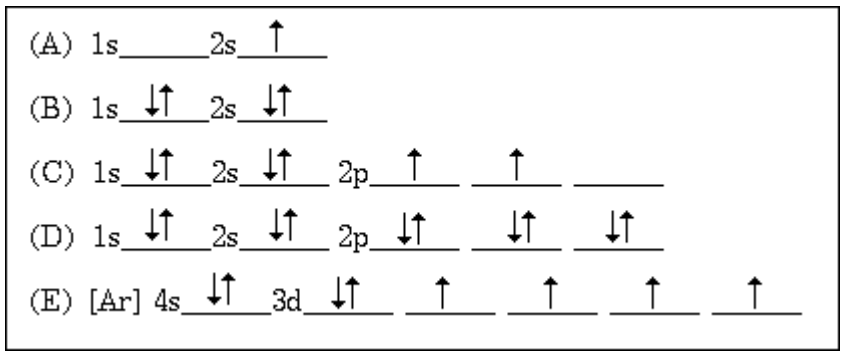
AP Chemistry Problem Set Chapter 7 **Name_____**

Multiple Choice. Please indicate your multiple choice answers below.

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

6. _____ 7. _____ 8. _____ 9. _____ 10. _____



1. Represents an atom that is chemically unreactive.
2. Represents an atom in an excited state.
3. Represents an atom that has four valence electrons.
4. Represents an atom of a transition metal.
5. Represents a common ion of an alkaline earth element.

6. Which of the following represents the ground state electron configuration for the Mn^{3+} ion?
(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) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^3\ 4s^1$

7. One of the outermost electrons in a strontium atom in the ground state can be described by which of the following sets of four quantum numbers?
(A) 5, 2, 0, ½ (B) 5, 1, 1, ½ (C) 5, 1, 0, ½ (D) 5, 0, 1, ½ (E) 5, 0, 0, ½

Ionization Energies for element X ($kJ\ mol^{-1}$)				
First	Second	Third	Fourth	Five
580	1815	2740	11600	14800

8. 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

9. In the periodic table, as the atomic number increases from 11 to 17, what happens to the atomic radius?
(A) It remains constant. (B) It increases only. (C) It increases, then decreases.
(D) It decreases only. (E) It decreases, then increases.

10. The electron configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ corresponds to the electron configuration of:
(A) S^{2-} (B) Ca^{2+} (C) Cl^- (D) K^+ (E) all of these

Essays:

1. **(1999 - #2)**

Answer the following questions regarding light and its interactions with molecules, atoms, and ions.

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. Indicate 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.

2. **(1993 - #6 a & b; 2006B - #7 b, c & d)**

Account for each of the following in terms of principles of atomic structure, including the number, properties, and arrangements of subatomic particles.

(a) The second ionization energy of sodium is about three times greater than the second ionization energy of magnesium.

(b) The difference between the atomic radii of Na and K is relatively large compared to the difference between the atomic radii of Rb and Cs.

(c) Atomic size decreases from Na to Cl in the periodic table.

(d) The first ionization energy of K is less than that of Na.

(e) Each element displays a unique gas-phase emission spectrum.

3. (**2000 - #7 a, b & c; 2005 - #7 c)**

Answer the following questions about the element selenium, Se (atomic number 34).

(a) Samples of natural selenium contain six stable isotopes. In terms of atomic structure, explain what these isotopes have in common, and how they differ.

(b) Write the complete electron configuration (e.g., $1s^2 2s^2$ ... etc.) for a selenium atom in the ground state. Indicate the number of unpaired electrons in the ground-state atom, and explain your reasoning.

(c) In terms of atomic structure, explain why the first ionization energy of selenium is
   (i) less than that of bromine (atomic number 35), and
   (ii) greater than that of tellurium (atomic number 52).

(d) As shown in the table below, the first ionization energies of Si, P, and Cl show a trend.

Element	First Ionization Energy ($kJ\ mol^{-1}$)
Si	786
P	1,012
Cl	1,251

(i) For each of the three elements, identify the quantum level (e.g., $n = 1$, $n = 2$, etc.) of the valence electrons in the atom.

(ii) Explain the reasons for the trend in first ionization energies.

4. **(2002 - #6 a & b; 2003B - #7 b, c & d)**

Account for the following observations using principles of atomic structure and/or chemical bonding. In each part, your answer must include specific information about both substances.

(a) The atomic radius of Li is larger than that of Be.

(b) The second ionization energy of K is greater than the second ionization energy of Ca.

(c) Carbon and lead are in the same group of elements, but carbon is classified as a nonmetal and lead is classified as a metal.

(d) Compounds containing Kr have been synthesized, but there are no known compounds that contain He.

(e) The first ionization energy of Be is 900 kJ mol^{-1}, but the first ionization energy of B is 800 kJ mol^{-1}.

5. **(2006 - #8)**

Suppose that a stable element with atomic number 119, symbol Q, has been discovered.

(a) Write the ground-state electron configuration for Q, showing only the valence-shell electrons.

(b) Would Q be a metal or a nonmetal? Explain in terms of electron configuration.

(c) On the basis of periodic trends, would Q have the largest atomic radius in its group or would it have the smallest? Explain in terms of electronic structure.

(d) What would be the most likely charge of the Q ion in stable ionic compounds?

(e) Write a balanced equation that would represent the reaction of Q with water.

(f) Assume that Q reacts to form a carbonate compound.

(i) Write the formula for the compound formed between Q and the carbonate ion, CO_3^{2-}.

(ii) Predict whether or not the compound would be soluble in water. Explain your reasoning.