Mole Fun Stations: Conversion Practice

Overview
Students will work in groups, moving through stations to practice single chemical stoichiometry conversions. At each station, they will work with a real-world object (water, chips, soda, salt, etc.) while using measurements or the nutrition facts to practice conversions related to stoichiometry. It is recommended that students use a mole map (included below) to practice setting up dimensional analysis (fence post or train track) methods. Atoms, molecules, and formula units exist on the nano level and it is important to understand how we measure these particles and how they interact in a reaction.

Key Search Words
High School, Science, Chemistry, Physical Science, Kinesthetic Activity, Stoichiometry, Mole, Average Atomic Mass, Volume, Representative Particles (Formula Unit, Molecule, Atom), Mole Map, Dimensional Analysis, Conversions

Learning Objectives
At the end of this lesson, students will be able to:
- Identify what type of problem they are solving (e.g. mole to particle).
- Convert (and calculate) between the following:
    - mole to volume
    - mole to mass
    - mole to representative particles
    - volume to mass
    - mass to representative particles
    - representative particles to volume
- Evaluate a solved problem for the mistake.
- Create a test question.

Curriculum Alignment
NC Standards:
- Chm.1.2.2 Infer the type of bond and chemical formula formed between atoms.
- Chm.2.2.4 Analyze the stoichiometric relationships inherent in a chemical reaction.

Classroom time required
- This lesson works for a 90 minute block class or two 45-55 minute class periods

Materials & Technology
1. Printed instruction cards for each station. See appendix.
2. Station materials:
    - Station 1: balance, 400 mL (or more) beaker
    - Station 2: Snack bag of chips
    - Station 3: Can of regular (not diet) soda
    - Station 4: Balance, 400 mL (or more) beaker, small cup of NaCl, spoon
    - Station 5: Balance, granola bar with potassium on nutrition label
3. Students will each need a piece of paper, writing utensil, calculator, and mole map

Safety
Teachers should be mindful when setting up stations. Before the activity begins, teachers should remind students not to ingest anything involved in the activity, even if they think they know what the substance is. Explain that science is messy and things can be contaminated (beakers, substances, ect.). Laboratory equipment is not food safe.

Teacher Preparation for Activity
1. Teachers should print instruction cards and set up all station materials ahead of time.
2. Each student should utilize a mole map.

Note: Teachers can double the number of stations to accommodate larger classes and smaller groups.

Student Preparation for Activity

Prior to this lesson, students should be aware of single chemical stoichiometry (mole) conversions, as mentioned in the learning objectives. This lesson is meant to allow for practice of these skills, with a focus on recognizing appropriate steps, proper set up (dimensional analysis) and proper calculations with units. If students are struggling with this, the mole map offers great scaffolding.

Procedure

1. A warm up of some type is recommended, specifically to remind students of the dimensional analysis process and prepare them to run these calculations on their own. For example:

How many molecules of CO_2 are in 3.5L of CO_2 gas?

$$\frac{3.5\text{ L } CO_2}{} \left| \frac{1\text{ mol } CO_2}{22.4\text{ L } CO_2} \right| \frac{6.02\times10^{23}\text{ mlcl } CO_2}{1\text{ mol } CO_2} = \boxed{9.41\times10^{22}\text{ mlcl } CO_2}$$

2. Instruct students to obtain a piece of paper with their names at the top, pencil, calculator, and mole map. They are each responsible for their own work which will be submitted at the end of class.
3. Organize students into groups as you see fit (2-4 works best) and assign them to one of the stations.
    a. There are seven stations (14 if you double them). I would make 6 groups (12 groups if you double), leaving a station (two if you double) open to allow for easier station rotation.
4. Explain to students that they will move as a group to each station and complete the requirements at each station. They should each show work for every station and work as a group if they get stuck.
5. As students complete the stations, teachers should be prepared to be mobile, making sure station changes are smooth and answering questions as needed.
6. Students should submit their work at the end of class.
    a. Note, one of the stations requires students to create a test question - you can use these for their tests or study guides!

Differentiation

For your more advanced students, challenge them to try the problems without the mole map first. Students may find a cheat sheet of abbreviations of units to be helpful.

Assessment/Check for Understanding

The work each student submits will be an indicator of their level of understanding.

1. Stations 1-5 are practice problems. Check these problems for basic understanding.
2. Station 6 requires them to identify common student mistakes, and station 7 requires them to create an original test question. Check these problems for higher level understanding.
    a. Don't forget, station 7 provides you with questions you can use for their test!

Appendices

Station Questions:

(It is recommended you print each problem horizontally on one page)

Mole Fun – Problem 1

Show your work for each problem!

While having fun in Chemistry class, you get your hands dirty doing a lab. You wash your hands using one of the sinks. You rinse for 2 seconds.

(Fill the beaker with water for about 2 seconds, you may count out loud.)

Use the balance (after zeroing/ taring with an empty beaker) to weigh the water (but not the beaker) in grams.

a. Assuming it is pure water, how many molecules of water did you use to rinse your hands?
b. How many total atoms did you use?

Mole Fun – Problem 2

Show your work for each problem!

