

## Experiment 3: Forensic Analysis

### Skills/Concepts

- Experimental Design
- Deductive Reasoning
- Qualitative Analysis of Physical Properties
- Identifying Unknown Compounds

### Relevant Reading

Hein & Arena 4.1–4.3

### Introduction, Part 1:

**Forensics:** The scientific analysis of physical evidence (as from a crime scene)<sup>1</sup>

Forensics relies heavily on chemical analysis. Forensic scientists use knowledge of the physical properties of compounds to identify unknown substances, such as those found on a crime scene.

You have been asked to help solve a crime. A local art museum has reported a theft. The art piece was found with traces of white powder on it. Three of the arrested suspects also have traces of white powder on their clothing. The forensics department wants you to identify the powders from the stolen item and from the suspects' clothing. To do this, you will observe physical and chemical properties of the 4 samples.

### Introduction, Part 2:

A pure substance is a material with a fixed, definite composition throughout the sample. Chemists often try to catalogue the physical and chemical properties associated with various pure substances. Once known, these properties can help identify unlabeled matter and to predict the properties of mixtures or solutions created from pure substances.

We often subject samples to conditions that change the properties of a sample. **Physical changes** alter the matter's form and appearance, but not its chemical composition. Grinding wheat, melting butter, and boiling water are examples of physical change. **Chemical changes** alter the chemical composition. Baking bread, getting a suntan, and reacting oxygen and hydrogen to form water are examples of chemical changes. Chemical changes often include physical changes. Physical change can be informative of chemical change.<sup>2</sup>

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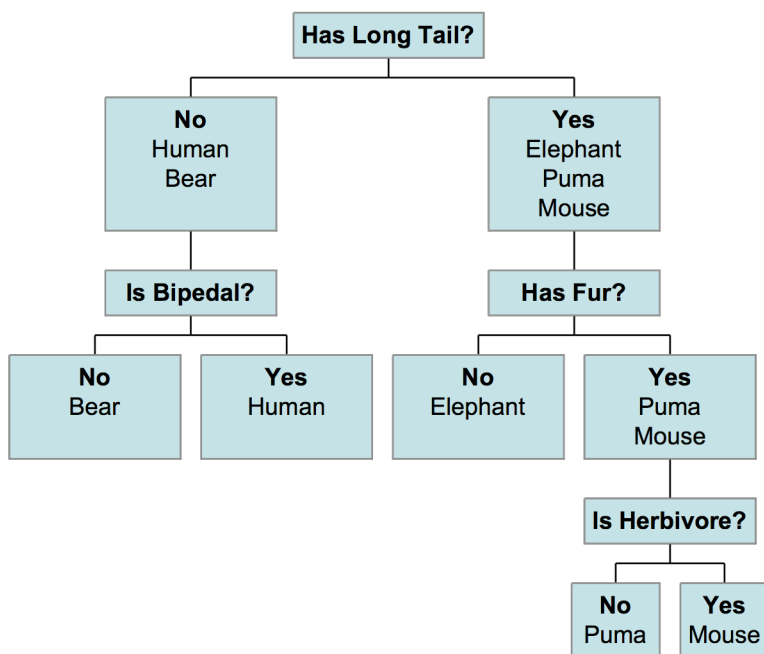
<sup>1</sup> Merriam-Webster Dictionary, ©2009

### Pre-Lab

Decision trees can be used to find the solution to a question while asking the minimum intermediate questions. In this lab, you will determine the characteristics of known compounds and then create a decision for identifying unknown compounds. Below is a sample set of data and a flow chart made from it. Note that even though four characteristics are known for each animal, three of the animals can be identified by observing only two features.

	Has Long Tail?	Herbivore?	Bipedal?	Furry?
Human	No	No	Yes	No
Puma	Yes	No	No	Yes
Elephant	Yes	Yes	No	No
Mouse	Yes	Yes	No	Yes
Panda	No	Yes	No	Yes

Animal Identification Decision Tree



Name: \_\_\_\_\_

**Pre-Lab**

Think of 5 objects and 4 relevant properties. Fill out the data table below and then draw a decision tree for testing the identity of any of the 5 objects.

1. _____				
2. _____				
3. _____				
4. _____				
5. _____				

## Procedure

First, determine physical and chemical properties of four common household substances using the three tests below.

Household Name	Chemical Composition
Cornstarch	$(C_6H_{10}O_5)_n$
Epsom Salt	$MgSO_4$
Baking Powder	Mixture of <ul style="list-style-type: none"> <li>• <math>KOCo(CHOH)_2COOH</math> (cream of tartar)</li> <li>• <math>NaHCO_3</math> (baking soda)</li> <li>• <math>(C_6H_{10}O_5)_n</math> (cornstarch)</li> </ul>
Table Salt	$NaCl$

### Water Solubility Test

To a test tube, add

- a pea-sized amount of powder
- ~5 mL of water

Invert the tube repeatedly to mix. Determine if the solid has sufficiently dissolved or not.

### Iodine Test

To a test tube, add

- a pea-sized amount of powder
- a few drops of tincture of iodine
- ~1 mL of water

Invert the tube repeatedly to mix. Note the color of the solution or mixture.

### Phenolphthalein

To a test tube, add

- a pea-sized amount of powder
- a few drops of phenolphthalein
- ~1 mL of water

Invert the tube repeatedly to mix. Note the color of the solution or mixture.

### Acetic Acid (Vinegar)

To a test tube, add

- a pea-sized amount of powder
- a few mL of vinegar

Invert the tube repeatedly to mix. Note whether or not the solution or mixture fizzes.

### Procedure

Record your test results below:

Table 1: Physical Property Tests

	Appearance	Water Solubility	Iodine	Phenolphthalein	Acetic Acid
Cornstarch					
Epsom Salt					
Baking Powder					
Table Salt					

With your lab partner, determine a flowchart to test to the samples from the forensics lab.

Using the available tests and the decision tree that you have made, identify the samples provided by the forensics department. Fill in the following chart with data you collect. You do not need to perform each test on each sample. The decision chart should help you reduce the number of tests you need to perform.

Table 2: Physical Property Tests

	Appearance	Water Solubility	Iodine	Phenolphthalein	Acetic Acid	Identity of Substance
Art Piece						
Suspect 1						
Suspect 2						
Suspect 3						

Name: \_\_\_\_\_

Lab Partner: \_\_\_\_\_

**Post-Lab****Results:**

Table 1: Physical Property Tests

	Appearance	Water Solubility	Iodine	Phenolphthalein	Acetic Acid
Cornstarch					
Epsom Salt					
Baking Powder					
Table Salt					

Include a copy of your decision tree here:

Table 2: Physical Property Tests

	Appearance	Water Solubility	Iodine	Phenolphthalein	Acetic Acid	Identity of Substance
Art Piece						
Suspect 1						
Suspect 2						
Suspect 3						

**Discussion:**

1. What powder was on the stolen art piece?
2. Which suspect had the same powder on his clothing?
3. Classify the following as physical or chemical change:
  - a. Melting ice
  - b. Burning wood
  - c. Phenolphthalein changing color
  - d. Acid and Bicarbonate forming carbon dioxide and water
4. Considering that sea salt can be obtained by boiling off seawater, is the dissolution of table salt or sugar in water a physical or a chemical change?