TEACHER GUIDE

ACTIVITY 4

Learning About Evaluating pH Paper Test Strips

OVERVIEW

In this structured investigation, students compare and evaluate their group-manufactured pH strips against a commercial version on several known pH standard materials.

OBJECTIVES

- *To compare* the group-manufactured pH test strip (ACTIVITY 3) pH determination against a commercial pH strip determination for 3 unknown test solutions.

- *To understand* the terms *precision* and *accuracy.*

MATERIALS

(Per Class)

In the Kit::

- Commercial pH strips with color comparator panel
- Medicine cups (30)
- CD-ROM

Needed but not supplied:

From the grocery store

Group-created pH strips with color comparator panel (ACTIVITY 3)
Unknown Standard 1 Distilled (bottled) water pH 7
Unknown Standard 2 Lemon juice (bottled or fruit) pH 3
Unknown Standard 3 Laundry detergent (powder) pH 12

BEGINNINGS ...

Background Information Topics

pH, INDICATORS, & DYES
PIGMENT EXTRACTION?
PLANT PIGMENT BIOMOLECULES & THEIR STRUCTURE
pH & POH
PLANT PIGMENTS AS pH INDICATORS
ALTERING PLANT PIGMENT BIO MOLECULES
LEARNING HOW LITMUS PAPER IS MADE
✔ **MEASURING - PRECISION vs. ACCURACY**

These topics are available as individual PDF files on the CD-ROM. They can be emailed or uploaded to the school server.

- Read the *Background* material concentrating on:

PIGMENT EXTRACTION?
PLANT PIGMENT BIOMOLECULES & THEIR STRUCTURE
pH
PLANT PIGMENTS AS pH INDICATORS
ALTERING PLANT PIGMENT BIO MOLECULES
LEARNING HOW PAPER IS MADE
✔ **MEASURING - PRECISION vs. ACCURACY**

- Students should have a good understanding of the following concepts:

Precision
Accuracy

PLANNING & INVESTIGATING ...

- Students should create an evaluation table for comparing:
  - COMMERCIAL vs GROUP pH strips
  - Accuracy against standard

PREP NOTES:

(Prior to the student investigation)

- Label and dispense approximately 10mL into each of 10 medicine cups:
  - **#1** (containing water)
  - **#2** (containing lemon juice)
  - **#3** (containing laundry detergent solution)

- Prepare the unknowns (10 each)
  - WATER - pour distilled (or bottled) water
  - LEMON JUICE - use bottled concentrate
  - LAUNDRY DETERGENT (liquid concentrate)

- 3 commercial pH test strips per group

- 3 student group test strips

<u>Each student group should have</u>:

- Labeled medicine cups:
  - **#1** (containing water)
  - **#2** (containing lemon juice)
  - **#3** (containing laundry detergent solution)
- 3 commercial pH test strips
- 3 student group test strips

DATA TABLE 1 *pH Strip Evaluation*				
Strip Type	**Unknown No.**	**Unknown ID**	**Expected**	**Measured**
Commercial pH Paper	1	Water	**7**	**7**
	2	Lemon Juice	**2**	**2**
	3	Laundry Detergent Solution	**11.5**	**11.5**
Cyanidin pH Paper	1	Water	**7**	**± 0.5 unit**
	2	Lemon Juice	**2**	**± 0.5 unit**
	3	Laundry Detergent Solution	**11.5**	**± 0.5 unit**
Betalain pH Paper	1	Water	**7**	**± 0.5 unit**
	2	Lemon Juice	**2**	**± 0.5 unit**
	3	Laundry Detergent Solution	**11.5**	**± 0.5 unit**

TEACHER NOTES:

- Variances of 0.5 pH unit should be considered 'accurate'. Greater variances are, due to the ten-fold differences in unit values, should be considered inaccurate. (There can be obvious result variability due to number of factors, including: color hue, pigment concentration, paper pH, and test solution concentration. The main factor is that students are testing the same solution (acid, neutral, base) against two test paper - and expecting similar (to a pH unit of 0.5) results.)
- Class data should be pooled so that students can compare indicators as well as the commercial pH strip.

PRECISION						
GROUP NO.		Unknown Cup #1 pH		Unknown Cup #2 pH		Unknown Cup #3 pH
GROUP/ TRIAL 1		**7**		**2**		**11.5**
GROUP/ TRIAL 2		**7**		**2**		**11.5**
GROUP/ TRIAL 3		**7**		**2**		**11.5**
GROUP/ TRIAL 4		**7**		**2**		**11.5**
GROUP/ TRIAL 5	How well group (or multiple) values agree	**7**	How well group (or multiple) values agree	**2**	How well group (or multiple) values agree	**11.5**
GROUP/ TRIAL 6		**7**		**2**		**11.5**
GROUP/ TRIAL 7		**7**		**2**		**11.5**
GROUP/ TRIAL 8		**7**		**2**		**11.5**
GROUP/ TRIAL 9		**7**		**2**		**11.5**
GROUP/ TRIAL 10		**7**		**2**		**12**

ANALYZING ...

- Have student groups share their accuracy data (expected vs. measured). Have them note in their Laboratory Notebooks how 'accurate' their group's pH strip is compared to:
  - a commercial pH strip
  - the indicator
  - other groups

A variance of greater than ± 0.5 pH unit is considered "inaccurate".

TEACHER
Generally, all strips should be more or less accurate since the students are evaluating the center (and outer portions of the scale. For example, cyanidin pigment strips will register BLUE and RED for <pH 3 or > pH 8. Obviously how the strips are prepared makes a big difference! Commercial strips should be accurate. (They do not use plant pigments indicators.)

- Have student groups describe how they can measure the "precision" of their pH test strips.

Take 10 separate pH measurements (class data) of an unknown; evaluate any change.

- How "precise" and "accurate"are your group's pH strips?

Student answers will vary but should include:
- strips are "accurate" if they agree within ± pH unit of commercial for a similar "unknown"
- strips are precise if multiple measurements of the similar "unknown"

EVALUATING ...

Remind students that commercial manufacturers routinely run quality control tests on their products to assure that they meet the specified performance parameters. In the process, they evaluate the degree of precision and accuracy of their manufactured product against a known set of standards.