

LAB

7.2

LABORATORY MANUAL

The Periodic Puzzle

Use with
Section 7.3

Imagine the following scenario. You are the new lab assistant for a professor in a highly underbudgeted chemistry department. Your first task is to finish a project started by the former assistant, who suffered an accident while failing to observe proper safety procedures. The accident occurred while he was in the process of labeling and storing example specimens of each element in identical containers.

Unfortunately, the labels on 36 containers were either damaged or burned beyond recognition during the incident. To further complicate matters, much of the information contained in the assistant's notebook was damaged as well. This notebook contained practical facts about the elements' uses and traits, and data collected by other students. What did survive, however, were the etched serial numbers on each of the containers, which the assistant often referenced in notes.

The professor and some of the students have assigned an alphabetic label (from **a** to **jj**) to each of the mystery elements, and they've combined the remaining information with some of their own preliminary observations. Using this data and your deductive reasoning skills, can you determine the identities of the 36 elements?

Problem

How can you place elements in a periodic table based on their characteristics?

Objective

Identify various elements by using your understanding of periodic properties and relationships.

Materials

a computer with access to the Internet

Pre-Lab

Read the entire laboratory activity. Decide upon the best strategy for solving the puzzle.

Procedure

The professor provided you with a list of notes and observations based on data from the damaged notebook. **Figure A** is a periodic table with the unknown elements omitted.

- Element **c** has the highest melting point of the metals.
- Element **ff** started to turn white when its container was opened.
- The assistants were reluctant to burn some of the elements after element **e** produced a violet vapor with an extremely unpleasant odor.
- Compounds of element **y** combined with element **u** can be found in "hard water."
- As useful as element **h** can be, it can also be quite poisonous if ingested. That is why other metals are used in its place to perform its previous functions.
- Clearly, the person who ordered element **q** was not a chemist, because the unstable element would have decayed long before its arrival.
- Element **j** is used to make permanent magnets.
- If a patient drinks a compound of elements **u** and **p**, doctors can view the patient's digestive tract.

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- Element **b** is a silvery metal that was submerged in some sort of oil.
- Of the known metals, element **d** is an essential nutrient for plant growth and is found in most soils. It is also essential in the human diet.
- Element **t** is the lightest element.
- Element **f** is a significant part of stainless steel. It has an atomic number that is six times greater than that of element **x**.
- Element **z** is most commonly found as part of a compound with element **l**.
- Element **gg** plays a key role in photography, among other things.
- Most often, when someone thinks of element **a**, the person immediately thinks of nuclear power. This is probably because all the isotopes of **a** are radioactive.
- In the early 1800s, element **w** had been thought to be identical to the element directly above it in the periodic table.
- The common names for the allotropes of element **v** are based upon their colors.
- Thankfully, the container holding element **l** was not destroyed in the accident because this element can be quite poisonous when inhaled.
- Most solar cells rely upon the natural properties of element **bb**.
- Element **k** is synthetic.
- Element **ee** is the most malleable metal.
- Element **i** is a shiny, silver liquid.
- It has been hypothesized that element **dd**, the most reactive nonmetal, can be substituted for element **t** in organic compounds.
- Neither element **gg** nor element **ii** are ferromagnetic, but their magnetic properties change when they are combined with each other chemically or physically, in alloys.
- Element **n** is the heaviest alkaline-earth metal.
- Element **x** is a lightweight metal through which x rays pass easily.
- Elements **g** and **aa** share similar physical properties, but the allotropes of element **aa** are much more widely known. Element **aa** is found in organic compounds.
- Although every compound of element **o** is poisonous, it had once been used to treat medical conditions.
- Element **hh** is a shiny, reddish metal.
- Hydrochloric acid had a considerably more dramatic effect on element **jj** than it did on the other metals in element **jj**'s group, elements **s** and **j**.
- Element **m** was used to plate steel to make cans.

Data and Observations

Table 1: The Mystery Elements

a	g	m	s	y	ee
b	h	n	t	z	ff
c	i	o	u	aa	gg
d	j	p	v	bb	hh
e	k	q	w	cc	ii
f	l	r	x	dd	jj

Analyze and Conclude

- 1. Acquiring and Analyzing Information** Which element was the most difficult to identify? How did you identify it?

- 2. Thinking Critically** What are some of the reasons that this scenario is unlikely to take place in real life?

- 3. Using the Internet** Was there a particular web site or type of web site that you found most useful for solving the puzzle? If so, which web site, and why?

Real-World Chemistry

1. The computer has added a new dimension to chemistry. Databases of chemical information are maintained not only for elements, but also for molecules. The database of substances at Chemical Abstracts Service reports more than 23 million registered substances. How can so many different substances and molecules be created from just over 100 different elements?
2. Each registered substance in the database is given a unique number or key. For example, the element argon (Ar) has a key number of 7440-37-1. What would you expect to happen if you searched the Internet with this unique key? What is the benefit of having a unique number for each substance?
3. Many substances must have Material Safety Data Sheets (MSDS) to describe their hazards and methods to correctly handle the substance. Using an internet search engine, find the primary health risk associated with argon, a noble gas.