Strand: 7.1.3

**Emphasis**: models of forces

**Anticipated Time Required** (assuming 50 minute class periods): 5 periods

**Dominant CCC**: cause and effect  
**Dominant SEP**: constructing models

**Management Strategies** to support equitable access to content: Famous Pairs and Fantastic 4

**Shopping list:**
- Pvc pipe
- Rag
- Match sticks
- Wire
- Glass containers
- Plexiglass (acrylic) sheet
- Tin foil
- Styrofoam balls
- Thread
- Tape
- Plastic grocery bags
- Styrofoam plates
- Bubble solution
- Shallow cardboard box
- Wooden blocks
- Bubble solution
- Balloons
- Glass container
- Cork
- Styrofoam cup
- Whiteboards or poster paper
- Markers
- Sticky notes
## Storyline Overview 7.1.3

**Anchor Phenomenon:**
Pouring water into a glass until no more water can be poured forming a dome that hangs off the edge of the cup or on a penny using a pipet.

**Student Performance Expectation:**
Construct a model using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects such as magnets or electrically charged objects and the forces they exert.

<table>
<thead>
<tr>
<th>Dominant DCI</th>
<th>Dominant CCC</th>
<th>Dominant SEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Science</td>
<td>Cause and effect Systems and system models</td>
<td>Construct a model</td>
</tr>
</tbody>
</table>

### Science Experiences

<table>
<thead>
<tr>
<th>CCC/SEP</th>
<th>What are students doing? (This should match your SEP!)</th>
<th>What specific understandings should students get from this experience? (What pieces of the performance expectation does the experience provide?)</th>
<th>New questions students have to propel us to the next science experience</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Cause and effect/Questioning</td>
<td>Pour water into a container until it bulges without spilling (penny or cup)</td>
<td>Construct mental models of forces acting within the system. Recognize another force (besides gravity) acting on the water. FORCE is a push or a pull. A FIELD is an invisible zone where the force is effective. Forces are EXERTED on other objects in the FORCE FIELD</td>
<td>Why doesn't the water fall down? What force holds the water together?</td>
<td>OEQ template in journal Define Force in journal Define Field in journal Define Exert in journal Construct a model and an explanation of the forces acting in and out of the water in journal. Some students share explanations with the class. Students transfer questions from their journals and put on sticky notes and bring to a parking lot on the board.</td>
</tr>
<tr>
<td>2</td>
<td>patterns/constructing a model</td>
<td>Examine and generate questions about examples of spheres in nature. Observe many planets and identify pattern that all planets are round. Why is that? Construct a model of the earth, including people at different positions around the earth and showing which way is “down.”</td>
<td>Round is often a default shape in nature. Gravity is a force that pulls everything towards center. There is no such thing as “down.” GRAVITATIONAL FIELDS pull things towards the center.</td>
<td>What force is holding water together? When do we see forces pull? When do we see forces push? How far do gravitational fields extend? Does gravity make everything round? Are there other forces that exert fields like gravity? Is that why water forms a sphere in microgravity?</td>
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</tr>
<tr>
<td>3</td>
<td>Cause and effect/carrying out investigations, constructing and using models</td>
<td>Conduct research on several items to explore the properties of static and opposite charges</td>
<td>Students will observe that some force is being transferred between objects that make them attract</td>
<td>What is being transferred? How far do electric fields extend? Which is stronger, gravity or electric charge?</td>
</tr>
<tr>
<td>4</td>
<td>Systems and system models/obtaining information using math and computational thinking</td>
<td>Direct Instruction: Students obtain, evaluate and communicate about the structure of Atoms with positive particles in nucleus (protons) and negative charges around the outside (negative) Review rules for</td>
<td>All matter is made of ATOMS that are composed of particles. POSITIVE CHARGED particles are in the nucleus (protons) and NEGATIVE CHARGED particles are found around the outside (electrons).</td>
<td>How do electrons transfer? What happens when they transfer? Will that make objects attracted to each other?</td>
</tr>
<tr>
<td>5</td>
<td>Cause and effects/analyzing and interpreting data. And developing and using a model</td>
<td>Explore positive and negative charges for the objects in the lab. Construct a model of one station showing objects, charges and observed effects. Students should consider how this relates to the phenomenon of water forming a sphere in microgravity.</td>
<td>PVC and balloons acquire a negative charge when rubbed with a towel or fur. Opposite charges attract, negative charges, and neutral objects are neither attracted nor repelled. Charged objects have fields that act at a distance Water is only attracted to charged objects.</td>
<td>Does water have a charge? What is the charge of the water? Is water magnetic? Does water have static electricity? Make observations and construct models of electric fields based on observations. Group models of concepts highlighted at stations.</td>
</tr>
<tr>
<td>6</td>
<td>Cause and effect/ Students Observe demonstration of water</td>
<td>The polarity of water makes it stick to itself like</td>
<td>Is this why water sticks to other</td>
<td>Ask Questions about the structure of water.</td>
</tr>
<tr>
<td>developing and using a model</td>
<td>moving towards charged PVC pipe. Direct instruction: Polarity, polarity of water, and the relationship between atoms and molecules.</td>
<td>little magnets.</td>
<td>things? Is magnetism related to electric charges since the same rules apply</td>
<td>Students construct preliminary a model of magnetic fields between water molecules. Random students selected to share model.</td>
</tr>
<tr>
<td>----------------------------</td>
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<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Cause and effect /obtaining information systems/ constructing and using models</td>
<td>Students will list all of the forces that are acting on and within the glass of water. Students introduced to the word SYSTEM Direct Instruction - There are 4 forces in the universe</td>
<td>There are many forces acting on every system. There are 4 major forces in the universe: Strong force and Weak force, gravity, electric/magnetic force. Strong and weak forces are found in the atom and will be discussed next year. 7th grade focuses on gravity and electric/magnetic forces and Fields (electromagnetic forces). The structure and behavior of everything in the universe can be explained with these 4 forces.</td>
<td>What is the effect of two or more forces acting in a system? Are these forces universal? Did these forces create the earth?</td>
<td>Vocabulary review game Worksheet - Students construct a model of the forces acting in this system including gravity, electric charges transferred within water molecules and magnetic attraction between water molecules. Complete worksheet questions on 4 major forces Ask Questions</td>
</tr>
</tbody>
</table>
## 7.1.3 Episode 1

### Student Science Performance

<table>
<thead>
<tr>
<th>Topic: Forces and Fields</th>
<th>Title: Forces and Fields</th>
</tr>
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</table>

### Overarching Performance Expectations (Standard) from State Standards or NGSS:
Construct a model using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects (such as magnets or electrically-charged objects) and the forces they exert.

### Lesson Performance Expectations: Students will observe two phenomena related to cohesion of water. Students will make observations, attempt an explanation, and ask questions related to the phenomenon in an attempt to determine the cause of the effects they observe in this system. Students will learn the language tools scientists use to model forces and fields.

**CCC:** Cause and Effect and systems and system models  
**SEP:** Asking Questions, Developing and Using models

<table>
<thead>
<tr>
<th>Students Will... To Construct Meaning</th>
<th>Teacher Will... To Support Students</th>
</tr>
</thead>
</table>
| **Management Strategy:** Famous Couples  
Students should be given a card and matched with their “famous partner” (cookie, milk; french fries, ketchup; Bert and Ernie, etc.)  
Students construct the Observation/Explanation/Question (OEQ) template in journal.  

Phenomenon,  
Students pour water into a container until it bulges over the top without falling.  
(Students could also drop water on a penny for the same effect if pipettes are available).  
(Students can film in slow motion with their phones in possible to help with their observations.)  

Phenomenon:  
Student watches the behavior of water in space  

<table>
<thead>
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<th>Management Strategy:</th>
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</tr>
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</table>
| Have students complete a OEQ template for their observations of both phenomenon in student journals.  
**Management Strategy:** Provide students with sticky notes to write questions and stick on the board in a ‘parking lot’  

Phenomenon:  
Provide students with a container of water and an empty container and paper towels.  

Phenomenon:  
Show video of water in space from ISS  
Video from ISS of astronauts wringing out wet rag.  
[https://www.youtube.com/watch?v=KFPvdNbf70Y](https://www.youtube.com/watch?v=KFPvdNbf70Y)  

Students will observe that the water beads up at the surface, if done well the water will even hang over the edge of the container without spilling. If students are able to watch in slow motion, they will see that the...
While students are engaged with the phenomenon they should be recording their observations, constructing explanations from their observations and asking questions.

