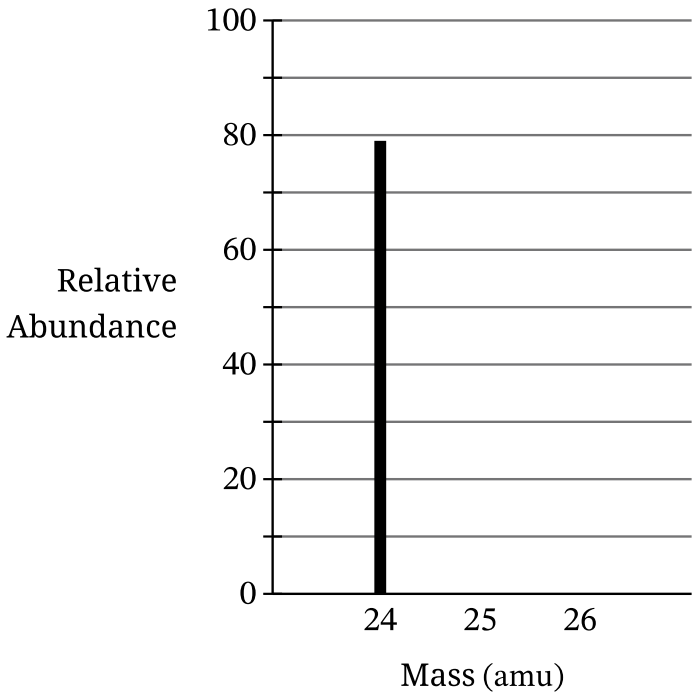
1. Answer the following questions about magnesium.

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

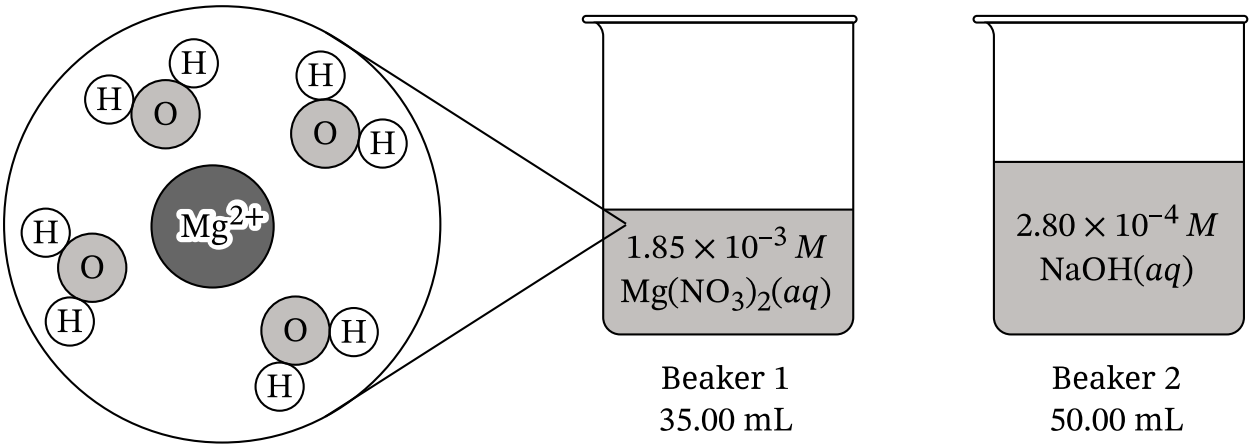


The percent abundance of magnesium-24 is 79%. The percent abundances of the other two natural isotopes of magnesium, magnesium-25 and magnesium-26, are approximately equal.

i. 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.

ii. Describe the difference in atomic structure that accounts for the difference in mass between magnesium-25 and magnesium-26.

A student prepares a $1.85\times10^{-3}\ M$ solution of $\mathrm{Mg(NO_3)_2}(aq)$ in beaker 1 and a $2.80\times10^{-4}\ M$ solution of $\mathrm{NaOH}(aq)$ in beaker 2, as shown.



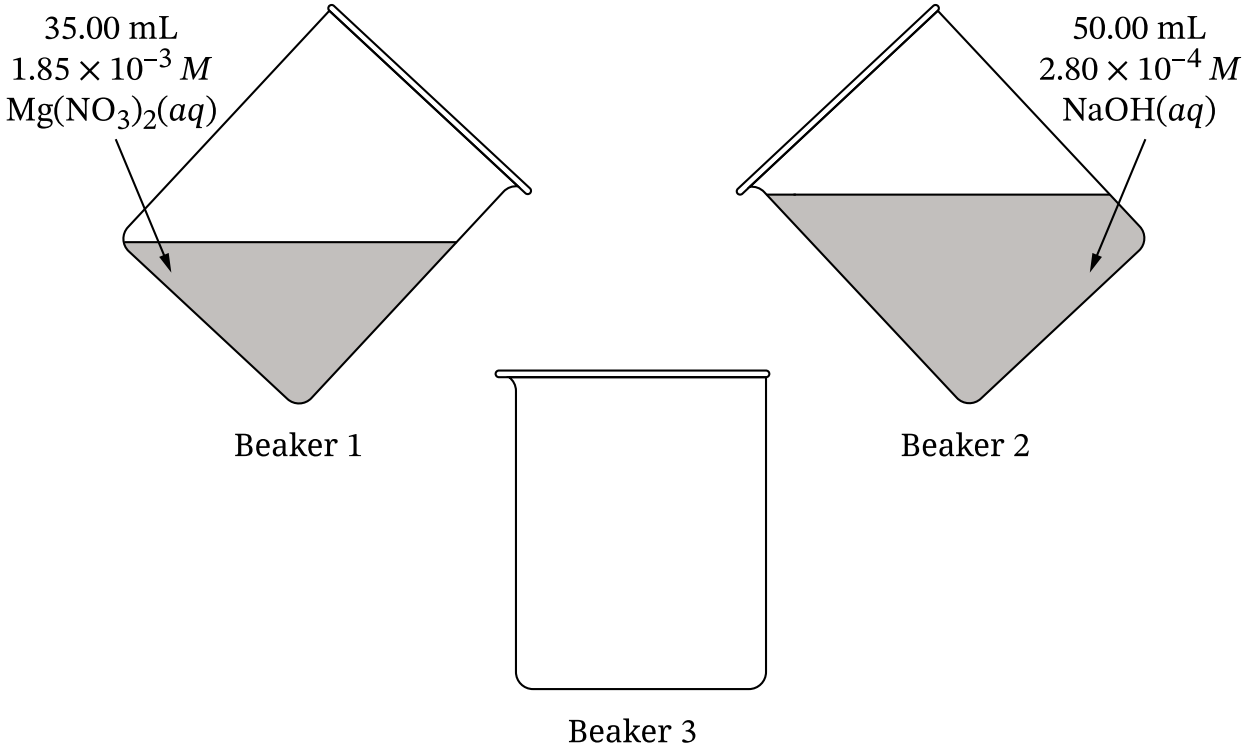
B. The particle diagram shown represents a magnesium ion, $\mathrm{Mg^{2+}}$, in beaker 1. A sodium ion, $\mathrm{Na^{+}}$, in beaker 2 has a weaker attraction to water than the $\mathrm{Mg^{2+}}$ does. Explain this phenomenon using Coulomb's law and each of the following.

i. The relative charge of the ions

ii. The relative radii of the ions

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

D. A student combines 35.00 mL of $1.85\times10^{-3}\ M\ \mathrm{Mg(NO_3)_2}(aq)$ with 50.00 mL of $2.80\times10^{-4}\ M\ \mathrm{NaOH}(aq)$, as shown in the diagram. Calculate $\left[\mathrm{Mg^{2+}}\right]$ 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.

$$\mathrm{Mg(OH)_2}(s) \rightleftarrows \mathrm{Mg^{2+}}(aq) + 2\ \mathrm{OH^-}(aq) \quad K_{sp} = 5.61\times10^{-12}$$

i. Write the expression for the solubility product constant, K_{sp}.

ii. After the two solutions are combined in beaker 3 as described in part D, but before any reaction takes place, $\left[\mathrm{OH^-}\right] = 1.65\times10^{-4}\ M$. Using your answer to part D, calculate the value of the reaction quotient, Q.

iii. 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 $\mathrm{HNO_3}(aq)$ to decrease the pH of a saturated solution containing undissolved $\mathrm{Mg(OH)_2}(s)$. Does the amount of undissolved $\mathrm{Mg(OH)_2}(s)$ increase, decrease, or remain the same as the $\mathrm{HNO_3}(aq)$ is added? Justify your answer.