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

1. Explain the meaning of the term first ionisation energy.

b. Write an equation to show the first ionisation energy of sodium.

c. A student wrote the following equation to represent the second ionisation energy of sodium.

$Na_{(g)} \longrightarrow Na^{2+}{}_{(g)} + 2e$

Unfortunately this equation is NOT correct. Write the correct equation to represent the second ionisation energy of sodium. What mistake did the student make?

2. What factors affect the ionisation energies down a group in the periodic table?

b. What is meant by the term effective nuclear charge? Discuss the idea of screening or shielding in your answer.

3. Explain the trends in the first ionisation energies for the group 2 elements Be to Ba.

4. The table below shows the first 4 ionisation energies for an element.

Ionisation energy	1	2	3	4
Ionisation energy/ $kJmol^{-1}$	589	1145	4912	6490

a. What group in the periodic table is this element in? Give a reason for your answer.

5. Why is the first ionisation energy of sodium less than that of neon?

6. Write equations to show the first and second ionisation energy of magnesium.

a. Explain why the second ionisation energy of magnesium is higher than the first ionisation energy.

Answers

1. Explain the meaning of the term first ionisation energy.

The enthalpy change for the removal of 1 mole of electrons from one mole of isolated gaseous atoms.

b. Write an equation to show the first ionisation energy of sodium.

$$Na_{(g)} \longrightarrow Na_{(g)} + e$$

c. Write an equation to show the second ionisation energy of sodium .

$$Na^{+}_{(g)} \longrightarrow Na^{2+}_{(g)} + e$$

The student removed 2 electrons from an isolated atom, however the electrons need to be removed one at a time and not in blocks

2. What factors affect the ionisation energies down a group in the periodic table?

- The size of the nuclear charge. The larger the nuclear charge the greater will be the electrostatic attraction between the protons and any electrons in the shells.
- Distance. The further apart the electrons and the nucleus are the less will be the force of electrostatic attraction between them.
- Shielding. The inner or core electrons will screen or shield the nuclear charge from any electrons in higher principal energy levels. This means that any outer electrons will not feel the full nuclear charge.

b. What is meant by the term effective nuclear charge? Discuss the idea of screening or shielding in your answer.

Effective nuclear charge = the actual nuclear charge - number of shielding electrons

3. Explain the trends in the first ionisation energies for the group 2 elements Be to Ba.

They drop as you descend group 2. Despite the nuclear charge increasing the effective nuclear charge remains constant down group2 at 2+, as the amount of shielding increases down the group. As you descend group 2 the atoms get larger and the outer valence electrons are in a higher principal energy level, so they are further from the nucleus so are easier to remove

4. The table below shows the first 4 ionisation energies for an element.

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Ionisation energy/ $kJmol^{-1}$	589	1145	4912	6490

a. What group in the periodic table is this element in? Give a reason for your answer.

Group 2. The first 2 electrons are relatively easy to remove with a fairly small increase in going from the first to the second ionisation energy. However there is a huge increase in the 3rd ionisation energy which suggests that the electron being removed here is in a lower principal energy level which is much closer to the nucleus.

5. Why is the first ionisation energy of sodium less than that of neon?

The electronic structure of neon and sodium is shown below:

Na $1s^2 2s^2 2p^6 3s^1$

Ne $1s^2 2s^2 2p^6$

The outer valence electron in sodium is in the 3rd principle energy level, in the 3s sub-level, whereas for neon the outer valence electron is in a 2p sub-level, in the second principle energy level. The outer electron in a neon atom is closer to the nucleus and not as well shielded as the outer 3p electron in a sodium atom, this means the effective nuclear charge felt by an electron in a sodium atom will be much less than that felt by an electron in the outer shell of an atom of neon.

6. Write equations to show the first and second ionisation energy of magnesium.

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

$Mg^{+}_{(g)} \longrightarrow Mg^{2+}_{(g)} + e$

a. Explain why the second ionisation energy of magnesium is higher than the first ionisation energy.

The second ionisation energy involves removing an electron from a positively charged ion, there will be attraction between the ion and the electron you are trying to remove, this will required energy to overcome it. There are also less electrons in a Mg^{+} ion than a Mg atom, this means there will be less repulsion between the electrons and the ion will be smaller, this means the electrons will be closer to the nucleus and they will experience a larger effective nuclear charge.