Practice MC Test H (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 1.5 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

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 ⇅ ⇅ ⇅

3. The least reactive element is represented by:

4. The transition metal is represented by:

5. The most chemically reactive element is represented by:

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

7. The electron configuration of a halogen is:

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

9. This electron configuration is not possible.

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

11. 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

12. 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] $5s^2 4d^{10} 5p^5$

13. 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

14. 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

15. 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. $1s^2 2s^2 2p^6 3s^2$

16. 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

17. This is the most electronegative element.

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

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

20. 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

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

22. This element is liquid at room temperature.

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

24. 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

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

26. 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

27. 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

28. Which of the following is the ground state electron configuration of an oxide ion?
    a. $1s^2 2s^2 2p^4$
    b. $1s^2 2s^2 2p^5$
    c. $1s^2 2s^2 2p^6$
    d. $1s^2 2s^2 2p^6 3s^1$
    e. $1s^2 2s^2 2p^6 3s^2$

29. 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.

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

31. Position on the Periodic Table gives information regarding an element's electron configuration. Which is true about 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 occupied energy levels 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

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

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

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

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

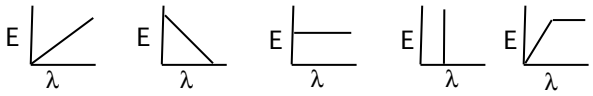
36. How many unpaired electrons are in the Ni^{2+} ion?
    a. 0
    b. 2
    c. 3
    d. 4
    e. 6

37. 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.

38. 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

39. 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

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



a b c d e

41. 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

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

43. 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

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

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

45. An electron configuration of an excited atom is

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

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

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

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

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

51. 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

52. 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. $P^+ + e^- \rightarrow P$

53. 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] $4s^1$

54. The atom with the largest atomic radius is _____

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

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

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

58. 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^+

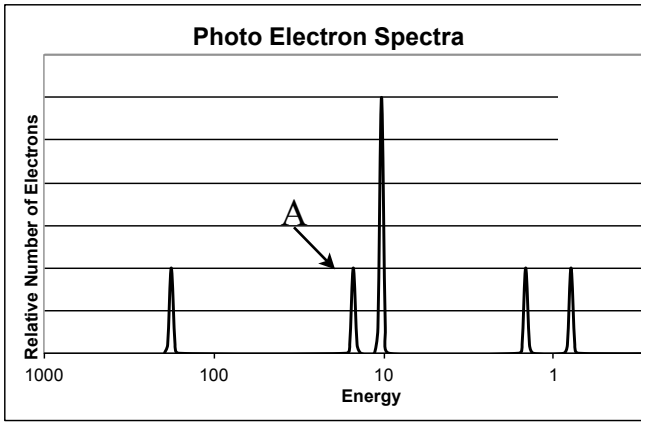
59. In general, as you go across a period in the periodic table from left to right: the atomic radius _____, the electron affinity becomes _____ negative, and the first ionization energy _____.
    a. decreases, decreasingly, increases
    b. increases, increasingly, decreases
    c. increases, increasingly,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

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

61. 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).

62. 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



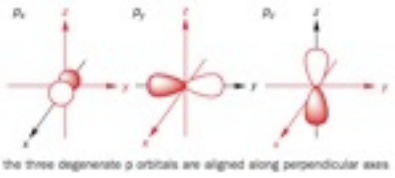
63. The PES shown above represents what element?
    a. C
    b. Mg
    c. Al
    d. Si
    e. Cl

64. The Peak labeled "A" represents which electrons?
    a. $1s^2$
    b. $2s^2$
    c. $2p^2$
    d. $3s^2$
    e. $3p^2$

