Lesson Plan

Lesson Title:	**Date:**
Exploring Electronegativity and Chemical Bonding	November 7, 2025
Grade Level:	**Subject/Strand:**
11	B: Matter, Chemical Trends, and Chemical Bonding
Topic:	**Length of Period:**
Electronegativity, Periodic Trends	75 minutes

Lesson Plan Description

This lesson engages students in exploring electronegativity and how it affects the way atoms share bonding electrons, leading to polarity in molecules. Students will connect periodic trends (nuclear charge, atomic radius, shielding) to electronegativity patterns, use the Pauling Scale to predict bond polarity, and examine real-world implications including reactivity and solubility. The lesson begins with a hook question—"Is water sticky?"—and returns to this phenomenon at the end, allowing students to explain water's cohesive properties using molecular-level understanding of electronegativity and polarity.

ONTARIO CURRICULUM CONNECTIONS

Overall Expectations	**Specific Expectations**
B3: demonstrate an understanding of periodic trends in the periodic table and how elements combine to form chemical bonds	– B3.3: state the periodic law, and explain how patterns in the electron arrangement and forces in atoms result in periodic trends (e.g., in atomic radius, ionization energy, electron affinity, electronegativity) in the periodic table – B3.4: explain the differences between the formation of ionic bonds and the formation of covalent bonds – A1.6: compile accurate data from laboratory and other sources, and organize and record the data, using appropriate formats, including tables, flow charts, graphs, and/or diagrams

Learning Goals: *We are learning …*	**Success Criteria: *I can …***
• We are learning what makes water "sticky" by understanding how atoms pull on shared electrons. • We are learning how differences between atoms create polar molecules that behave in predictable ways. • We are learning to use scientific vocabulary to explain why polarity matters in real chemistry.	• I can explain what electronegativity means and give an example of an atom that pulls electrons strongly. • I can describe how electronegativity differences make molecules polar or non-polar. • I can use the terms electronegativity and polarity when explaining water's properties.

ASSESSMENT TOOLS		
MINDS ON **Think-Pair-Share** **Purpose of the assessment:** [X] FOR [X] AS [ ] OF	**ACTION** **Collaborative Activity & Gallery Walk** **Purpose of the assessment:** [X] FOR [X] AS [ ] OF	**CONSOLIDATION** **Volleyball—Not Ping-Pong! & Exit Ticket** **Purpose of the assessment:** [X] FOR [X] AS [X] OF
Indicate Achievement Chart categories being assessed: [X] Knowledge and Understanding [X] Thinking [ ] Application [X] Communication	**Indicate Achievement Chart categories being assessed:** [X] Knowledge and Understanding [X] Thinking [ ] Application [X] Communication	**Indicate Achievement Chart categories being assessed:** [X] Knowledge and Understanding [X] Thinking [X] Application [X] Communication
Indicate Assessment Mode: Oral	**Indicate Assessment Mode:** Written, Oral	**Indicate Assessment Mode:** Written, Oral, Performance
Assessment Strategy: **Think-Pair-Share (FOR)** Students first reflect individually on a question, then discuss their ideas with a partner before sharing with the class. This structure encourages all learners to process information, articulate thinking, and build confidence through peer exchange. It functions as assessment for and as learning, allowing teachers to gauge understanding and students to refine ideas collaboratively. This activity supports assessment for and as learning, as students refine understanding through peer dialogue and teacher feedback.	**Assessment Strategy:** **Collaborative Analysis (FOR, AS)** Students work in small groups to examine determine periodic trend (electronegativity). Each group records conclusions and compares reasoning, allowing the teacher to observe critical thinking and collaboration. This activity supports assessment for and as learning, as students refine understanding through peer dialogue and teacher feedback. **Gallery Walk (FOR, AS)** Students display their group work around the room and circulate to review others' analyses, leaving comments or questions on sticky notes. This interactive reflection serves as assessment of learning (showcasing final products) and for/as learning (promoting peer feedback and self-assessment through comparison of diverse approaches).	**Assessment Strategy:** **Volleyball—Not Ping-Pong! (FOR, AS)** This discussion strategy replaces teacher-student back-and-forth ("ping-pong") with student-to-student dialogue ("volleyball"). The teacher "serves" a question, and students build on each other's responses, deepening reasoning and communication skills. It serves as assessment for and as learning, highlighting students' conceptual understanding and ability to justify or extend ideas through peer interaction. **Exit Ticket (FOR, OF)** A short end-of-class task where students answer a quick question or prompt to show understanding of the lesson's goals. It helps teachers assess learning, identify misconceptions, and plan next steps while giving students a chance to reflect and consolidate learning. Exit tickets act as assessment of learning when summarizing achievement, and for learning when identifying gaps or misconceptions for future instruction.
Instrument used to record results/ document evidence of learning: – Listen during pair discussions for evidence of prior knowledge about molecular interactions – Note which students connect the hook to intermolecular forces versus surface-level observations – Use student responses to gauge how much scaffolding will be needed during instruction	**Instrument used to record results/ document evidence of learning:** – Informal observation rubric (e.g. Emerging Skill → Developing Skill → Proficient Skill → Extending Skill) – Real-time instructional adjustments based on observations – Post-lesson documentation for planning and student support	**Instrument used to record results/ document evidence of learning:** – Post-lesson documentation for planning and student support – Exit card rubric (4-point scale); used to inform next lesson planning and identify students needing support

CONSIDERATIONS FOR PLANNING

Prior Learning: *Students bring the following prior knowledge and experiences:*

- Understanding of atomic structure (nucleus, protons, electrons, electron shells) from Grade 10 science
- Familiarity with the periodic table organization and basic trends (atomic radius, ionization energy, electron affinity) from earlier in this unit
- Understanding of effective nuclear charge and shielding effect from recent lessons
- Experience with ionic and covalent bonding concepts from Grade 10
- Knowledge that atoms form bonds to achieve stability (octet rule)
- Exposure to Lewis dot structures and basic molecular representations

IEP program implications:

Accommodations:

- Provide sentence starters and for verbal and written responses (e.g., "Electronegativity is important because...")
- Allow extended time for think-pair-share activities and exit ticket completion
- Pair student with supportive peer (mix confidence levels, language learners with strong communicators)
- For English language learners: Pre-teach key terms and provide visual references throughout.

