The Attraction Is REAL

Intermolecular Forces

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Grade Level	9th – 12th Grade	**Time Frame**	4-5 class period(s)
Subject	Science	**Duration**	200 minutes
Course	Chemistry, Physical Science		

Essential Question

How do the interactions between molecules affect chemical properties?

Summary

In this lesson, students will explore, learn, and connect concepts of Intermolecular Forces (IMFs) to physical phenomena. Prerequisite knowledge would be that bonding exists (that is, there is continuum from non-polar covalent to ionic bonding) as well as the formation of ions and electron configuration. This lesson has add-ons to make it effective for AP Chemistry as well.

Snapshot

Engage

Students determine how many paper clips can fit inside of a full glass of water.

Explore

Students investigate different intermolecular forces using the Jigsaw strategy.

Explain

Students present their Jigsaw findings.

Extend

Students classify phenomena into the different intermolecular forces.

Evaluate

Students share out their answers from the Extend in an inverted pyramid.

Standards

ACT College and Career Readiness Standards - Science (6-12)

IOD505: Analyze presented information when given new, simple information
SIN201: Find basic information in text that describes a simple experiment
SIN502: Predict the results of an additional trial or measurement in an experiment
EMI401: Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with a data presentation, model, or piece of information in text
EMI502: Determine whether presented information, or new information, supports or contradicts a simple hypothesis or conclusion, and why
EMI505: Determine which experimental results or models support or contradict a hypothesis, prediction, or conclusion

Next Generation Science Standards (Grades 9, 10, 11, 12)

HS-PS1-3: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

Attachments

- Claim Cards KEY—The Attraction Is Real.docx
- Claim Cards KEY—The Attraction Is Real.pdf
- Claim Cards—The Attraction Is Real - Spanish.docx
- Claim Cards—The Attraction Is Real - Spanish.pdf
- Claim Cards—The Attraction Is Real.docx
- Claim Cards—The Attraction Is Real.pdf
- Cornell Notes—The Attraction Is Real - Spanish.docx
- Cornell Notes—The Attraction Is Real - Spanish.pdf
- Cornell Notes—The Attraction Is Real.docx
- Cornell Notes—The Attraction Is Real.pdf
- IMF Research Questions—The Attraction Is Real - Spanish.docx
- IMF Research Questions—The Attraction Is Real - Spanish.pdf
- IMF Research Questions—The Attraction Is Real.docx
- IMF Research Questions—The Attraction Is Real.pdf
- Lesson Slides—The Attraction is REAL.pptx
- Paper Clip Activity—The Attraction Is Real - Spanish.docx
- Paper Clip Activity—The Attraction Is Real - Spanish.pdf
- Paper Clip Activity—The Attraction Is Real.docx
- Paper Clip Activity—The Attraction Is Real.pdf
- Teacher SetUp—The Attraction Is Real.docx
- Teacher SetUp—The Attraction Is Real.pdf

Materials

- Lesson Slides (attached)
- Paper Clip Activity (attached, one per student)
- IMF Research Questions (attached, one per student)
- Claim Cards (attached, one per group)
- Claim Cards KEY (attached)
- Cornell Notes (attached, one per student)
- Teacher SetUp (attached)
- Small plastic cups (Dixie would be fine; enough for a class set)
- Water
- Paperclips (enough for each group to have well over 100 paperclips)

- Devices with computer access
- All the supplies listed in the Teacher SetUp

10 minutes

Engage

Make copies and pass out the **Paper Clip Activity** handout. Put students in groups of 3-5. Each group will need a small plastic cup filled to the brim with water and hundreds of paper clips.

Go to **slide 4**, instruct students to make a hypothesis about how many paper clips can fit into the very full glass of water before the water spills over the cup. Then tell the students to add the paperclips SLOWLY to the full glass of water.

What To Expect

Most students will predict less than 30 paperclips, but the real answer is HUNDREDS of paperclips.

Go to slide 5, ask the students to revisit their original hypothesis and revise it based on what they observed.

