Answer all the questions below as fully as you can then check your answers

1. Fill in the gap to complete the sentence below:
The first ionisation energy of a Group 2 element involves removing an electron from the _____ subshell.

2. Which of the following factors does NOT directly affect the size of ionisation energy?

a) Atomic radius
b) Electron shielding
c) Number of protons
d) Number of neutrons

3. Fill in the Gap to complete the sentence below:
As you go down Group 2, the first ionisation energy generally _____________.

4. Which of the following correctly represents the equation for the second ionisation energy of calcium (Ca)? All the atoms and ion shown are in the gaseous state.

a) $Ca^{+} \rightarrow Ca^{2+} + e$
b) $Ca \rightarrow Ca^{+} + e$
c) $Ca^{2+} \rightarrow Ca^{+} + e$
d) $Ca \rightarrow Ca^{2+} + 2e^{-}$

5. Write the equation for the first ionisation energy of magnesium (Mg).

6. List the three main factors that affect the size of the ionisation energy of an element.

7. Explain the trend in first ionisation energy as you move down Group 2.

8. Which Group 2 element has the highest first ionisation energy? Explain your answer.

a) Beryllium (Be) b) Magnesium (Mg)

c) Calcium (Ca) d) Strontium (Sr)

9. How does the trend in the second ionisation energy of Group 2 elements provide evidence for the presence of electron shells?

Answers

1. Fill in the gap to complete the sentence below:
The first ionisation energy of a Group 2 element involves removing an electron from the ____ subshell.

Answer: s

2. Which of the following factors does NOT directly affect the size of ionisation energy?

a) Atomic radius
b) Electron shielding
c) Number of protons
d) Number of neutrons

Answer: d) Number of neutrons

3. Fill in the Gap to complete the sentence below:
As you go down Group 2, the first ionisation energy generally ____________.

Answer: decreases

4. Which of the following correctly represents the equation for the second ionisation energy of calcium (Ca)? All the atoms and ion shown are in the gaseous state.

a) $Ca^{+} \rightarrow Ca^{2+} + e$
b) $Ca \rightarrow Ca^{+} + e$
c) $Ca^{2+} \rightarrow Ca^{+} + e$
d) $Ca \rightarrow Ca^{2+} + 2e-$

Answer: a) $Ca^{+} \rightarrow Ca^{2+} + e$

5. Write the equation for the first ionisation energy of magnesium (Mg).

Answer:

$Mg_{(g)} \rightarrow Mg^{+}_{(g)} + e^{-}$

6. List the three main factors that affect the size of the ionisation energy of an element.

Answer:

Atomic Radius: The larger the atomic radius, the lower the ionisation energy, as the outer electrons are further from the nucleus.

Nuclear Charge: A higher nuclear charge increases ionisation energy because the nucleus exerts a stronger pull on the electrons.

Electron Shielding: More electron shielding (due to inner electrons) decreases ionisation energy because it reduces the effective nuclear charge felt by the outermost electron.

7. Explain the trend in first ionisation energy as you move down Group 2.

Answer:
As you move down Group 2, the first ionisation energy decreases. This is because atomic radius increases, which means the outermost electron is further from the nucleus and less tightly held. Additionally, there is more electron shielding from the inner electron shells, which reduces the effective nuclear charge felt by the outermost electron, making it easier to remove.

8. Which Group 2 element has the highest first ionisation energy? Explain your answer.

a) Beryllium (Be) b) Magnesium (Mg)
c) Calcium (Ca) d) Strontium (Sr)

Answer: a) Beryllium (Be)
Explanation: Beryllium has the highest first ionisation energy among Group 2 elements because it is at the top of the group, meaning it has the smallest atomic radius and the least electron shielding, resulting in a stronger attraction between the nucleus and the outermost electron.

9. How does the trend in the second ionisation energy of Group 2 elements provide evidence for the presence of electron shells?

Answer:

The first and second ionisation energies of Group 2 elements involve the removal of electrons from the same s subshell of the outermost principal energy level. These ionisation energies are relatively similar because the electrons are being removed from the same energy level, with the second ionisation energy being slightly higher due to the increased positive charge of the ion after the first electron is removed.

However, the third ionisation energy shows a dramatic increase compared to the first and second ionisation energies. This is because, after the removal of two electrons, the third electron is removed from a lower principal energy level, which is closer to the nucleus and more strongly attracted by the nuclear charge. This significant jump in ionisation energy provides evidence for the existence of electron shells, where electrons in lower energy levels (closer to the nucleus) are much more tightly bound and require significantly more energy to remove.

Additional information:

Trend: The third ionisation energy is significantly higher than the first and second ionisation energies.

Reason: After the second ionisation, the atom has lost both of its valence electrons (from the 3s sublevel in a Group 2 element like magnesium), leaving behind a Mg^{2+} ion. The third electron must be removed from a lower principal energy level (specifically the 2p sublevel for magnesium). Not only is this electron closer to the nucleus and inner shell, but the ion now has a 2^{+} charge. The increased positive charge means the remaining electrons are more strongly attracted to the nucleus, making the third ionisation energy significantly higher.

Fourth and Fifth Ionisation Energies:

Trend: These ionisation energies continue to increase steeply.

Reason: As you remove additional electrons, you're still dealing with a positively charged ion, now with a 3^+ or 4^+ charge, respectively. Each time an electron is removed, the ion's positive charge increases, leading to a stronger attraction between the nucleus and the remaining electrons. The fourth and fifth electrons being removed are from the same inner 2p subshell, but the increasing positive charge of the ion further raises the ionisation energies.

Sixth Ionisation Energy and Beyond:

Trend: The ionisation energies continue to rise dramatically.

Reason: After the removal of all 2p electrons, the next electron to be removed comes from the 2s sublevel. With each electron removal, the ion's positive charge increases (for example, Mg^{5+} becoming Mg^{6+}). The ionisation energy needed continues to increase because of the stronger electrostatic attraction between the now more positively charged nucleus and the remaining inner electrons. It is also worth noting that electrons in the same principal energy level or shell tend to screen each other relatively poorly.

Key Points to Remember:

Increasing Positive Charge: As electrons are removed, the ion becomes more positively charged (e.g., Mg^+ to Mg^{2+}, and so on). This increasing positive charge results in a stronger attraction between the nucleus and the remaining electrons, requiring more energy to remove each subsequent electron.

Third Ionisation Energy: This is particularly high because you are removing an electron from the inner 2p sublevel, which is closer to the nucleus, and the ion has a 2+ charge, significantly increasing the ionisation energy.

Further Ionisations: The trend of increasing ionisation energies continues as you move deeper into the electron shells, with the positive charge of the ion playing a crucial role in increasing the energy required to remove each additional electron.