Checking Radius Claims in a Model Ion Sorter

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

A classroom ion sorter groups particles by the modeled distance of their outer electrons from the nucleus. The class compares a neutral magnesium atom and two positive ions. The table reports proton counts and the number of electrons in each occupied shell.

Particle	**Protons**	**Electrons in occupied shells**
Mg atom	12	2, 8, 2
Mg^{2+} ion	12	2, 8
Na^{+} ion	11	2, 8

1 Explain why the magnesium ion is smaller than the neutral magnesium atom in the model. Use the shell information. [1]

Answer and work

2 Which pair can the class compare to study a difference in proton count while keeping the electron arrangements the same?

(1) Mg atom and Mg^{2+} ion

(2) Mg atom and Na^{+} ion

(3) Mg^{2+} ion and Na^{+} ion

(4) All three particles together

For particles with identical electron arrangements, the model predicts that a nucleus with more protons pulls the outer electrons closer. The class now adds an Al^{3+} model. It has 13 protons and the same electron arrangement, 2, 8.

3 Rank Na^{+}, Mg^{2+}, and Al^{3+} from greatest to least modeled radius. Explain using the model rule. [1]

Answer and work

4 A student wants to apply the same rule to rank the neutral Mg atom and Al^{3+} using their proton counts alone. Explain why that comparison does not meet the stated condition of the rule. [1]

Answer and work