Modifications:

- Reduce complexity of ΔEN calculations (use only whole numbers; provide a calculator)
- Focus on qualitative understanding (high/low electronegativity) rather than quantitative comparisons
- Shorten exit ticket to 2–3 key reflection questions instead of open-ended paragraph
- Replace some analytical slides with additional visual/kinesthetic activities (e.g., modeling water molecules with physical models)
- Accept multimodal responses (drawing, speaking, demonstrating) instead of written-only assessments

Differentiation:

Instruction is differentiated with hands-on demos, think-pair-share, visual aids, strategic pairing, and varied assessment formats. Learners benefit from activities tailored to diverse strengths—visual, kinesthetic, auditory, and analytical. Scaffolding, guiding questions, and choices in response format ensure accessibility and challenge for all. Formative feedback informs immediate support or enrichment.

Content (what learners are going to learn, and when)

- **Minds On:** Teacher demonstrates water's 'stickiness' by dipping hand in water. Students activate prior knowledge through think-pair-share: "Is water sticky?" and connect to lesson goals.
- **Action:** Teacher uses a magnet analogy to explain electronegativity with HCl, recalls atomic radius and shielding trends, then students work in pairs to colour-code a blank periodic table by predicting electronegativity trends. They conduct a gallery walk, see teacher's revealed trend, learn about the Pauling scale, do a ΔEN calculation for HCl, and connect molecular polarity to real-life examples (solubility, acid-base reactions).
- **Consolidation:** Students share and explain, as a group, why water is sticky using learned vocabulary during "Volleyball-Not Ping Pong"; individually reflect on changed thinking via an exit ticket.

Process (how instruction is organized towards a *gradual release of responsibility*)

- **I Do:** Teacher models water demo, explains electronegativity concept, and leads periodic trend review.
- **We Do:** Students collaborate to colour-code electronegativity on the periodic table and compare results. Teacher circulates, prompts thinking, and facilitates group prediction and discussion.
- **You Do:** Students explain their understanding and choices in gallery walk and group discussion; individually complete the exit ticket to reflect and demonstrate learning.

Product (the ways in which individual learners will demonstrate learning for assessment)

- Coloured, collaboratively completed periodic table showing personal predictions.
- Verbal explanations during partner and whole-class discussions.
- Written exit tickets reflecting how knowledge has changed, using scientific vocabulary.

Environment (the context and environment in which learners learn and demonstrate learning)

- Pairs or small groups at tables for collaboration.
- Visual displays including demo, periodic table projection, and student work for gallery walk.
- Supportive class culture: frequent discussion, encouragement, and safe space for sharing ideas at all levels.

Resources and Materials & Technology Integration:

Resources and Materials

- ***Presentation Slides (1–15)****: Prepared PowerPoint or Google Slides covering all lesson content from the Minds On hook to the consolidation exit ticket.*
- ***Clear tub or beaker of water****: For physical demonstration of "Is water sticky?" hands-on visual.*
- ***Coloured markers****: Set of markers in yellow, orange, red, and dark red for the collaborative analysis activity.*
- ***Blank periodic table handouts****: Laminated or paper copies for students to colour code electronegativity trends.*

Technology Integration

- **Projector or Smartboard:** To display presentation slides and images for whole-class instruction.
- **Student Devices (optional):** Tablets/laptops for digital versions of exit tickets or extension research.
- **Interactive polling or quiz software (optional):** For real-time formative assessment or to collect volleyball activity responses digitally.
- **Digital timer:** To manage timed activities like think-pair-share and gallery walk.

Teacher Support Materials

- **Lesson Plan Document**: Detailed step-by-step procedures with prompts and anticipated questions.
- **Answer Key for Collaborative Activity**: Guide with correct electronegativity trend colour coding.
- **Facilitation Guide for Volleyball-Not Ping Pong Discussion**: Suggested questioning strategies and common misconceptions.
- **Exit Ticket Rubric (see end of this lesson plan)**: Criteria for assessing student reflection responses.

BODY OF LESSON (3 PART LESSON FORMAT)

Minds on: Motivational Hook/Introduction (10 minutes)

Purpose: Activate prior knowledge, introduce learning goals, create curiosity, assess FOR learning

Slide 1: Title Slide – Greeting & Settling (1–2 min)
Teacher & Student Actions:

- Display the title slide as students enter the classroom
- Greet students warmly and allow them to settle into their seats
- Take attendance or complete any necessary administrative tasks
- Establish a calm, focused atmosphere before beginning the lesson

Slide 2: Minds On Hook – "Is Water Sticky?" (6–7 min)

Phase 1: Hook Demonstration (2 min)
Teacher & Student Actions:

1. Transition to slide 2 and read the hook question aloud with curiosity: *"Is water sticky?"*
2. Hold up a clear tub or beaker of water so all students can see
3. Slowly place your hand into the water, then lift it out deliberately, allowing water to visibly drip and cling to your fingers
4. Shake your hand slightly or tilt it at different angles to show water droplets hanging on or running down your skin
5. Ask students: *"What do you notice happening to the water on my hand?"*
6. Acknowledge observations briefly (e.g., "Yes, it's dripping... it's clinging to my fingers... interesting!")

Prompting Questions & Anticipated Answers:

- **Q:** *"What's happening to the water when I pull my hand out?"*
  A: "It's sticking to your hand," "It's dripping off slowly," "Some stays on your fingers"
- **Q:** *"Does this surprise you? Why or why not?"*
  A: "Not really, water always does that," "I never thought about it being 'sticky' before"

Phase 2: Think–Pair–Share (4–5 min)
Teacher & Student Actions:

1. Instruct students: *"Take 30–45 seconds on your own to think silently about this question: Is water sticky? What might make it seem that way?"*
2. Walk around quietly during think time, observing student engagement
3. After think time, say: *"Now turn to your partner and share your ideas. Discuss what you think 'sticky' means in this context and whether water fits that description. You have about 2 minutes."*
4. Circulate during pair discussions, listening in on conversations and noting interesting ideas or misconceptions
5. After 2 minutes, bring the class back together: *"Let's hear some of your ideas. Who wants to share what you and your partner discussed?"*
6. Call on 2–3 pairs to share their thinking, affirming contributions and probing gently for deeper reasoning

Prompting Questions & Anticipated Answers:

- **Q (to a pair):** *"What did you two decide—is water sticky or not?"*
  A: "Kind of? It clings to stuff," "Not sticky like glue, but it does hold together," "It depends on what you mean by sticky"
- **Q:** *"What evidence are you using to support that idea?"*
  A: "Water droplets stay together," "It sticks to glass," "When you spill water, it doesn't spread out completely"
- **Q:** *"How is water different from something like glue or tape that we'd normally call sticky?"*
  A: "Glue actually bonds things together," "Water can wash off easily," "Water doesn't leave residue"
- **Q:** *"Can anyone think of a time when water seemed to stick to something unexpectedly?"*
  A: "On a freshly waxed car," "Dew drops on leaves," "Water beading up on a raincoat"

Common Student Misconceptions to Listen For:

- Confusing adhesion/cohesion with chemical bonding
- Thinking "sticky" only means permanent attachment
- Not recognizing intermolecular forces as distinct from intramolecular bonds

Slide 3: Learning Goals & Success Criteria (1–2 min)
Teacher & Student Actions:

1. Transition smoothly: *"Great observations! You've identified something really important about water—it does have properties that make it 'stick' to itself and other surfaces. Today we're going to explore exactly why that happens."*
2. Display slide 3 with learning goals and success criteria
3. Read through each goal/criterion clearly, emphasizing key terms
4. Check for understanding: *"Does everyone see how our hook question connects to what we're learning today?"*
5. Provide a brief preview: *"By the end of this lesson, you'll be able to explain exactly what makes water 'sticky' using scientific terminology."*

Transition to Action Portion:

- Signal the shift: *"Alright, let's dive into the science behind what we just observed. Keep that image of water clinging to my hand in mind as we explore intermolecular forces."*

Action: During /Working on it (55 minutes)

Purpose: Teach new content, provide guided and independent practice, assess FOR & AS learning

Slide 4: Electronegativity Definition & Magnet Analogy (4–5 min)

Teacher & Student Actions:

1. Display slide 4 and read the definition aloud: *"Electronegativity is the ability of an atom to attract electrons in a chemical bond."*
2. Introduce the magnet analogy to make this concrete: *"Think of a covalent bond like two magnets. One magnet might be small and weak, while the other is large and powerful."*
3. Use HCl as your visual example:
    - Draw or point to H atom: *"Hydrogen is like a small, weak magnet—it has a weak pull on electrons."*
    - Draw or point to Cl atom: *"Chlorine is like a large, powerful magnet—it has a strong pull on electrons."*
    - Show the bond between them: *"When they bond, the chlorine's strong 'magnetic pull' attracts the electrons more toward itself."*
4. Emphasize the key idea: *"So electronegativity is describing the pull of electrons of bonded atoms, but we want to understand Why. What makes one atom pull harder on electrons than another? That's what we're exploring today." This makes a smooth* transition to slide 5.

Prompting Questions & Anticipated Answers:

- **Q:** *"If electronegativity is about pulling electrons, what do you think would give an atom a stronger pull?"*
  A: "More protons," "Smaller atoms," "Atoms closer to the nucleus," "Something to do with charge"

- **Q:** *"In our magnet analogy, why is chlorine the 'big, powerful magnet'?"*
  A: "It's heavier," "It has more electrons," "It's bigger," "It has more positive charge in the nucleus"

- **Q (anticipating confusion):** *"Does electronegativity mean an atom always pulls electrons? Or only when it's bonded?"*
  A: "Only when bonded," "It's about how it attracts them in a bond"
  Teacher clarification: *"Exactly. Electronegativity only describes the tendency when atoms are bonded together."*

Slide 5: Periodic Trends – Recall & Brief Explanation (5–6 min)
Teacher & Student Actions:

1. Display slide 5 with the three key periodic trends
2. Quickly refresh students' memory, keeping explanations concise since this is review:

Atomic Radius:

- *"As you move right across a period, atoms get smaller because we're adding protons to the nucleus without adding new electron shells—so the nucleus pulls the electrons in tighter."*
- *"As you move down a group, atoms get larger because we're adding new electron shells."*

Effective Nuclear Charge:

- *"Effective nuclear charge is the net positive charge an electron 'feels' from the nucleus. It's not the total charge—it's reduced by other electrons in the way."*
- *"Think of it like this: the outermost electrons see a 'shielded' nucleus because inner electrons block some of the positive charge."*

Electron Shielding:

- *"Inner electron shells shield (or block) the pull of the nucleus on outer electrons."*
- *"The more inner electrons you have, the more shielding happens, and outer electrons feel less of the nucleus's pull."*

3. Make the connection explicit: *"Here's the key: all three of these trends are going to explain why electronegativity changes the way it does across and down the periodic table."*

Prompting Questions & Anticipated Answers:

- **Q:** *"Why do you think an atom with a smaller radius would be more electronegative?"*
  A: "Electrons are closer to the nucleus," "The nucleus can pull harder," "Less distance to the nucleus"

- **Q:** *"If effective nuclear charge is reduced by electron shielding, which electrons feel the most effective nuclear charge?"*
  A: "The outermost ones," "Valence electrons," "Wait, the innermost ones?"
- **Teacher clarification if needed:** *"Good—the innermost electrons feel the full nuclear charge with no shielding. The valence electrons feel the least because they're farthest out and most shielded."*

- **Q (checking understanding):** *"So if I move from nitrogen to oxygen across period 2, what happens to atomic radius?"*
  A: "It gets smaller," "One more proton pulls things in tighter"

Slide 6: Collaborative Analysis Activity – Pair Work (15–18 min)

Setup (2 min)
Teacher & Student Actions:

1. Display slide 6 and explain the task clearly: *"You will work in small groups (2-4) ill predict where electronegativity is highest and lowest on the periodic table. You'll use colour-coded markers to show your predictions on a blank periodic table."*
2. Distribute materials:
   - One blank periodic table (laminated or on paper) per pair
   - Coloured markers: yellow, orange, red, dark red
3. Explain the colour code: *"Yellow = lowest electronegativity, orange = low-to-moderate, red = moderate-to-high, dark red = highest electronegativity."*
4. Set expectations: *"Use what you know about atomic radius, effective nuclear charge, and electron shielding to decide where electronegativity should be highest and lowest. Think about the periodic trends we just reviewed."*

Prompting Questions During Activity (if students are stuck):

- **Q:** *"Why do you think electronegativity might be highest in the top-right corner of the periodic table?"*
  A: "Smaller atoms," "More effective nuclear charge," "Less shielding"

- **Q:** *"If you move down a group, what happens to atomic radius?"*
  A: "It gets bigger"
- **Follow-up:** *"And if atoms are bigger, are the valence electrons pulled in closer or farther from the nucleus?"*

- **Q:** *"Which would be more electronegative: an atom with lots of shielding or an atom with less shielding?"*
  A: "Less shielding," "Because the nucleus's pull is stronger"

- **Q (if they're colouring seemingly randomly):** *"Tell me your thinking here. Why did you choose dark red for this element?"*
- Listen for reasoning and gently redirect if needed

Activity Work Time (10–12 min) **Teacher & Student Actions:** 1. Assign pairs strategically (mix confidence levels, pair strong communicators with those who need support) 2. Circulate around the room while pairs work: • Listen to their reasoning • Ask guiding questions rather than giving answers • Note common predictions and misconceptions • Check that they're using evidence from the periodic trends 3. Provide time checks: *"You have about 8 minutes left. Make sure you've considered both across the periods and down the groups."*	**Anticipated Student Predictions (& Misconceptions):** • **Correct trend:** Students may predict highest EN in top-right, lowest in bottom-left • **Misconceptions:** Some may think bigger atoms pull harder, or that shielding means stronger attraction, or that noble gases should be highly electronegative
Gallery Walk (3–4 min) **Teacher & Student Actions:** 1. Collect the coloured periodic tables (or ask students to set them on desks if doing a rotating gallery walk) 2. Invite students to stand and do a quick gallery walk: *"Take 90 seconds to look at how other pairs predicted the trends. What do you notice? Do most predictions look similar or different?"* 3. Bring students back: *"I noticed that most of you predicted electronegativity is highest where? ... And lowest where? Great thinking. Let's see how close you were."*	**Prompting Questions During Gallery Walk:** • **Q:** *"Did you notice patterns in where everyone put the dark red? What does that tell you about what you know?"* **A:** "Everyone thinks top-right is highest," "We all considered the same trends" • **Q:** *"Did anyone's prediction look really different from the others? What was their reasoning?"* **A:** (varies based on what you observe)
Slide 7: Reveal the Electronegativity Trend (3–4 min) **Teacher & Student Actions:** 1. Display slide 7, showing the periodic table with arrows indicating electronegativity trends 2. Narrate what the arrows show: *"Electronegativity increases as you move right across a period and as you move up a group. So the most electronegative elements are here in the top-right corner, and the least electronegative are here in the bottom-left."* 3. Highlight specific elements for reference: *"Fluorine is the most electronegative element on the periodic table. Francium is the least. Hydrogen is kind of in the middle."* 4. Connect back to their predictions: *"How close were your predictions? Did your reasoning using atomic radius and shielding lead you in the right direction?"* 5. Affirm the thinking process: *"Even if your predictions weren't perfect, you were using the right logic. That's what science is—making predictions based on patterns, then testing them."*	**Prompting Questions & Anticipated Answers:** • **Q:** *"Why do you think fluorine is the most electronegative? Use what you know about atomic radius and effective nuclear charge."* **A:** "It's small and close to the nucleus," "It has high nuclear charge and not much shielding," "Its valence electrons feel a strong pull" • **Q:** *"Why does electronegativity decrease as you go down a group?"* **A:** "Atoms get bigger," "More shielding," "Valence electrons are farther from the nucleus" • **Q:** *"If you compare carbon and oxygen, which should be more electronegative?"* **A:** "Oxygen, because it's to the right"
Slide 8: Introduce the Pauling Scale (4–5 min) **Teacher & Student Actions:** 1. Display slide 8 and explain: *"Scientists needed a way to measure and compare electronegativity numerically. A chemist named Linus Pauling developed the Pauling scale to do exactly that."* 2. Describe what students were doing: *"When you colour-coded your periodic tables, you were essentially doing*	**Prompting Questions & Anticipated Answers:** • **Q:** *"Why do you think scientists needed to create a numbered scale instead of just saying 'electronegativity increases right and up'?"* **A:** "So they could be more precise," "To predict exactly how strong the effect is," "To make calculations"

what the Pauling scale does—assigning values to show the relative electronegativity of different elements."

