MODULE TOPIC:
Physical properties of matter: dissolution

STANDARD(S) & INDICATOR(S):
- NGSS: Science and Engineering Practices, NGSS: 9-12, Practice 3. Planning and carrying out investigations
  - Plan an investigation collaboratively to produce data to serve as the basis for evidence as part of testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled.
  - Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.
  - Select appropriate tools to collect, record, analyze, and evaluate data.
- NJCCCS Math:
  - 4.5.E.1: Create and use representations to organize, record, and communicate mathematical ideas.
  - 4.5.E.3. Use representations to model and interpret physical, social, and mathematical phenomena.

OBJECTIVE(S): Students will be able to:
- Compare and contrast the effect of pH in the dissolution of an aspirin.
- Predict how different types of aspirin, i.e: regular and enteric, interact in our body in particular our digestive system

MATERIALS:
1 uncoated aspirin tablet
1 enteric-coated aspirin tablet
2 clear plastic cups
1 cup vinegar
2 teaspoons baking soda
salt, water

LIST OF HANDOUTS (attach original copies of each handout - teacher & student edition)
- Drawing in worksheet

BACKGROUND INFORMATION:
The human digestive process begins in the mouth and involves the grinding of food by the teeth and breakdown of the food by the digestive enzymes in saliva. Next, food passes through the esophagus into the stomach.
The environment in the stomach is acidic, about pH 1.5, which is due to the gastric acid (contains hydrochloric acid). Some nutrients are absorbed in the stomach, but most nutrients are absorbed in the small intestine.
In the small intestine, food is mixed with a variety of excretions and bile. Bile is alkaline and therefore neutralizes the gastric acid and creates a basic environment (~ pH 9).
After the small intestine, food passes through the large intestine and eventually out of the body.

CLASSROOM ACTIVITY DESCRIPTION (LABORATORY/EXERCISES/PROBLEMS) including detailed procedures:

A simple model of the digestive system is used with a cup filled with vinegar as the stomach and a cup filled with water and baking soda as the small intestine. We'll attempt to test a medication commonly used to relieve pain or fever — aspirin.

Unfortunately, aspirin may also hurt the stomach. To avoid this, researchers have developed different types of coatings to keep aspirin from being digested until it has reached the small intestine.

Procedure: Fill a clear plastic cup with vinegar. Fill a second clear plastic cup with a mixture of 1.5 teaspoons baking soda, a pinch of salt, and half a cup of water.

Immerse 2 aspirin tablets (one uncoated and another enteric-coated) into the cup containing vinegar. Record (draw, describe) your observations in the worksheet. Wait a few minutes and place the enteric-coated aspirin out of the vinegar-filled cup and transfer it into the cup containing baking soda / water mix. Record (draw, describe) your observations.

SAMPLE QUESTIONS TO ELICIT CLASS DISCUSSION:

What happens to your food or medicine after you swallow it?

How is food or medicine absorbed into your system?

What are the similarities and differences between the stomach and small intestine?

PARAMETERS TO EVALUATE STUDENT WORK PRODUCTS:

Students will design an experiment where they can observe and assess the dissolution rate of 2 different types of aspirin. Students will determine which pill is affected by an acidic pH and which one is affected by a basic pH. Students will record relevant physical characteristics of the given pills and their dissolution rate.

REFERENCES:

TeachEngineering. *Activities © 2008 by Regents of the University of Colorado; Integrated Teaching and Learning Program, College of Engineering, University of Colorado Boulder*

ACKNOWLEDGEMENT

This material is based upon work supported by the National Science Foundation under Grant No. 1301071

Supporting Program: Center for Pre-College Programs, at the New Jersey Institute of Technology

Contributors

Paul Orbe, Union City HS - Academy for Enrichment & Advancement, Union City, NJ, Primary Author

Howard Kimmel, Levelle Burr-Alexander - Center for pre-College Programs, NJIT.

Meng Li, Dr. Rajesh Dave - C-SOPS, NJIT

MODULE TOPIC:
Physical properties of matter: dissolution

STANDARD(S) & INDICATOR(S):
- NGSS: Science and Engineering Practices, NGSS: 9-12, Practice 3. Planning and carrying out investigations
  - Plan an investigation collaboratively to produce data to serve as the basis for evidence as part of testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled.
  - Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.
  - Select appropriate tools to collect, record, analyze, and evaluate data.
- NJCCCS Math:
  - 4.5.E.1: Create and use representations to organize, record, and communicate mathematical ideas.
  - 4.5.E.3. Use representations to model and interpret physical, social, and mathematical phenomena.

OBJECTIVE(S): Students will be able to:
- Develop a pill coating and test their durability
- Discuss different properties of each ingredient used to coat the pill
- Test their developed recipes and compare to the rest of the class.

MATERIALS:
60 mL flour
30 mL corn starch
60 mL sugar
30 mL vegetable oil
1 enteric-coated aspirin tablet
2 pieces of color-coated candy per group (Skittles)
1 plastic spoon
2 clear plastic cups
1 cup clear diet soda
timer
micrometer, caliper
balance

LIST OF HANDOUTS (attach original copies of each handout - teacher & student edition)
- Recipe and fraction worksheet (one per group)

BACKGROUND INFORMATION:
Certain medications may irritate the stomach of patients with an extreme sensitivity. To prevent stomach pain while still allowing medicine to enter our bodies, engineers and pharmacists have develop pill coatings that do not dissolve until after they have passed through our stomachs. These specially-coated pills are called "enteric."

CLASSROOM ACTIVITY DESCRIPTION (LABORATORY/EXERCISES/PROBLEMS) including detailed procedures:

Students will create a recipe for our coating, and then test it by observing its effectiveness in protecting a piece of candy placed in an environment simulating our stomachs. A protective coating can serve a variety of functions: protecting the chemical components in a pill during packaging and handling; protecting the pill from temperature, moisture or light during storage, masking the bad taste of certain chemicals; providing an extended dose/fast release of medication.

Procedure:

Before activity: gather materials and measure specified amounts of flour, corn starch, sugar, and vegetable oil in separate bowls. Make copies of the recipe and fraction worksheet to provide each group.

With the students:

Students will work in groups of 3s. Each group will develop different recipes with the provided ingredients. Several constraints will be determined (i.e: size, weight). Students will coat one pill and allow to dry for about 15 minutes. All groups in the class will test their recipes simultaneously in a clear plastic cup with clear diet soda. Time will be taken for full dissolution of pill for each group. Students will compare the rates among groups.

SAMPLE QUESTIONS TO ELICIT CLASS DISCUSSION:

What happens to your food or medicine after you swallow it?

How is food or medicine absorbed into your system?

What are the similarities and differences between the stomach and small intestine?

PARAMETERS TO EVALUATE STUDENT WORK PRODUCTS:

Students will be assessed in their ability to conduct measurements and to infer the effect of each of the ingredients in the rate of dissolution.

Recipe analysis: have students calculate on their recipe and fraction worksheet the fraction of each individual ingredient. Have teams compare their recipes looking for relationships between performance and the proportion of certain materials in the recipe. Discuss possible drawbacks and advantages to using certain ingredients. Students will submit a formal lab report with data obtained from the experiment. Rubric will be used to grade lab report.

REFERENCES:

TeachEngineering. *Activities © 2008 by Regents of the University of Colorado; Integrated Teaching and Learning Program, College of Engineering, University of Colorado Boulder*

ACKNOWLEDGEMENT

This material is based upon work supported by the National Science Foundation under Grant No. 1301071

Supporting Program: Center for Pre-College Programs, at the New Jersey Institute of Technology
Contributors
Paul Orbe, Union City HS - Academy for Enrichment & Advancement, Union City, NJ, Primary Author
Howard Kimmel, Levelle Burr-Alexander - Center for pre-College Programs, NJIT.
Meng Li, Dr. Rajesh Dave - C-SOPS, NJIT

NJIT New Jersey's Science & Technology University

Name: **Date:**

Recipe and fraction worksheet:

Recipe 1		
	Number of spoonfuls	**Fraction**
Oil		
Sugar		
Flour		
Corn starch		
Total		

Recipe 2		
	Number of spoonfuls	**Fraction**
Oil		
Sugar		
Flour		
Corn starch		
Total		

Fraction = $\frac{\text{Number of spoonfuls of ingredient}}{\text{Total number of spoonfuls}}$