LEARNING ACTIVITY:

Soil has a Charge!

GRADES 7–10

MATERIALS

- Copper wire
- Lantern battery (6V)
- Clay: Pottery clay, bentonite or native soil with clay texture*
- Hammer or mortar and pestle (optional, to break up aggregates (clumps) in dry soil)
- Water
- Plastic cup (3 oz)
- Spoon or craft stick
- Timer
- Wire cutter, if needed

* What is clay texture? **https://bit.ly/soil-texture-by-feel** (by Dr. Dirt)

How does texture-by-feel work? **https://bit.ly/soil-texture-video** (by UC Davis)

Soil Science Society of America

Source: Soil Science Society of America.

Developed by Clay Robinson, a.k.a. Dr. Dirt for SSSA.

Soils transport water and provide homes for trillions of bacteria and other organisms. Soils also contain solids (sand, silt, clay, organic matter) with pores between them filled with air and water. The soil solids affect the ability of soil to hold and release plant nutrients.

Plant nutrients are ions (See Analysis Question #2 for examples) which are atoms or molecules with a net electrical charge. Clay particles and organic matter have charged surfaces that either attract cations (positive ions) or anions (negative ions). Different kinds of clay minerals vary in their amount of negative surface charges which allow the soil to attract and hold different amounts of cations. The cation exchange capacity of soil is determined by the amount and type of clay minerals and the amount of organic matter within the soil.

Why is this important? These charged surfaces have a role in retaining soil nutrients for plant use by a process called *ion exchange*. Water in soil is a solution — it always contains ions. Ion exchange involves the movement of cations or anions between the soil solution and another cation or anion that is stuck (adsorbed) to the clay surface. The following activity shows how ions are attracted to soil surfaces.

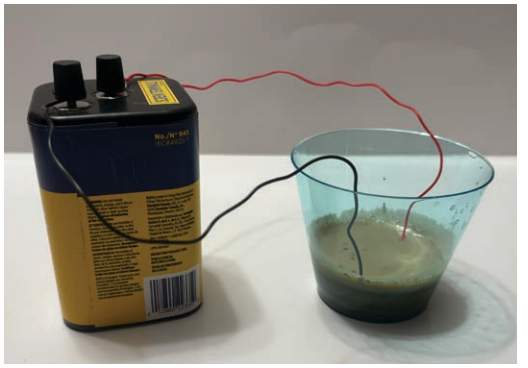
PROCEDURE

1. Cut two 8 inch lengths of copper wire. Strip about 1 inch of the insulation off both ends of the wires.
2. Add 30 mL (2 Tbsp) water to a plastic cup.
   a. Stir the water while slowly adding 5 g (1 tsp) clay at a time, breaking up aggregates that form.
   b. Continue stirring and adding clay until it is a slurry with the consistency of thick glue.
3. Attach one copper wire to the positive pole of a 6-Volt battery. Attach the second wire to the negative pole.
4. Submerge the ends of both wires in the clay slurry ½ inch apart (see photo).
5. After 10 minutes, carefully pull the wires upward out of the slurry to observe both ends. Is the clay sticking to one of the wires? If so, which battery pole wire attracts the soil?

ANALYSIS

1. Discuss your observations with your classmates. Explain what occurred using the terms *cation* and *anion*.
2. These are some of the ions commonly added to soils from fertilizers and the atmosphere:

H^+	Hydrogen	Cl^-	Chloride
NH_4^+	Ammonium	Ca^{2+}	Calcium
NO_3^-	Nitrate	SO_4^{-2}	Sulfate
K^+	Potassium		



Experimental setup.
Credit: E. Robeck, AGI

   a. Based on your understanding, identify the ions in the list that will attach to a clay-rich soil's exchange sites.
   b. Describe how you determined this using evidence from this activity.
   c. Research why these ions are needed by plants.

FURTHER STEPS

Try this activity with soil from your yard. The amount of interaction between the wires and the soil can be an indicator of how much clay (and organic matter) is in the soil.

Check out more information on this activity from Dr. Dirt: **https://cdrdirt.com/soil-is-charged/**.

NGSS CONNECTIONS

SEP: Planning and Carrying Out Investigations
DCI: ESS2.A: Earth's Materials and Systems
CCC: Energy and Matter

SDG CONNECTIONS

2: Zero hunger
15: Life on land