

**Description:** Students become scientists as they design and conduct experiments based on the famed “Diet Coke and Mentos” experiment.

**WOW!:** Students present their findings from their experiments to create the biggest soda explosion and explain the science behind their findings.

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### People

1 Citizen Teachers

[1-5] guests

1 Citizen Schools team leader

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### Materials provided

See Curriculum

## 10-Week Plan

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|----|--|
| 1  | Observation, Research, and Hypothesis    |
| 2  | Pressure, Volume, and Force              |
| 3  | Carbonation                              |
| 4  | Soda Types                               |
| 5  | Temperature                              |
| 6  | Calculating Speed                        |
| 7  | Begin building and designing rocket car  |
| 8  | Finish building the rocket car/Trial run |
| 9  | The Big Day: Rocket Car Race             |
| 10 | WOW! Prep                                |

# Exploding Soda Science STEM Sector Apprenticeship

Taught Fall 2012

Neal Middle School

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Fellow) and Dayne Filer (Citizen  
Teacher)

### Apprenticeship:

Wow format - presentation

Apprenticeship Title: Exploding Soda Science

21 Century Skill – Citizen Schools students will create and test a hypothesis.

- Define and give examples of a hypothesis
- Ask a clear question and form a hypothesis that connects to it
- Explain the role a hypothesis and data play in learning about a phenomenon
- Explain the method(s) by which a hypothesis can be tested
- Conduct tests of a hypothesis and gather data

### Unit Guide

1. Observation, Research and Hypothesis
  - a. Hook – “I’ve always wondered...”
  - b. Expectations
    - i. Respect yourself, others, their opinions, and all other objects.
    - ii. If you make a mess, clean it up.
    - iii. Follow all directions.
    - iv. Come with an open mind.
  - c. Experiment: basic diet coke and mentos
  - d. Introduce concept of variable
  - e. Set a goal as a class
2. Pressure, Volume and Force
3. Carbonation
4. Soda Types
5. Temperature
6. Calculating Speed
7. Begin building the rocket car designs
8. Finish building the designs / Trial run of rocket cars
9. The Big Day: tweak rocket cars from the trials, conduct the race that counts of rocket cars
10. Prepare materials for the WOW
  - a. Trifold
  - b. video

### Materials:

Ponchos

Diet Coke

Mentos

Flip Cam

Pocket-sized observation notebooks

Class ideas:

- Hook – “I’ve always wondered...”: Students ask questions about how things work and formulate a quick hypothesis. The following week, we answer one of their questions/hypotheses. Example: Student asks and then formulates a hypothesis “Why does slime ooze? I think it oozes because...” The next week we answer that slime oozes because it is a special state of matter known as a non-Newtonian fluid, which is a state that sometimes acts like a liquid and sometimes acts like a solid. (Note: the answers will have to be crafted into kid-friendly language.)
- Film every experiment so that students can show footage of their experiments at the WOW
- Students must record all of their observations, hypotheses, design changes, etc. in a small notebook. That way, they have a record of everything they’ve tried.

## **Lesson 1: Introduction to Exploding Soda Science**

### **Objective:**

- Students will be able to define and give examples of a hypothesis

### **Agenda:**

5 min – Hook: I’ve always wondered... (Filer)

10 min – Intro to New Material: Introductions and Expectations (Hubbard)

15 min – Activity 1: What is a Hypothesis? (both)

20 min – Activity 2: Lab Notebooks (Filer)

30 min – Activity 3: Why does mentos make diet coke explode? (both)

### **5 min - Hook: I’ve always wondered... (Filer)**

- Introduce the hook ritual
- Ask students for questions to be answered next week
- This week’s question: why does dropping mentos into diet coke make an explosion?

### **10 min - Intro to New Material: Introduce ourselves and expectations (Hubbard)**

- Introductions: Filer and Hubbard
- Expectations:
  - Respect yourself, others, their opinions, and all other objects.
  - If you make a mess, clean it up.
  - Follow all directions.
  - Come with an open mind.
  - Keep a thorough lab notebook
- Apprenticeship Roles: time keeper, clean-up captain

### **15 min - Activity 1: Hypothesis - both**

- Define hypothesis
- Teacher-produced examples (Hubbard)
  - written on paper around the room – find and classify as good hypothesis, bad hypothesis, or not a real hypothesis
  - Students must also create at least 2 examples of good hypotheses.
- Write hypothesis of today’s lab (Filer)

### **20 min - Activity 2: Lab notebooks - Filer**

- Learn format
- Write the intro & methods of today’s lab – board as paper (write on the board exactly what you want students to write in their lab books)

- Teach students that they must write in notebooks as they go through each step. Need to write everything that they do so they know what they actually varied.

### **30 min - Activity 3: Why does mentos make diet coke explode? (both)**

- Introduce the concept of varying only one thing at a time.
- Divide class into 5 groups, explain the lab & expectations of the lab.
- Test with different materials in diet coke
  - Use diet coke in clear Dixie cups
  - Groups must test at least 4 different materials
- We circulate between groups to monitor students' progress.
  - Possibly have access to a microscope to see the surfaces of the materials that students are using.
- Clean-Up!!!!

### **10 min - Closing: Lab Notebook Entry**

1. Define hypothesis
2. Give 2 examples of good hypotheses
3. In one sentence, explain why mentos makes diet coke explode.

### **Materials Needed:**

- Lab Notebooks
- Ponchos
- 2 bottles of diet coke
- ? packs of mentos
- Marbles
- Golf balls
- Ice cubes
- Raisins
- Math counters
- Clear Dixie cups

## Lesson 2: Pressure, Volume and Force

### Objectives:

- I can explain the relationship between pressure and volume
- I can test a hypothesis and rework it to conduct more trials.

### Agenda:

10 min – Hook: I’ve always wondered...

10 min – Intro to New Material: Boyle’s Law

60 min – Activity 1: Pressure/Volume Tests

10 min – Closing: Lab notebooks

### Materials:

12 20oz soda bottles

2 mentos per bottle, drilled through and strung up (Filer will prep)

2 Ponchos

Drill with various bits

### **10 min - Hook: I’ve always wondered...**

- Show video to answer why mentos works (2 min)
  - <https://www.youtube.com/watch?v=LjbJELjLgZg>
- Students ask their questions

### **10 min - Intro to New Material: Boyle’s Law**

- Introduce the inverse relationship between pressure and volume
  - Boyle’s Law: For a given amount of something, an increase in pressure causes a decrease in volume, and vice versa.
- Do a demonstration where you have 3-4 students standing apart from each other (low pressure). Look at how much space (high volume) they take up. Now squeeze them together (increase pressure). Notice how the students now take up less space (volume).
- Do a demonstration where a student tries to blow up a balloon inside a soda bottle
  - Give 50 value stars to any kid who can do it ...they can’t because of the volume of air inside the soda bottle.
- Debrief again

### **60 min - Activity 1: Pressure/Volume tests**

- Transition: Now that we know the inverse relationship between pressure and volume inside the soda, we can think about the inverse relationship of the bottle's hole size and the force with which the soda exits the bottle (1 min)
  - Small hole = more pressure, (but tiny hole = misty spray instead of large height)
  - \*\*\*\*Highlight the 21<sup>st</sup> Century Skill
- Students use their knowledge of inverse relationships to make a hypothesis about the coke bottle's hole size (2 min)
  - Students can have a bottle cap hole size of  $\frac{3}{32}$ ",  $\frac{5}{32}$ ",  $\frac{1}{8}$ ",  $\frac{1}{4}$ ",  $\frac{3}{8}$ ", or no cap
  - \*\*\*pre-drill caps into these sizes.
- Students must fill out intro, hypothesis, methods, and make a chart before they get to test. (7 min)
  - "I think \_\_ will happen because \_\_."
- Transition outside. (expectations for outside – be fast: you are wasting your time, not ours)
- Groups must design 1 trial, test it one at a time, then redesign. Rinse and repeat for a total of 3 trials per group (3 min per trial)
  - 2 mentos per 20 oz bottle.
  - Have a student time keeper
  - One adult with groups doing the experiments, other adult with groups on deck, checking students' work in their lab notebooks.

### 10 min - Closing: Lab Notebooks

- Discussion: Which hole size worked best and what size hole will you use from now on?
- 1. If we decrease pressure what happens to the volume?
- 2. What causes mentos to fizz?
- 3. Why is it important to retest your hypothesis?

