Ionization Energy Chemistry Questions with Solutions

Q1. Ionization energy depends upon
(a) Effect of the arrangement of electrons
(b) Penetration effect of the electrons
(c) Screening effect of inner electrons
(d) All of the above

Answer: (d), Ionisation energy depends on the electron arrangement, electron penetration effect, and the screening effect of the inner electrons.

Q2. Which of the following elements has the lowest ionization energy?
(a) Barium
(b) Magnesium
(c) Calcium
(d) Chromium
Answer: (a), Barium has the lowest ionization energy.
Explanation: The force of attraction between electrons and the nucleus decreases on moving down the group. Hence, the ionisation energy decreases on moving down the group.

Q3. The ionic mobility of alkali metal ions in an aqueous solution is maximum for
(a) Sodium ions
(b) Potassium ions
(c) Rubidium ions
(d) Lithium ions
Answer: (c), The ionic mobility of alkali metal ions in an aqueous solution is maximum for rubidium ions.
Explanation: The smaller the size of an ion, the higher its mobility.
Li^+ is the smallest in size, and hence, its mobility is the highest. However, it is not reasonable in an aqueous solution. In an aqueous solution, ions get hydrated, due to which their size increases.
Since Li^+ has the highest charge density, it is hydrated the most, while Rb^+ is the least.
Hence, the adequate hydrated size of Li^+ is more than that of Rb^+, so the ionic mobility of Rb^+ is more than Li^+.

Q4. Which of the following elements has the highest first ionization energy?
(a) Lithium
(b) Fluorine
(c) Sodium
(d) None of the above

Answer: (b) Fluorine has the highest first ionization energy.
Explanation: The force of attraction between electrons and the nucleus increases on moving left to right in the group. Hence, the ionisation energy increases on moving left to right in the group.

Q5. Ionization energy _____, and atomic radius _____ down a group of the periodic table.
Answer: Ionization energy decreases, and atomic radius increases down a group of the periodic table.

Q6. What is ionization energy?
Answer: Ionization energy or ionization potential is the minimum energy required to remove an outermost electron from an isolated atom or molecule.
It is expressed in joules or electron volts.

Q7. Why does ionization energy decrease down the group?
Answer: Ionization energy decreases down the group because the outermost electron is far from the nucleus, i.e. it is held less tightly bonded to the nucleus and requires less energy to remove. Thus, ionization energy decrease down the group.

Q8. Why does ionization energy increase from left to right in the period?
Answer: Ionization energy increases from left to right in the period because as we move left to the right in a period, the nuclear charge increases, leading to a strong bond between the electrons and the nucleus. Thus, large amounts of energy are required to remove the outermost electron from an atom. Thus, ionization energy increase from left to right in the period.

Q9. Match the following.

Column A	Column B
Group	**Tendency to gain electrons**
Period	**Energy required**
Metallic character	**Vertical columns**
Non-metallic character	**Energy released**
Electron Affinity	**Horizontal rows**
Ionisation energy	**Tendency to lose electrons**

Answer:

Column A	Column B

Group	Vertical columns
Period	Horizontal rows
Metallic character	Tendency to lose electrons
Non-metallic character	Tendency to gain electrons
Electron Affinity	Energy released
Ionisation energy	Energy required

Q10. Differentiate between ionization energy and electronegativity.

Answer:

S. No.	Ionization Energy	Electronegativity
1.	Ionization energy is the minimum energy required to remove an electron from a neutral atom.	Electronegativity is the tendency of an atom to attract the shared pair of electrons.
2.	Ionization energy deals with the removal of electrons from an atom.	Electronegativity explains the attraction of electrons.
3.	Ionization energy increases from left to right in a period and decreases from top to bottom in a group.	Electronegativity increases from left to right in a period and decreases from top to bottom in a group.

Q11. What are the factors that affect the ionization energy of an element?

Answer: The factors that affect the ionization energy of an element are mentioned below.

- Nuclear Charge.
- Atom Size.
- Screening Effect

Q12. What is the effect of nuclear charge on the ionization energy of an element?

Answer: The ionization energy of an element increase with increasing nuclear charge. As the force of attraction between the nucleus and electron increases, it becomes difficult to remove the outermost

electron from an atom. Thus, more energy is required to remove an electron from its valence shell. Thereby increasing the ionization energy of the element.

