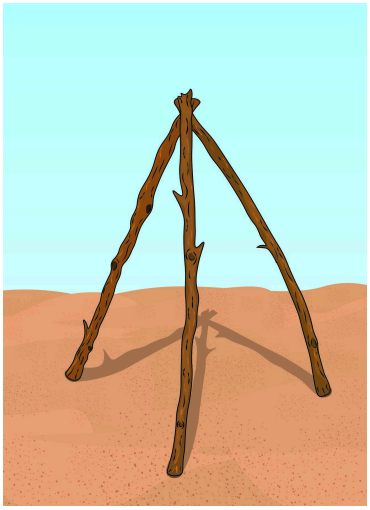
Lesson 4 or Lesson 8

Assessment Part 1

Three students were talking about why this trellis does not move and is stable. Here is what they said.



Esme: *I think that the forces from the sticks are pushing on each other equally and that is why the trellis does not move.*

Sally: "*I think there are no forces acting on the trellis and that is why it does not move.*

Michael: *There is more force pushing on one stick than the others so the trellis does not move.*

Which student do you agree with the most? Explain your thinking.

TWO-DIMENSIONAL ASSESSMENT

Construct an explanation about why a trellis does not move because forces within it are balanced.

What to look for

	Emerging	Approaching proficiency	Excelling
Description of performance	Chooses the **correct response** (Esme) with **no explanation** or an **incorrect response** (Sally, Michael) with **no, vague, or inaccurate** explanation.	Chooses the **correct response** (Esme) and **partially, accurately, and/or vaguely** explains their reasoning. OR Chooses the **incorrect response** (Sally), and **clearly and accurately** uses physics reasoning.	Chooses the **correct response** (Esme) and **clearly and accurately** explains their reasoning.
Sample student responses	*I agree with Esme.* *I agree with Sally because I think when there are forces it can fall over.* *I agree with Michael because force is on one of the sticks.*	*Esme because each stick is held in place because they are pushed into the soil.* *Esme is right because if you do the same force on something it will make it stand up.* *I agree with Esme because I also think they lean against each other so they are stable.* *Esme. The sticks are pushing the same.* *Sally is right because the forces will cancel each other out, so there is no extra force acting on the sticks.*	*Esme because the soil is holding the sticks into the ground which causes the sticks to be balanced where they touch at the top.* *I agree with Esme because all of the sticks are pushing against each other with the same force so it doesn't fall over. If one stick was pushing more than the trellis would fall over.* *I agree with Esme because when there are equal forces on every side, then it will stay up but if it is unsturdy and it has more force on one side than the other then it will fall down and not stay up.*

Additional background

Balanced forces: Esme's response is the best response. When an object is not moving, it typically has multiple forces acting on it, but they add up to a zero net force so the object does not move. In this trellis, the three sticks exert forces on each other where the sticks meet at the top. The sticks are not moving because the forces are balanced.

Sally's response could be correct if the assumption is made that Sally is talking about unbalanced, or net, force. Physicists often talk this way about the force on an object being zero when they mean the net force. Read students' responses carefully to look for this kind of reasoning and consider using probing questions to clarify the students' understanding before giving appropriate feedback.

Unbalanced forces: Michael's response is the opposite of Esme's response, which makes it incorrect.

Additional ideas you might see
Soil holding the sticks in place: In any of these responses, students may also discuss how the soil "holds the sticks in place". This is technically accurate and does explain partially why the trellis does not fall down (hence, students get 1 point if this is their full reasoning). A more complete explanation that the unit has emphasized would also include how the forces of the sticks pushing against each other where they meet at the top of the trellis are balanced (as articulated in Esme's response).

The science behind how the soil holds the sticks in place is high school-level physics and is still about balanced forces. If two sticks are stuck in the soil without touching each other, each stick will not fall down provided the torque caused by gravity is balanced by the torque from the stick in the soil.

Holding force: Many students may have the idea that a "holding force" holds things in place. This is a common conception students have in elementary or middle school. Students might explain that the reason the sticks aren't moving is because another kind of force is keeping them in place.

Lesson 8

Assessment Part 2

Your class recently planted 6 pepper plants in the garden. But, the next day you come to the garden and you see this. Oh no! The snails are eating the leaves. Your class decides to design a solution to address this problem. You determine the following criteria for success and constraints: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Criteria

- Will keep the snails off the pepper plants
- The pepper plants gets everything they need to stay alive.

Constraints

- You have 20 minutes a day Monday–Friday during the school day to work in the garden.

Since you just completed a unit on thinking like an engineer in the garden, your class comes up with these 3 possible solutions.

