Lyniece McKim
Biology Instructor
Star Valley High
Afton, WY
lmckm@lcsd2.org
Biology: Chemistry of Life

- **Lab: Testing Mystery Substances**
  - Inquiry activity
  - Using indicators; i.e. red cabbage juice
  - Testing common acids & bases
  - Recognizing pH of human cells/homeostasis

- **National Science Standards**
  - NS.9-12.1 Science as Inquiry
  - NS.12.2 Physical Science
  - NS.9-12.3 Life Science
Lab Groups of Three

- Classroom organized in groups of three.
- Lab groups are the same.
- Assigned roles in class and lab.
Equal Participation

• All students must be involved/responsible.

• Roles for each student:
  ▪ Student #1: Cabbage paper
  ▪ Student #2: Cabbage gel
  ▪ Student #3: Cabbage juice
Using Litmus Paper

- Pre-lab discussion & activity
- Ammonia & vinegar drops
- Red, blue, wide-range litmus
- Discover color change
- Role of indicators
Three Testing Indicators:
Red Cabbage juice, gel, paper
• **Safety Precautions:**
  - Gloves, aprons, glasses
  - Clear dropper bottle tips between uses if needed

• **Materials List:**
  - 12 dropper bottles (3 sets); marked #1-12
  - 12 common acids & bases
  - Red cabbage juice in gallon containers
  - Small measuring pitcher per group
  - 10 ml graduated cylinder per group
  - Test tubes & rack per group
  - Paper towels & scissors
  - Cabbage gel & plastic knives
  - Paper plates & markers
Why Red Cabbage?

- Red Cabbage juice’s purple color is due to pigments of anthocyanins.
- Slight molecular change takes place when mixed with acids and bases.
- Causes change in absorbing and reflecting light.
- Changes the colors we see when mixed with various acids or bases.
- Lasts many days when refrigerated.
- Dispose of down the drain.
- Safe; non-staining.
- Inexpensive
Teacher Preparation

- **Juice:**
  - Boil one medium-sized, sliced red cabbage in 2 gallons water, 30 min.
  - Remove cabbage/Collect juice/Refrigerate.

- **Gel:**
  - Add 1 Knox gelatin envelope to 1 C. cooled juice (x4).
  - Stir and heat to dissolve.
  - Pour 1/4” deep into shallow containers/Refrigerate 2 hrs.
• **Indicator Paper:**
  - Rinse paper towels in juice
  - Gently squeeze towels/Lay out to dry
  - Cut dry towels in 1/4’s --- (1/4 per group)

• **Dropper Bottles:**
  - Number each set of dropper bottles #1-12; organize sets: red, black, green numbers
  - 3 or 4 sets can be shared
  - Fill 12 dropper bottles with familiar acids and bases found at home
  - Include distilled water as a neutral
SUGGESTED MYSTERY SUBSTANCES

Vinegar
Grapefruit juice
Ammonia - diluted
Lysol
Baking Powder in H₂O
Simple Green - 50% H₂O
Lime juice
Lemon juice
7-Up
Distilled H₂O
Liquid hand soap - diluted
Malox in H₂O
Student Roles

Indicator Paper

Mystery Substances

STUDENT #1

Indicator Gel

STUDENT #2

1 2 3 4 5 6
7 8 9 10 11 12

Rinse Test Tubes in Sink. Leave upside-down to dry.

Indicator

1 2 3

Juice to 1st Wire

Control

STUDENT #3 & #4
Student Lab: Testing Mystery Substances

OBJECTIVE: Determine the acidic or basic property of 12 unknown Mystery Substances with 3 lab partners using 3 organic indicators. Compare and record the various results. The identities of the mystery substances could be determined as an added interest. Demonstrate knowledge related to pH by completing post lab questions.

PROTOCOL:
1) Three activities will be taking place at the same time due to using 3 indicators: paper, gel, juice.
2) Each student will test each Mystery Substance with his/her assigned indicator according to procedures listed below. Carefully match numbers.
3) Must share dropper bottles with lab partners and other groups.
4) Compare observations with lab partners. Fill in all columns of data table.
5) Third column is for fun F.Y.I. Try to fill it in.
6) Following clean-up, complete Post-lab Questions.
STUDENT ROLES AND PROCEDURES:

STUDENT #1:
1) Trace, number, and cut 12 strips of cabbage paper from 1/4 paper towel. Number each one as shown below:

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2) Place one drop from numbered dropper bottles Mystery Substances on corresponding number of cabbage indicator paper. Unchanged edges will serve as the control.

3) Record observation on Data Table.

4) Clean-up: Place all paper items into waste container.
STUDENT #2:

1) Number 1-12 on paper plates using a marker, as in a clock face.
2) Cut 12 small pieces of cabbage gel; ¼ or less cm each (smaller is better)
3) Place gel pieces on clock face near each number.
   Place 13th gel in clock center; save as an untouched control.
4) Place several drops of each Mystery Substance on corresponding number of gel. Use equal number of drops per gel.
5) Needs to sit for a short time.
6) Record observation on Data Table
7) Clean-up: Place paper plate with gels into waste container.
STUDENT #3: (#4 also if you have one)

1) Set up & number 12 test tubes in 1 rack; 13th tube can be a control.
2) Pour 1/3 C of cabbage juice into small pitcher; return to lab station.
3) Measure 5 ml cabbage juice, using a graduated cylinder, into each test tube.
4) Add 5 drops of each Mystery Substance to the corresponding number of each test tube. (Concentrated strength of juice will determine the number of drops needed. Use equal number of drops per tube.)
5) Record observation on Data Table.
6) Clean-up: Pour juice down drain; flush with water. Rinse & brush/scrub tubes; place upside down in rack.
## MYSTERY SUBSTANCES LAB

### DATA TABLE

<table>
<thead>
<tr>
<th>Mystery Substances</th>
<th>Paper Color</th>
<th>Gel Color</th>
<th>Juice Color</th>
<th>Base or Acid</th>
<th>Guess the Identity</th>
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POST LAB QUESTIONS:

1) What color changes were observed in this lab?
   a)  
   b)  

2) Each color change was an “indication” of?
   a)  
   b)  

3) Explain possible reasons for no color change in a Mystery Substance test.

4) What would the pH number be in a substance lacking a color change?_______

5) Did the pH color test of your group’s three indicators (paper, gel, juice) generally match? _______ Explain why or why not.

6) How many acids did your lab group discover today? ______ Bases? __________

7) Why was it a good plan to have three students performing similar lab tests?
Refer to class discussion, activity, and text book.

8) Red and blue litmus paper appeared _________ when indicating a base, and _________ when indicating an acid.

9) The gold wide-range indicator paper appeared ______________ when indicating a base, and ______________ when indicating an acid.

10) On a pH scale which numbers indicate bases? ___________ Acids? ___________

11) Where can you find most common acids and bases?

12) Name two acids and list their pH numbers:
   a) 
   b) 

13) Name two bases and list their pH numbers:
   a) 
   b) 

14) What numbers on the pH scale indicate a dangerous base? ___________
    A dangerous base? ___________
    What is more dangerous, an acid or a base? ___________

15) A pH solution is measured on a logarithmic scale, so changing one number reflects a ___________ change.
16) What does pH stand for? ________________ of ________________

17) The symbol and charge for the hydrogen ion is _____, and the symbol and charge for the hydroxide ion is ______.

18) When a water molecule separates forming the ions of hydrogen and hydroxide, what process was used? ________________

19) How could an acid or a base be neutralized?

20) The most common neutral substance is ________________ having a pH of _______.
   It contains equal amounts of ________________ and ________________.

21) Another adjective for “basic” is ________________.

22) Commercial soap is produced by reacting a base with a ________________.

23) Some acids such as ascorbic acid are important to your health. Ascorbic acid is found in what vitamin? ________________

24) Hydrochloric acid, another important acid, is necessary for digestion. It is found in the ________________ and functions best at a pH of ________.

25) Most human cells function best at a pH near ________.

26) Controlling a healthy pH balance in a living organism is important in maintaining h______________.
SUMMARY

• Involves Inquiry and Active Learning
• Young scientists compare/cooperate
• All students engaged
• Appealing - bright color changes
• Inexpensive