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Educational Resources: Exchange Rates and Unit Conversion

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Exchange Rates and Unit Conversion

Students might have experience in 3rd-6th grade with converting basic ideas such as volume and measurements. This is intended to expand that idea and introduce the mole. It's also a general interactive conversion/exchange activity. All items in here are just based on what we had available and convenient, so feel free to swap out items such as rubber stoppers with something more easily available to you such as pieces of dry pasta.

Related Indiana state standards
Despite the intention here to introduce a chemistry topic, most standards for elementary/junior high deal with math. Science standards are marked in **bold**

SEPS.5 Using mathematics and computational thinking
5.C.1: Multiply multi-digit whole numbers fluently using a standard algorithmic approach.
5.C.2: Find whole-number quotients and remainders with up to four-digit dividends and two digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Describe the strategy and explain the reasoning used.
5.AT.1: Solve real-world problems involving multiplication and division of whole numbers (e.g. by using equations to represent the problem). In division problems that involve a remainder, explain how the remainder affects the solution to the problem.
5.AT.4: Solve real-world problems involving division of unit fractions by non-zero whole numbers, and division of whole numbers by unit fractions (e.g., by using visual fraction models and equations to represent the problem).
5.M.1: Convert among different-sized standard measurement units within a given measurement system, and use these conversions in solving multi-step real-world problems.
6.GM.1: Convert between measurement systems (English to metric and metric to English) given conversion factors, and use these conversions in solving real-world problems.
C.4.4 Apply the mole concept to determine the mass, moles, number of particles, or volume of a gas at STP, in any given sample, for an element or compound.

Main Activity

Supplies
This supplies estimate works for around 20 students. If you have enough time, write out the order of conversions you plan to do and calculate exact amounts. If you run out of an item during the exchanging, just have students combine into groups.

- 1 small container per person/group (to hold large amounts of smaller items)
    - Something like a medium-sized beaker, tin muffin wrapper, or Styrofoam bowl would work well
- Approx. 2000+ small beads
    - There's meant to be around 100 per person to allow for a lot of exchanges
- Approx. 300+ paperclips
- Approx. 50+ rubber stoppers
- Approx. 100+ pens
    - Don't keep reducing the numbers as you go higher – plan for exchanges of just pens -> folders and other lower level items. Having around 100 of each object is not a bad plan.
- Approx. 75+ test tubes

- Approx. 25+ folders
- Bins to hold items

Pre-activity questions

- Does anyone know how many eggs are in a dozen?
    - 12
- Why do we call it a dozen?
    - Everyone knows a dozen is 12. It's easier to say a dozen.

Discussion topics/topics to know

- Unit Conversion
- After completing some exchanges, talk about how this relates to life/science
    - Equations require certain units
    - Ex. –Buying stuff is conversion! You pay so many dollars per gallon of gas.
- Possibly bring up interesting foreign exchange rates (looked up day of, as they shift quickly).
    - Travelling in different countries requires exchanging money
    - This also brings in the idea of decimal conversions
- Dimensional analysis
    - It's what they're doing! Related to currency and conversion factors.
    - Dimensional analysis is cancelling and multiplying units to find out what an end result is.
        - It's like converting gallons of gas into maximum miles that you can drive through miles per gallon.
- Chemistry moles to grams and atoms
    - It's just a conversion factor. The mole is a large number (6.022×10^{23}), grams are weight, and atoms are small units.
    - Scientists calculated the weight of one mole of each element in grams, which is the molecular weight.

Extra Information

Our conversion factors referenced in this activity
6 beads = 1 paperclip
5 paperclips = 1 rubber stopper
2 rubber stoppers = 1 pen
4 pens = 1 test tube
3 test tubes = 1 folder

Instructions

1. Before starting, set up stations around the classroom with the different objects.
    a. To simplify exchanging, you can place the objects in the order of the conversion factors (for example, if students exchange 5 beads for a paperclip, place the bead and paperclip stations beside each other)
    b. Alternatively, to create more motion, the stations could be scattered.
    c. If this is being run by a different class/teachers' aides, having an adult at each station can help with getting the proper exchange rates. Stations can contain two different objects if needed to man all areas.
    d. Students can also be in charge of objects as "storekeepers"
2. Prepare the bowls for students with a specified amount of some starting item (for example, starting with 10 paperclips).