1. Build a metal barrier around each pepper plant so the snails can't get in.
2. Pick off all the snails you see every day at 8:00 in the morning and 8:00 at night.
3. Stop watering the pepper plants so you won't attract more snails.

1. Which solution will likely meet **all** the criteria and constraints. Why?

   I think ...

   _____

   Because ...

   _____

Evidence of progress towards 3-5-ETS1-2. ~~Generate and~~ compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

What to look for

	Emerging	Approaching proficiency	Excelling
Description of performance	Chooses **any response** with **little to no explanation** for why they chose that response. *or* Chooses **any response** with **reasoning** for why they chose that response that is **not based on criteria or constraints** described here.	Chooses **any response** and **accurately** connects reasoning to **one or two** criteria or constraints.	Chooses the **correct response** (barrier) and **accurately** connects reasoning to **all** criteria and constraints.
Sample student responses	*They should pick the snails off.* *I think a barrier is best.*	*Number 1. If you build something around it, snails can't get in.* *Number 2. You can still give the plant all of the things it needs to survive every day.* *Number 3. Maybe if you stop watering the spinach, the snails don't like it.*	*If we put a barrier the spinach will get to stay alive and the snails won't get to it. It only takes a few minutes to build.*

2. Which of these solutions likely **will not meet all** the criteria and constraints? Why?

   I think ...

   _____

   Because ...

   _____

Evidence of progress towards 3-5-ETS1-2. ~~Generate and~~ compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

What to look for

	Emerging	Approaching Proficiency	Excelling
Description of performance	Chooses **any response** with **little to no explanation** for why they chose that response. *and* Chooses **any response** with reasoning for why they chose that response that is **not based on criteria or constraints** described here.	Chooses **one response** and connects reasoning to **criteria or constraints that are not met.**	Chooses **two or more responses** and connects reasoning to **criteria or constraints that are not met** for each response.
Sample student responses	*We shouldn't water spinach.* *Picking off snails is hard.*	*Number 2. The snails can come all day and all night.* *Number 3, because if you stopped watering the spinach it would die and the snails will still come!* *Number 3. If you stop watering, snails won't come.*	*Number 1 won't work because snails can climb over it, and if you cover the whole thing, you won't be able to even water. Number 3 won't work because the spinach won't be super healthy.* *Not watering would make the plant die and the students only have 20 minutes after school to pick off the snails.* *Building a metal barrier would make the spinach stop growing because the spinach needs full sun and if you stopped watering the spinach then they would die.*

Sally and Michael both think a metal barrier design is the best. They each design a different kind of metal barrier. They test their designs for one week. Sally waters her pepper plants every day and adds Sluggo to her plants. Sluggo is a product used to kill slugs and snails. Michael waters his pepper plants once during the week and doesn't use Sluggo. Esme claims this test isn't fair so they can't compare the barriers.

3. How could you change the test to make it fair?

Evidence of progress towards 3-5-ETS1-3: Plan ~~and carry out~~ fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

What to look for

	Emerging	Approaching proficiency	Excelling
Description of performance	Does not talk about controlling any variables.	Explains how to control one variable (watering or Sluggo).	Explains how to control both variables (watering and Sluggo).
Sample student responses	*Try again next week.* *Do it again next week and have them do the opposite.*	*Everybody or nobody adds Sluggo.* *Michael should water his plant as much as Sally.* *They both have to do the same thing.*	*Have them water their spinach the same amount and use the same amount of Sluggo.* *Michael also waters his spinach every day. Sally doesn't use Sluggo.*

After 2 weeks, Michael looks at his design and finds that all the pepper plants have snails on them. Here is what his metal barrier looked like before and after 2 weeks.

Before	After
	

4. What might be a problem with Michael's barrier? Why?

5. How could he fix it?

Evidence of progress towards 3-5-ETS1-3: Plan ~~and carry out~~ fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

What to look for

	Emerging	Approaching proficiency	Excelling
Description of performance	**Does not** identify a failure point.	**Partially identifies** a **general** failure point (not about a specific barrier feature) and gives one idea for how to improve the design that connected to the failure point. *or* Identifies only a failure point and does not connect it to a design.	Identifies a **specific** failure point of the barrier design and one idea for how to improve the design that is **explicitly** connected to the failure point.
Sample student responses	*Snail crossed it.*	*Snail crossed it. Make it heavier.* *Snails got over. Fix it so they can't get over.*	*The barrier was not made sturdy. Get rocks and put them on top so it does not blow it away.* *The snails could easily get over it. Put wire around it so they can't get in.*