

Atomic Radii Information Page

Search Terms:

- What are periodic trends?
- Periodic trends
- Atomic radius, periodic trend
- How do periodic trends affect atomic radius?
- Atomic radius, Coulomb's law
- Atom size and periodic table
- Why does the size of an atom decrease as you go from left to right across the periodic table?
- Explanation of atomic radii trends and examples
- Why does the size of an atom increase as you go down a family in the periodic table?
- Ionic radii
- Atomic and ionic radius

Broad definition of what we are considering

- We are considering primarily the conceptual understanding related to atomic radii and what causes the atomic radius to increase down a column and increase left to right across a row.
- We will NOT consider videos that just present the trends and then use the trends to answer questions/problems like which atom of X, Y, Z has the largest radius.

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Johnstone's Triangle Elements

Element	Examples
Macroscopic	<i>General Definition for Macro: things we can see (observations) OR specific measurements.</i> Reported measurements of atomic radii. Must give actual radii for this to be macroscopic. Reactivity can be a macroscopic representation, but there must be some specific reaction (e.g. alkali metals reacting with water)
Symbolic	<i>General Definition for Symbolic: standardized, discipline-specific short-form representations that efficiently communicate significant information. It is a universal shorthand that bridges the macroscopic and particulate levels.</i> Periodic table is a symbolic representation IF connected to the concept (i.e. including the arrows to show trends across a row and/or down a column). Zeff calculations, nucleus with circles around it indicating shells without electrons depicted. Graphs that show trends in atomic radii. Element or ion abbreviations are considered symbols if used directly with the topic (e.g. comparing Li, Na,

	K... or Na and Na ⁺)
Particulate	<i>General Definition for Particulate: visual model that helps “visualize” arrangement, movement, interaction, or composition of matter as it relates to the concept of interest</i> E.g. Particle depictions showing examples of atoms and their relative sizes in periodic table (need to show trend - just two atoms like Li and Ne is not enough). Bohr model of the atom showing # protons in the nucleus and electrons in orbits around the nucleus (Note: if electrons are not present - just nucleus and rings, we are saying that is symbolic); particle level depictions of how radii (covalent or vanderWaals) radii are measured
Connection between levels	Videos should make explicit connections between two or more levels for this to be coded as present. For example, showing a table with relative sizes of atoms and giving values for atomic radii. Graph of atomic radii if explicitly connected to the PT - Just saying you can see the trend in radii going across the PT is not good enough.

Core Ideas

Core Idea Elements	
Atomic/Molecular Structure & Properties	Electrostatic Bonding and Interactions
The macroscopic physical and chemical properties of a substance are determined by the three-dimensional structure, the distribution of electron density, and the nature and extent of noncovalent interactions between the particles. Video needs to include: A description of how the variability of radii will result in different macroscopic or chemical properties (e.g. greater reactivity of alkali metals further down the periodic table)	Attractive and repulsive electrostatic forces govern noncovalent and bonding (covalent and ionic) interactions between atoms and molecules. The strength of these forces depends on the magnitude of the charges involved and the distances between them. Video needs to include: Must explicitly address the attractive forces between the nucleus and the electrons and how it varies depending on the number of protons and/or the distance. (e.g. addressing Coulomb's Law) - don't need to specifically say Coulomb's Law but cannot just say increasing/decreasing Z_{eff} OR increasing/decreasing force of attraction and not address WHY.

Scientific Practices

Note: A trend is a phenomena/observation so as these videos are focused on trends, all should have phenomena/observations - so what we need to focus on is whether a complete explanation is given.

If videos have CMR, they will then by default also have SP of at least Constructing Explanations.

Scientific Practices Criteria (must satisfy all criteria)
SP 1: Asking Questions ☐ Instruction presents an event, observation, phenomenon, data, scenario, or model. ☐ Instruction has instructor/students <i>generate</i> an empirically testable question about the given event, observation, phenomenon, data, scenario, or model. (Question cannot be rhetorical or simply a part of instruction; rather it must be a <i>process of generating</i> a testable question.)
SP 2: Developing and Using Models ☐ Instruction presents an event, observation, or phenomenon for instructor/students to explain or make a prediction about. ☐ Instruction presents a representation or asks instructor/students to construct a representation. ☐ Instruction has instructor/students explain or make a prediction about the event, observation, or phenomenon. ☐ Instruction has instructor/students provide the reasoning that links the representation to their explanation or prediction.
SP 3: Planning Investigations ☐ Instruction poses a scientific question, claim, or hypothesis to be investigated. ☐ Instruction has instructor/students describe or design an investigation, or identify the observations required to answer the question or test the claim or hypothesis. ☐ Instruction has instructor/students justify how their description, design, or observations can be used to answer the question or test the claim or hypothesis.
SP 4: Analyzing and Interpreting Data ☐ Instruction presents a scientific question, claim, or hypothesis to be investigated. ☐ Instruction provides a representation of data (table, graph, or list of observations) used to answer the question or test the claim or hypothesis. ☐ Instruction provides an analysis of the data or asks instructor/students to analyze the data. ☐ Instruction has instructor/students interpret the results or assess the validity of the conclusions in the context of the scientific question, claim, or hypothesis.
SP 5: Using Mathematics and Computational Thinking ☐ Instruction presents an event, observation, or phenomenon. ☐ Instruction has instructor/students perform a calculation or statistical test, generate a mathematical representation, or demonstrate a relationship between parameters. ☐ Instruction has instructor/students give a consequence or an interpretation in words, diagrams, symbols, or graphs of their mathematical results while demonstrating reasoning in the context of the given event, observation, or phenomenon.
SP 6: Constructing Explanations and Engaging in Argument from Evidence ☐ Instruction presents an event, observation, or phenomenon. ☐ Instruction presents or asks instructor/students to make a claim based on the given event, observation, or phenomenon. ☐ Instruction has instructor/students provide scientific principles or evidence (data or observations) to support the claim. ☐ Instruction has instructor/students provide reasoning about why the scientific principles or evidence support the claim.

