Sum of the Parts

Summary

The students will use math expressions and equations to discover that the sum of an object's parts is equal to the whole and that in a chemical reaction or physical change matter is neither created nor destroyed.

Materials

Apple
Sharp knife to cut apple
4 red balloons
4 white balloons
1 black balloon
Sodium polyacrylate
Candle/matches
New box of chalk
Digital scales

For each team of 35 students:

Digital scales
Water bottle with about 175 mL of vinegar
3 oz. paper cup ½ full of baking soda
New box of crayons or pencils

Books:

- *Dr. Art's Guide to Science*
, by Art Sussman; ISBN 0787983268

Background for Teachers

To an adult, the concept that the weight of an object's parts is always equal to the weight of the whole object, and that during a chemical reaction matter is not destroyed, seems the only reasonable way it could be, but to an elevenyearold child this fact is not always that clear cut. Many fifth grade students need a variety of handson experiences before they truly begin to understand and generalize this concept. To facilitate these experiences, students must gain a working knowledge of metric units used to measure weight. This knowledge can only be gained through multiple opportunities to make estimates and use scales and balances to weigh and compare objects.
This lesson uses a "whole/part" math model drawing strategy to help students understand the relationships between the parts and wholes, reactants, and products in physical and chemical changes. The lesson begins by having students weigh a set of items like a box of crayons and then write algebraic expressions to solve for the weight of the box and one crayon. Next, students weigh an object like a piece of chalk, then break it, write an expression, and solve for the weight of one of the pieces. Finally, students compare the weight of the reactants and the products in a chemical reaction.

Intended Learning Outcomes

Given the appropriate instrument, measure length, temperature, volume, and mass in metric units as specified.
Describe or explain observations carefully and report with pictures, sentences, and models.

Instructional Procedures

Invitation to Learn:

Shell Game:

To play the shell game, you will need 3 small paper cups, sodium polyacrylate, and water. Prepare for this demonstration by placing a small amount of sodium polyacrylate in the bottom of one of the cups. Tell the class that you are going to pour some water into one of the cups and then move the cups quickly around as they try to keep track of which cup has the water in it. Pour water into the cup with the sodium polyacrylate. It will absorb the water and form a solid mass in the cup that will not fall out when it is turned over. Move the cups and ask if anyone knows which cup has the water. They will probably guess the correct cup. Turn the cup upside down over somebody's head. Nothing will fall out. Try the remaining cups. Ask what happened to the water. Tell the class that it is still there. Show the sodium polyacrylate powder and explain that you put a small amount of the powder in the bottom of the cup. Ask students to try and explain what happened. Was this a physical or chemical change? What evidence supports your choice?

This is a physical change. No new substances are formed. It can be reversed by evaporating the water. Write the following equation on the board: sodium polyacrylate + water = sodium polyacrylate + water

Light a Candle:

Show the class a candle and ask what it is made of. List their responses on the board in the following manner: wax + wick.

Light the candle. Ask: "What changes have been made?" Complete the equation: wax + wick (heat, light given off) = smoke + ash (H20 + C02 + C).

Ask: "Is this a physical change or a chemical reaction?" It is a chemical reaction because there are new substances formed. Explain that today's lesson will explore chemical and physical changes as equations that show that nothing is lost, and matter is not destroyed.

Instructional Procedures:

Dr. Art's Ball:

Tell the story of Dr. Art's Ball from Dr. Art's Guide to Science pages 5257; see Resources) and discuss the differences between a chemical reaction and physical change at a molecular level.

Balloon Atoms:

Before class, blow up:

4 red balloons

4 white balloons

1 black balloon

Get a helper and give him/her the 4 red balloons. He/she should hold 2 balloons in each hand. These represent 2 molecules of oxygen (O_2). Stand in front of your helper and make a methane molecule by holding the 4 white (hydrogen, H) and the one black (carbon, C) together in front of you.

Yell "FIRE!" Turn and make an exchange with your partner so he/she has two water (H_2O) molecules (2 white and a red) one in each hand. You should end up with 1 carbon dioxide (CO_2) molecule (2 reds and a black).

Explain that this is what happens when methane is burned, which is a chemical reaction. You end up with completely new substances. Write the equation on the board: $O_2 + CH_4 = H_2O + CO_2$.

Why can this be written as an equation? Why would it be difficult to weigh the products in this reaction?

Parts of the Big Apple:

Show the class an apple and have each student record an estimate of its weight in grams in their journal. Weigh the apple and write the weight on the board. Write "whole" next to the apple's weight and award the student with the closest estimate to the actual weight a piece of candy or small toy.

Next, cut the apple into fourths. Select one piece and ask the class to record an estimate of its weight. Ask students to share the strategies they used to make their estimate. Look longingly at the piece of apple and say something like, "Oh, I'm so hungry," and eat the piece of apple. Apologize to the class and say, "I'm so sorry, now we will never know the weight of the piece." If nobody says anything, suggest that maybe there is a way to find out the weight of the missing piece.

