What's the Matter? Part I

This e-mail is in response to a teacher's request for information about the properties of ***matter***.

Think about our "plant-in-a-jar." How would you respond if asked to describe the objects and substances in the jar? You might describe the plant's height, color, texture, and shape. The water condensed on the inner surface of the jar is a colorless liquid. The soil is composed of chunks of materials that are different textures and colored different shades of brown. The air in the jar is colorless and transparent. You could measure the weight and volume of the plant (an object*), the soil (a mixture), and the water (a pure substance*). Color, texture, and physical state (solid, liquid, and gaseous) are all properties of matter. Length, volume, and weight are also properties of matter that we can measure.

This week, we're transitioning from the Living Environment (and our plant-in-a-jar) to the Physical Setting.

Matter is important for several reasons:

- Matter and energy are the foundations of the natural environment.
- The relationships among matter, its property of inertia, and the measure of inertia are poorly understood by adults and difficult for children to learn
- These relationships are an important part of the NYS Elementary and Intermediate Core Curricula.

The first question for today is: What do **all** objects and substances have in common?
The answer is that all are composed of ***matter***.

The second question is: What properties does all ***matter*** have in common?

Let's begin the exploration of **matter** with the familiar definition →

Matter
- Takes up space
- Has mass

First, let's think about "takes up space."

⇒ If you want to find out how much **space** a sugar cube or a sample of granulated sugar takes up, you measure their **volume**.

Volume is the *measure* of how much space is occupied by an object (e.g., a sugar cube) or a sample of substance (e.g., some granulated sugar).

Now let's look at the second property of all matter: "**has mass**." ***Mass*** is a complex concept, and for the moment we're going to look at one aspect of it. We're going to change the definition of **matter** just a bit to →

Matter
- Takes up space
- Resists changes in motion

Our plan is to show you how the phrases, **"has mass"** and **"resists changes in motion"** are related.

Both phrases can be applied to almost any object or substance in the natural environment, from our plant-in-a-jar, to the glass jar, to the water, to the soil, to the oxygen in the jar, to the moon, the stars, and almost everything else. Something this extensive and encompassing must have a lot behind it…

Measuring ***"resistance to change in motion"*** is a bit more complicated than measuring how much space an object or sample of a substance takes up.

⇒ If you want to measure how much an object (a baseball) or substance (some sand in a bag*) resists changes in motion*, you measure its **mass**.

So how did we get from the property, "resists change in motion," to its *measure*, "mass?" The story line includes a familiar word, ***inertia***.

Inertia is resistance to change in motion.

We use this word in everyday language, as in "I can't get up off the couch this weekend to do some chores because of ***inertia***." Scientifically, the definition is more involved than that, because we're talking about *any* change in motion of any object or sample of a substance.

In what ways can the motion of an object change?

- An object can go from being at rest to being *in motion*
- An object can be traveling in a straight line and *stop* moving
- An object can be traveling in a straight line at a constant speed and *slow down*
- An object can be traveling in a straight line at a constant speed and *speed up*
- A body can be traveling in a straight line at a constant speed and *change direction***

⇒ Next week we'll continue looking at the relationships among force, changes in motion, and ***mass***. In the meantime, here are two practical questions about ***inertia***:

1. If you think about an automobile as an object, what are automobile engineers' designs concerning change in motion?
2. What happens to objects inside an automobile that *aren't* directly attached to the car when there *is* a change in motion?

A prize to the <u>school</u> whose teachers come up with greatest number of responses!

New York State Elementary and Intermediate Standards

FYI: Concepts and principles pertaining to **matter** are found throughout the NYS Core Curriculua. The ones most pertinent to this week's email include:

Elementary Core Curriculum: Standard 4: The Physical Setting

- ***Key Idea 3:*** Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

  Major Understandings

  - 3.1a Matter takes up space and has mass. Two objects cannot occupy the same place at the same time.
  - 3.1b Matter has properties (color, hardness, odor, sound, taste, etc.) that can be observed through the senses
  - 3.1c Objects have properties that can be observed, described, and/or measured: length, width, volume, size, shape, mass or weight, temperature, texture, flexibility, reflectiveness of light

- ***Key Idea 5:*** Energy and matter interact through forces that result in changes in motion

  Major Understanding

  - 5.1b The position or direction of motion of an object can be changed by pushing or pulling.

Intermediate Core Curriculum: Standard 4: The Physical Setting

- ***Key Idea 3:*** Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

  Major Understanding

  - 3.1a Substances have characteristic properties. Some of these properties include color, odor, phase at room temperature, density, solubility, heat and electrical conductivity, hardness, and boiling and freezing points.

- ***Key Idea 5:*** Energy and matter interact through forces that result in changes in motion

  Major Understandings

  - 5.1c An object's motion is the result of the combined effect of all forces acting on the object. A moving object that is not subjected to a force will continue to move at a constant speed in a straight line. An object at rest will remain at rest.
  - 5.1d Force is directly related to an object's mass and acceleration. The greater the force, the greater the change in motion.

*Think for just a minute about the distinction between an object and a substance. The plant in the jar is an object composed of many different substances including chlorophyll, water, and cellulose. A cube of sugar is an object composed of sugar (sucrose), a substance. All are matter: the plant and the sugar cube, which are objects, and the chlorophyll, water, cellulose, and sucrose, which are substances.

The scientific term for *all* of these changes in motion is ***acceleration*.