Mole Samples and Molar Mass

Authentic Assessment

Introduction

Why do different elements have different molar masses? What is the molar mass of a compound? Use this two-part activity to introduce students to the concept of molar mass and then evaluate their ability to carry out mole and molar mass calculations. After viewing a variety of mole element samples on display in Part A, students are assigned a "mole baggie" in Part B. These mole sample bags contain pre-measured amounts of white mystery compounds. Students must calculate the molar mass of the compound in the bag and determine its identity from a list of possibilities.

Concepts

- Mole
- Molar mass

Materials

Balances, centigram precision (0.01-g), 3

Plastic bottles with caps, 4- or 8-oz, 10 (number required to match element samples)

Element samples [aluminum foil, calcium turnings, carbon (charcoal), copper wire, iron filings, lead shot, magnesium ribbon, sulfur, tin shot, mossy zinc, etc.], 1 mole of each

Periodic table

Permanent markers

Zipper-lock plastic bags, 7 (with labels)

White crystalline compounds (calcium acetate, calcium oxide, potassium sulfate, sodium acetate, sodium carbonate, sodium chloride, zinc oxide), 1–8 g each (see Table 1)

Safety Precautions

The safety hazards depend on the materials chosen. Keep the sample bottles and zipper-locked bags capped and sealed throughout this activity. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Part A. Elements on Display

Prepare a set of mole element samples (steps 1–3) prior to class.

1. Measure the mass of empty sample bottles and their caps. Label each bottle with the combined mass of the bottle and cap.
2. Measure out one-mole samples of each element (e.g., 12 g of carbon, 32 g of sulfur, 24.3 g of magnesium, etc.)
3. Fill as many sample bottles as possible with the mole element samples. Label the bottles with unknown element labels A, B, C, D, etc., and cap the bottles.
4. Display the sample bottles to the class. Explain that each bottle contains the same number of atoms, namely, one mole or an Avogadro's number of atoms.
5. *(Optional)* Review the definitions of Avogadro's number, mole, and molar mass.
6. Using a balance in the front of the room, measure the total mass of each sample bottle.
7. Have students record the total mass of each sample bottle, along with the mass of the empty bottle and cap (from the bottle label).
8. Ask students to determine the molar mass of each element and to identify the elements using a periodic table.

Publication No. 10634
061616

Part B. "Mole Baggies" — Authentic Assessment Exercise

Prepare the unknown mole bags (steps 1–3) prior to class. Table 1 gives suggestions for seven mole bags, enough for a class of 28 students working in groups of four. Adjust the number of sample bags based on the number of students in the class and the desired working group size. Samples may be repeated with different letter codes to accommodate the number of desired unknowns.

1. Obtain a set of zipper-lock plastic bags, equal in number to the number of student groups that will be working independently.
2. Measure the mass of each empty zipper-lock plastic bag and record the mass on the bag label.
3. Fill the bags with the appropriate amount of each compound, as shown in the following table. Label the sample bags with the unknown label code and the number of moles. Do NOT identify the compound or the mass.

Table 1.*

Unknown Label	Compound	Number of Moles	Mass
A	Sodium chloride	0.050	2.93 g
B	Potassium sulfate	0.020	3.48 g
C	Sodium carbonate	0.035	3.71 g
D	Calcium acetate	0.015	2.37 g
E	Zinc oxide	0.025	2.04 g
F	Sodium acetate	0.045	6.39 g
G	Calcium oxide	0.030	1.68 g

**These are suggestions only. Any white solids may be used in any amounts.*

4. Instruct students to use the information on the label to identify the substance inside, based on a prescribed list of possibilities. *Note:* Give students a list of the names of the possible compounds. Do not give them the formulas of the compounds.
5. Students may not open the sample baggies to identify the compounds.
6. Each member of the group should turn in an answer sheet that gives the unknown "mole baggie" code, the name of the compound, and its molar mass, including detailed calculations for the latter.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Store the element display samples and "mole baggies" for future use. If the "unknown" containers are stored for future use, please be sure that they are stored in larger containers that are properly labeled with the names of the substances and their specific hazard warnings.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter, chemical reactions

Tips

- There are many possible variations for this activity. Be creative. Add more mystery to Part A, for example, by using only silver-colored metal shot (zinc, aluminum, nickel, lead)—all the samples will look alike. Have students identify the metals based on their molar masses. Another suggestion is to use Part A as an authentic assessment exercise.
- Quart-size, household-type, zipper-lock plastic bags are convenient sample containers for Part B. Use the freezer-style brands—they are sturdy enough to stand up to repeated use and usually have a handy label printed right on the plastic. Write on the labels using permanent markers.
- A common misconception is that equal volumes of chemicals contain equal number of atoms or equal number of moles. This is approximately true only for gases (it is absolutely true only for ideal gases).

Reference

This activity was adapted from *Flinn ChemTopic™ Labs*, Volume 7, *Molar Relationships and Stoichiometry;* Cesa, I., Editor; Flinn Scientific: Batavia, IL (2002).

Materials for *Molar Samples and Molar Mass—Authentic Assessment* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP6255	Molar Relationships and Stoichiometry, Flinn ChemTopic™ Labs, Volume 7
A0020	Aluminum, Foil
C0008	Calcium, Turnings
C0203	Charcoal, Block
C0146	Copper, Wire
I0011	Iron, Filings
L0090	Lead, Shot
M0001	Magnesium, Ribbon
S0140	Sulfur, Roll
T0016	Tin, Shot
Z0003	Zinc, Mossy

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.