CHEMISTRY ONLINE
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# CHEMISTRY

## INORGANIC CHEMISTRY

| | |
|---|---|
| Level & Board | AQA (A-LEVEL) |
| TOPIC: | PERIODICITY |
| PAPER TYPE: | SOLUTION - 4 |
| TOTAL QUESTIONS | 10 |
| TOTAL MARKS | 34 |

# Periodicity - 4

1.

(a)

The electronic configuration of potassium is $1s^2\ 2s^2\ 2p^6\ \ 3s^2\ 3p^6\ \ 4s^1$. Potassium belongs to the s-block in the Periodic Table.

**(2)**

(b)

The bonding in metals has a lattice of positively charged metal cations surrounded by a sea of delocalized electrons. This shows the regular and often close-packed arrangement of metal cations in the metallic lattice, held together by the electrostatic attraction between cations and electrons.

**(2)**

(c)

The melting point of calcium is higher than that of Potassium.

**Explanation:**

**Greater Nuclear or Ionic Charge:**

Calcium has a greater nuclear or ionic charge compared to potassium.

**Smaller Atoms/Ions:**

Calcium ions are smaller than potassium ions.The smaller size of calcium ions contributes to a higher charge density in the calcium lattice.

**More Delocalized Electrons/Free Electrons:**

In both calcium and potassium, there are delocalized electrons forming a sea of electrons. Calcium, is larger and having more electrons, contributes to a higher number of delocalized electrons.

**Stronger Attraction Between Ions and Delocalized Electrons:**

The combination of greater nuclear charge, smaller ions, and more delocalized electrons in calcium results in a stronger electrostatic attraction between the metal cations and the delocalized electrons.

So, the higher melting point of calcium compared to potassium can be attributed to a greater nuclear charge, smaller ions, and more delocalized electrons in calcium, which result in a stronger electrostatic attraction between the metal cations and the delocalized electrons.



**(3)**

(d)

Metals conduct electricity due to delocalized electrons that Move in a particular direction under the influence applied potential difference.

**(2)**

2. B

(1)

3.

(a)

Nitrogen (N), oxygen (O), fluorine (F), and neon (Ne) are classified as p-block elements because their last electrons fill the p orbital, so they are located in the p-block of the periodic table, and they have similar chemical properties as elements within the same group.

**(2)**

(b)

Atomic radius decreases from nitrogen to fluorine across a period.
Increase in nuclear charge as protons in the nucleus increases.
So, outer electrons experience a stronger attraction to the nucleus. Shielding effect remains constant, contributing to a higher effective nuclear charge. Decrease of atomic size occurs as outer electrons are pulled closer to the nucleus.

(3)

(c)

Neon, a noble gas, has a full outer electron shell, and chemically inert. Its complete electron configuration ($1s^2\ 2s^2\ 2p^6$ ) gives stability, and it has the octet rule without a need for bonding. This leads to very low reactivity, making neon unlikely to form compounds with other elements.

(3)

4. B

(1)

5.

(a)

The second ionization energy of sodium can be represented by the following equation:

$Na^+(g) \rightarrow Na^{2+}(g) + e^-$

In this equation:

$Na^+(g)$ represents a sodium ion in the gaseous state.
$Na^{2+}(g)$ represents a sodium ion with a +2 charge in the gaseous state.
$e^-$ represents an electron.

**(2)**

**(b)**

The second ionization of $Na^+$ involves the loss of an electron from a 2p orbital or the 2nd energy level while for $Mg^+$, the second ionization requires the loss of an electron from a 3s orbital or the 3rd energy level. $Na^+$ loses an electron from a lower-energy orbital compared to $Mg^+$, not involving the 3p orbital.
The differences in ionization energy are due to factors such as less shielding in $Na^+$, where the loss of the first electron results in a full 2p subshell, and the second ionization involves removing an electron from a filled 2p subshell.
Additionally, the electron in $Na^+$ is closer to the nucleus, experiencing more attraction, whereas the situation is vice versa for $Mg^+$.

**(3)**

**6.**

**(a)**

The equation representing the second ionization energy of oxygen is:
$O^+(g) \rightarrow O^{2+}(g) + e^-$
**In this equation:**
$O^+(g)$ represents an oxygen ion with a +1 charge in the gaseous state.
$O^{2+}(g)$ represents an oxygen ion with a +2 charge in the gaseous state.
$e^-$ represents an electron.

**(1)**

**(b)**

The second ionization energy of oxygen is greater than the first due to the removal of an electron from a positively charged oxygen ion, forming $O^{2+}$.
This process requires more energy as electrons are pulled against the stronger electrostatic attraction of the doubly positive nucleus. Additionally, after the first ionization, remaining electrons experience reduced repulsion, making it energetically more difficult to remove a second electron. The increased effective nuclear charge on remaining electrons further contributes to the higher energy required for the second ionization.



 

(1)

7. A

(1)

8.

(a)

The electronic configuration of a bromine atom is as:

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$

(1)

(b)

Bromine classified as a p-block element because its outermost electrons fill the p orbital.

In the electronic configuration of bromine (Br), the last electron is located in the 4p orbital.

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$

(1)

9.

(a)

Aluminum (Al) is an element that deviates from the general trend of increasing ionization energy across Period 3.

**Explanation for Deviation:**

The general trend across Period 3 is an increase in ionization energy from left to right due to an increasing nuclear charge, aluminum shows a lower ionization energy than expected.

This deviation occurs because aluminum (Al) has its outermost electron in the 3p orbital, which is higher in energy than the 3s orbital. The 3p orbital is shielded by the inner 2s and 2p electrons, which reduces the effective nuclear charge felt by the outer electron. As a result, aluminum's ionization energy is lower than that of the elements before it in Period 3 (sodium and magnesium), where the outermost electron is in the 3s orbital.



(3)

(b)

 

The equation representing the process for the third ionization energy of sodium is:
$Na^{2+}(g) \rightarrow Na^{3+}(g) + e^{-}$
In this equation:
$Na^{2+}(g)$ represents a sodium ion with a +2 charge in the gaseous state.
$Na^{3+}(g)$ represents a sodium ion with a +3 charge in the gaseous state.
$e^{-}$ represents an electron.

(1)

10. B

(1)



 

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