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. e Least reactive means you are looking for a Noble gas.
4. c Looking for an element with unfinished d orbitals (or d^{10}).
5. 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.
6. 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.
7. d Halogens are always $ns^2\ np^5$
8. b "c" does not meet the criteria because it is missing its $4s^2$ electrons, thus it is a transition metal ion, Zn^{2+}
9. a the 1p orbital in "a" is impossible.
10. c For all transition metals, the outermost "s" orbitals loose their electrons first before loosing any d electrons.
11. 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] $4s^23d^7$, but they may not. Don't let it fool you.
12. d Hopefully you need no explanation for this problem.
13. 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. Effective nuclear charge is approximately equal to the number of valence electrons for the "s and p" elements. This increasing effective nuclear charge (aka: Z_{eff} or ENC) draws those valence electrons closer and reduces the size of the atomic radii when moving left to right across the periodic table.
14. a Ionization energy is inversely proportional to size. Because size increases left across chart and down the chart, "a" is the only choice. **Important Side NOTE:** 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.
15. b Be sure and note that the question asks about a sodium ion, which of course would have lost its s^1 electron.
16. d chlorine is smaller in size, due to its increased effective nuclear charge which also causes Cl's larger first ionization energy.
17. d Electronegativity increases moving up and to the right on the periodic table. Fluorine is the "biggest electron hog."
18. e "Spin-paired" means, two electrons in the same orbital. Since all s and p (and full d & f) core electrons would be paired, so sketching out a quick valence orbital notation would help with this answer.
    C = ⊗ ⊘⊘ N = ⊗ ⊘⊘⊘ O = ⊗ ⊗⊘⊘ F = ⊗ ⊗⊗⊘ F = ⊗ ⊗⊗⊗
19. b N_2 is of course ~80% of the earth's atmosphere.
20. c This is a memorization of the terms paramagnetic and diamagnetic. Substances that are diamagnetic show NO response to a magnetic field and will have all paired electrons. Be with s^2, meets that paired electron criteria.
21. 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
22. a mercury (Bromine is the only other element that is liquid at standard conditions.)
23. b Sand is mostly SiO_2, which is a network covalent solid, thus Si is the next most common element in the earth's crust.
24. d Since alkali metals are so reactive, they will always be found in nature as compounds, never as a pure metallic element. Further you should know that compared to most other elements, alkali metals have low first ionization energies, which is what contributes to their high reactivity.
25. e Positive ions are always smaller than their parent atoms because they usually contain one full energy level less than their parent atom. These five particles are all isoelectronic, thus Al^{3+} would be the smallest because Al has the most protons, and the largest effective nuclear charge, causing the electron cloud to "skootch" in.
26. 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 (more than 5x greater), indicating this is an atom with two valence electrons, and removing the third electron would be "reaching into one energy level closer to the nucleus." This describes Mg with its two valence electrons.

27. d Silicon has four valence electrons, thus a very high increase would be expected for the fifth ionization energy. The very hight increase is always displayed for the ionization that is one greater than the number of valence electrons.
28. c An oxide ion would have two extra electrons than the oxygen atom.
29. d Electron affinity is a measure of the ability of an atom to take on another electron. Electron affinity values are usually negative because the positive nucleus of atoms attract electrons. Adding an electron to phosphorus with its half full p sub-level ⊘⊘⊘, would subject the incoming electron to extra repulsion because the electron would be forced to pair up with another electron. Thus the electron affinity energy is less negative and achieving less stability than silicon. When adding an electron to silicon, the incoming electron can enter an empty p orbital.
30. b Arsenic and selenium have electrons occupying the 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.
31. 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.
32. 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.
33. c This question does not tell you to consider *only* the valence electrons, instead 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.
34. d The condensed electron configuration for iron is [Ar] $4s^2$ $3d^6$ and the orbital diagram would be ⊗ ⊗⊘⊘⊘⊘ indicating four unpaired electrons.
35. a Hopefully you need no explanation for this problem.
36. 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. (Remember, you are more likely to lose your jacket, than your underwear!) 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 s and d orbitals of the Ni^{2+} **ion** would be ◯ ⊗⊗⊘⊘⊘ which is 3 unpaired electrons.
37. 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.
38. e Alkaline earth metals is group II: Be, Mg, Ca, etc
39. 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.
40. b If you combine these two equations: $E = h\nu \;\; and \;\; c = \lambda\nu$ you can produce this: $E = \frac{hc}{\lambda}$ which tells us that energy and wavelength are inversely proportional.
41. 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. If AP expects you to know anything about the shapes of orbitals, such knowledge would only include the "s and p" orbitals



42. 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. While you do not need to know quantum numbers for the AP exam, they may use the term; principle quantum number when referring to the row of the periodic table.
43. 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.
44. c To represent a transition metal, you would be looking for a configuration in which the last orbital written would be a d-orbital.
45. 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.
46. 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.
47. 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
48. 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.
49. 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

50. 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.
51. b An extraordinarily large increase for the second electron would occur for an element that has only one valence electron, K
52. d A reaction to represent the second ionization must show a reaction in which an electron is removed from a +1 ion.
53. a Electron affinity is the energy (usually released, though sometimes absorbed) 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: $S + e^- \rightarrow S^-$
54. 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
55. d Highest first ionization energy − You would be looking for smallest in number of energy levels and furthest to the right.
56. c The configuration of $4p^4$ would take on 2 electrons to complete the octet and become a 2 − ion.
57. 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.
58. 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
59. d All of these properties are affected by the increasing effective nuclear charge that occurs from left to right across the chart.
60. 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.
61. a memorize the definition (Note: A is the symbol for mass number, and Z is the symbol for atomic number.)
62. c Atomic number form the periodic table = 92 protons and equal to 92 electrons, and 235 − 92 = 143 neutrons
63. d The shorter peaks are representing 2 electrons, and the tall peak represents 6 electrons, thus 14 electrons total which would be Silicon
64. b In a PES spectrum, the x-axes is represented higher to lower left to right. Thus the $1s^2$ electrons are furthest to the left. Thus the electrons represented by peak A are the $2s^2$ electrons.