Q13. What is the effect of atomic size on the ionization energy of an element?

Answer: The ionization energy of an element decrease with increasing atomic size. As the force of attraction between the nucleus and electron decreases with increasing size, it becomes easy to remove the outermost electron from an atom. Thus, less energy is required to remove an electron from its valence shell. Thereby decreasing the ionization energy of the element.

Q14. What is the first ionization energy?

Answer: The first ionization energy is the minimum energy required to remove the first electron from an isolated atom or molecule. It is numerically equal to the orbital energy of the electron but is of the opposite sign.

Q15. What is the second ionization energy?

Answer: The second ionization energy is the minimum energy required to remove the second electron from a unipositive ion.

Practise Questions on Ionization Energy

Q1. Calculate the ionization energy of sodium in kJ mol–1. If em radiation of wavelength 242 nm is sufficient to ionize the sodium atom.

Answer:

Ionization Energy (E)

$$E = hv = \frac{hv}{\lambda} = \frac{6.6\times10^{-34}\times3\times10^{8}}{242\times10^{-9}} = \frac{19.8}{242} \times 10^{17} = 8.18 \times 10^{15} J/atom$$

Q2. How much energy is required to ionize a hydrogen atom if the electron occupies n = five orbit?

Answer:

The energy of the electron in the hydrogen atom is given by

$$\Delta E = 2.18 \times 10^{-18} \times 1^1 \{\frac{1}{n1^2} - \frac{1}{n2^2}\}) J/atom$$

a) For ionization from n = 1 to n = ∞,

$$\Delta E = 2.18 \times 10^{-18} \times 1^1 \{\frac{1}{1^2} - \frac{1}{\infty^2}\}) = 2.18 \times 10^{-18} \times 1^1 \{1 - 0\} = 2.18 \times 10^{-18} J/atom$$

b) For ionization from n = 5 to n = ∞,

$$\Delta E = 2.18 \times 10^{-18} \times 1^1 \{\frac{1}{5^2} - \frac{1}{\infty^2}\}) = 2.18 \times 10^{-18} \times 1^1 \{\frac{1}{25} - 0\} = 2.18 \times 10^{-18} \times \frac{1}{25} J/atom$$

The energy required for ionization from the fifth orbit is 25 times less than that required from the first orbit.

Q3. Calculate the wavenumber for the shortest wavelength transition in the Balmer series of atomic hydrogen.

Answer:

The Balmer series belongs to the second orbit. The shortest wavelength corresponds to the highest energy.

- The highest energy is equal to the ionization energy from that orbit.

Ionization energy from the second orbit =

$$\Delta E = 2.18 \times 10^{-18} \times 1^1 \{\frac{1}{2^2} - \frac{1}{\infty^2}\}) = 2.18 \times 10^{-18} \{0.25 - 0\} = 2.18 \times 10^{-18} \times 0.25 J/atom$$

Ionization Energy (E)

$$E = h\upsilon = \frac{hc}{\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{\lambda} = 5.7 \times 10^{-19} J/atom$$

Shortest wavelength

$$= \lambda = \frac{19.8}{5.7} \times 10^{-7} m = 347 nm$$

Q4. Which element would have the highest first ionization energy?
(a) Boron
(b) Oxygen
(c) Nitrogen
(d) Carbon

Answer: (b) Oxygen has the highest first ionization energy.
Explanation: The force of attraction between electrons and the nucleus increases on moving left to right in the group. Hence, the ionisation energy increases on moving left to right in the group.

Q5. Which of its ionization energies will be greatest for scandium?
(a) First ionization energy
(b) Second ionization energy
(c) Third ionization energy
(d) Fourth ionization energy

Answer: (d), The fourth ionization energy will be greatest for scandium.
Explanation: Scandium can release three electrons before it develops a noble gas electron configuration (hence its tendency to become an ion with a charge of +3).
Sc: [Ar] $3d^1$ $4s^2$
Sc^{3+}: [Ar]
At this point, the atom will require a massive amount of absorbed energy to release the fourth electron. This means that the 4th ionization energy for scandium is the highest.