Checking Two Ionization Steps in a Model Detector

Base your answers on the information provided and your knowledge of chemistry. Use the 2025 Chemistry Reference Tables as needed.

A detector simulation models removing electrons from individual sodium and magnesium atoms. The first value applies to removing an electron from the neutral atom. The second value applies to removing another electron after the first is gone. The model supplies up to 1,500 kJ per mole in each step.

Element	First removal energy (kJ/mol)	Second removal energy (kJ/mol)
Na	496	4,560
Mg	738	1,450

1 Which prediction fits the supplied energy limit?

(1) Only sodium can lose its first electron.

(2) Both elements can lose a first electron, and only Mg can lose a second.

(3) Both elements can lose two electrons.

(4) Neither element can lose any electrons.

2 Calculate how far above the limit the second removal energy for sodium is. [1]

Answer and work

The model represents neutral Na with one electron in its third occupied shell and neutral Mg with two. Both have eight electrons in the second shell.

3 Use the shell model to explain why sodium’s second electron is much harder to remove than its first. [1]

Answer and work

4 A new model allows up to 4,600 kJ/mol per step. Use the data to decide whether sodium can lose its first two electrons and whether the data establish that it can lose a third. [1]

Answer and work

5 Explain why each removal from magnesium changes its charge while the periodic table still identifies it as magnesium. [1]

Answer and work