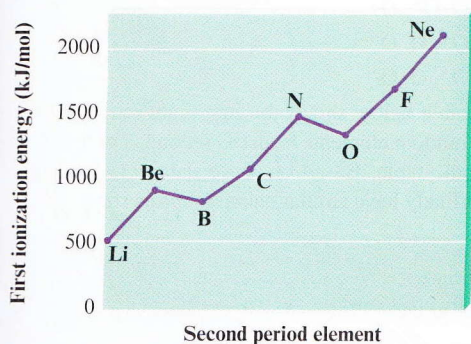


AP Multiple-Choice Review Questions

1. The first ionization energy of magnesium is 738 kJ/mol. A good estimate for the second ionization energy of magnesium is
- (A) 370 kJ/mol
 (B) 735 kJ/mol
 (C) 1450 kJ/mol
 (D) 6900 kJ/mol

Use the following graph to answer questions 2–4.



2. Which of the following is the *reason* that ionization energy generally increases from left to right across the first period of the periodic table?
- (A) As the atomic number increases, the electrons are harder to remove.
 (B) Ionization energy increases as the atomic number increases in a period.
 (C) As the atomic number increases, more electrons are added to the atoms, thus increasing the electron–electron repulsions.
 (D) As the atomic number increases, more protons in the nucleus cause an increase in the effective nuclear charge, making it harder to remove the electrons.
3. What is the best explanation for the decrease in first ionization energy moving from Be to B?
- (A) Moving from Be to B, more electrons are added to the atoms, thus increasing the electron–electron repulsions.
 (B) Moving from Be to B, more protons in the nucleus attract the valence electrons, making it harder to remove the electrons.
 (C) The electrons in Be are being removed from a full subshell, which is more stable than the half-filled subshell in B.
 (D) The electrons in Be are located in the 2s subshell, which is closer to the nucleus and thus harder to remove than the 2p electrons in B.

4. What is the best explanation for the decrease in first ionization energy moving from N to O?
- (A) The oxygen atom is smaller, thus making it easier to remove the electrons compared with N.
 (B) The electrons in N are being removed from a half-full subshell, which is more stable than the partially filled subshell in O.
 (C) The electrons in N occupy the 2p orbitals singularly, whereas the electrons in one of the 2p orbitals of O are paired, thus increasing the electron–electron repulsions.
 (D) Moving from N to O, there are more protons in the nucleus, thus increasing the effective nuclear charge (Z_{eff}), causing a greater amount of attraction for the valence electrons and making it harder to remove the electrons.
5. The table shows the first ionization energies of element X in kJ/mol.

First ionization energy	Second ionization energy	Third ionization energy
738	1450	7730

What is the most likely formula of the compound between element X and Y, where Y is a halogen?

- (A) XY
 (B) XY₂
 (C) XY₃
 (D) X₃Y
6. Which diagram shows an excited state?
- (A) $1s$
 \uparrow
- (B) $1s$ $2s$
 \uparrow \uparrow
- (C) $1s$ $2s$ $2p$
 $\uparrow\downarrow$ $\uparrow\downarrow$ \uparrow \uparrow \square
- (D) $1s$ $2s$ $2p$
 $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$
7. What is the electron configuration for Zn²⁺?
- (A) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8$
 (B) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$
 (C) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$
 (D) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
8. Which of the following electron configurations shows the ground state of an ion of a halogen?
- (A) $1s^2 2s^2 2p^5 3s^2 3p^5$
 (B) $1s^2 2s^2 2p^6 3s^2 3p^6$
 (C) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$
 (D) $1s^2 2s^2 2p^6 2d^{10} 3s^2 3p^6$

9. When placed in order of increasing atomic radius, what is the correct order for the elements Al, Ca, and Mg?
- (A) Al, Mg, Ca
 (B) Mg, Al, Ca
 (C) Ca, Al, Mg
 (D) Ca, Mg, Al
10. Which of the following electron configurations shows a violation of Hund's rule?
- (A) $1s$
 \uparrow
- (B) $1s$ $2s$
 $\uparrow\downarrow$ \uparrow
- (C) $1s$ $2s$ $2p$
 $\uparrow\downarrow$ $\uparrow\downarrow$ \uparrow \square \square
- (D) $1s$ $2s$ $2p$
 $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$
11. The reactivity of the alkali metals increases going down the group. Which is the correct explanation for this trend?
- (A) The ionization energy decreases as you move down the group, thus it requires less energy to remove the valence electron and results in greater reactivity.
 (B) The greater nuclear charge as you move down the group results in a greater ability to attract electrons to the atom, thus making them more reactive.
 (C) As you move down the group, the nucleus's stability decreases, thus causing an increase in the number of radioactive isotopes, hence an increase in the reactivity of the alkali metals.
 (D) The greater mass as you move down the group causes an increase in the kinetic energy for any given molecular velocity. The increase in kinetic energy accounts for the increase in reactivity.
12. In which of the following electron transitions for a hydrogen atom does the light emitted have the longest wavelength?
- (A) $n = 5$ to $n = 2$
 (B) $n = 4$ to $n = 3$
 (C) $n = 3$ to $n = 1$
 (D) $n = 2$ to $n = 1$
13. An element X has the ground-state valence electron configuration of ns^2np^5 . The formula for the compound composed of element X and nitrogen is most likely
- (A) NX
 (B) NX₂
 (C) NX₃
 (D) NX₅
14. When placed in order of increasing ionization energy, what is the correct order for the species O, O⁺, and O⁻?
- (A) O, O⁺, O⁻
 (B) O, O⁻, O⁺
 (C) O⁺, O, O⁻
 (D) O⁻, O, O⁺
15. The table below shows the first eight ionization energies for four random elements from the second and third periods of the periodic table. Based on these data, which elements would most likely have similar chemical properties?

Ionization Energy (kJ/mol)	Elements			
	W	X	Y	Z
First	1,314	1,000	578	496
Second	3,388	2,252	1,817	4,562
Third	5,301	3,357	2,745	6,910
Fourth	7,469	4,556	11,577	9,543
Fifth	10,990	7,004	14,842	13,354
Sixth	13,327	8,496	18,379	16,613
Seventh	71,330	27,107	23,326	20,117
Eighth	84,078	31,719	27,465	25,496

- (A) W and X
 (B) W and Y
 (C) X and Z
 (D) Y and Z