Construct an inferred model and explanation as a pair that can be shared with the class.

Water forms a film or sheet at the surface. You can explain to students that this is called surface tension. Students will be aware that something is weird, but as you circulate the room, you may need to help them with the explanation and questioning by asking them to describe what is ‘weird’ about this? Why are they surprised? What did they expect? Students are aware of the effects of gravity, but will not have any understanding of the internal forces found in this system. They will construct explanations about the interaction of the water with the container, or hypothesize that there is something holding the water together.

Management Strategy: Provide whiteboards or paper and markers for students to construct their first model and explanation of the phenomenon.

Wander the room and check out their models. Look for well thought out models and explanations you could share with the class.

Review the questions brought to the board. Best Questions could be written on the board.

Management Strategy: From your observations, select one or two students to come to the board and share their models. Look for drawings that show thought and an attempt at explanation of the phenomenon. Redraw their models on the board for everyone to see. Have the class reconstruct the models you demonstrate in their journals. Help them to add arrows and vocabulary words to their models. Have the class record those models in their journals to help them better understand future expectations.

Direct Instruction in vocabulary would be appropriate to help students form questions and construct explanations. Students should use the words FORCE (a push or a pull) EXERT (the action of a force on an object) and FIELD (a region or zone of influence of that force) in the future to describe the influence of objects acting on each other without touching to either draw them together or push them apart.

Select ‘What force is holding the water together?’ as the questions that will motivate research in next episode.
Assessment of Student Learning

Students generate questions for research and participate in class discussion. Questions may be about the nature of water or the amount of gravity in space. The guiding question for the next episode will be “What is holding the water together?” Journals notes including OEQ structure may be graded for participation, however this is just an engagement activity.

OEQ Table

<table>
<thead>
<tr>
<th>Observations (FACTS, things you personally observe with your SENSES or TECHNOLOGY)</th>
<th>Explanations How you EXPLAIN your observations These are INFERENCES or GUESSES based on your observations.</th>
</tr>
</thead>
</table>

Questions: These can be questions about anything related to the phenomenon

Episode 1 - Mode / Inference with new vocabulary

Is there a FORCE here?

Gravity is a force that pulls Earth - has a gravitational FIELD that exerts a force on everything pulling it Down. Why isn’t it falling?
These are famous couples that can also become FANTASTIC 4

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7.1.3 Episode 2

**Student Science Performance**

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**Overarching Performance Expectations (Standard) from State Standards or NGSS:**
Construct a model using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects (such as magnets or electrically-charged objects) and the forces they exert.

**Lesson Performance Expectations:**
Students will construct a basic model of gravitational fields by observing patterns in behavior of objects within that field. Students will engage with multiple examples of electric fields (static). Through observations of patterns students will construct a model of electrostatic fields and recognize that electrons can be transferred between objects creating potential.

**CCC: Patterns**

**SEP: Construct and use a model**

| Students Will... To Construct Meaning Phenomenon: Students observe many images of planets and look for patterns. Students may notice several features but the guiding phenomenon for this episode is that all planets are round! Students are shown images of man objects that are naturally round. Why does nature often choose round? What role does force play here? Students are asked to constructing a model of the earth and draw people at different positions around the earth and explain what the model means about why planets are round in their journals.

Students share models and explanations with their partner. Then partners draw one of their models on a white board and compare it to the models of their neighbors and explain their models to each other. |
| Teacher Will... To Support Students Phenomenon: Show students images of planets and help students recognize an important pattern, all planets are round. Nature often chooses round: bubbles, tree rings, fruit and vegetables, ripples in water, etc. Show pictures of these round things and ask students to consider, “Why are all planets round?” “Which of these shapes were made by a force or energy?”

**Management Strategy:** Think, Pair, Share Students journal about the question, then share their thoughts with their neighbor, then bring their thoughts to a class discussion.

After discussion, instruct students to draw a planet in their journals and place people all around that planet (stick figures). Students should show with arrows which way is DOWN for every person on this ‘planet’. and write an explanation of their model and an answer to the question in their journals. Have students pairs choose one of their model to draw on a whiteboard and show to the class. Have them explain their model to two neighbor pairs. When they have had a chance to discuss their models, bring them together for a class discussion. |

H. Waite
Students consider the questions “Why do you think water forms a sphere in microgravity?” and discuss with the class.

Construct the same model on the board and use the force arrow magnets to model the gravitational field produced by earth. Call on a few students to explain the model.

Ask students
“How far do you think a gravitational field extends?”
“How close do you have to be to a gravitational field before it exerts a force on you?”

Students should carefully consider that there is no end to a force field, it goes on forever, but becomes weaker as it spreads out..kind of like light or ripples in a pond.

Best student explanations should show an understanding that the gravitational field of the earth pulls everything towards a center of gravity. That planets are round because this force pulls equally in all directions.

Ask students: (or check question board, they may have already asked the questions)
“Why do you think water forms a sphere in microgravity?”
“Is there another force besides gravity acting on or in the water?”

Their answers will vary and should guide students towards the next episode.

Assessment of Student Learning:
Students share preliminary models of gravitational fields
Students ask questions: do force fields usually pull things into a circle? What is the force that is holding the water into a sphere shape?
**Episode 2 - Model - Why Planets are Round?**

- **Hey! Down is always towards the center!**
- **No such thing as DOWN**
- **Gravitational Field goes out forever - gets weaker through infinite radius.**
- **Force of gravity pulls towards center equally from all directions.**

**Water in space?**

Inference

- ![Diagram of Earth with arrows pointing towards center]
- ![Diagram of Earth with arrows pointing in all directions]
- ![Diagram of Earth with horizontal arrows]
- ![Diagram of Earth with vertical arrows]
# 7.1.3 Episode 3

<table>
<thead>
<tr>
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</tr>
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<tbody>
<tr>
<td><strong>Topic:</strong> Forces and Fields</td>
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</table>

**Overarching Performance Expectations (Standard) from State Standards or NGSS:**
Construct a model using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects (such as magnets or electrically-charged objects) and the forces they exert.

**Lesson Performance Expectations:** Students will engage with multiple examples of electric fields (static). Through observations of patterns students will construct a model of electrostatic fields and recognize that electrons can be transferred between objects creating potential.

**CCC:** Cause and effect  
**SEP:** Carrying out an Investigation, Construct and use models

<table>
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| Students organize into groups of 4 by find a famous couple that would get along with them | Management Strategy: from famous pairs to FANTASTIC 4  
Organize students into lab groups by having famous pairs become The FANTASTIC 4 by having them pair up with a famous pair that would complement them (Bert and Ernie with Kermit and Miss Piggy or Milk and Cookies with pillow and jammies) |
| Students engage with 8 lab stations involving electric charges. | Set up 8-9 lab stations involving Electric charges: This video has 9 excellent examples of lab stations that would help students to learn about electric charge.  
**Save the one with moving water until episode 6.** |
| Students fill out OEQ template in their journals. | **Management Strategy:** Each station should have a **set of instructions** for how to successfully and carefully observe the phenomenon. Students should engage in conversation with their lab partners and complete an OEQ template in their journals.  
**Materials list is found in video but include:**  
- 1 inch Pvc pipe (about 18 inches long)  
- Rag |

H. Waite
As a group, students should decide on 2 questions to write on **sticky notes** and bring to the PARKING LOT.

**Management Strategy:** Question Parking Lot
Students should meet with their lab group and discuss their questions. They should choose their 2 BEST questions, write them on **sticky notes**, and bring them to the Parking Lot on the board for class discussion.

**Questions students may generate**
- "Is something being transferred between the towel and the pvc pipe or the balloons?"
- "Is this like magnetism?"
- "Would this work with...?"

**Assessment of Student Learning**
Students will demonstrate engagement by completing OEQ template and producing questions. Journals may be graded for participation by asking students to have a required number of observations, explanations and questions.
These are famous couples that can also become FANTASTIC 4

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<td>Kanye West and Kim Kardashian</td>
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## Overarching Performance Expectations (Standard) from State Standards or NGSS:

Construct a model using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects (such as magnets or electrically-charged objects) and the forces they exert.

## Lesson Performance Expectations:

**CCC:** Systems and System Models and Structure and Function

**SEP:** Obtaining Information, Mathematical and Computational Thinking

### Students Will... To Construct Meaning

Students will receive direct Instruction and engage in note taking in journals: Students obtain, evaluate and communicate about the structure of Atoms with positive particles in nucleus (protons) and negative charges around the outside (negative).