\*\*\*Ask students what kinds of sodas they want to test with next week (diet coke, diet pepsi, club soda, etc.)



### Lesson 3: Why does diet coke work best?

5 min - Hook: I've always wondered

- Answer 2 questions from last week.
- Students ask questions about how things work and formulate a quick hypothesis. The following week, we answer one of their questions/hypotheses.

5 min – Finish last week's lab discussion and conclusion

- Get a teach back on what we did/varied.
- Timer: students have 2 minutes to answer the discussion question.
- Timer: students have 2 minutes to answer the closing question.

10 min - Intro to New Material: how to choose a variable

- Revisit idea of varying only one condition: control vs. variables
  - Quick game: Can we do this?
  - We name different ways to conduct an experiment with a mix of varying one thing or multiple things.
  - Students move to one side of the room if it meets the one variable requirement, move to the other side if it does not.
  - Questions:
    - Testing how high a plant grows by growing a plant in soil vs. rocks
    - Testing how high a plant grows by growing a plant with or without fertilizer and in soil or rocks
    - Testing what kind of dog food your dog prefers: kibble & bits, iams, and chicken & rice
    - ...
- Students brainstorm different things to vary in our experiment
  - Student scribe writes on board
  - Students toss around ball to volunteer to share ideas.
- Today we're going to vary the soda

30 min - Activity 1: Carbonation Test

- Students test putting 1 mentos into different carbonated beverages (diet coke, regular coke, cheerwine, sprite)
- Record their data

30 min - Activity 2: Carbonation Demo

- Students test the amount of carbonation in a 20 oz. bottle of soda in their groups
  - one group per beverage
    - Methods:
      - Put a bottle of soda into a 1 gallon Ziploc bag.
      - Remove all air from the bag and seal it.
      - Sink the bag in a bucket of water.
      - Measure the water level on the side of the bucket.
      - Carefully open the soda bottle inside the plastic bag.

- Gently shake the bag.
  - Sink the bag into the water again.
  - Measure the water level.
- Use a ruler to measure the space between the two water level marks.
  - Note: although sugary sodas may have more carbonation in them, diet sodas work better in the long run. The sugar in the regular sodas gets sticky and messes up the nucleation of the carbon dioxide gas with the mentos.
  - Give students roles about who does which part of the lab set up.
  - Each group must write findings in the chart on the board so that all students can write all of the findings in their lab notebooks.

10 min - Closing:

1. Discussion: what worked best?
2. Why do you vary only one thing?

## Lesson 4: Testing Soda Types

Agenda:

5 min - Hook – I've always wondered...

10 min - Cheerwine carbonation demo

- Show last week's demo from the soda that had a hole in the bag. (we need the data that we weren't able to get)

15 min- Intro to New Material – Scientific Method Matching Game & lab notebooks

- State 21<sup>st</sup> century skill
- Teach students how to make a data chart
  - Notes section: "this worked and we trust the data." "the bottle fell over"
  - What to put in discussion vs. notes sections.

45min - Activity 1: mentos lab with hole size

- Emphasize CO<sub>2</sub> gas as carbonation
- 2 trials for each group at the same time
- Students will test the soda and mentos reaction with the soda of their choice. Indicate ahead of time that all students use the same amount of mentos (3) and use the same hole size that their team has used in prior weeks/tests.

10 min – Activity 2: lab notebooks

- teach back before students start writing
- students must fill out their entire lab reports before the Sprite treat!

5 min - Closing: Sprite

- Bring Sprite as a treat!

Word wall:

Boyles law

Scientific method

Lab notebook parts

Carbonation

Nucleation

Carbon dioxide

## Lesson 5: Temperature Labs

Agenda:

5 min – I've always wondered...

50 min - Activity 1 – Temperature Demo

- Pose the question: What do you think the relationship is between temperature and volume?
- Students do a water bottle demo
  - Stations: hair dryer, ice water, room temperature
    - Use empty, thin plastic water bottles. Directions are below.
- Ask students for their theories – each student must have his/her own theory
  - Do a silent ballot where students write their name and their theory on the ballot and vote
  - We give 3 options and there is a bonus for explaining your theory
- Charles Law - Explain temp and volume are directly related (5 min)
  - Do a demo where the students are molecules – when it's hot, they want to spread out, which demonstrates the direct relationship between temperature and volume
  - Try to make the connection/leap from the direct relationship between T and V, and then the inverse relationship between P and V, to understand Gay-Lussac's Law: P and T are directly related

20 min Activity 2 – Soda Temperature Lab

- Fill out lab notebooks
- Students will test how well the mentos fizzes in soda at different temperatures.
- We will have warm, room temperature, and cold soda in small cups (use the same type of soda for each temp). Students will drop a mentos in each cup and measure the results.

15 min - Vocabulary Hot Seat (5-10 questions)

- Game is on Powerpoint
- Played like Taboo

**Station 1: Heat**

1. Squish a little bit of air out of the water bottle and put on the cap.
2. Hold your water bottle by the cap.
3. Turn on the hair dryer on high heat.
4. Blow the hair dryer at the bottle for 60 seconds.
5. Observe what happens to the bottle.
6. Write your observations into the data chart in your lab notebook.

**Station 2: Cold**

1. Hold your water bottle by the cap.
2. Submerge the bottle into the ice water bath for 60 seconds.
3. Observe what happens to the bottle.
4. Write your observations into the data chart in your lab notebook.

**Station 3: Room Temperature**

1. Take the water bottle out of the ice water bath.
2. Leave it on the table for 60 seconds.
3. Observe what happens to the bottle.
4. Write your observations into the data chart in your lab notebook.

## Lesson 6: Need for Speed

- 5 min - Hook: I've always wondered...
- 35 min - Activity 1: Test soda explosion with different temps
  - Go outside and have groups be equal in terms of same number of mentos and same hole size)
- 10 min - Activity 2: introduce the class to our new challenge—Rocket Cars!
  - show the rocket car video (<http://www.eepybird.com/featured-video/the-mentos-mini-rocket-car/>)
- 15 min - Activity 3: Learn how to calculate speed (distance over time)
  - Do a few practice problems on the board
- 25 min - Activity 4: measure speed of hot wheels rolling down a ramp
  - Each group does 10 trials
  - Precision: the more you practice, the better you get.

\*\*\*make a summary table from last week's result

## Lesson 7: Get creative!

- 5 min - Hook: I've always wondered
- 5 min – Mini-lesson: friction with demo
  - Fill the bowl half way with water. Put the smooth ball into the water and give it a spin. Discuss how fast it spins.
  - Put the tennis ball into the water and give it a spin. Discuss and how the friction makes it spin slowly.
- 60 min - Activity 1: students construct their own wheel bases in pairs
  - \*\*by the end of class, you must have the wheels made to your liking, a team name, a description of why they think their rocket car will work
  - Have materials available, such as: bottle tops, old cd's, tennis balls cut in half, anything round, dowels, something to use as the car base
  - \*\*\*bonus: groups that finish early can use flipcams to make video interviews about what they've learned, why the science works, their favorite part of the apprenticeship
- 20 min - Activity 2: students test their wheels by putting a full soda bottle on them and rolling them. Their cars must be able to hold the weight of the soda.
  - Students should tweak their cars as needed to make sure they can work.

## Materials needed

$\frac{3}{4}$ " dowel

pvc pipe

wood blocks

straps

screws

wheel castors ...What if we have the students make their own wheels using soda bottle tops? I know they won't be as easy to use as castors, but they'll be almost free. I have

tons of soda bottle tops that I've saved from previous lessons. We can construct them with tiny dowels, the bottle tops, and hot glue.

duct tape

soda bottle

question: does the dowel/pipe length matter?

### **Week 8: Time Trials**

- Finish constructing rocket cars
- Test rocket cars on the track (variables: temp, soda types, pipe length)
- Calculate distance and speed (bring a tape measure... ask about borrowing track long-jump measuring tape from athletic director)
- Class discussion: what works? Bring it all together

### **Week 9: The Big Day**

- Modify their cars
- Rocket car competition
- Start making talking points for the WOW!

### **Week 10: WOW! Preparation**

- Prepare for WOW!
- Make a Trifold board with what we've done
- Prepare and practice talking points for the WOW!
- Show compiled videos to be shown at the WOW!