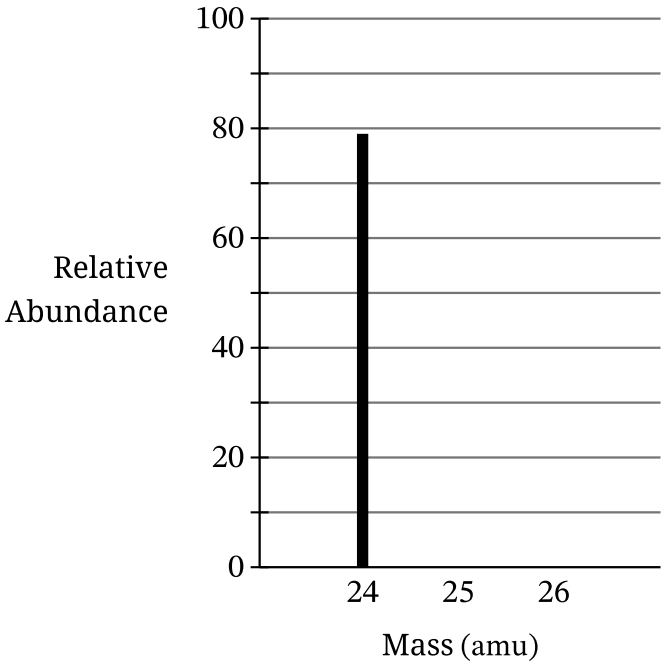
1. Answer the following questions about magnesium.

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

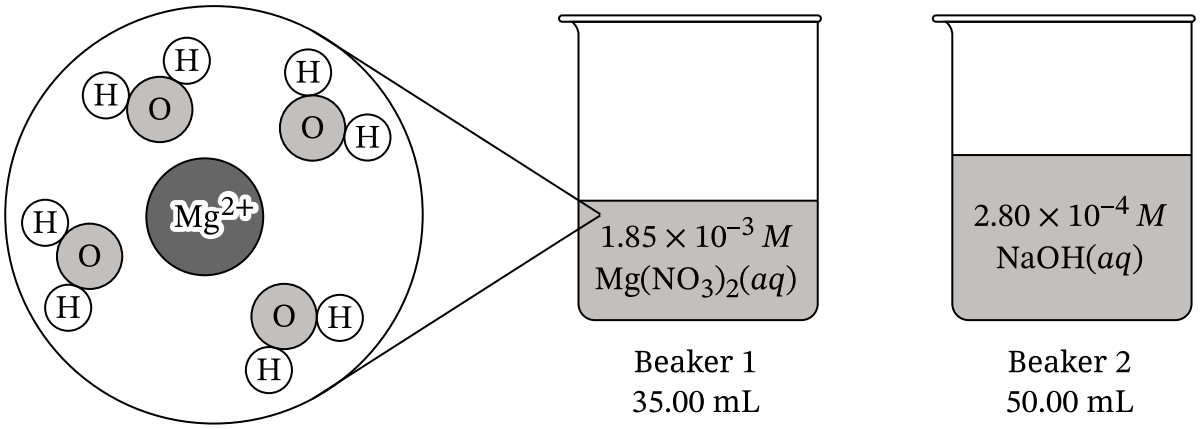


The percent abundance of magnesium-24 is 79%. The percent abundances of the other two natural isotopes of magnesium, magnesium-25 and magnesium-26, are approximately equal.

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

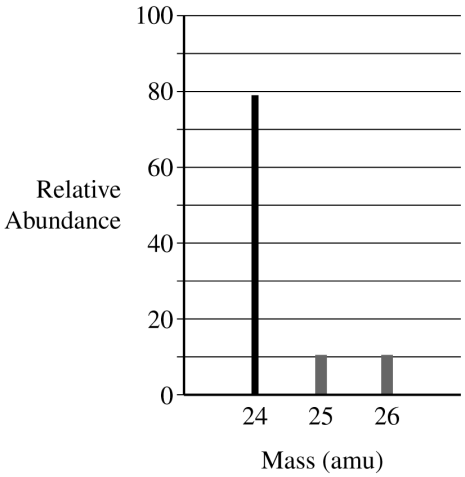
ii. The relative radii of the ions

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

Question 1: Long Answer — 10 points

A (i) For the correct plotted lines: **Point 01**

The abundance for the two lines should be between 10 and 11.



(ii) For the correct answer: **Point 02**

Magnesium-26 has one more neutron than magnesium-25 does.

B (i) For a correct explanation: **Point 03**

The charge on the sodium ion is less than the charge on the magnesium ion. A smaller charge results in a weaker Coulombic attraction between Na^+ *and water.*

(ii) For a correct explanation: **Point 04**

The Na^+ *ion is larger than the* Mg^{2+} *ion, so the distance between the* Na^+ *and the oxygen on the water molecule will be greater. As distance increases, Coulombic attraction decreases.*

C For the correct calculated value: **Point 05**

$$pOH = -\log(2.80 \times 10^{-4}) = 3.553$$

$$pH = 14 - pOH = 14 - 3.553 = 10.447$$

D For the correct calculated value: **Point 06**

$$M_1V_1 = M_2V_2$$

$$M_2 = \frac{(1.85 \times 10^{-3}\,M)(0.03500\text{ L})}{(0.03500\text{ L} + 0.05000\text{ L})} = 7.62 \times 10^{-4}\,M$$