orbitals because the 4s orbital "penetrates" deeper into the core, making the 4s a lower energy orbital as electrons in that orbital will "feel" the nuclear charge better. This allows the 4s orbital to fill before the 3d orbital. The principle that describes the building up order order of electrons in an atom is called the aufbau principle.
16. d AP is likely to write the d and s orbitals in reverse order as shown in this problem − listing the orbitals in order of principle quantum number, not in order of filling. I would prefer that they write [Ar] $4s^2 3d^7$, but they may not. Don't let it fool you.
17. d Hopefully you need no explanation for this problem.
18. a Because the electrons are not shielded by any new layers of inner "core" electrons, the added nuclear charge in atoms as you proceed to the right in the periodic table cause a greater effective positive electrostatic force on valence electrons. This draws those valence electrons closer and reduces the size of the atomic radii.
19. e You might be inclined to think that the chromium atom should be $4s^2 3d^4$, however, the energy "expended" by moving one of the 4s electrons into the higher energy 3d set of orbitals, is more than compensated by the stability achieved by the half full set of d orbitals, thus the over all configuration is more stable as $4s^1 3d^5$, resulting in 6 unpaired electrons.
20. a Ionization energy is inversely proportional to size. Because size increases left across chart and down the chart, "a" is the only choice. Can you discuss why N is not in this sequence? N was left out of this sequence because you may remember that it is an exception to the trend. The IE for oxygen is a bit lower than nitrogen (thus there is a blip in the decreasing trend if we were to include N in our list) because the "last in" $3p^4$ electron in oxygen atom has increased repulsion created by the first pairing of electrons which outweighs the increase in Z_{eff} and thus less energy is required to remove the electron in oxygen, making the removal of the electron nitrogen seem unusually larger than it should be compared to oxygen.
21. d Electron affinity is not the opposite of ionization energy. "d" says the energy "involved" because while energy is usually released when an electron is added (negative values), for some atoms, energy is required (positive value) to force the electron in.
22. b Be sure and note that the question asks about a sodium ion, which of course would have lost its s^1 electron.
23. d chlorine is smaller in size, due to its increased effective nuclear charge which also causes its larger first ionization energy.
24. d Electronegativity increases moving up and to the right on the periodic table. Fluorine is the "biggest hog."
25. a This is a bit of a random question, we'll look at it a bit closer in our nuclear section of this unit, but perhaps you remember from some past bio class you've had, that carbon-14 can be used to date organic materials (anything containing carbon) only up to 5,000 years old, after which the amount of ^{14}C remaining would be too minimal to be measured.
26. e "Spin-paired" means, two electrons in the same orbital. This will occurred in Be, Zn and He columns of the periodic table thus the only choice is Ne.
27. b N_2 is of course ~80% of the earth's atmosphere.
28. c Substances that are diamagnetic show no response to a magnetic field and will have all paired electrons. Be-s^2, meets that paired electron criteria.
29. b Si is a metalloid, a semi-conductor, having metallic and nonmetallic properties, most notably, the ability to conduct electricity − or not under different conditions
30. a mercury (Bromine is the only other element that is liquid at standard conditions.)
31. b Sand is mostly SiO_2, thus Si is the next most common element in the earth's crust.
32. d Since alkali metals are so reactive, they will always be found in nature as compounds, never as a pure metallic element.
33. e Positive ions are always smaller than their parent atoms because the usually contain one full energy level less than their parent atom. Al^{3+} would be the smallest of the three listed because it has the greatest proton/neutron ratio − a larger effective nuclear, causing the electron cloud to "skootch" in.
34. b Don't panic that these energy values are given in eV (electron Volts) instead of the usual kJ mol^{-1}. You are looking for an indicator as to the number of valence electrons present, which would let you identify the element from those given. There is a very large increase from the second to the third ionization energy, indicating this is an atom with two valence electrons, and removing the third electron would be "reaching into one complete energy level closer to the nucleus." This describes Mg with its two valence electrons.
35. d Silicon has four valence electrons, thus a very high increase would be expected for the fifth ionization energy.
36. d It is the photoelectric effect for which in 1921 Einstein won his one and only Noble prize. While it is not so likely to be on the AP exam, one can never be sure. The photons of a light beam have a characteristic energy determined by the frequency of the light. In the photoemission process, if an electron within some material absorbs the energy of one photon and that "chunk" of energy is of high enough energy, the electron will ejected. If the photon energy is too low, the electron is unable to escape the material. Increasing the intensity (brightness) of the light beam increases the number of photons in the light beam, but does not increase the energy that each electron possesses. The energy of the emitted electrons does not depend on the intensity (more photons) of the incoming light, but only on the energy or frequency of each individual photon. Electrons can absorb energy from photons when irradiated, but they usually follow an "all or nothing" principle. All of the energy from one photon must be absorbed and used to liberate one electron from atomic binding, or else the energy is re-emitted as heat or light, and an electron not emitted. This gives direct experimental evidence to the "quantized" nature (and thus

particle property) of light. This experiment continued to move forward the theory of the dual-nature of both matter and energy - both exhibit particle *and* wave properties. There is a link on the Unit H document page to an interactive simulation about the photoelectric effect. Check it out: http://phet.colorado.edu/en/simulation/photoelectric

37. b Although I suspect it will not be in the MC of the AP exam, and the formula is on the formula sheet, it might be worth remembering E = hν. Thus a quick estimation of $(4 \times 10^{10})(6.626 \times 10^{-34})$ would only yield "b"

38. c An oxide ion would have two extra electrons than the oxygen atom.

39. d Electron affinity is a measure of the ability of an atom to take on another electron. Adding an electron to phosphorus with its half full energy level, would subject the incoming electron to extra repulsion because it would be forced to pair up with an electron. Thus the electron affinity energy is less negative since less energy is released. When adding an electron to silicon, the incoming electron can enter an empty p orbital.

40. b Arsenic and selenium have a fourth energy level, and since arsenic is further left with a lower effective nuclear charge, it will be the atom with the larger radius. In the question the term "covalent radius" is referring to the radius of the atom when it is in a covalent bond.

41. b The period number tells you the number of "shells" = energy levels and group number referring to the old-school numbering system 1−8 across the s and p blocks, an thus tells you about the number of valence electrons.

42. e On the 3rd energy level, three types of orbitals are possible; s, p, and d. And the total number of electrons that those three types of orbital can hold is 18. Since "s" is a single orbital that can hold 2 electrons, "p" are three orbitals that can hold 6 electrons, and "d" are five orbitals that can hold a total of 10 electrons.

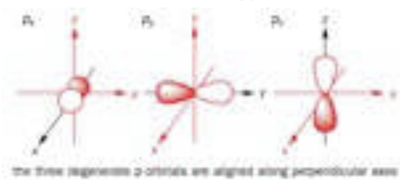
43. c This question does not tell you to consider only the valence electrons, thus you must consider all of kryptons p-orbitals. there are full p-orbitals on the 4th, 3rd, and 2nd energy levels for a total of 9 filled p-orbitals.

44. b You may recall E = hν and c = λν. To see the relationship of E to λ, you must so solve c = λν for $\nu = \dfrac{c}{\lambda}$ and substitute into E = hν, resulting in $E = \dfrac{hc}{\lambda}$ which shows and *inverse* relationship between E and λ.

45. d The condensed electron configuration for iron is $[Ar]\ 4s^2\ 3d^6$ and an orbital diagram would be ⊗ ⊗⊘⊘⊘⊘ indicating four unpaired electrons.

46. a Hopefully you need no explanation for this problem.

47. b Shortest wavelength refers to highest energy. Remember that electrons dropping to the first energy level all emit more anergy than only dropping to higher levels. Further from higher energy level down to the first will emit the most energy, thus b is the correct choice. The energy emitted would be in the ultraviolet region.



48. e There are 3 "p" orbitals on all energy levels n=2 and higher. Those 3 "p" orbitals are arranged in space in 3 different planes along the 3 axes, x, y, and z as demonstrated in the diagram to the right.

49. b When transition metals lose electrons and turn into ions, the "s" electrons are stripped away first since they are further from the nucleus than the d-orbitals. Thus the electron configuration Ni atom $[Ar]\ 4s^2\ 3d^8$ and the Ni^{2+} ion would be $[Ar]\ 3d^7$ and the orbital notation for the ion would be ◯ ⊗⊗⊘⊘⊘ which is 3 unpaired electrons. This ion would be paramagnetic.

50. c The particles listed are all isoelectronic, same total number of electrons, 36. Thus we must consider the nuclear charge to determine the size of these particles. Se^{2-} has only 34 protons, Kr has 36 protons, and Rb^+ has 37 protons. Rb^+ with the larger nuclear attractive force will pull the electron cloud in closer and make the ion smallest, Kr would be next, and Se^{2-} with the least nuclear attractive force pulling on the 26 electrons would be largest.

51. e Alkaline earth metals is group II: Be, Mg, Ca, etc

52. c Essentially this question is asking you for which row of elements in the periodic table would you write the condensed electron configuration as [Ne] ....etc. This of course would be any element in the the third row of the periodic table.

53. c To represent a transition metal, you would be looking for a configuration in which the last orbital written would be a d-orbital.

54. e When looking for an excited atom, you are looking for an electron configuration in which a lower orbital is unfilled while some other electrons are in higher energy orbitals.

55. a The least amount of valence electrons would be s^1, this would indicate a or e, however, the question asks for ground state atom, and since is representing an excited configuration, the only choice is a.

56. d The most chemically un-reactive elements are the noble gases, with 8 valence electrons in the group VIII column with a configuration of $s^2\ p^6$ thus the only choice is d

57. b An element with 7 valence electrons in the group VII halogen column with a configuration of $s^2\ p^5$ will form −1 ions.

58. a The most reactive metals are the alkali metals which are represented by s^1, and notice that the question refers to ground state, eliminating option d

59. c Principal quantum number is the first quantum number, which corresponds to the row of the periodic table and the energy level. For iodine, the highest energy that contains electrons is the 5th energy level.

60. a In this problem, it is important to realize that this is an atom that has lost 3 electrons. Two of them must be lost from the 6s orbital, and the third one from the 5d orbital. This is because electrons will be lost/stolen from electrons in the outermost orbitals first, simply because those are the electrons that are most exposed/sticking out! Put those three electrons back in and voila you get: [Xe] $6s^2 4f^{14} 5d^4$ which is tungsten, W.
61. c Since gallium has three valence electrons, removing the fourth electron would be the largest successive increase since that electron would be removed from one full energy level closer to the nucleus.
62. b An extraordinarily large increase for the second electron would occur for an element that has only one valence electron, K
63. d A reaction to represent the second ionization must show a reaction in which an electron is removed from a +1 ion.
64. b Since choice c is the normal expected configuration, the only viable option in choice b since the condensed configuration must show [Kr] with 11 more electrons represented in s and d orbitals. This exception arises because there seems to be some unusual stability achieved by having half-full and full subgroups, thus the energy "spent" by moving one of the $4s^1$ electrons to complete the $3d^{10}$, is more than compensated by the extra stability of the full d-orbital.
65. a Electron affinity if the energy (usually out, though sometimes in) when a neutral atom takes on an extra electron. While you would not be expected to know that the electron affinity is exothermic for sulfur, the only viable choice is a based on the requirement of the reaction being: $S + e^- \rightarrow S^-$
66. a Largest radius would be the atom with most energy levels with the lowest effective nuclear charge (that is to say, on the left of the periodic table). This criteria would be met by choice a
67. d Highest first ionization energy − You would be looking for smallest in number of energy levels and furthest to the right.
68. c The configuration of $4p^4$ would take on 2 electrons to complete the octet and become a 2 − ion.
69. a The most reactive atoms would be lowest in the alkali metal column and highest in the halogen problem. Since none of the configurations represent halogens, it would be best to pick the largest alkali listed.
70. e Remember that isoelectronic means the same total number of electrons. The particles in option "e" all have 10 electrons in total making them isoelectronic
71. d All of these properties are affected by the increasing effective nuclear charge that occurs from left to right across the chart.

72. a memorize the definition (Note: A is the symbol for mass number, and Z is the symbol for atomic number.)

73. a This problem is a bit tedious, you simply must calculate the difference between the mass number and and atomic number − the charge plays no roll in the calculation.

74. c Atomic number form the periodic table = 92 protons and equal to 92 electrons, and 235 − 92 = 143 neutrons

Kinetics review for first order radioactive decay.

75. c 75% decayed would mean two half lives (100 >> 50 >> 25 remaining = 75% decayed), thus two half-lives for a total of 24.6 years would be 12.3 per half life.

76. d Short of having a calculator, you could estimate between 2 & 3 (closer to just beyond two, further from the third) half lives since 100 >> 50 >> 25 >> 12.5(which is to say between 75% decayed and 87.5% decayed,) 2 half lives = 58 years, and 3 half lives = 87, that should allow and easy pick of "d"

77. b 100 >> 50 >> 25, thus 2 half lives, each would be 22 minutes

78. d nuclear particles, also called nucleons make the mass number (sum of protons and neutrons)

79. e With a half-life of 3.5 days, the time period of two weeks would be 4 half lives, thus 8 >> 4 >> 2 >> 1>>0.5 would be 4 half lives

80. c Like others problems: 40 >> 20 >> 10 >> 5 >> 2.5 is 4 half lives at 15 days each = 60 days

81. a In this problem, use the formula $t_{halflife} = \frac{0.693}{k}$ if you rearrange and substitute, then k will solve to 0.01. The temperature is unimportant to solving the problem.

82. b For all of the other orders, the half life is continually changing as the concentrations changes

83. a Use the equation $t_{halflife} = \frac{0.693}{k}$ (I think you should memorize this one) and substitute: $t_{halflife} = \frac{0.693}{0.00346}$. Look for the easy math and solve for ~200 which is just over 3 hours.

84. c Consider the decay 100 >> 50 >> 25 >> 12.5, thus just over 3 half lives occur. Looking over the answer options, c should be an easy pick.

85. a For this problem you must work backwards. If delivery takes 12 hours, that's two half lives. To have 10 mg remaining, work backwards 10 << 20 << 40 mg must be sent.