A.P. Chemistry

Test – Electrons and Periodicity

Multiple Choice

1. Which of the following represents the ground state electron configuration for the Mn^{3+} ion? (Atomic number Mn = 25)

(A) $1s^2\,2s^2 2p^6\,3s^2 3p^6 3d^4$ (B) $1s^2\,2s^2 2p^6\,3s^2 3p^6 3d^5\,4s^2$ (C) $1s^2\,2s^2 2p^6\,3s^2 3p^6 3d^2\,4s^2$
(D) $1s^2\,2s^2 2p^6\,3s^2 3p^6 3d^8\,4s^2$ (E) $1s^2\,2s^2 2p^6\,3s^2 3p^6 3d^3\,4s^1$

Use these answers for questions 2 - 5.

(A) $1s^2\,2s^2 2p^5\,3s^2 3p^5$ (B) $1s^2\,2s^2 2p^6\,3s^2 3p^6$ (C) $1s^2\,2s^2 2p^6 2d^{10}\,3s^2 3p^6$
(D) $1s^2\,2s^2 2p^6\,3s^2 3p^6 3d^5$ (E) $1s^2\,2s^2 2p^6\,3s^2 3p^6 3d^3\,4s^2$

2. An impossible electronic configuration
3. The ground-state configuration for the atoms of a transition element
4. The ground-state configuration of a negative ion of a halogen
5. The ground-state configuration of a common ion of an alkaline earth element

Ionization Energies for element X ($kJ\ mol^{-1}$)

First	Second	Third	Fourth	Five
580	1815	2740	11600	14800

6. The ionization energies for element X are listed in the table above. On the basis of the data, element X is most likely to be...

(A) Na (B) Mg (C) Al (D) Si (E) P

7. All of the following statements concerning the characteristics of the halogens are true EXCEPT...

(A) The first ionization energies (potentials) decrease as the atomic numbers of the halogens increase.
(B) Fluorine is the best oxidizing agent.
(C) Fluorine atoms have the smallest radii.
(D) Iodine liberates free bromine from a solution of bromide ion.
(E) Fluorine is the most electronegative of the halogens.

8. Which of the following properties generally decreases across the periodic table from sodium to chlorine?

(A) First ionization energy
(B) Atomic mass
(C) Electronegativity
(D) Maximum value of oxidation number
(E) Atomic radius

Use these answers for questions 9-11.

(A) O (B) La (C) Rb (D) Mg (E) N

9. What is the most electronegative element of the above?
10. Which element exhibits the greatest number of different oxidation states?
11. Which of the elements above has the smallest ionic radius for its most commonly found ion?

12. How many electrons in an atom can have the quantum numbers n=3, l=3?

(A) 2 (B) 5 (C) 10 (D) 0 (E) 6

13. Which of the following sets of quantum numbers (n, l, m_l, m_s) best describes the valence electron of highest energy in a ground-state gallium atom (atomic number 31) ?

(A) 4, 0, 0, 1/2
(B) 4, 0, 1, 1/2
(C) 4, 1, 1, 1/2
(D) 4, 1, 2, 1/2
(E) 4, 2, 0, 1/2

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

(A) Na has a greater density at standard conditions than Ne.

(B) Na has a lower first ionization energy than Ne.

(C) Na has a higher melting point than Ne.

(D) Na has a higher neutron-to-proton ratio than Ne.

(E) Na has fewer naturally occurring isotopes than Ne.

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

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

(B) $1s^2 2s^2 2p^5 3s^2$

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

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

(E) $1s^2 2s^2 2p^6 3s^2 3p^5$

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Free Response

1. Mars is roughly 140 million miles from Earth. How long will it take a for a radio wave to reach Mars from Earth?

2.

a. The longest wavelength of light with enough energy to break the Cl-Cl bond in $Cl_2(g)$ is 495 nm.

   i. Calculate the frequency, in s^{-1}, of the light

   ii. Calculate the energy, in J, of a photon of the light.

   iii. Calculate the minimum energy, in kJ mol^{-1}, of the Cl-Cl bond.

b. A certain line in the spectrum of atomic hydrogen is associated with the electronic transition in the H atom from the sixth energy level ($n = 6$) to the second energy level ($n = 2$).

   i. dicate whether the H atom emits energy or whether it absorbs energy during the transition. Justify your answer.

   ii. Calculate the wavelength, in nm, of the radiation associated with the spectral line.

   iii. Account for the observation that the amount of energy associated with the same electronic transition ($n = 6$ to $n = 2$) in the He^+ ion is greater than that associated with the corresponding transition in the H atom.

3. Use the deBroglie relationship to calculate the wavelength of a potassium atom travelling at 100 mi/hr.

4. A laser in a CD player has an output wavelength of 780 nm. If the power level is 0.154 milliwatts, how many photons strike the CD surface during the playing of a CD of length 73.4 minutes?