Students model electric fields

Recognize the many meanings of the word NEUTRAL by having students write 2 sentences using the word NEUTRAL. Students share their sentences with the class and construct a definition of the word.

### Teacher Will... To Support Students

**Management Strategy:** Review and Recognize

The 6th grade SEED standards cover atoms and molecules and their relationship, however, the depth of that conversation is unclear and it is important that students recognize that the atom is made of charged parts for them to understand electric fields. All matter is made of ATOMS that are composed of particles. Some of those particles are POSITIVE CHARGED particles which are found in the nucleus (protons) and NEGATIVELY CHARGED particles which are found moving very quickly around the outside of the atom (electrons).

Draw a simple atom model with charged particles in their proper position.

Explain to students that charged Particles exert an ELECTRIC FIELD.

In journals: have students write 2 sentences using the word NEUTRAL. There are many applications of the word, but they all have the same implied meaning: neither this nor that, not one thing, not another.
Students review and recognize rules for magnets that state that opposites attract and like charges repel.

Discuss concept of neutrality and balance.

Bringing a balance similar to this may help students understand the idea of Balanced charges (balanced forces) recognizing that the balance doesn’t move if the masses are equal, likewise, if forces and charges are balanced motion does not occur. This could help them understand why the water did not fall and also sets them up for understanding of Newton’s laws later.

When charges are BALANCED the atom is NEUTRAL, when charges are not BALANCED then the atom acquires the charge of the greatest charge value.

Atoms can GAIN electrons and acquire a negative charge or LOSE electrons and acquire a positive charge..

OPPOSITE CHARGES ATTRACT and LIKE CHARGES REPEL. Help students recognize that Electrically charged particles follow the same rules as magnets. (is there a connection between electricity and magnetism? This question may come up, this can be floored until 7.1.4)
Find your partner: Students receive charge value cards and organize themselves into different partnerships as if they were the positive and negative parts of an atom. If the charges are opposite and the value is the same they are a NEUTRAL atom. If the charges are opposite and their number values are different than they will be a charged atom. Students should pair up according to their instructions.

**Pair up and be a NEUTRAL atom**
**Pair up and be a POSITIVELY charged atom**
**Pair up and be a NEGATIVELY charged atom**

Students could also imagine that their card represents the charge of an entire atom that has gained or lost electrons and acquired a charge.

**Have students match with some they would REPEL and match with someone they would ATTRACT.**

The atom is typically a neutral object with an equal number of positive and negative charges and do not respond to each other except to bond. Bonding is the exchange or sharing of electrons that creates electric potential.

**Management strategy: Find Your Partner (Do Si Do)**
To reinforce the concept, each student can be given a card with a charge value (1+, 2+ 3+, 1-, 2-, 3- etc.) Tell students that they are going to make a NEUTRAL atom by finding a partner that has the opposite charge but an EQUAL value so (3+ pairs with 3-)
Then students pair up with a partner that would give the atom a NEGATIVE charge (1+, 2-) This will leave 1- out of the activity temporarily.
Then students pair up with a partner that would give the atom a POSITIVE charge (2+, 1-) This time 1+
It is not important that students understand the complete nature of bonds at this time, but ionic bonding can help students understand the transfer of electric charge and covalent bonding can help students understand polarity.

Images from: Willliams Science Power School

**Assessment of Student Learning**
Students construct models of electric fields and review and recognize rules for magnetism and recognize that these rules also apply to charged objects. Students Assessment is participation in learning activity.
<table>
<thead>
<tr>
<th>1+</th>
<th>1-</th>
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</thead>
<tbody>
<tr>
<td>2+</td>
<td>2-</td>
</tr>
<tr>
<td>3+</td>
<td>3-</td>
</tr>
<tr>
<td>4+</td>
<td>4-</td>
</tr>
<tr>
<td>5+</td>
<td>5-</td>
</tr>
</tbody>
</table>
Episode 4 - Electric Charges

- negative charges are attracted to + parts in the flour

↓

This makes the pipe (+) charged so it will be attracted to charged things like water or bubbles and repelled by + charge things like a plastic bag or balloon!
### Student Science Performance

