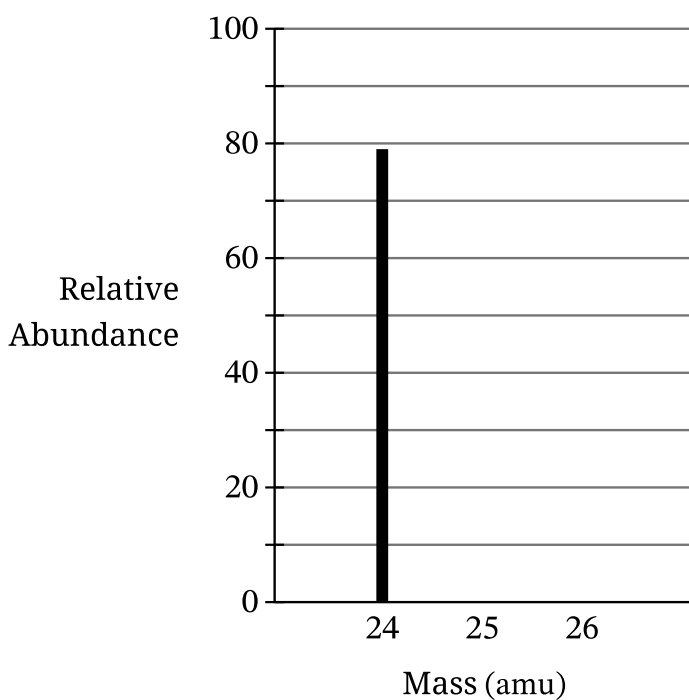


1. Answer the following questions about magnesium.

A. An incomplete mass spectrum for magnesium is shown in the diagram.

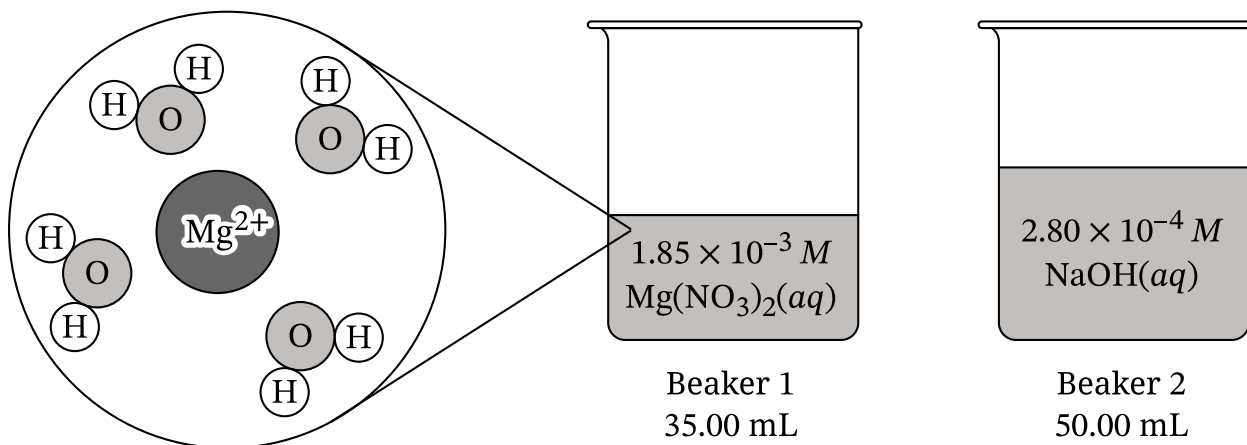


The percent abundance of magnesium-24 is 79%. The percent abundances of the other two natural isotopes of magnesium, magnesium-25 and magnesium-26, are approximately equal.

- Complete the mass spectrum in part A by drawing thick lines in the appropriate locations to represent the percent abundance of magnesium-25 and magnesium-26.
- Describe the difference in atomic structure that accounts for the difference in mass between magnesium-25 and magnesium-26.

AP CHEMISTRY 2020 – FREE-RESPONSE QUESTIONS

A student prepares a $1.85 \times 10^{-3} \text{ M}$ solution of $\text{Mg}(\text{NO}_3)_2(aq)$ in beaker 1 and a $2.80 \times 10^{-4} \text{ M}$ solution of $\text{NaOH}(aq)$ in beaker 2, as shown.