Have the teams put their heads together and see if they can come up with a way to find out what the weight of the missing piece was. Allow teams to share their ideas. If nobody suggests weighing the three remaining pieces and subtracting their combined weight from the weight of the whole apple, you may need to give a few hints to guide their thinking.

Use the strategy mentioned above and determine the weight of the missing piece; reward the student with the closest estimate, and introduce the "whole/part" model that could be used to represent the problem. Fill in the weight of the whole apple and the total of the three known parts. Write an expression to solve for the missing part.

Chalk It Up:

Show the class a box of chalk. Have each student record an estimate of its weight in grams. Record a few of the student's estimates on the board.

Weigh the box and write the weight on the board along with the word "whole." Draw a line to represent the whole.

Ask the students to name all the parts that are part of the whole box of chalk; be sure to include the box. Draw a box under the line. This box represents all the parts and should be the same length as the line. Draw a line to divide off a small square on one of the boxes; label it "box." Draw a bracket under the rest of the box and label it "chalk." This section represents the chalk. Since there are 12 pieces of chalk, label this box 12C.

Ask the students how you could determine the weight of the box without weighing the box. Have students share suggestions. Take out the chalk and find the weight of all the pieces and record it on the drawing. Use the equation:

whole -- weight of chalk = weight of box

Fill in the values and calculate the weight of the box. Check your calculation by weighing the box.

Ask, "How could I find the weight of one piece of chalk without weighing it?" Write the equation:

weight of chalk / 12 = weight of one piece

Draw lines to represent 12 pieces of chalk in the diagram.

Give each team a box of pencils or crayons and have them follow the above procedures and calculate the weight of the box and one pencil or crayon.

Give teams time to share their results with the class.

Lesson and Activity Time Schedule:

Each lesson is 55 minutes.

Each activity is 30 minutes.

Total lesson and activity time is 90 minutes.

Activity Connected to Lesson:

Physical Changes:

Give each team a piece of chalk and have them find and record its weight.

Students should carefully break the chalk into 3 or 4 pieces and draw a model with a line representing the whole weight and a box to represent the parts.

Instruct the teams to select one piece of chalk and use the scale, drawing and an equation to find the weight of that piece of chalk. They should check their answer by weighing the piece. If it

doesn't weigh the same as they calculated, can they explain why? Maybe they lost a few small pieces when they broke the chalk, or they may have made a mistake in their calculations.
Have teams share their results with the class.
Ask the following questions: Are all of your pieces of chalk the same weight? Is it possible to use division to find the weight of each piece? Why not?
Next give each team a small bag of Legos and have them construct an object that will stand unaided on their scale.
When the structures are complete, have the teams find and record its weight.
Go to each team and remove a part of their structure; instruct them to draw a model, write an equation, and calculate the weight of the missing part.
Give the teams back their part and have them check their calculations by weighing the part.
Finally have students take their structure apart, weigh all the pieces and compare their weight to the weight of the whole structure.
Have teams share with the class.

Chemical Changes:

Give each team a 16 oz. water bottle with about 175 mL of vinegar in it, and a 3oz paper cup half full of baking soda.
Have students list all the parts including the bottle and the cup and draw a "whole/part" model, put everything on the scale, find the combined weight of the parts and record it on the drawing.
Have students carefully dump the baking soda into the bottle and observe what happens. What has changed? Can they see any baking soda? Why did it bubble?
Have students place the bottle and the cup on the scale and find its weight. Has it changed? Why is it less? Explain that the whole isn't really less, but something has been lost. To help students understand what has happened, draw a new model. Explain that we have made something new and we can calculate the weight of the new gas that was made even though it has left. Write an equation and calculate the weight of the missing CO2 gas.
If you wish, this activity could be repeated, only this time put the baking soda in a balloon, stretch the mouth of the balloon over the top of the bottle, and then dump the baking soda into the vinegar. The CO2 will be collected in the balloon and then the whole thing can be weighed. (It should, of course, be the same, but often it is not because some gas may escape.)

Extensions

Additional Activities With Scales:

Estimate how many Postit notes there are in a stack without counting them.
Make KoolAid. First weigh all the parts, draw a model, write an equation and calculate the weight of the KoolAid.
Find out how much pencil lead and eraser are used by the class in one day.
Weigh a Ziploc bag with 250 mL of water, freeze it, and weigh the ice.
Weigh 3 tablespoons of salt and 250 mL of water, dissolve the salt in the water, and set it on the window sill until all the water has evaporated. Weigh the salt.

Family Connections:

Have students bring in items that are made of parts, such as puzzles, small toys, or objects made of Legos. Students can weigh the items, take them apart and determine their weight.

Assessment Plan

Observe student teams as they work.

Authors

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