Academic Language

Hopefully their revisions will include the words cohesion, surface tension, etc., especially if your students have already had biology. If they're almost there but need some nudging, it's ok to help refresh their memories.

30 minutes

Explore

Split the students into four groups so that a modified Jigsaw can start. *If this is an AP Chemistry class, five, maybe six, groups would be needed*

Assign each group one of the following:

- Hydrogen Bonding
- London Dispersion Forces
- Dipole-Dipole
- Induced Dipole
- *Ionic Bonding (for AP Chemistry; yes, it is a bond, but it is technically a very strong intramolecular force without the merging of electron clouds, something AP Chem students need to grasp)
- *Van der Waals forces (for AP Chemistry; this one is also tricky since London Dispersion Forces, Hydrogen Bonding, and Dipole-Dipole are all Van der Waals forces)

Go to **slide 6**, make copies and pass out the **IMF Research Questions** handout or display the questions that students need to answer about their specific IMF, and allow the students to research their IMF and construct a presentation over it.

40 minutes

Explain

Go to **slide 7**, after the students have conducted their research and made their presentations, make copies and pass out the **Cornell Notes.** Have the groups present their IMF presentations to the class and fill out the notes as each group presents.

Stay Engaged

To help students stay engaged during presentations, try having them do a strategy like 3-2-1 or something similar to help them summarize what they are learning about from their peers. If doing a 3-2-1, present students with the writing prompt: What are three things you learned? What are two questions you still have? What is one thing you found interesting? for each of the presentations (excluding their own). This might seem time consuming but will help student stay focused and can be used to formatively assess student learning. Students could also share some of their questions that they had with the presenting group so their questions can be answered by their peers.

After the presentations, students will participate in the Claim Cards strategy. Go to **slide 8** and pass out a set of **Claim Cards** to each group. Have each group discuss whether each claim is correct or incorrect, and why each is correct or incorrect. When the discussion is over, talk about the answers (which is in the teacher key).

60 minutes

Extend

Set-Up Is A Must

If you are doing the demonstrations in person, you must have everything set-up and ready to go before the class starts. To save time and help keep students stay engaged, set-up demos using the **Teacher SetUp** guide and read through procedures before class. Demos can be done as a class with student volunteers assisting. This would allow students to be actively engaged while ensuring safety for everyone.

There are 5 different reactions that you will show the students:

- Bent Water
- Oil, Water, and Dish Soap
- Mixing Water and Ethanol
- Mixing iodine in various solutions
- Mixture of water, ethanol, and potassium carbonate

Go to **slide 9** and present each demonstration to the students. During and after each demonstration, have the students write down which IMF (or IMFs) are cause what they are observing.

On The Cheap

If you can't or don't have access to the materials, there are plenty of videos of all of these phenomena on the internet. However, the best option would be to have student see these phenomena in real time if at all possible. Seeing anything in person is more impactful than seeing it in a video. If there are just a few materials that you can't find, some demo stations could be set up with video while others have hands on materials.

Acknowledging Limitations

Keep in mind, all of these demos involve water, and so there's a limited scope of all the IMFs in the demos listed. If you find more phenomena that show more, awesome. If you feel the need to add in more, that is understandable.

20 minutes

Evaluate

Go to **slide 10**. Once the demonstrations are finished and the students have their answers, pair up students to do an Inverted Pyramid. Have the pairs share their answers with each other and explain what they wrote. Then, have pairs share out their reasoning with the whole class.

Have students turn in their answers so you can read what every student wrote whether they shared out loud or not.

Resources

- Bennett, L. (2012). Intermolecular forces (IMFs). Boise State University. http://edtech2.boisestate.edu/lindabennett1/502/Bonds%20and%20IMFs/bonding%20jigsaw.html
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- K20 Center. (n.d.). Jigsaw. Strategies.https://learn.k20center.ou.edu/strategy/179
- K20 Center. (n.d.). Inverted pyramid. Strategies. https://learn.k20center.ou.edu/strategy/173