SP 7: Evaluating Information

- ❑ Instruction provides an excerpt from a conversation, article, student solution, or other communication that makes one or more assertions.
- ❑ Instruction presents a conclusion about the validity of the assertion(s) made or asks instructor/students to make a conclusion about the validity of the assertion(s), or reconcile multiple assertions with each other.
- ❑ Instruction has instructor/students provide reasoning to support their conclusion(s) about the validity of the assertion(s) or reconciliation with data, observations, or scientific principles.

Causal Mechanistic Reasoning - Must have Both How and Why!

Option 1: What causes atoms to get smaller going across the periodic table? (Linked to electrostatic interactions)

- **How:** As we go across the periodic table, atoms gain an additional proton and *electron in the same electron shell (must explicitly address this)*. This will increase the attractive force (Z or Z_{eff}) between the electrons and the proton.
- **Why:** Increased attractive forces between the electron and the nucleus will pull the electrons in more strongly. Electrons at the same shell do not effectively screen each other from the nucleus (this would be good to include but not required). The answer should address the concept of Coulomb's Law, though specifically naming it is not required.

Option 2: What causes atoms to get larger going down the periodic table? (Linked to electrostatic interactions)

- **How:** As we go down the periodic table, atoms gain an additional occupied shells of electrons and size of atom is determined by electron cloud (this can be implicit - e.g., showing larger size with more "rings").
- **Why:** Increased shells will increase the distance of the electrons from the nucleus. Although the nucleus also has more protons, the Z_{eff} will remain relatively constant meaning that the outermost electrons do not experience a greater pull OR force of attraction is inversely proportional to the distance so electrons in shells further from the nucleus experience a weaker force of attraction.

Option 3: What causes cations to be smaller than their neutral atoms? (cations)

- **How:** Cations have fewer electrons than their related neutral atom.
- **Why:** When electrons are lost, still holding the same number of protons, there's a stronger attraction for the remaining electrons because there are fewer. OR If removing electrons results in fewer electron shells being filled, then can use the rationale that the remaining shells are closer to the nucleus making is smaller.

Option 4: What causes anions to be bigger than their neutral atoms? (anions)

- **How:** Anions have more electrons than their neutral atom counterpart.
- **Why:** When electrons are gained, electron-electron repulsion forces increase, while Z_{eff} remains the same and the overall size of the atom increases.

Option 5: What effect does atomic radius have on chemical reactivity within a group?

- **How:** Chemical reactivity depends on valence electrons and atomic radius affects the strength of the attraction for valence electrons.
- **Why:** Electrons that are further from the nucleus will be attracted to the nucleus with a lesser force (higher energy) so are easier to remove and/or electrons closer to the nucleus will be attracted to the nucleus with greater force so exert stronger attraction on valence electrons from other atoms (e.g., F is more reactive than I as it is smaller in size and thus attracts electrons more effectively). The answer should address the concept of Coulomb's Law (strength of attraction decreases exponentially with distance), though specifically naming it is not required.

Must address both aspects of the why.

Multimedia Principles

Multimedia learning as knowledge construction: The goal of multimedia presentations is not only to present information but also to provide guidance for how to process the presented information – that is, for determining what to pay attention to, how to mentally organize it, and how to relate it to prior knowledge. We will categorize the videos along each of the following criteria (High and Low should be mutually exclusive.)

High	Low
• Video almost exclusively involves <u>meaningful and relevant</u> images and verbal components <u>AND images are explained for a novice learner</u> • Text on screen is minimal (ex. Only brief bullet points or keywords if text is used) • Content is all relevant to the topic and learning (no music, unhelpful animations, graphics, etc.) • Contains elements that meaningfully support student organizing content or identify key ideas (introductory organizer, section heading, summary, guiding questions/topic (for short, focused video only) Key Question: Could a novice learner clearly understand what they should take away from the video? Yes=high.	• Large segments of video are presented just verbally and not pictorially (ex. just the instructor talking, or just written words) OR images presented are not relevant to learning or explained • Contains full sentences of written text that are also narrated (<i>e.g., several bullet points or sentences on one screen OR full sentences of text on many screens includes forced closed captioning</i>) • Contains extraneous content, music, graphics, animations, background changes, sounds, or just too much stuff on the screen at one time - anything that detracts attention from core content • Does not contain any elements that meaningfully help learners organize content or identify key ideas (e.g., no introductory organizer, section headings, video segments, summary, guiding question/topic (for short focused videos only)

Misleading vs. Inaccuracies

- Several minor spelling issues is misleading, not inaccurate

Captions

- Videos with full on-screen captions (that can not be removed) are considered “low” for multimedia when considering text usage.

Self-Assessment

- Self-assessment needs to be relevant to the general conceptual idea, and there needs to be enough pause or verbal suggestion to imply to a watcher they should take time to answer the question.