    a. Starting with an item nearer to the middle works well, because 10 paperclips can exchange “down” to get 60 beads, or up all the way to 1 pen.
3. Give students a sheet of conversion factors.
4. Introduce the concept and location of the different stations and hand out the bowls.
    a. If there are a lot of students/very limited supplies, students could go in pairs
5. Start announcing conversions! (Ex. You have paperclips. Exchange them for rubber stoppers. Go!)
    a. Make sure that the students also understand there is no running and they have to wait their turn to exchange.
    b. At the stations, make students say how many rubber stoppers they can purchase.
    c. Start with simple one-level conversions, then slowly get to activities such as converting beads to pens.
    d. Due to numbers of objects, students will probably need to be given more supplies at some point (or be forced to combine groups to get large enough amounts)
    e. Optional addition: Make sure some activities will leave a remainder to talk about division with remainders and whole objects
6. A final step to prepare students for doing math without objects: Have a single student take a test tube and trade it down for paperclips. Write the conversion factors on the board and walk through how the math works.
7. Once students have shown they understand/are growing bored, start them on the conversion worksheet.

Post-activity questions

- If this is a graded activity, ask some basic conversions from the activity so students practice doing the math without objects.
    - A challenge question can have students converting folders to beads
- Having a sub-section with a real life conversion such as inches to centimeters can extend the subject.
    - Also have a question about moles
- How do you use conversions in your daily life?

<u>Sample math questions including answers:</u>

- Convert 2 pens into rubber stoppers.
    - 2 pens=4 rubber stoppers
- Convert 80 paperclips into test tubes.
    - 80 paperclips x (1 rubber stopper/5 paperclips) x (1 pen/2 rubber stoppers) x (1 test tube/4 pens) = 2 test tubes

Scientists use the metric system for measuring data. However, most daily measurements and dimensions in America are in the American Standard System. So, sometimes scientists need to convert inches to centimeters or ounces to grams. [You will want a calculator for this part!]

1 inch=2.54 cm 1 ounce=28.3495 g

- Alan, a chemist, needs a piece of string to reach the bottom of his 10 centimeter tall beaker. However, he accidentally only brought a ruler that measures in inches with him to measure the string. How long should Alan’s string be in inches? (How many inches is 10 cm?)
    - 10 cm x (1 inch/2.54 cm) = 3.937 inches
- Rosa needs to know the weight of some pasta in grams so she can calculate the density for a class project. However, the pasta box only lists that it has 8 ounces of pasta. How many grams of pasta did Rosa buy?

    - 8 ounces x (28.3495 g/1 ounce) = 226.796 g
- In chemistry, there is a unit called a **mole**, which is approximately 6.022×10^{23} particles. 1 mole of carbon (or 6.022×10^{23} atoms of carbon) is 12 grams of carbon (so **1 mole=12 g carbon**). If I had 36 grams of carbon, how many moles would I have?
    - 36 grams x (1 mole/12 grams) = 3 moles of carbon
- Another common element is oxygen. Oxygen has a mass of 16 grams per mole. If I had 2.5 moles of oxygen, how many grams of oxygen would I have?
    - 2.5 moles x (16 grams/1 mole) = 40 grams

Bonus questions:
Convert 1 folder into beads.

1 folder x (3 test tubes/1 folder) x (4 pens/1 test tube) x (2 rubber stoppers/1 pen) x (5 paperclips/1 rubber stopper) x (6 beads/1 paperclip) = 720 beads

1 folder = 720 beads

Go back to question 8. How many carbon atoms are in 36 grams of carbon? (Remember, there are 12 grams of carbon in every mole and a mole of carbon is 6.022×10^{23} carbon atoms)

36 grams x (1 mole/12 grams) x (6.022×10^{23} carbon atoms/1 mole) = 2.16792×10^{25} carbon atoms (or 216.792×10^{23} carbon atoms)

Optional additions beyond the original activity

Organizing the items
For simpler counting/storage, items can be put into smaller piles in muffin tins (for example, beads can be placed 10 or 20 per cup).

Weigh out your money
If you have access to a balance, bring that out near the end and ask if it could help exchange faster/more accurately. If students need prompting, talk about weighing objects. For example, if you weighed 10 beads and they were 1 gram, then if everyone agrees that 10 beads=1 gram of beads, a person could exchange 6 grams of beads for 10 paperclips. Adding in weight also brings in moles more seamlessly, as a mole is a specific quantity that we know the weight and count of.

Visualizing factors of ten/units
Grace Hopper was known for showing/handing out pieces of telephone cable that were approximately 1 light nanosecond long (so around 29.979 cm), then contrasting it with a light microsecond (coil of wire 1000 times longer) and a light picosecond (a piece of black pepper).

- This example brings in a historical figure in computing (Grace Hopper) and helps students visualize extremely large and small numbers when dealing with powers of 10.
- Lengths of string around 30 cm long can also make good take-home pieces for students.

http://americanhistory.si.edu/collections/search/object/nmah_692464
https://en.wikipedia.org/wiki/Grace_Hopper