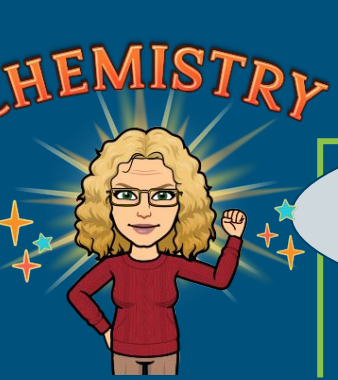
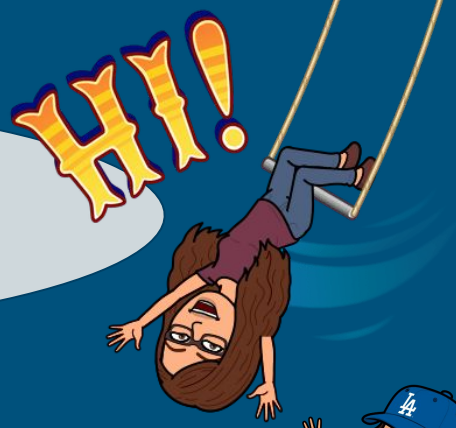
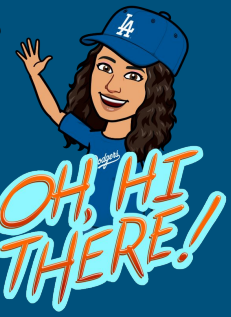


So glad you are here! Feel free to introduce yourself in the chat!

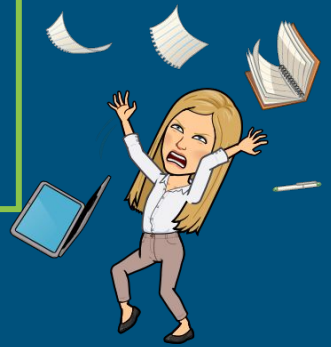


Welcome to APTeach: What's the attraction with Coulomb's Law?



PLEASE reach out to join us for planning sessions!!

AP TEACH
9.25.25



Here's how to find us!

Option 1: Sign up at ChemEdX for free (no need to choose the paid options) on the ChemEd X web site to receive updates via the email Newsletter and Facebook for future sessions!

Option 2: We are also on Facebook!

Join us online

2018 3b shows nucleus - electron

(3c shows ion-dipole) [Link to 2018 Scoring Guidelines]

Ion	Ionic Radius (pm)
Fe^{2+}	92
Fe^{3+}	79

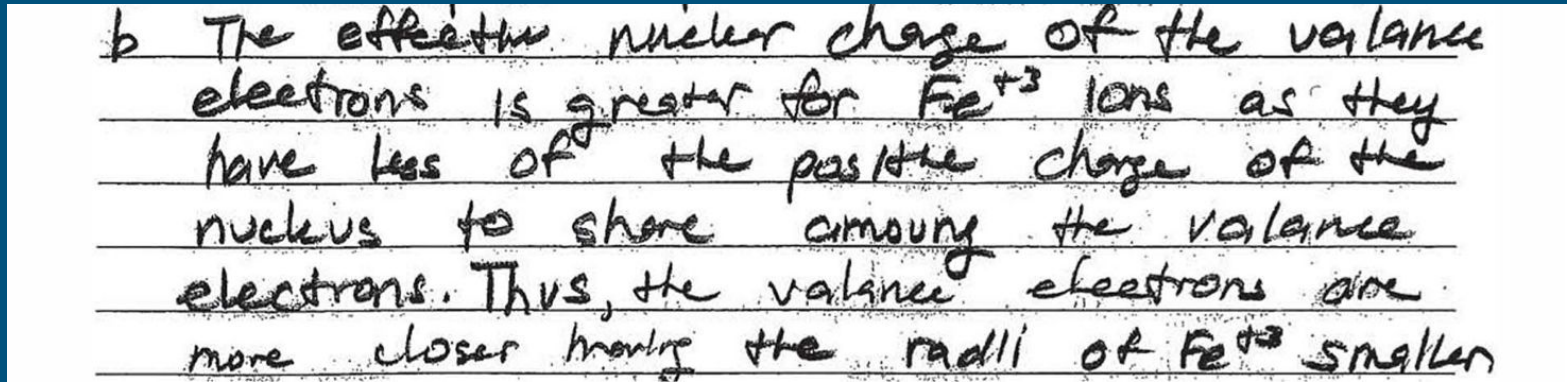
(b) The radii of the ions are given in the table above. Using principles of atomic structure, explain why the radius of the Fe^{2+} ion is larger than the radius of the Fe^{3+} ion.

Both ions have the same nuclear charge; however, the greater number of electrons in the outermost shell of Fe^{2+} results in greater electron-electron repulsion within that shell, leading to a larger radius.	1 point is earned for a valid explanation

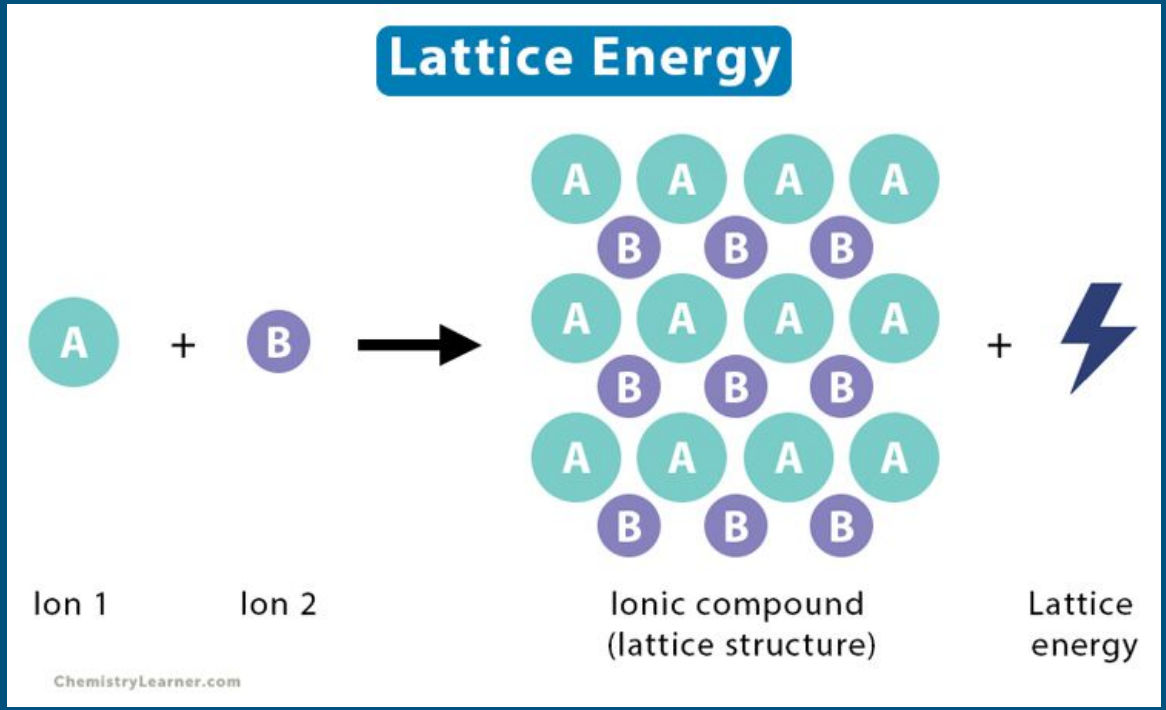
2018 3b shows nucleus - electron

- More electron-electron repulsion increases the radius in Fe^{2+}
- Fewer electrons means higher effective nuclear charge, more attraction between protons in the nucleus and valence electrons decreases the radius in Fe^{3+}

No point for the answer below because the electron repulsion isn't discussed


b The effective nuclear charge of the valance electrons is greater for Fe^{+3} ions as they have less of the positive charge of the nucleus to share among the valance electrons. Thus, the valance electrons are more closer having the radii of Fe^{+3} smaller

Attractive Forces - Cations and Anion in Ionic Compounds



AP 2017 FR Q6b

Link to 2017 Scoring Guidelines

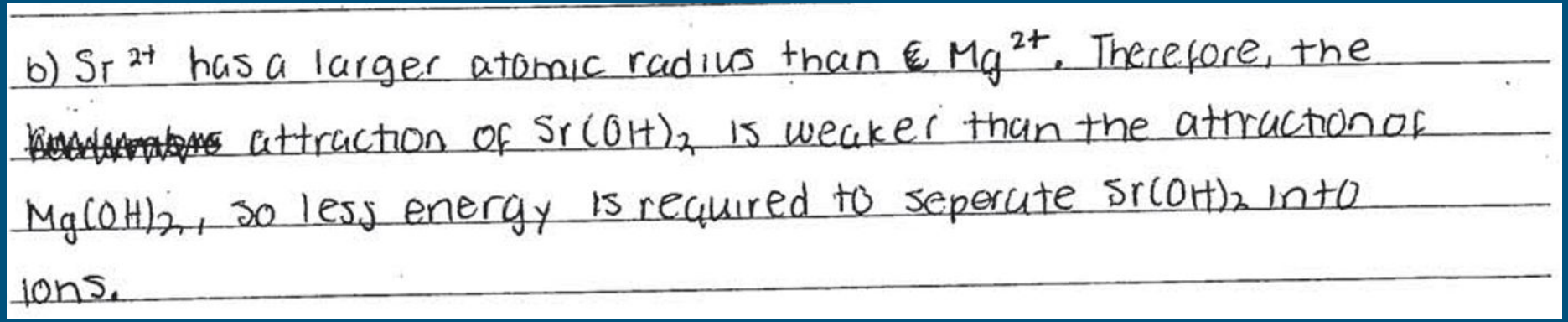
(b) The energy required to separate the ions in the $Mg(OH)_2$ crystal lattice into individual $Mg^{2+}(g)$ and $OH^-(g)$ ions, as represented in the table below, is known as the lattice energy of $Mg(OH)_2(s)$. As shown in the table, the lattice energy of $Sr(OH)_2(s)$ is less than the lattice energy of $Mg(OH)_2(s)$. Explain why in terms of periodic properties and Coulomb's law.

Reaction	Lattice Energy (kJ/mol)
$Mg(OH)_2(s) \rightarrow Mg^{2+}(g) + 2\ OH^-(g)$	2900
$Sr(OH)_2(s) \rightarrow Sr^{2+}(g) + 2\ OH^-(g)$	2300

1 point is earned for the correct comparison of cation sizes.

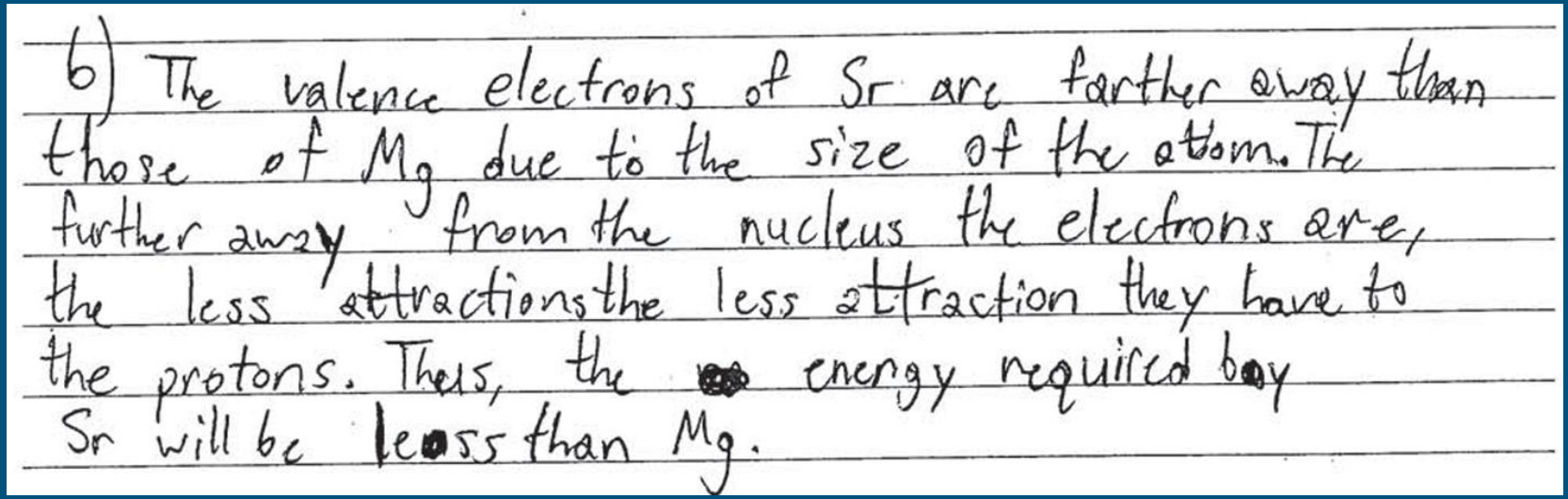
1 point is earned for indicating that smaller interionic distances lead to a greater lattice energy.

Sample Answer #1


b) Sr^{2+} has a larger atomic radius than Mg^{2+}. Therefore, the attraction of $Sr(OH)_2$ is weaker than the attraction of $Mg(OH)_2$, so less energy is required to seperate $Sr(OH)_2$ into ions.

Student received one point. Student discuss that Sr^{2+} has a greater ionic radius than Mg^{2+}, but does not mention the distance between cation and anion. Not clear which attractions student discussing.

Sample Answer #2


b) The valence electrons of Sr are farther away than those of Mg due to the size of the atom. The further away from the nucleus the electrons are, the less attractions the less attraction they have to the protons. Thus, the energy required by Sr will be less than Mg.

Student received one point. Understands the relative sizes of Mg and Sr atoms. Discusses relative attraction between nucleus and electrons in atom rather than between ions.

Constructing Answers

1. Is there a difference in charge?
2. Is there are difference in distance?
3. Use Coulomb's law to complete the argument: smaller distance between cation and anion leads to greater attractive forces and larger charges on cation and anion leads to greater attractive forces

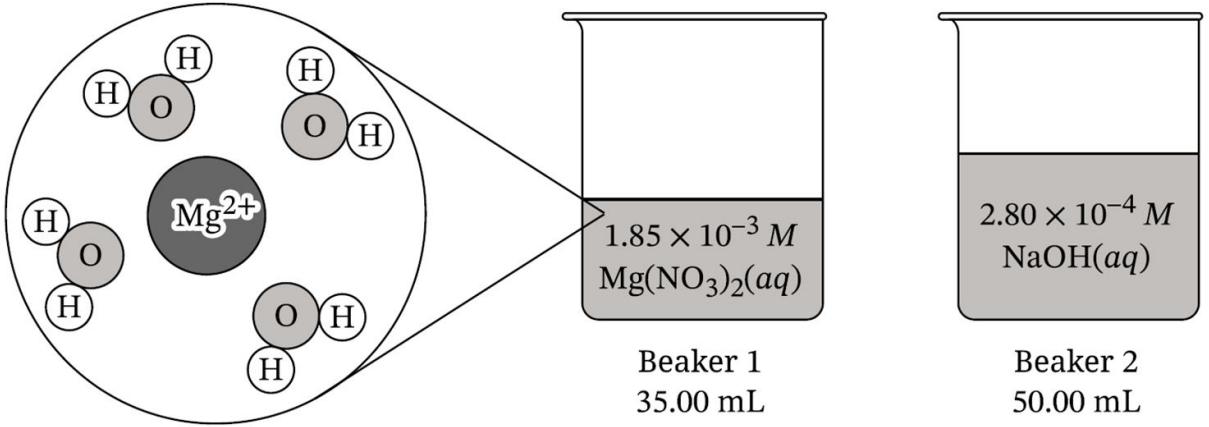
Tips

- For students:
  - Avoid using electronegativity
  - Make sure to specify the species involved
- For teachers:
  - Label the distance between the ions as d instead of r
  - Sketch particle-level diagrams of lattice and discuss the forces between the ions

2025 FRQ 1(b)

[Link to 2025 Free Response Questions]

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

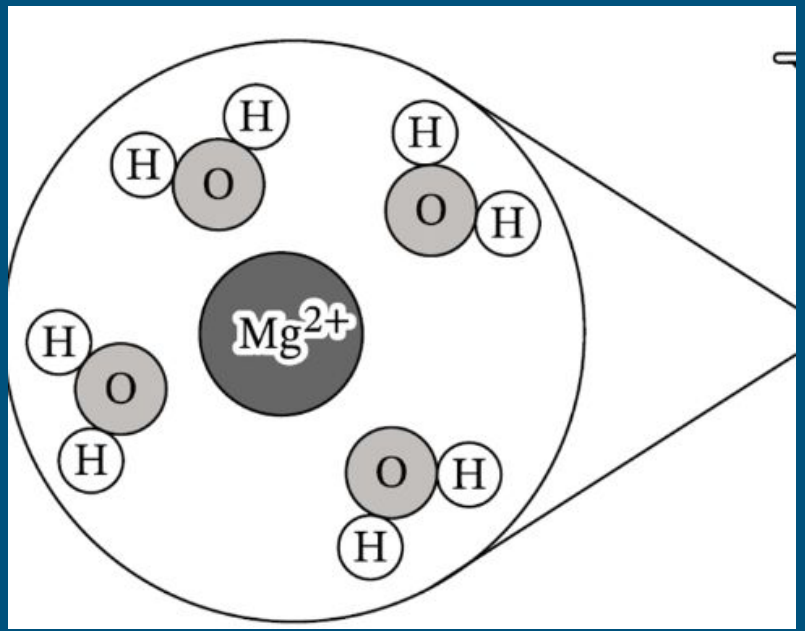
i. The relative charge of the ions

ii. The relative radii of the ions

Each part is 1 pt

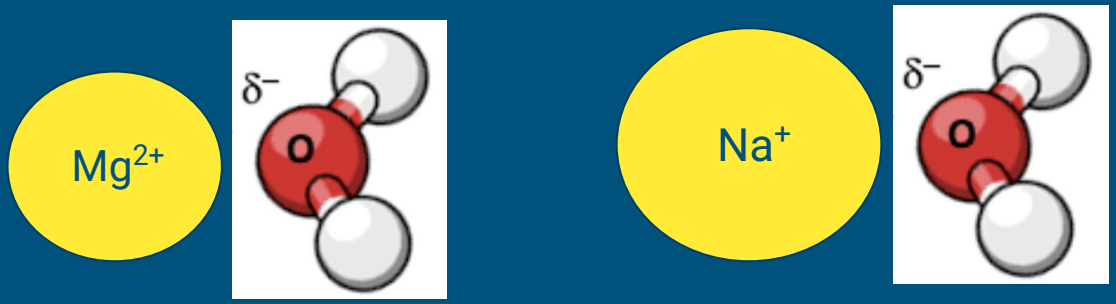
2025 FRQ 1(b)

It’s an ion:dipole attraction



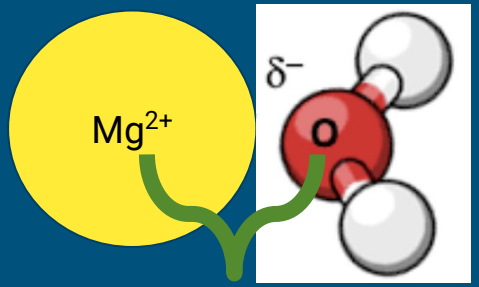
2025 #1b (i) ion - dipole attractions

- Mg^{2+} has a higher charge magnitude than Na^{+}
- ∴the attraction between Mg^{2+} and the partially negative oxygen atom in water is stronger than the attraction between Na^{+} and the partially negative oxygen atom in water
  - *Have to COMPARE the charges (simply stating the charges is not enough)*

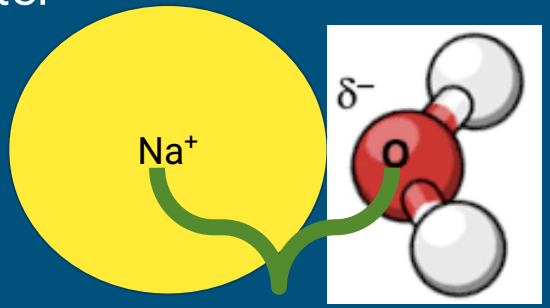


2025 #1b (ii) ion - dipole attractions

- Mg^{2+} has a smaller ionic radius than Na^{+}
- ∴the distance between Mg^{2+} and the partially negative oxygen atom in water is shorter than the distance between Na^{+} and the partially negative oxygen atom in water



Shorter interparticle distance so stronger Coulombic attraction



Longer interparticle distance so weaker Coulombic attraction

2025 #1b (ii) ion - dipole attractions

- Mg^{2+} has a smaller ionic radius than Na^{+}
- ∴the distance between Mg^{2+} and the partially negative oxygen atom in water is shorter than the distance between Na^{+} and the partially negative oxygen atom in water
-
  - It's NOT asking about WHY the Mg^{2+} radius is shorter than the Na^{+} radius
    - It's NOT about the distance between the nucleus and the valence electrons

It’s still all about Coulomb’s Law

Correctly identify the particles that are interacting! Answer the question!

First: compare charge magnitudes

Second: compare interparticle distance

Apply Coulomb’s law to complete the argument:

a. Higher charge magnitudes: stronger attraction
b. Shorter interparticle distance: stronger attraction

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