After doing all of these chemistry calculations, you are hungry. You decide to have a bag of chips. Do not actually eat the chips!

a. How many moles of sodium (NaCl) did you just consume after eating the entire bag?

b. How many atoms of sodium did you consume?

Mole Fun – Problem 3
Show your work for each problem!
Doing the chemistry problems is now making you thirsty. You decide that you should have a can of soda.

a. How many moles of sugar ($C_{12}H_{22}O_{11}$) did you just consume?
b. How many molecules of sugar did you just consume?
*Bonus: What is the molecular structure of this sugar molecule?

Mole Fun – Problem 4
Show your work for each problem!
A chef finds a new recipe that calls for 2 spoonfuls of sodium chloride.

a. How many moles of sodium chloride did she use?
b. How many formula units of sodium chloride did she use?
c. How many total atoms of sodium and chlorine are in the recipe?

Mole Fun – Problem 5
Show your work for each problem!
After eating a bunch of junk food, you decide to have a (semi-healthy) granola bar.

a. How many moles of potassium are in your granola bar?
b. How many atoms of potassium would you consume if you ate the whole package?

Mole Fun – Problem 6
Each of the problems below contains an error. The black font is the question, the blue font is the student work, marked wrong with a red X. Identify the mistake and provide a sentence explanation of how to correct the problem.

$12\,g$ of H_2SO_4 = ___?___ moles of H_2SO_4

$$\frac{12\,g\ H_2SO_4}{} \Bigg| \frac{1\,mol\ H_2SO_4}{49.07\,g\ H_2SO_4} = \boxed{0.2445\,mol\ H_2SO_4}\ \text{X}$$

$5.6\,L$ of H_2O = ___?___ atoms of H_2O

$$\frac{5.6\,L\ H_2O}{} \Bigg| \frac{1\,mol\ H_2O}{22.4\,L\ H_2O} \Bigg| \frac{6.02 \times 10^{23}\ atoms\ H_2O}{1\,mol\ H_2O} = \boxed{1.51 \times 10^{23}\ atoms\ H_2O}\ \text{X}$$

Mole Fun – Problem 7
Create and solve a stoichiometry test question.

1. Write a problem converting from one unit to another (ex: mass to volume)
2. Show how to solve the problem (using dimensional analysis – be sure to cancel units!!)
3. Box your answer.
4. Swap your problem with a partner in your group to check that the question makes sense.

Answer Key:

1a. $\frac{?\ mL\ H_2O}{} \cdot \frac{1\ g\ H_2O}{1\ mL\ H_2O} \cdot \frac{1\ mol\ H_2O}{18\ g\ H_2O} \cdot \frac{6.02 \times 10^{23}\ mlcl\ H_2O}{1\ mol\ H_2O} = \square$

1b. $\frac{1a.}{} \cdot \frac{3\ atoms\ H_2O}{1\ mlcl\ H_2O} = \square$

2a. $\frac{?\ g\ NaCl}{} \cdot \frac{1\ mol\ NaCl}{58.5\ g\ NaCl} = \square$

2b. $\frac{2b.}{} \cdot \frac{6.02 \times 10^{23}\ f.u.\ NaCl}{1\ mol\ NaCl} \cdot \frac{2\ atoms\ NaCl}{1\ f.u.\ NaCl} = \square$

3a. $\frac{?\ g\ sugar}{} \cdot \frac{1\ mol\ sugar}{342.3\ g\ sugar} = \square$

3b. $\frac{3a.}{} \cdot \frac{6.02 \times 10^{23}\ mlcl\ sugar}{1\ mol\ sugar} = \square$

4a. $\frac{?\ g\ NaCl}{} \cdot \frac{1\ mol\ NaCl}{58.5\ g\ NaCl} = \square$

4b. $\frac{4a.}{} \cdot \frac{6.02 \times 10^{23}\ f.u.\ NaCl}{1\ mol\ NaCl} = \square$

4c. $\frac{4b.}{} \cdot \frac{2\ atoms\ NaCl}{1\ f.u.\ NaCl} = \square$

5a. $\frac{?\ g\ K}{} \cdot \frac{1\ mol\ K}{39\ g\ K} = \square$

5b. $\frac{5a.}{} \cdot \frac{6.02 \times 10^{23}\ f.u.\ K}{1\ mol\ K} \cdot \frac{1\ atom\ K}{1\ f.u.\ K} = \square$

6a. wrong molar mass for H_2SO_4.

$\frac{12\ g\ H_2SO_4}{} \cdot \frac{1\ mol\ H_2SO_4}{98\ g\ H_2SO_4} = \boxed{0.12\ mol\ H_2SO_4}$

6b. This is the number of molecules. There are 3 atoms in 1 molecules.

$\frac{5.6\ L\ H_2O}{} \cdot \frac{1\ mol\ H_2O}{22.4\ L\ H_2O} \cdot \frac{6.02 \times 10^{23}\ mlcl\ H_2O}{1\ mol\ H_2O} \cdot \frac{3\ atoms\ H_2O}{1\ mlcl\ H_2O} = \boxed{4.53 \times 10^{23}\ atoms\ H_2O}$

7. Answers will vary.

Mole Map

Name: