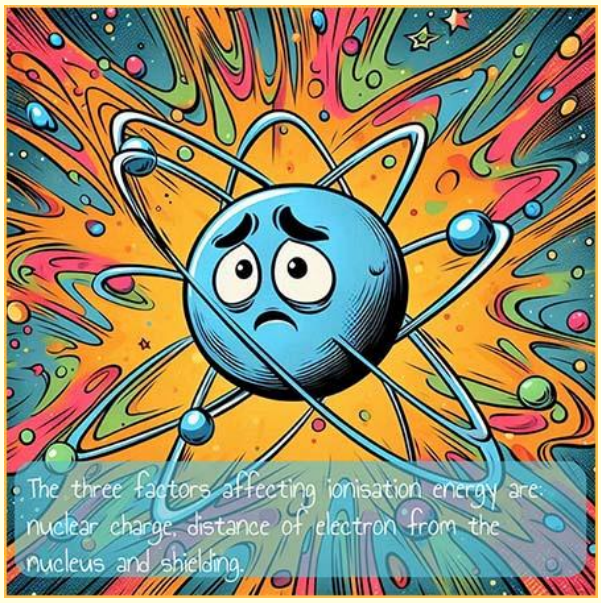
Trends in the ionisation energy across a period

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

1. Which of the following best describes the first ionisation energy of an element?

a) The energy required to add one mole of electrons to one mole of gaseous atoms.
b) The energy required to remove one mole of electrons from one mole of gaseous atoms.
c) The energy required to remove one mole of protons from one mole of gaseous atoms.
d) The energy required to add one mole of protons to one mole of gaseous atoms.



2. Fill in the gap to complete the sentence below:

The second ionisation energy of an element is generally _____ than the first ionisation energy.

3. Which factor does NOT affect the size of ionisation energy?

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

4. Fill in the Gap to complete the sentence:

Ionisation energy generally _____ as you move from left to right across a period in the periodic table.

5. Match the following terms with their correct definitions:

Term	Definition
First Ionisation Energy	The total positive charge of the nucleus.
Shielding Effect	The size of the atom, which affects the distance between the nucleus and the outermost electron.
Nuclear Charge	The energy required to remove one electron from a gaseous atom.
Atomic Radius	The attraction between the outer electrons and the nucleus decreases due to inner electron shells.

6. Define the first ionisation energy of an element.

7. Explain why the second ionisation energy of an element is higher than the first ionisation energy.

8. Identify and explain three factors that affect the size of ionisation energy for an element.

9. Which of the following elements has the highest first ionisation energy?

a) Sodium (Na) b) Magnesium (Mg) c) Aluminium (Al) d) Phosphorus (P)

10. Discuss the general trend in ionisation energy across Period 3 elements.

11. Consider the elements magnesium (Mg), aluminium (Al), phosphorus (P), and sulfur (S) in Period 3 of the periodic table.

a) For each of the following pairs of elements, state whether the first ionisation energy increases or decreases, and explain why:

1. Magnesium (Mg) to Aluminium (Al):
2. Phosphorus (P) to Sulfur (S):

b) Which element in this group (Mg, Al, P, S) has the highest first ionisation energy? Explain your answer.

Answers

1. Which of the following best describes the first ionisation energy of an element?
a) The energy required to add one mole of electrons to one mole of gaseous atoms.
b) The energy required to remove one mole of electrons from one mole of gaseous atoms.
c) The energy required to remove one mole of protons from one mole of gaseous atoms.
d) The energy required to add one mole of protons to one mole of gaseous atoms.

Answer: b) The energy required to remove one mole of electrons from one mole of gaseous atoms.

2. Fill in the Gap to complete the sentence below:
The second ionisation energy of an element is generally _____ than the first ionisation energy.

Answer: higher

3. Which factor does NOT affect the size of ionisation energy?
a) Atomic radius
b) Nuclear charge
c) Electron shielding
d) Number of neutrons

Answer: d) Number of neutrons

4. Fill in the Gap to complete the sentence:
Ionisation energy generally _____ as you move from left to right across a period in the periodic table.

