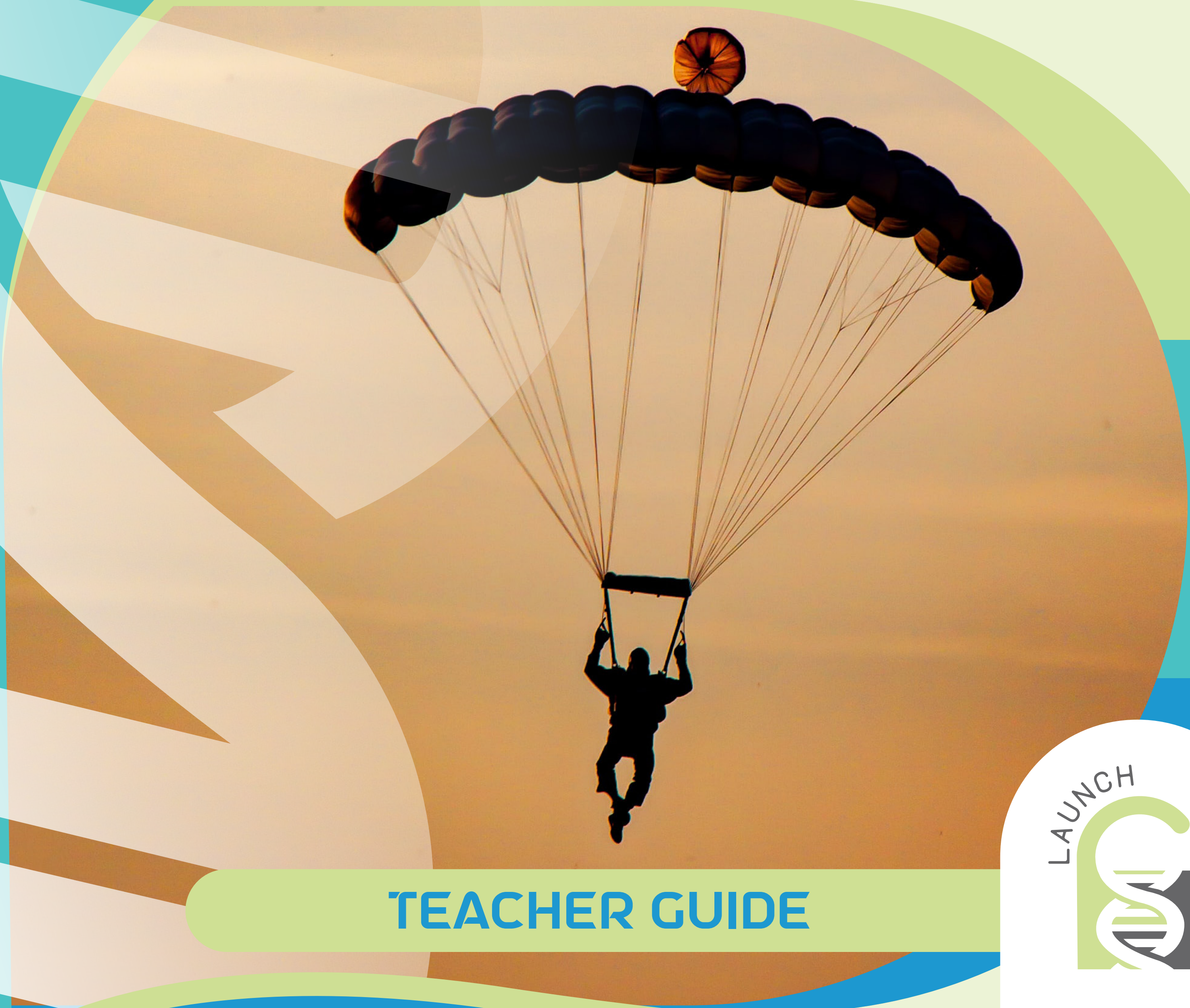
THE MIGHTY MOLE



TEACHER GUIDE

LAUNCH

PLANNING

Here's a suggested schedule for this kit! The activities should be completed in order, but you can choose when the lessons take place over time.

ACTIVITY INFORMATION	SECTION (S)	TIME REQUIRED	DAY/ LESSON
ACTIVITY I: INCREASE IN INFLATION Use chemistry to blow up balloons to differ-ent sizes. **Time required: 45 min**	☐ Bottles and Balloons	45 minutes	Day 1
ACTIVITY 2: MAKE MEANING WITH MOLES Study the connection between mass and particles. **Time required: 3 h**	☐ Massive Molecules	60 minutes	Day 2
	☐ Great Gases	60 minutes	Day 3
	☐ Counting Mass With Moles	60 minutes	Day 4
ACTIVITY 3: FORMULA FUN Find out about formulas and ratios by hy-drating silica gel. **Time required: 3 h**	☐ All About the Ratio	60 minutes	Day 5
	☐ Am I Th		

Full schedule available with purchase

Question 2: What are at least two questions you have about what happened in the experiment?
Answer:
- Possible questions might include:
  - Why did the balloon get bigger with more baking soda?
  - Why did the balloon stop getting bigger as the baking soda increased past a certain point?
  - Would the same thing have happened if the baking soda was kept the same and the vinegar was changed?
  - Does this happen with other chemical reactions?
  - Will the same amount of baking soda and vinegar produce the same amount of gas each time?

How to Help:
• Encourage your student to wonder what would happen if various parts of the experiment were different.
• You can also ask them how this is related to something in their everyday life to spur them into creating more questions.

activity 2

MAKE MEANING WITH MOLES

Your student is probably wondering why different amounts of baking soda led to different amounts of gas being produced. Here, they will begin to find out, starting with the connection between mass and particles.

LEARNING GOALS:
- **I can use mathematic models to show that atoms and mass are conserved in a chemical reaction.**
- **I can use a model to determine the numbers of atoms of elements in molecules and ions and balance simple chemical equations.**

MASSIVE MOLECULES

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PREPARATION AND SUPERVISION: PART I

- In this experiment, your student will study the relationship between the mass of individual items and the mass of a set of those items.
- Later, they will apply this understanding to atoms, molecules, and sets of atoms and molecules.
- This subsection has Part 1 of the experiment and the next has Part 2.
- In Part 1, the student will be finding the mass of sets of 10 small items.
- Here are the expected results.

WARNING! CHOKING HAZARD - Small parts. Not for children under 3 years.

Massive Molecules Part 1 Table			
Mass of 10 green beads (g)	**Mass of 10 lead BB shot (g)**	**Mass of 10 metal nuts (g)**	**Mass of 10 Skittles™ (g)**
2.8	5.0	32.1	10.6

Molar Mass of Glucose, $C_6H_{12}O_6$			
Element	**Molar mass of that element (from periodic table)**	**Number of atoms of that element in the compound**	**Total molar mass from that element**
Carbon, C	12.011 g	6	72.066 g
Hydrogen, H	1.008 g	12	12.096 g
Oxygen, O	15.999 g	6	95.994 g
		Total molar mass from all elements	**180.156 g/mol**

How to Help:

• *Follow along with the steps with your student: check the periodic table for the average atomic mass in amu, record it as the molar mass in g, find the total number of atoms for each element based on the number of atoms of each element that are in the compound, and add up the totals for each element to get the total molar mass for the compound.*

• *Here's an analogy if your student is struggling:*

- *Imagine you have 3 pennies, 2 nickels, and 1 dime, and you want to know how many cents you have.*
- *You must know how many cents each coin is, and how many of each coin you have, to know the total cents.*
- *Each penny is worth 1 cent, and you have 3 of them, so that's 3 cents.*
- *Each nickel is worth 5 cents, and you have 2 of them, so that's 10 cents.*
- *Each dime is worth 10 cents, and you have 1 of them, so that's 10 cents.*
- *That makes the total 23 cents.*

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Unit Conversion

• A brief introduction to dimensional analysis, also known as unit conversion or the factor labeling method, is provided in this subsection.

• This is a concept that is typically introduced in introductory algebra courses because it is a math skill. However, it is learned in most chemistry courses because it is necessary when doing complex calculations involving quantities of substances.