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| Lesson Performance Expectations: |
| Students will listen and participate in direct instruction on the transfer of electric charge between objects and observe the behavior of water in an electric field. Students will construct and use models of electric fields in different situations based on evidence. |

**Students will ask questions**  
**CCC: cause and effect**  
**SEP: analyzing and interpreting data, developing and using models**

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<td><strong>Direction Instruction:</strong></td>
<td></td>
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<tr>
<td>Recognize positive and negative charges for the objects in the lab.</td>
<td></td>
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<tr>
<td>Students will be assigned to a lab station with their Fantastic 4 group. There they will Construct a model of that one station showing objects, charges and observed effects. They should elect a voice from the group and prepare to ‘stand and deliver’</td>
<td></td>
</tr>
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| **Direct Instruction:** |
| PVC and balloons acquire a negative charge when rubbed with a towel or fur. |
| **Management Strategy: Prepare to Stand and Deliver** |
| Once students have this information they should be asked to return to one lab station. (this could be assigned based on difficulty) and draw a model of the cause of the phenomenon they observed on their **whiteboards or paper**. Students should be able to **INFER** from the information given to them where electric charge is found and where it is being transferred to. |
| Students prepare to come to the front of the class and show and explain their model. The fantastic 4 should elect a spokesperson for the group, but they should all stand and deliver. |

| **Management Strategy:** |
| Walk the room while students are working and asking guiding questions like: |
| “If the balloon is negatively charged and it attracts hair, then what could you infer about the charge of the hair?” “How would you model that?” “How would you draw what you just told me?” “How are you going to explain that to the class?” |

H. Waite
Students Observe water moving towards charged PVC pipe
Make observations and construct models of electric fields based observations.
Students will complete a OEQ template and turn in for assessment. Their explanation could be a model.

Management Strategy: Questions are just as important as answers.
Groups should take turns presenting their models. Listening students should be asked to take notes and ask good questions. Bonus points could be awarded to students who ask GREAT QUESTIONS
As a class have students construct a list of BIG IDEAS they have learned from the lab.

Demonstration: To end this episode, show students that pouring water will move towards a charged pvc pipe.
Assessment: Have students complete a OEQ template as an exit ticket and turn in. Their explanation could be a model.

Assessment of Student Learning
Students ask questions and journal.
OEQ Exit ticket on water phenomenon: When evaluating the assessment, look for correct use of vocabulary, accuracy in the model and questions about the nature of water.

Episode 5 - Exit ticket model

phenomenon: Water is pulled toward water when PVC is rubbed with towel.

Explanation: Pipe acquires a positive charge when it transfers e- to towel. This means water must have - charge!
Because opposites attract.

Questions: Is water negatively charged? Is water magnetic?
Exit Ticket

Observe: Describe the phenomenon:

Explain: Explain the cause of this effect in words and pictures. Be sure to label all charges and use arrows to show the forces and fields that are involved.

Questions

Exit Ticket

Observe: Describe the phenomenon:

Explain: Explain the cause of this effect in words and pictures. Be sure to label all charges and use arrows to show the forces and fields that are involved.

Question:
Episode 5 - Exit ticket model

**Phenomenon:** Water is pulled toward water when PVC is rubbed with towel.

**Explaination:**
- Pipe acquires a charge when it transfers an electron to towel.
- This means water must have charge because opposites attract.
- Stream of water is negatively charged.
- Is water negatively charged?
- Is water magnetic?
### Student Science Performance

<table>
<thead>
<tr>
<th>Topic: Forces and Fields</th>
<th>Title: Forces and Fields</th>
</tr>
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</table>

**Overarching Performance Expectations (Standard) from State Standards or NGSS:**
Construct a model using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects (such as magnets or electrically-charged objects) and the forces they exert.