Answer: increases

5. Match the following terms with their correct definitions:

Term	Definition
First Ionisation Energy	The energy required to remove one electron from a gaseous atom.
Shielding Effect	The attraction between the outer electrons and the nucleus decreases due to inner electron shells.
Nuclear Charge	The total positive charge of the nucleus.
Atomic Radius	The size of the atom, which affects the distance between the nucleus and the outermost electron.

6. Define the first ionisation energy of an element.

Answer: The first ionisation energy is the energy required to remove one mole of electrons from one mole of gaseous atoms to form one mole of gaseous ions with a single positive charge.

7. Explain why the second ionisation energy of an element is higher than the first ionisation energy.

Answer: The second ionisation energy is higher because it involves removing an electron from a positive ion, which has a higher effective nuclear charge compared to the neutral atom. After the first electron is removed, the remaining electrons experience a stronger attraction to the nucleus because there are fewer electrons to repel each other,

and the nuclear charge remains the same. This stronger attraction makes it more difficult to remove the second electron, requiring more energy.

8. Identify and explain three factors that affect the size of ionisation energy for an element.

Answer:

- Atomic Radius: Larger atomic radius means the outermost electron is farther from the nucleus, reducing the attraction and lowering ionisation energy.
- Nuclear Charge: Higher nuclear charge increases the attraction between the nucleus and the outer electrons, increasing ionisation energy.
- Electron Shielding: Increased electron shielding by inner electrons reduces the effective nuclear charge experienced by the outermost electron, decreasing ionisation energy.

9. Which of the following elements has the highest first ionisation energy?
a) Sodium (Na) b) Magnesium (Mg) c) Aluminium (Al) d) Phosphorus (P)

Answer: d) Phosphorus (P)
Explanation: Phosphorus has a higher ionisation energy than the others because it is located further to the right in Period 3, meaning it has a higher nuclear charge and less electron shielding, leading to a stronger attraction between the nucleus and the outermost electron.

10. Discuss the general trend in ionisation energy across Period 3 elements.

Answer:
The ionisation energy generally increases across Period 3 from sodium (Na) to argon (Ar). This is because, as you move across the period, the nuclear charge increases, pulling the outer electrons closer to the nucleus and increasing the ionisation energy. The atomic radius decreases across the period, meaning the electrons are held more tightly by the nucleus. There is also minimal additional shielding across the period, so the outer electrons experience a stronger attraction from the nucleus.

11. Consider the elements magnesium (Mg), aluminium (Al), phosphorus (P), and sulfur (S) in Period 3 of the periodic table.

a) For each of the following pairs of elements, state whether the first ionisation energy increases or decreases, and explain why:

3. Magnesium (Mg) to Aluminium (Al):
4. Phosphorus (P) to Sulfur (S):

b) Which element in this group (Mg, Al, P, S) has the highest first ionisation energy? Explain your answer.

Answer:

a)

1. Magnesium (Mg) to Aluminium (Al):

The first ionisation energy decreases from Mg to Al. This is because, in aluminium, the electron being removed is in the 3p orbital, which is slightly further from the nucleus and more shielded by the inner 3s electrons than the 3s orbital in magnesium. The increased shielding and distance reduce the effective nuclear charge experienced by the 3p electron, making it easier to remove.

2. Phosphorus (P) to Sulfur (S):

The first ionisation energy decreases from P to S. This decrease is due to electron-electron repulsion within the 3p orbital in sulfur. In phosphorus, each of the three 3p electrons occupies its own orbital, while in sulfur, one of the 3p orbitals contains a pair of electrons. The repulsion between these paired electrons makes it easier to remove one, resulting in a lower ionisation energy.

b)

Phosphorus (P) has the highest first ionisation energy among Mg, Al, P, and S.
This is because phosphorus has a half-filled 3p subshell, which is relatively stable. Additionally, as you move across the period from magnesium to phosphorus, the nuclear charge increases without a significant increase in shielding, leading to a

stronger attraction between the nucleus and the outermost electrons. As a result, phosphorus requires more energy to remove an electron compared to the other elements mentioned.