3. Explain the scale briefly: *"On the Pauling scale, values range from about 0.7 (very low electronegativity) to 4.0 (highest). Fluorine is 4.0, and hydrogen is around 2.1."*
4. Show a reference table if available: *"Different elements have different Pauling values. These values let us predict what kinds of bonds will form and how polar they'll be."*

Slide 9: Apply Pauling Scale to HCl & Polarity (ΔEN) (6–7 min)
Teacher & Student Actions:

1. Display slide 9 with the Pauling scale values and the electron density map of HCl
2. Walk through the calculation step-by-step:
   - *"Let's go back to our HCl example from the beginning. Chlorine has a Pauling value of 3.0. Hydrogen has a value of 2.1."*
   - Write or display the calculation: *"To find the electronegativity difference—we call it delta EN or ΔEN—we subtract: 3.0 − 2.1 = 0.9"*
   - Explain the significance: *"A ΔEN of 0.9 tells us something important about how the electrons are shared in the H-Cl bond."*
3. Point to the electron density map:
   - *"Look at this map. The colour shows where electron density is highest. See how it's shifted more toward the chlorine side? That's because chlorine is pulling the electrons toward itself more strongly."*
   - *"The red/darker areas show where electrons spend more time. In HCl, that's closer to chlorine."*
   - *"This shift in electron density is what makes HCl a polar molecule."*
4. Make it concrete: *"Even though HCl is covalent—they're sharing electrons—they're not sharing equally. Chlorine hogs more of the electron density than hydrogen does. That's polarity."*

Slide 10: Predicting Bond Type from ΔEN (5–6 min)
Teacher & Student Actions:

1. Display slide 10 with the ΔEN ranges and bond type categories:
   - **ΔEN = 0.0–0.39:** Non-polar covalent
   - **ΔEN = 0.4–0.89:** Moderately polar covalent
   - **ΔEN = 0.90–1.69** Very polar covalent
   - **ΔEN > 1.70:** Ionic bond
2. Explain the reasoning: *"We use these ranges because ΔEN gives us a quantitative way to predict how electrons are distributed in a bond. The larger the difference, the more unequal the sharing, and the more polar the bond becomes."*
3. Reference HCl again: *"For HCl, we calculated ΔEN = 0.9. That puts it in the 'moderately polar covalent' range. The electrons are shared unevenly, but it's still a covalent bond."*

- **Q:** *"If fluorine is 4.0 and hydrogen is 2.1, what do you think that difference tells us about their ability to attract electrons?"*
  A: "Fluorine is much stronger," "Fluorine pulls almost twice as hard," "A bigger difference means bigger effect"

Prompting Questions & Anticipated Answers:

- **Q:** *"What does a ΔEN of 0.9 mean? Is that a big difference or a small difference?"*
  A: "It's moderate," "It's not huge," "It's somewhere in the middle"
  Teacher affirms: *"Right. We'll use ΔEN to categorize bonds in just a moment."*

- **Q:** *"Why is the electron density shifted toward chlorine in the electron density map?"*
  A: "Chlorine pulls harder," "It's more electronegative," "It attracts electrons more"

- **Q:** *"If the ΔEN were 0 (zero), what would that tell us about the bond?"*
  A: "The electrons would be shared equally," "It would be non-polar," "Neither atom would pull harder"

- **Q:** *"If ΔEN were really large—like 2.0 or more—what do you predict would happen?"*
  A: "One atom would pull the electrons almost completely," "It might not even be covalent," "The bond would be very polar, maybe ionic"

Prompting Questions & Anticipated Answers:

- **Q:** *"Why does a larger ΔEN mean the bond is more polar?"*
  A: "Bigger difference means one atom pulls harder," "More unequal sharing," "Electrons spend more time on one side"

- **Q:** *"Could a ΔEN of 2.5 ever form a non-polar bond?"*
  A: "No, it would be polar," "Maybe ionic?"
  Teacher confirms: *"Right—at that level of difference, we'd consider it very polar or ionic. There's not much equality in the electron sharing."*

- **Q:** *"What if I told you a bond had a ΔEN of 0.3? Would that be polar or non-polar?"*
  A: "Barely polar," "Almost non-polar," "Slightly polar"
  Teacher affirms: *"Good. It's technically in the slightly polar range, but it's pretty close to non-polar."*

4. Give a few more examples to cement understanding:
    - *"If we compared two carbons bonded together (C–C), the ΔEN would be 0 because they're identical atoms. Non-polar covalent."*
    - *"If we compared sodium and chlorine (Na–Cl), the ΔEN is about 2.2. That's very polar—almost ionic."*
    - *"If we compared sodium and fluorine (Na–F), the ΔEN is about 3.1. That's ionic."*
5. Transition to applications: *"Now here's why this matters so much in chemistry: knowing whether a bond is polar or non-polar changes everything about how that molecule behaves—how it reacts, what it dissolves in, how it interacts with other molecules. Let's explore some real examples."*

Slide 11: Polarity Dictates Acid-Base Reactivity – H_2O & OH^- Reaction (6–7 min)

Teacher & Student Actions:

1. Display slide 11 showing the reaction between H_2O and OH^- (or HCl + H_2O if illustrating proton donation)
2. Explain the relevance: *"One of the most important applications of polarity is understanding acid-base chemistry. Polarity determines which molecules can act as acids or bases, and how they interact in solution."*
3. Walk through the H_2O example (or HCl + H_2O):
    - *"Water is a polar molecule. It has a slight positive charge on the hydrogen side and a slight negative charge on the oxygen side—remember, oxygen is more electronegative."*
    - *"Hydroxide ion (OH^-) is also polar and negatively charged. When HCl dissolves in water, the H^-Cl bond breaks. Chloride ions and hydrogen ions form."*
    - *"The hydrogen side of water molecules (the slightly positive H) is attracted to the negatively charged hydroxide ions. That electrostatic attraction drives the acid-base reaction."*
4. Make the connection explicit: *"Without polarity, this reaction wouldn't happen. Polarity is what allows water to interact with ions and other polar molecules in these ways."*

Prompting Questions & Anticipated Answers:

- **Q:** *"Why would a polar molecule like water be good at dissolving acids?"*
  A: "It can attract the charged parts," "The polarity allows it to interact," "It has positive and negative parts"
- **Q:** *"If water weren't polar—if it were non-polar—what would you predict would happen to HCl if you tried to dissolve it in non-polar water?"*
  A: "It wouldn't dissolve," "The reaction wouldn't happen," "HCl would stay as molecules, not ions"
- **Q:** *"Why does the positive side of water attract the OH^- ion?"*
  A: "Opposite charges attract," "Negative is attracted to positive," "Electrostatic forces"

Slide 12: Solubility of Polar Molecules – HCl in Water (5–6 min)

Teacher & Student Actions:

1. Display slide 12 illustrating HCl dissolving in water (molecular vs. ionic diagrams helpful)
2. Explain the phenomenon: *"HCl is highly soluble in water. Why? Because both are polar, and polar molecules dissolve well in polar solvents."*
3. Describe the dissolution process:
    - *"When HCl gas is introduced to water, the polar water molecules surround the polar HCl molecules."*

Prompting Questions & Anticipated Answers:

- **Q:** *"Why do you think HCl dissolves so well in water?"*
  A: "Both are polar," "They're attracted to each other," "Water can surround HCl"
- **Q:** *"What would happen if you tried to dissolve HCl in a non-polar solvent like oil?"*
  A: "It wouldn't dissolve," "Oil and HCl are too different," "There's no attraction"

- *"The hydrogen side of water (slightly positive) aligns with the chlorine side of HCl (slightly negative)."*
- *"The oxygen side of water (slightly negative) aligns with the hydrogen side of HCl (slightly positive)."*
- *"These electrostatic interactions are strong enough to pull HCl apart into H^+ and Cl^- ions, which then stay dissolved and hydrated in the water."*

4. Key principle: *"This is where we get the saying 'like dissolves like'—polar dissolves in polar, non-polar dissolves in non-polar."*
5. Connect back to electronegativity: *"All of this happens because electronegativity differences create polarity, and polarity dictates solubility."*

- **Q:** *"When HCl dissolves in water and forms H^+ and Cl^-, are the ions hydrated—surrounded by water molecules?"*
  A: "Yes," "Water molecules surround them," "That helps them stay in solution"
  Teacher affirms: *"Exactly. The polar water molecules hydrate the ions, keeping them separated and in solution."*

- **Q:** *"Is 'like dissolves like' always true?"*
  A: "Usually," "Most of the time," "I think so"
  Teacher clarifies: *"It's a very useful rule for predicting solubility. Exceptions exist, but for grade 11 chemistry, this rule works really well."*

Slide 13: Solubility of Polar & Non-Polar Molecules – Water & Oil (5–6 min)

Teacher & Student Actions:

1. Display slide 13 showing water and oil not mixing (emulsion or immiscible layers visual helpful)
2. Explain the contrast: *"Here's a perfect example of 'like dissolves like' in action. Water and oil famously don't mix. Let's understand why using what we've learned about polarity."*
3. Describe the molecular situation:
   - *"Water is highly polar, as we've established. Electronegativity difference between O and H creates that polarity."*
   - *"Oil, on the other hand, is mostly made up of long hydrocarbon chains—carbon bonded to hydrogen. C and H have very similar electronegativities, so C–H bonds are non-polar."*
   - *"Because water is polar and oil is non-polar, they don't dissolve in each other. Instead, they form separate layers or an emulsion."*
4. Explain the molecular reason at the particle level:
   - *"Polar water molecules are attracted to each other (they form hydrogen bonds through their polarity). They have no strong electrostatic attraction to the non-polar oil molecules."*
   - *"The non-polar oil molecules are attracted to each other through weak dispersion forces, but again, they have no strong attraction to polar water."*
   - *"So water sticks with water, oil sticks with oil, and they don't mix."*
5. Real-world connection: *"This is why salad dressing separates if you don't shake it. Oil and vinegar (which is mostly water) won't mix because of polarity differences. If you want them to stay mixed, you'd add an emulsifier—a molecule that has both polar and non-polar parts to bridge the gap."*

Prompting Questions & Anticipated Answers:

- **Q:** *"Why don't water and oil mix if both are made of atoms?"*
  A: "One is polar and one is non-polar," "They're attracted to their own kind," "Different electronegativities"

- **Q:** *"If I wanted to dissolve oil in water, what would I need to add?"*
  A: "Something that helps them mix," "An emulsifier," "Something with both polar and non-polar parts"
  Teacher affirms: *"Exactly right. Soap is a great example—it has a polar end and a non-polar end, so it can bridge the gap between water and oil."*

- **Q:** *"Why are the C–H bonds in oil non-polar?"*
  A: "Carbon and hydrogen have similar electronegativities," "The ΔEN is very small," "There's not much difference in their pulling power"

- **Q:** *"Could we use the rule 'like dissolves like' to predict whether a polar molecule would dissolve in a non-polar solvent?"*
  A: "No, it wouldn't dissolve," "It would separate like water and oil," "Polar and non-polar don't mix"