• Dimensional analysis is a way of converting a quantity from one unit to another by using conversion factors (each of which is equal to 1) based on equivalence statements (two quantities that are equal to each other).

• The following vocabulary terms are defined: dimensional analysis, equivalence statement, and conversion factor.

THINK ABOUT IT!

Question 1: Fill in the missing parts of the equivalence statements.

Answer:

1 mol = 6.02 × 10^{23} molecules	6.02 × 10^{23} atoms = 1 mol
1 mol = 4.003 g helium	44.01 g CO_2 = 1 mol CO_2

How to Help: Have your student use the definitions of mole and molar mass.

Question 2: Fill in the missing parts of the conversion factors.

Answer:

$\frac{32.06\ g\ S}{1\ mol\ S} = 1$	$\frac{35.45\ g\ Cl}{1\ mol\ Cl} = 1$
$\frac{6.02 \times 10\text{^}23\ atoms\ C}{1\ mol\ C} = 1$	$\frac{6.02 \times 10^{23}\ atoms\ C}{1\ mol\ C} = 1$

How to Help: *Have your student use Avogadro's number and the definition of molar mass.*

MULTIPLE AGES AND ABILITIES:

The kit contains three pieces of gum, so you could have one student do the experiment 3 times or you could have 3 students do the experiment at once. They could compare chewing times or their change in mass. They could either work together on the math or they could work independently and compare their answers.

Question 1: In the following questions, show your process for all calculations. Did the mass of the gum come close to your prediction? Explain.
Answer: Answers will vary depending on the student's prediction.

Question 2: The mass lost was sugar in the gum that dissolved as you chewed it. The type of sugar in bubblegum is sucrose, $C_{12}H_{22}O_{11}$.
a. Determine the molar mass of sucrose.
b. Calculate the number of moles of sucrose that were in the gum.
c. Calculate the number of molecules of sucrose that were in the gum.
d. What mass of sucrose would contain 3.01×10^{23} sucrose molecules?
Answer:
- The molar mass of sucrose is 342.3 g/mol.
- The number of moles of sucrose that were in the gum is based on the loss of mass caused by chewing the gum. A typical loss of mass might be 4 g, which would be (4/342.3) = 0.0088 mol sucrose.
- The number of molecules will vary based on the mass lost and hence, moles lost. If the difference in mass was 4 g, meaning 0.0088 mol sucrose, then the number of molecules would be (0.0088 mol x 6.02×10^{23} molecules per mole) = 5.3×10^{21} molecules

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MOLES AND GAS VOLUME

- In Activity 2, your student explored the connection between moles, number of particles, and the pressure of gases. In this section, they will practice performing stoichiometric calculations involving gases, but in terms of their volume.
- They will perform calculations using the molar volume of a gas.

THINK ABOUT IT!

Question 1: In the following questions, show your process for all calculations. A container of helium gas has a volume of 112.0 L. How many helium atoms are in the container?
Answer:
$$112.0 \text{ L helium x } \frac{1\,mol\ helium}{22.4\,L\ helium} = 5 \text{ mol helium}$$

Question 2: What would the volume be for a balloon containing 11.0 g of CO2?
Answer:
$$11.0 \text{ g of } CO_2 \text{x } \frac{1\,mol\ carbon\ dioxide}{44.01\,g\ carbon\ dioxide} \text{ x } \frac{22.4\,L\ carbon\ dioxide}{1\,mol\ carbon\ dioxide} = 6 \text{ L } CO_2$$

Question 3: A canister of oxygen has a volume of 33.6 L. What would its mass of oxygen be?
Answer:
$$33.6 \text{ L of } O_2 \text{x } \frac{1\,mol\ oxygen\ gas}{22.4\,L\ oxygen\ gas} \text{ x } \frac{31.998\,g\ oxygen\ gas}{1\,mol\ oxygen\ gas} = 48 \text{ g } O_2$$

How to Help: *Don't forget: the oxygen is diatomic and the molar mass shows that a molecule of oxygen as 2 oxygen atoms instead of 1.*

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Kit	SU-MIMOLE
Instructions	IN-IN-MIMOLET
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