Lesson Title	A Solution for Moles
Length of Lesson	1 hour 15 min
Created By	Chris Ruhs
Subject	Chemistry
Grade Level	10-12th Grade
State Standards	Chemistry I: 11a,b,e
DOK Level	DOK 2
DOK Application	Students demonstrate their knowledge of the molarity through laboratory activities.
National Standards	B (Physical Science)
Graduate Research Element	Molarity is perhaps the single most important concept for environmental chemists, biogeochemists, toxicologists. Specifically, making standard solutions of reference compounds for quantification of environmental compounds is integral to my graduate work.

Student Learning Goal:
MS 9-12th Grade:
Chemistry I: 5 (a) Describe solutions in terms of solute and solvent; electrolyte or non-electrolyte; soluble or insoluble; unsaturated, saturated or supersaturated; miscible or immiscible. *Students will learn and use the terms "solute" and "solvent" to describe solutions.* (b) Express the concentration of a solution as percent by mass, molarity, molality, and mole fraction, given appropriate data. *Students will express concentration of solutions in terms of molarity.* (e) Describe how to dilute a solution in terms of molarity and volume. *Students will actually perform a dilution of known molarity to a set volume.*
National Science Education Standards of Content 9-12:
B: Physical Science: Chemical Reactions. *Students will discover molarity, titration, and dilution through an acid-base reaction.*

Materials Needed (supplies, hand-outs, resources):
Six 100mL volumetric flasks, six titration stands with burettes, six 50mL beakers, eight pipettes with suction bulbs, 1M HCl stock, 0.1M NaOH stock.

Lesson Performance Task/Assessment:
Formative:
1. Review what a mole is, what a pure substance is, and what a mixtures is.
2. After reviewing mixtures, home in on solutions, noting that moles of a pure substance can be dissolved in a solvent like water to make a solution.
3. Review the shape of the water molecule, why it's polar, and what molecules it is likely to dissolve because of its polarity. Discuss the sugar molecule here as well.

4. Use cool-aid as a visual analogy for Molarity: ask "what does cool-aid taste like if you don't put much powder in?" ask "what does cool-aid taste like if you put too much powder in?" Discuss the difference in terms of "concentration".
5. Begin discussion of Molarity in earnest, using
    a. Molarity = moles solute/ Liters solution (for calculating)
    b. Molarity 1 x Volume 1 = Molarity 2 x Volume 2 (for dilution and tiration)
6. Discussion and example problems
7. Discuss how scientists use this knowledge, and what you can do with it.

Summative:

1. Give each student a laboratory worksheet.
2. Lead students through solution making lab (make a 0.1M solution of HCl).
    a. Each group will be given a volumetric flask, and will be carefully guided through diluting concentrated HCl with de-ionized water to 0.1M.
3. Lead students through the acid-base titration lab (HCl, NaOH, and phenolphthalein).
    a. Tell the students that it is important sometimes to check the molarity of either a pre-made solution or of an unknown sample. Have students check their 0.1M HCl solutions by titrating them with a 0.1M NaOH.

Lesson Relevance to Performance Task and Students:
Understanding what a solution is and how to calculate it is sometimes difficult. In this case, actually making a solution is helpful for understanding the equations, especially for the common misconception "that moles of solute is added to liters of solvent" when, in fact, "moles of solute are added to liters of solution".

Anticipatory Set/Capture Interest:
Pore sugar into water and ask the students "Where the sugar is going when it disappears?" When someone answers "It dissolves," follow up by asking, "How do you know how much sugar has dissolved?" or "How can we find out how much sugar is in the water?"

Guided Practice:
Reviews, discussion and example problems will serve as guided practice.

Independent Practice:
The two laboratory activities with the worksheet will serve as independent practice.

Remediation and/or Enrichment:
Remediation:
Individual IEP, focus on one simpler examples and fewer geometries.

Enrichment: Discussion of other concentration units: ppm, ppb, molality, etc.

Check(s) for Understanding:
What is a Solution?
What is the equation for making a solution? Making a dilution?
How do scientists use this knowledge?

Closure:
A Q&A session led by the teacher will bring closure to the lesson plan.

Possible Alternate Subject Integrations:
Environmental science: understanding transport and fate of chemicals in the environment.
Biology: understanding chemicals dissolved in blood or fat; understanding how chemicals in nature affect ecosystems.
Geology: understanding how minerals, especially soluble minerals, migrate and precipitate.

Teacher Notes: