FLINN STEM

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IMSA Fusion — You Be the Judge STEM Curriculum Module

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You Be The Judge

Curriculum Overview

Everyone's life is affected by chemistry. From the various systems within the human body needing to maintain specific pH levels to the detergent used in the laundry, chemistry is involved. Chemistry discoveries have advanced the fields of medicine, agriculture, manufacturing, and many others. Along with advancements come choices, and with choices come trade-offs.

You Be the Judge introduces students to some basic principles involved in chemistry, the application of chemistry as well as process skills required to create and carry out meaningful investigations. After students have experienced the concepts in a lab setting, they will have a chance to apply their knowledge and lab skills in a variety of simulations throughout the curriculum. Students will take the role of experts as they identify problems, develop methods of testing, and conduct the tests. After gathering, analyzing, and interpreting results, students will make and share evidence based decisions in a variety of settings.

Curriculum Objectives

The students will:

- understand the difference between physical and chemical changes
- become familiar with pH testing
- design and conduct experiments
- collect, analyze, and interpret data
- make decisions based on evidence
- communicate results
- learn practical applications of chemical principles
- practice safety in the lab
- develop lab skills

Logistics

Class age/size:	All lessons are designed for twenty 4th-5th grade students.
Materials:	See insert for each individual activity within this unit.
Time:	This curriculum is designed for 32 content hours. See individual activities for suggested times.
Location:	All activities may be taught in a classroom. Water access is needed for some activities.

Notes

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Standards and Practices

NGSS Scientific and Engineering Practices

1. Asking questions and defining problems (SEP1)
2. Developing and using models (SEP2)
3. Planning and carrying out investigations (SEP3)
4. Analyzing and interpreting data (SEP4)
5. Using mathematics and computational thinking (SEP5)
6. Constructing explanations and designing solutions (SEP6)
7. Engaging in argument from evidence (SEP7)
8. Obtaining, evaluating, and communicating information (SEP8)

Next Generation Science Standards

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sounds, light, heat, and electrical currents.
5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.
5-PS1-3. Make observations and measurements to identify materials based on their properties.
5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
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.
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.
MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.
MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

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Common Core State Standards Mathematical Practices

4. Model with mathematics. (MP4)
5. Use appropriate tools strategically. (MP5)
6. Attend to precision. (MP6)
7. Look for and make use of structure. (MP7)

Common Core State Standards

5.MD.5.B Apply the formulas $V = l \times w \times h$ and $V = b \times h$ for rectangular prisms to find volumes of right rectangular prisms with whole-number edge lengths in the context of solving real world and mathematical problems.
6.EE.7 Solve real-world and mathematical problems by writing and solving equations of the form $x + p = q$ and $px = q$ for cases in which p, q and x are all nonnegative rational numbers.
8.G.9 Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.
RI.5.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.
RI.5.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4-5 text complexity band independently and proficiently.
W.5.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
W.6.1 Write arguments to support claims with clear reasons and relevant evidence.
SL.5.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.
RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

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Unit Summaries and Objectives

Density

Students begin by focusing on the physical property of density. They have the opportunity to work firsthand with two models that demonstrate the relationship between how tightly packed molecules are and the space left between them. They then move to calculating the density of a variety of regularly shaped objects.

The students will:

- develop an understanding of density
- calculate density of objects
- collect, analyze, and interpret data
- solve equations
- collaborate with partners and share materials

Changes

Changes introduces students to polymers. Through the exploration of polymers, the concepts of physical and chemical changes will be pursued. The production of slime and the examination of super absorbing polymers will provide needed background for the next challenge. The SBG Company has hired the FUSION students to determine which diaper is the best.

The students will:

- observe and record evidence of chemical reactions
- develop an understanding that when a new material is made it has properties that are different than the original material
- distinguish between chemical and physical changes
- collaborate with partners and share materials

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Thirsty?

Polyacrylamide is the super absorbent cross-linked polymer that students are first introduced to in Thirsty. After examining this ingredient in Soil Moist®, students then launch into answering the question of which disposable diaper is best. Three brands of disposable diapers are compared using student developed procedures. After developing procedures, carrying out testing, collecting and analyzing data, student groups share their findings and interpretations of data with the rest of the class. Next students will examine the problems created by plastics in the oceans, bioaccumulation, and meet another design challenge.

The students will:

- observe effects of super absorbent polymers
- design and conduct experiments to test effectiveness of products
- collect, analyze and interpret data
- communicate findings and conclusions based on evidence
- mathematically represent concentrations
- determine concerns regarding use of plastics
- design alternative to plastic product

Acid, Base, Neutral?

Characteristics associated with these topics are explored in this lesson. Students learn various
methods of testing substances to determine their pH, including litmus paper, pH paper, and universal indicator. They will then apply this knowledge to tooth decay as they participate in a dental conference to develop a media campaign aimed toward candy.

The students will:

- develop an understanding of the role of pH indicators
- use a variety of pH indicators to identify substances as acids, neutrals, or bases
- collect and analyze data
- predict pH
- develop data tables
- research pH
- represent strength of acids mathematically
- collaborate with partners and share materials

Notes

Help!

Teams of students have the opportunity to observe and test known substances for their physical properties and chemical reactions. They then move to the simulation, Accident at the Bridge, which engages teams in attempting to determine the contents of a spill on a highway.

The students will:

- observe physical and chemical properties of substances
- conduct pH testing
- make inferences based on evidence
- collect, analyze, and interpret data
- share interpretations of data with a group

Oh My Aching Stomach

Oh My Aching Stomach is the culminating activity for You Be the Judge. After being introduced to the large economic industry of antacids, student teams design a method of testing and assessing the efficiency of over the counter antacids. After conducting testing, research teams make their recommendations to a panel based on their findings.

The students will:

- define a problem to investigate
- design a procedure for investigating the problem
- apply knowledge regarding pH
- collect, analyze, and interpret data
- use evidence to make a decision
- communicate a decision to a group

Oh, My Aching Stomach

Notes

Objectives

The students will:

- define a problem to investigate
- design a procedure for investigating the problem
- apply knowledge regarding pH
- collect, analyze, and interpret data
- use evidence to make a decision
- communicate a decision to a group

Standards

SEP1	MS-PS1-1
SEP2	MS-ETS1-1
SEP3	MS-ETS1-2
SEP4	MS-ETS1-3
SEP5	MP5
SEP6	MP6
SEP7	MP7
SEP8	RI.5.4
4-PS3-2	RI.5.10
5-PS1-3	W.5.10
5-PS1-4	W.6.1
3-5-ETS1-1	SL.5.1
3-5-ETS1-2	RST.6-8.3
3-5-ETS1-3	RST.6-8.7

Background

Antacids account for roughly one billion dollars' worth of business in the United States each year. There are several companies that produce over the counter and prescription strength antacids, both of which have the same purpose; balancing the stomach pH. Stomach acid usually ranges from 2 – 3 on the pH scale. If the pH goes below this range, problems tend to occur. Balancing the pH does not mean neutralizing or bringing the pH to a 7, rather somewhere from 3 – 4. Antacids are made from bases and additional ingredients for this chemical change to occur. Sodium (Alka-Seltzer®), calcium (Tums®), magnesium (Maalox®, Mylanta®), or aluminum (Rolaids®) are often used in combination with the base.

As with any medications, over the counter or prescription, there are potential side effects. Depending upon which classification of antacid is used; diets may need to be adjusted.

Inquiry Overview

Students will test brands of antacids to determine which is the most effective. Pairs of students will design a procedure for testing the various brands of antacids. After the teacher approves the procedure, then students will carry out their experiments, collect data, analyze data, interpret and present their findings to the group.

Notes

Activity One

Estimated Time:

Work in Pairs

- 1 Hour: Introduce Activity, Discuss Antacids, Brainstorm Questions
- 1 Hour: Develop Investigation Plan
- 1 Hour: Investigate
- 1 Hour: Prepare for Consumer Board Meeting
- 1 Hour: Consumer Board Meeting
- ½ Hour: Chemist Drawing, Comparison to Original Drawing

Materials

Each Student:
Goggles
Piece Plain Paper
Art Supplies

Each Pair of Students:
Alka-Seltzer®
Antacid #2
Antacid #3
Blue Litmus Paper
Chemplate
Household Vinegar
pH Paper
Paper Towel
Red Litmus Paper
Stir Stick
Stop Watch
Universal Indicator
Water

You may wish to introduce the activity to the students by sharing the old Alka-Seltzer® commercial. http://www.youtube.com/watch?v=rxYRhnBzp8U&feature=email

Inquire as to what they know about Alka-Seltzer®, what it is used for, and what other similar products exist on the market. Have students predict how much money is spent each year on antacids.

Host a discussion recalling the prior activities and knowledge regarding the pH scale, acids, bases, and neutral. Share with students that antacids are made of bases and other ingredients, such as sodium, calcium, magnesium, or aluminum. The purpose of antacids is to balance stomach acids and bring them to a lesser acid concentration. This means a higher pH number, but less than a 7, which is neutral.

Explain that students now have the opportunity to determine which of the antacids brands is the most effective. Share with students that they will have three brands of antacids to work with during their investigations.
Have students work in small groups to generate a list of questions that could be asked about the antacids. Next have the entire group share their questions. Record the questions for the students.

Share the available materials for use in an investigation. Ask students to work in their small groups to brainstorm the following, “What questions could be investigated using the materials we have available?” Again, gather the entire group to share their ideas.

Allow students to determine their partners for the activity. Each set of partners should come up with their question to investigate to help them determine effectiveness of the antacids.

Using their prior knowledge from this unit, they will design a procedure, get it approved by you, and then carry out the experiment. Assist students as they work through the process.