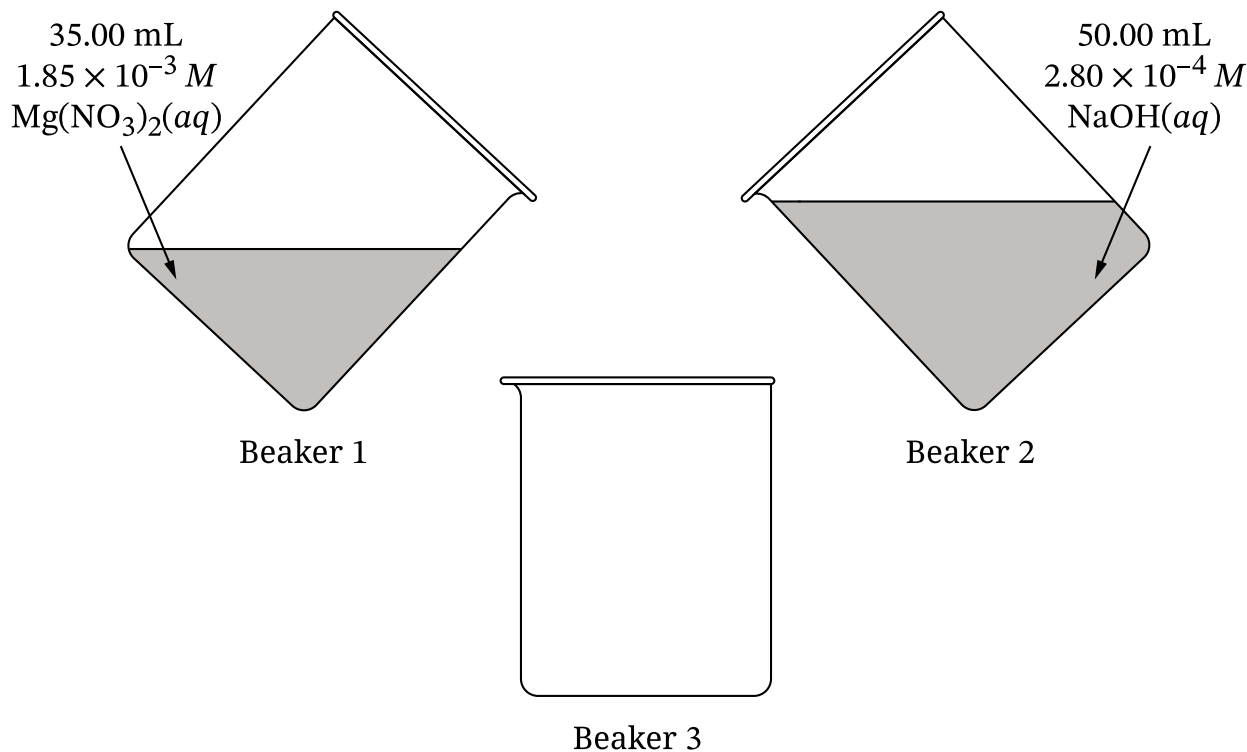
B. The particle diagram shown represents a magnesium ion, Mg^{2+} , in beaker 1. A sodium ion, Na^+ , in beaker 2 has a weaker attraction to water than the Mg^{2+} does. Explain this phenomenon using Coulomb's law and each of the following.

- The relative charge of the ions
- The relative radii of the ions

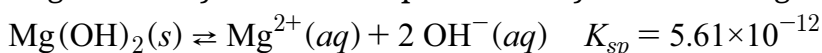
C. Calculate the pH of the solution in beaker 2.

AP CHEMISTRY 2020 – FREE-RESPONSE QUESTIONS

D. A student combines 35.00 mL of $1.85 \times 10^{-3} \text{ M}$ $\text{Mg}(\text{NO}_3)_2(aq)$ with 50.00 mL of $2.80 \times 10^{-4} \text{ M}$ $\text{NaOH}(aq)$, as shown in the diagram. Calculate $[\text{Mg}^{2+}]$ after the two solutions are combined but before any reaction takes place. (Assume that volumes are additive.)



E. The dissolution of magnesium hydroxide is represented by the following equation.



- Write the expression for the solubility product constant, K_{sp} .
- After the two solutions are combined in beaker 3 as described in part D, but before any reaction takes place, $[\text{OH}^{-}] = 1.65 \times 10^{-4} \text{ M}$. Using your answer to part D, calculate the value of the reaction quotient, Q .
- Using the reaction quotient, Q , predict whether a precipitate should form as the mixture in beaker 3 approaches equilibrium. Justify your answer.

F. In a separate experiment, the student adds $\text{HNO}_3(aq)$ to decrease the pH of a saturated solution containing undissolved $\text{Mg}(\text{OH})_2(s)$. Does the amount of undissolved $\text{Mg}(\text{OH})_2(s)$ increase, decrease, or remain the same as the $\text{HNO}_3(aq)$ is added? Justify your answer.