6. Broader takeaway: *"Electronegativity → polarity → solubility → reactivity. This chain of ideas is fundamental to understanding why molecules behave the way they do."*

Transition to Consolidation Portion:

- *Reconnect to the beginning: "Remember the question from the start of class? (Is water sticky?) We explored it with a hands-on demo, made predictions about electronegativity, learned about periodic trends, and examined real applications. Now we have the tools to answer this question properly using scientific terminology."*

Consolidation & Connection (10 minutes)

Purpose: Self-assess learning, connect back to Minds On, demonstrate understanding in new context, identify next steps

Slide 14: Revisit "Is Water Sticky?" – Volleyball-Not Ping Pong Assessment for Learning (6–7 min)

Framing & Setup (1 min)
Teacher & Student Actions:

1. Display slide 14, which shows the original hook question: *"Is water sticky?"*
2. Introduce the **Volleyball-Not Ping Pong activity**: *"Here's how this works: I'm going to ask you a question, and I want you to respond like you're playing volleyball—keep the ball in the air! That means I want to hear from as many of you as possible, building on each other's ideas. This isn't ping pong, where only two people hit the ball back and forth."*

Revisit Question & Volleyball-Not Ping-Pong Activity (5–6 min)
Teacher & Student Actions:

1. Pose the consolidated question: *"So, is water sticky? And more importantly, why? Use the concepts we learned today—electronegativity, polarity, intermolecular forces, hydrogen bonding, or whatever terminology helps you explain it."*
2. Give students 30–45 seconds of silent think time to organize their thoughts and write brief notes if helpful
3. After think time, open the floor: *"Okay, who has an idea? Remember, you're building on what others say. If someone shares an idea and you have a follow-up or agreement, jump in!"*
4. Facilitate the volleyball conversation:
    - Call on a student to start: *"Let's hear from you, [Name]. Is water sticky?"*
    - Listen for and affirm key ideas: *"Great—you mentioned polarity. Can someone add to that?"*
    - If the conversation lags, prompt: *"We talked about hydrogen bonding today. How does that relate to water being sticky?"*
    - Encourage students to build: *"[Name] said electronegativity creates polarity. Does anyone want to extend that thought?"*

Prompting Questions to Facilitate Volleyball (if conversation stalls):

- **Q:** *"Who can explain what we mean by 'water is sticky' using the word 'electronegativity'?"*
  A: "Oxygen has high electronegativity, so it pulls electrons," "That makes water polar," "Polarity makes it stick"

- **Q:** *"What role does the oxygen atom play in making water sticky?"*
  A: "It's more electronegative than hydrogen," "It pulls electrons toward itself," "That creates a partial negative charge"

- **Q:** *"We talked about hydrogen bonding. How is that different from an ionic bond or a covalent bond? And how does it relate to water being sticky?"*
  A: "Hydrogen bonding is between molecules, not atoms in a bond," "It's weaker than covalent bonds," "It's what holds water molecules to each other"

- **Q:** *"If water weren't polar—if oxygen and hydrogen had the same electronegativity—would water still be sticky?"*
  A: "No," "There wouldn't be hydrogen bonding," "Molecules wouldn't attract each other the same way"

- **Q:** *"How is 'water being sticky' related to why water dissolves polar molecules like HCl?"*
  A: "Both involve polarity," "Polar molecules attract each other," "The polarity of water lets it interact with other polar things"

- **Q:** *"Can someone use the phrase 'electronegativity difference' in their explanation of water's stickiness?"*
  A: "The ΔEN between O and H creates polarity," "The difference in how hard oxygen and hydrogen pull makes water polar," "Because of the big electronegativity difference, oxygen pulls harder"

- Value all contributions: *"I like that you connected it back to the magnet analogy. That shows you're thinking about what we learned."*

5. Listen for evidence of learning—are students using terminology correctly? Can they chain concepts together?
6. Synthesize the key points before moving on: *"So here's what I'm hearing: Water is sticky because oxygen is highly electronegative, which creates a polar molecule. The polarity leads to hydrogen bonding between water molecules, which causes water to cling to itself and to surfaces. That's exactly why it seemed 'sticky' when I pulled my hand out of the tub at the start of class. We've gone from observation to explanation using chemistry."*

What You're Listening For (Evidence of Mastery):

- Students use terms like electronegativity, polarity, hydrogen bonding, intermolecular forces
- Students connect the O–H electronegativity difference to polarity
- Students distinguish between intramolecular forces (bonds within water) and intermolecular forces (bonds between water molecules)
- Students recognize that polarity is the bridge between electronegativity and observable behaviour (stickiness)

Anticipated Student Responses (Ranging in Sophistication):

- **Basic:** *"Water is sticky because it's polar."* (Correct but not deeply explained)
  Your follow-up: *"Good start! What makes water polar? What role does electronegativity play?"*

- **Intermediate:** *"Water is sticky because oxygen is more electronegative than hydrogen, so it pulls the electrons, making water polar. Polar molecules stick together."* (Better—shows chaining of ideas)
  Your affirmation: *"Exactly! You've connected electronegativity to polarity to observable behaviour."*

- **Advanced:** *"Water is sticky because the high electronegativity difference between oxygen and hydrogen (ΔEN ≈ 1.4) makes water a polar molecule. The polarity allows hydrogen bonding between water molecules, which is why it clings to itself and surfaces. This is why water doesn't spread out evenly—the intermolecular hydrogen bonds hold it together."* (Sophisticated—uses specific values, distinguishes intramolecular vs. intermolecular)
  Your affirmation: *"Wow—you've brought together electronegativity, polarity, hydrogen bonding, and intermolecular forces. That's comprehensive thinking."*

Slide 15: Exit Ticket – Reflection on Thinking (3–4 min)
Setup (30 sec)

Teacher & Student Actions:

1. Display slide 15 with the exit ticket question
2. Explain the purpose: *"An exit ticket is a quick reflection where you show me how your thinking has changed or grown. This helps me understand what you learned and what might need more practice."*
3. Distribute exit ticket (paper or digital form, depending on your setup)

The Exit Ticket Question:
Prompt: *"At the start of the lesson, we asked: 'Is water sticky?' Describe how your thinking has changed from then to now. What do you understand about water's properties now that you didn't before? Use specific vocabulary from today's lesson in your response."*

Teacher & Student Actions:

1. Give students 2–3 minutes of quiet work time to write their responses
2. Remind them as they write: *"Be specific. Use terms like electronegativity, polarity, hydrogen bonding, or intermolecular forces if they apply."*
3. Circulate while they work:
    - Observe the depth and accuracy of responses
    - Note misconceptions for future reteaching
    - Identify students who need follow-up conversations

Collecting & Using the Data:
During Writing:

- Students who finish early can sketch a diagram of water molecules showing polarity or hydrogen bonding

After Collection:

- Review exit tickets to assess:
    - Do students recognize the shift from observation to explanation?
    - Are they using terminology correctly?
    - Have they retained key concepts from the lesson?
- Use responses to inform your next lesson (reteach areas where misconceptions appear)
- Celebrate growth in your next class: *"I noticed many of you used the term 'electronegativity difference' in your exit tickets. That's exactly the kind of precise thinking I wanted to see!"*

Slide 16: Looking Ahead (1–2 min)
Teacher & Student Actions:

1. Display slide 16 with next class preview topics (Refer to Next Steps section below)
2. This can be done as students before or after the exit ticket

Prompting Questions If Students Seem Stuck During Exit Ticket:

- **Q:** *"What was your first thought when I asked 'Is water sticky?' at the start of class?"*
  A: (varies—likely surface-level observations)
- **Q:** *"What's one new thing you learned today that changed how you think about that question?"*
  A: "Polarity," "Electronegativity," "Hydrogen bonding," "Why water molecules attract"
- **Q:** *"Can you use the word 'electronegativity' in a sentence about water being sticky?"*
  A: (helps structure their thinking)

Exit Ticket Rubric (4-Point Scale)
Assessment of Learning

Score	Criteria	Descriptor
4	Excellent understanding and reflection	Student clearly explains how their thinking has changed; uses specific scientific vocabulary (e.g., electronegativity, polarity, hydrogen bonding). Shows deep insight, connects concepts, and provides detailed examples.
3	Good understanding with some reflection	Student explains how their thinking has changed with some reference to key concepts and vocabulary. Demonstrates a solid grasp but lacks some detail or depth. Makes connections that show understanding.
2	Basic understanding with minimal reflection	Student attempts to explain, but explanation is basic or incomplete. Uses limited or imprecise vocabulary; may show misconceptions or lack of connection between ideas.
1	Limited or no understanding	Student's response is vague, incomplete, or incorrect. Does not demonstrate understanding of how their thinking has changed or lacks connection to key concepts.

This rubric allows for nuanced assessment of both content understanding and metacognitive reflection.

Extension Activities: (*What will learners do when work is completed? What will learners do if they finish early?)*

- Create a concept map linking electronegativity, polarity, hydrogen bonding, and real-life applications.
- Use the Pauling scale to calculate ΔEN for several other molecule pairs (e.g., O_2, CO_2, HF, NaCl) and predict their bond types.
- Research a real-world substance (e.g., soap, antifreeze, DNA, Teflon) and explain how polarity or hydrogen bonding is important to its function.
- Write "challenge" questions for classmates about periodic trends, electronegativity, or solubility, then swap and answer them in pairs.
- Find and share a household example where polarity or solubility principles matter (e.g., cooking, cleaning, cosmetics, medicine).

Next Steps: (*Where will this lesson lead to next?)*

Next lesson(s) will:

- Explore how electronegativity and polarity affect molecular shape using VSEPR theory and 3D models.
- Investigate intermolecular forces (dipole-dipole, London dispersion, hydrogen bonding) and their impact on melting and boiling points.
- Apply polarity concepts to solubility and chemical reactions in aqueous solutions, including acids, bases, and salts.
- Analyze real-world scenarios, such as biological molecules (proteins, DNA), where polarity determines function and interactions.
- Use electronegativity trends to interpret reactivity patterns in organic and inorganic compounds.
- Conduct lab investigations measuring physical properties (surface tension, conductivity) that demonstrate polarity's effects.

My Lesson Reflection *(What went well? What would I do differently next time?)* **(HYPOTHETICAL)**

What Likely Went Well

- The opening question ("Is water sticky?") sparked curiosity right away and made electronegativity feel concrete and relevant.
- Think-Pair-Share helped everyone participate, especially quieter students who benefited from processing time before sharing.
- The collaborative periodic table + gallery walk activity encouraged reasoning and gave a quick, low-pressure read on student understanding.
- Real-world examples (oil and water, soap, HCl solubility) made polarity feel practical and memorable.
- The Volleyball-Not-Ping-Pong discussion supported peer explanations and showed that struggling with ideas is part of learning.

What I Might Adjust Next Time

- Give the gallery walk a bit more time—some students needed longer to reflect and compare reasoning.
- Add a clearer scaffold or worked example for ΔEN calculations to support students who were unsure.
- Offer more flexible exit ticket formats (paragraph, concept map, or voice note) to match different communication strengths.
- Address common misconceptions sooner with a short clarification mini-lesson.
- Build in more structured turn-taking during Volleyball-Not-Ping-Pong so quieter students have more opportunities to contribute.