**Lesson Performance Expectations:**

<table>
<thead>
<tr>
<th>Students Will. . . To Construct Meaning</th>
<th>Teacher Will. . . To Support Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct instruction on polar nature of water molecules. Review concept of polarity. Review the relationship between atoms and molecules.</td>
<td><strong>Direct Instruction: Student Note taking in journals</strong> Have students draw a magnet and label the sides of the magnet N and S. <strong>Management Strategy:</strong> Think/pair/share Ask students to write a definition of POLAR and to think of other objects that are POLAR. Walk the room as they are drawing and writing and observe their thoughts and prepare for class discussion. Ask students to help define the word POLAR and to give examples of polar objects. Definitions should describe POLAR objects as having two opposing forces or charges on either side. Other polar objects might include the earth or a battery.</td>
</tr>
</tbody>
</table>

Students will learn that water molecules are polar and act like little magnets with a positive and negative side attracted to each other

Review and Recognize that atoms combine to make MOLECULES and that this occurs as negative particles are exchanged or shared. Sometimes molecules do not share negative charges evenly and one side of the molecule becomes negatively charged and the other side becomes positively charged. Water is an example of a molecule that has unequal sharing of negative charges (oxygen hoggs them) making water a POLAR object.

This polarity means that water molecules are attracted
to each other like this

It also causes water to be attracted to any other Polar molecules, like salt and sugar (this is why things dissolve in water

https://www.youtube.com/watch?v=xdedxfhcpWo
Shows how the polar water molecules are attracted to polar salt molecules)

However, polar molecules are repelled by NON POLAR molecules, for example oil, or nail polish or plastic (or our cell membranes which is why we don’t dissolve in water)

Explain that polar things are attracted to the opposite pole of other polar things.
NON POLAR things will only interact with other nonpolar things.

The polar nature of the water molecule makes them act like little magnets.
Bring up an image of the phenomenon of water in space.

In their journal have them model the forces acting
Students will construct a model of the forces acting within a drop of water in their journals, then share with their group. Then the group will construct a model to share with the class for discussion. Within a drop of water. When they are done, they should share their models with their group. Then the group should draw a group model on the **whiteboard or paper**. Students bring their images to the front and teacher will lead a discussion on similarities and differences within the models. Draw a correct model and have students correct or add to their notes appropriately.

Student Questions should be directed towards the original phenomenon of surface tension and the drops on a penny or water hanging over the edge of a glass of water. “How many forces are acting in this system??

**Assessment of Student Learning**

Students will construct models of forces acting within water drop and share them with the class.
### 7.1.3 episode 7

#### Student Science Performance

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**Overarching Performance Expectations (Standard) from State Standards or NGSS:**
Construct a model using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects (such as magnets or electrically-charged objects) and the forces they exert.

**Lesson Performance Expectations:**
Students will model forces and fields acting in phenomenon
Students will engage in discussion on the forces that act on matter and within matter including electromagnetic forces and gravitational forces.
CCC: Cause and Effect, Systems
SEP: develop and use a model, mathematical and computational thinking

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<tbody>
<tr>
<td>Students will list all of the forces that are acting on and within the glass of water. Primarily: gravity, and electromagnetic forces</td>
<td>Remind students that we are trying to understand this SYSTEM by recognizing the many forces that are acting in this system and are the cause of the effects we see.</td>
</tr>
</tbody>
</table>
| Direct Instruction- There are 4 forces in the universe students construct a model of the forces acting in this system including gravity, electric charges transferred within water molecules and magnetic attraction between water molecules. | **Direct Instruction**
there are 4 major forces in the universe:
Strong force and Weak force, gravity, electric/magnetic force (which go together we will discover) we can call these electromagnetic forces.
**strong and weak forces** are found in the atom and will be discussed next year.
This year we focus on gravity and electric/magnetic forces (electromagnetic forces) |

H. Waite
The structure and behavior of every atom and molecule, object and substance in the universe can be explained with these 4 forces. So far... :)

The word SYSTEM describes a set of connected things or parts forming a complex (complicated) whole.

**Assessment:** Students should discuss with their groups how to construct a model of the system above and include electromagnetic forces between charged atoms, electromagnetic forces between molecules and gravity pulling down on all of it. Each student should produce a model and explanation of the cause of the phenomenon.

See examples: and rubric

**Assessment:** Students should complete worksheet on content.

Next Guiding Question: Are these forces universal? Are these the forces that made the earth? The solar system? The universe? Or are these just earthly phenomena. 7.1.5
Assessment: Forces and Fields

Use the vocabulary to complete the statements below.

**Force**  **Field**  **Neutral**  **Polar**
**Exert**  **Balance**  **Positive Charge**  **Atom**
**Negative Charge**  **Molecules**  **Attract**  **Repel**

1. The basic unit of matter is called the ____________. It is made of positive parts and negative parts that are usually in ____________ to make the atom neutral.

2. When two like (same) charges come close to each other they will ____________, when opposite charges come close to each other they will ____________.

3. Specific properties of matter create fields that ____________ forces on other objects.

4. If something is marked with a (+) we say that thing has a ____________, if something is marked with a (-) we say that thing has a ____________. If there is no charge or charges are balanced then the object is ____________.

5. When something pushes or pulls on another thing without any attachment we can see, we say that thing possess a ____________.

6. Forces reach out in every direction to produce a ____________ which is a zone in which other objects can be affected by the force.

7. When atoms bond they form ____________ which sometimes have opposite charges on either side which makes them ____________.

8. Add Arrows to show the direction of force. Indicate if the force is a PUSH or a PULL.

A.  
   ![Diagram A](image1)

B.  
   ![Diagram B](image2)

C.  
   ![Diagram C](image3)

D.  
   ![Diagram D](image4)
9. If an atom has the following number of Positive and Negative charges, then the charge of the atom will be?

A. The charge of this atom is ____________

B. The charge of this atom is ____________

C. The charge of this atom is ____________

D. The charge of this atom is ____________

10. Draw the lines showing what direction force will act on these water molecules in these situations.

A. 

B. 

Construct a model of the forces acting within and on a glass of water filled beyond its capacity.

The model should include:

- Gravitational forces (acting on everything)
- Electric Forces (between atoms in water molecules)
- Magnetic Forces (between molecules of water)
- Description of your model in words
- Arrows and labels of forces
Episode 7 - Forces in water and out of water.

It looks like the attraction between atoms is really strong. Because water molecules aren’t pulled apart even though they are attracted to each other. The magnetic forces between water molecules are enough to resist the force of gravity pulling down. — When will it fall? When gravity is stronger than m.

This is the key for page 3 of the assessment. The rest of the key is below.
Assessment: Forces and Fields

Name ____________________________

Key

Use the vocabulary to complete the statements below.

Force  Field  Neutral  Polar
Exert  Balance  Positive Charge  Atom
Negative Charge  Molecules  Attract  Repel

1. The basic unit of matter is called the **Atom**. It is made of positive parts and negative parts that are usually in **Balance** to make the atom neutral.

2. When two like (same) charges come close to each other they will **Repel**. When opposite charges come close to each other they will **Attract**.

3. Specific properties of matter create fields that **Exert** forces on other objects.

4. If something is marked with a (+) we say that thing has a **Positive Charge**. If something is marked with a (−) we say that thing has a **Negative Charge**. If there is no charge or charges are balanced then the object is **Neutral**.

5. When something pushes or pulls on another thing without any attachment we can see, we say that thing possess a **Force**.

6. Forces reach out in every direction to produce a **Field** which is a zone in which other objects can be affected by the force.

7. When atoms bond they form **molecules** which sometimes have opposite charges on either side which makes them **Polar**.

8. Add Arrows to show the direction of force. Indicate if the force is a **PUSH** or a **PULL**.

A. [Diagram showing two positive charges attracting each other with an arrow indicating a pull]  
   [Diagram showing two positive charges repelling each other with an arrow indicating a push]

B. [Diagram showing two positive charges attracting each other with an arrow indicating a push]
   [Diagram showing two positive charges repelling each other with an arrow indicating a push]

C. [Diagram showing two molecules with opposite charges, arrow indicating push]  
   [Diagram showing two molecules with opposite charges, arrow indicating push]

D. [Diagram showing two molecules with opposite charges, arrow indicating balanced, no response]
9. If an atom has the following number of Positive and Negative charges, then the charge of the atom will be?

A. \[ \text{The charge of this atom is } -1 \]

B. \[ \text{The charge of this atom is } +1 \]

C. \[ \text{The charge of this atom is } \text{Neutral} \]

D. \[ \text{The charge of this atom is } -2 \]

10. Draw the lines showing what direction force will act on these water molecules in these situations.

A. 

B. 

These questions could make flashcards for a study game!
Construct a model of the forces acting within and on a glass of water filled beyond its capacity.

The model should include:

- Gravitational forces (acting on everything)
- Electric Forces (between atoms in water molecules)
- Magnetic Forces (between molecules of water)
- Description of your model in words
- Arrows and labels of forces