After gathering and analyzing data, they will design an advertisement to present to the consumer board on which brand of antacids is most effective. Explain how the board meeting will be run. Allow time for groups to prepare for the board meeting. Hold a consumer board meeting where each group must present their findings.

Notes

Debrief

- How did you and your partner define "most effective" when designing your procedure?
- What other factors would you consider if you were to do this testing again?
- Are you confident in your results? Explain.
- You tested only a few samples. When actual medicines are tested, the sample size is very large. Why do you think sample sizes need to be so large when medicines are tested?
- As a consumer/patient, what would you want to ask a pharmacist or doctor before using one of these products?
- After the final debrief, have students draw a picture of chemist. Compare this to their first drawing.

Notes

Oh, My Aching Stomach

Problem: Which brand of antacid is the most effective?

Available Materials:

- Chemplate
- Paper Towel
- Household Vinegar
- Walgreens Antacid®
- Alka-Seltzer®
- Tums®
- Universal Indicator
- pH Paper
- Litmus Paper
- Water
- Goggles
- Stir Stick
- Graduated Cups
- Stop Watch

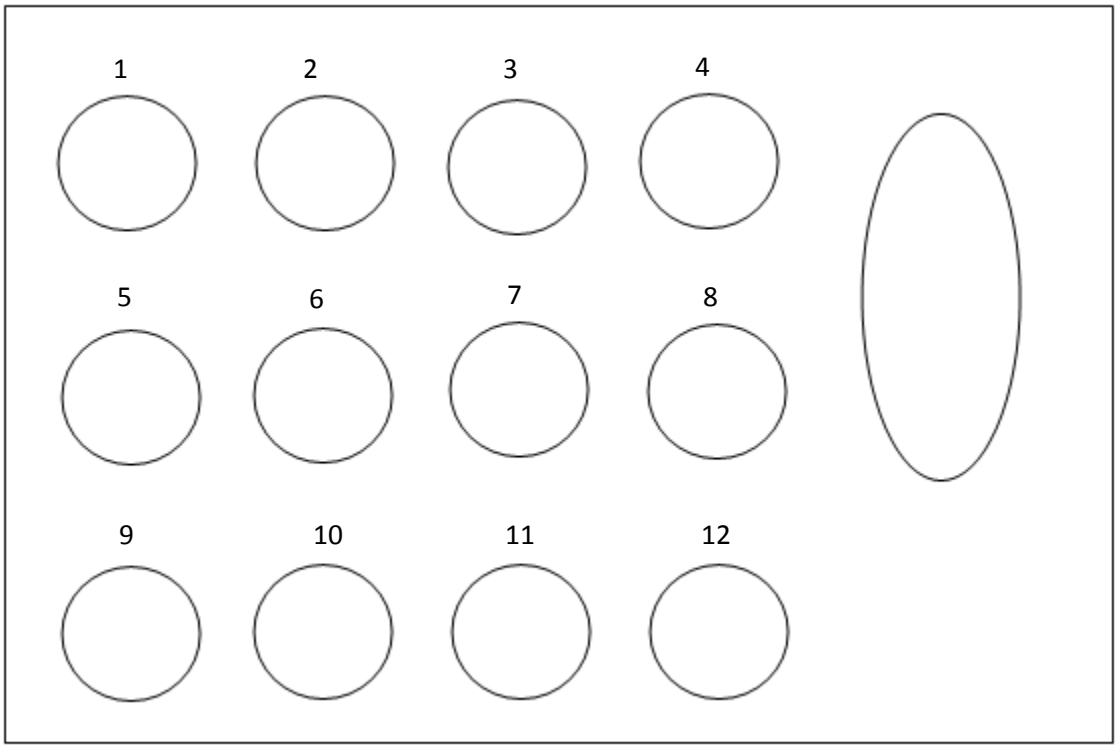
Procedure:

1. Use the household vinegar, which is 4% acetic acid, to simulate stomach acid.
2. Work with your partner to determine what problem you will investigate.
3. List the materials you will need to use.
4. Write a procedure that explains how you will carry out your investigation. Make sure to include quantities, times, and have the steps in order.
5. Explain what data will be collected and how it will be recorded.
6. Share your procedure with the judge, your teacher, and obtain their approval.

Oh, My Aching Stomach

7. Put your goggles on correctly.
8. Begin your experiment.
9. Record your results.
10. Clean up your equipment.
11. Wash your hands.
12. Remove your goggles after all of the chemicals in the room are safely stored.
13. Design an advertisement to share with the FUSION Consumer Board that shows quantitatively which product is the most effective.

Oh, My Aching Stomach



Oh, My Aching Stomach

Group Members

Question to be Investigated

Materials Needed

Judge's Approval

Oh, My Aching Stomach

Plan for Testing:

Oh, My Aching Stomach

Data/Observations/Results:

Oh, My Aching Stomach

Advertising Plan: