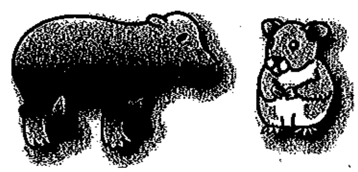
Name: ______________________________ Date: ____________________

What Is Matter?

ABSORB

Look around you. Everything you can see—from stars to dirty socks to washing machines and peanut shells—is made of "stuff" scientists call matter. Many things you can't see—like air and swamp gas and the smells of perfume and dead fish—are also made of matter. Each chunk of **matter** has certain unique **specific properties** that we can describe using our senses—things like color, size, texture, smell, taste, shape, hardness, and so forth. But all matter has two essential general properties: **mass** and **volume**.

Mass refers to the amount of matter an object has. A pygmy hippopotamus has more mass than a hamster. Mass resists being moved. This resistance is called **inertia**. Try pushing both a hippo and a hamster, and you will find that the hippo has more inertia. Mass is typically measured in metric units called **grams** (g) or **kilograms** (kg) (See page 40). A pygmy hippo weighs about 230 kilograms (230,000 grams), whereas a hamster weighs about 600 grams.



Matter also takes up space. It has a certain **volume**. The volume of liquids is measured in **milliliters** (ml) or **liters** (L). The volume of solids is measured in **cubic centimeters** (cm^3). 1 ml is the same volume as 1 cm^3.

APPLY

1. Select two convenient, nearby objects. Let's get wild and call them A and B. List five specific properties of each:

   A.: __________ __________ __________ __________ __________

   B.: __________ __________ __________ __________ __________

2. Which object has more mass? ______
3. How do you know? ______________________________
4. Which object appears to have a greater volume? ______
5. Will objects of larger mass always have more volume than objects of smaller mass?

   ____

   (Before you answer, think about matter in the form of Styrofoam ice chests, iron balls, cork pads, and balsa wood airplanes.)
6. What has more volume: 1,500 ml of lime soda or 1,700 cm^3 of bellybutton lint?

   ____

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Mass and Weight

ABSORB

Weight is another general property of matter that is often confused with mass. An object's mass always stays the same, but its weight can vary. All objects attract one another, but the **force** of that attraction—a force called **gravity**—depends on both the size of the objects and how far apart they are. Large objects possess more gravity than small objects. When one object, like the earth, is much bigger than the other, like you, the smaller object is pulled toward the larger with a force called its weight, which is measured in newtons (See page 40). A 1 kg object on the surface of the earth is pulled toward the center of the earth with a force of 9.8 newtons (9.8 N).

What? Your bathroom scale doesn't give your weight in newtons? True. On Earth, weight is often measured in grams and kilograms (or pounds) just like mass, because Earth is our "reference planet." But if you hopped a rocket to Jupiter, which has 318 times the mass of Earth, your 150-pound (68.2 kg) body would weigh 47,700 pounds (21,687.6 kg). Between planets, you would feel "weightless" (although you are not. You are still attracted to all the other masses in the universe.), but you would have the same mass. A pygmy hippo would resist being pushed just as much on a spaceship as it would in your backyard.

APPLY

1. Most of Earth's mass is concentrated below your feet. Will your weight change if you climb a mountain? ________ Why or why not? ______________________________

   ____

2. The moon has only about one-fourth the mass of the earth. Would you expect to weigh more or less there? ____________

3. Remember that pygmy hippo? Her mass is 230 kg. What does she weigh in newtons?

   ____

   To find out what you weigh, multiply your weight in kg times 9.8 newtons. ____________

4. Assume that Earth's mass is equal to one (1). The planets listed below would then have the following masses: Mercury, 0.055; Venus, 0.815; Mars, 0.108; Saturn, 95.2; Neptune, 17.2. On which planets would you weigh more than you do on Earth?

   ____

5. In a science fiction story, two astronauts are building a space station. A 500 kg mechanical arm threatens to crush one astronaut against the hull of his shuttle craft. The second astronaut comes to the rescue and pushes the mechanical arm away in the weightlessness of space. Why wouldn't the astronaut be able to save his friend in this way?

   ____

   ____

Name: ______________________ Date: ______________

Volume and Density

ABSORB

We know that volume is an important general property of matter. But to compare different kinds of matter, it is useful to look at another general property called **density**. Density is a measure of how much mass fits in a particular volume. If you eat a bowl of chili one day and compare it to eating a bowl of puffed rice the next day, the chili wins the density contest. **Density = mass/volume.** Water provides a useful standard for comparison on Earth. 1 gram of water fits in a volume of 1 ml (or cm^3). Thus, water has a density of 1 g/ml. Density of solids is usually expressed in g/cm^3. Here's the density of some common kinds of matter in g/cm^3: Air: 0.0013; water (as solid ice): 0.92; gold: 19.3; aluminum: 2.7; gasoline: 0.7; steel: 7.8.

Note that solid water (ice) is less dense than liquid water, which is why ice cubes float in your lemonade and icebergs float in the oceans.

Also note that you can change the basic formula for density to solve for unknown masses and volumes. **Volume x density = mass** and **volume = mass/density**.

APPLY

1. The earth has an overall density of 5.5 g/cm^3, similar to other "rocky" worlds in the inner solar system. Other planets farther away from the sun are less dense. Saturn has a density of 0.7 g/cm^3. If there was an ocean of water somewhere big enough to hold Saturn, what would happen? ______________________________

____

2. If you mix water and gasoline and let the two liquids settle, which would end up on top? Why? ______________________________

____

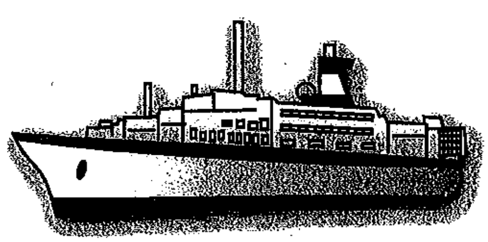
3. Lead has a density of 11.3 g/cm^3. What mass of lead will fit in a 20 cm^3 container?

____

4. How big a container (in liters) do you need to hold 2,000 g of gasoline? (Gasoline's density is 0.7 g/cm^3.) Refer to page 40, if necessary. ______________

5. How can a heavy cruise ship, made with lots of steel and other materials denser than water, float? ______________________________

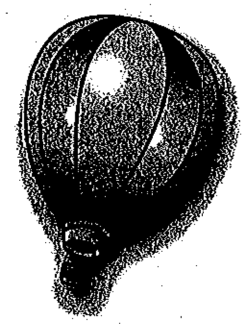
____



Name: ______________________________ Date: ______________

Matter: Putting It All Together

CONTENT REVIEW



1. General properties of matter include all but which of the following.
   A. Mass B. Color C. Volume D. Density
2. All of the following is true about the mass of an object except:
   A. mass can vary with distance from the sun.
   B. mass resists being moved.
   C. mass is typically measured in grams or kilograms.
   D. mass is a general property of all matter.
3. Fill in the blanks:
   All objects are attracted to each other by a force called __________, which can vary depending on the __________ of the objects and the __________ between them.
4. If astronauts landed on a planet $\frac{2}{3}$ the size of Earth, their weight would be __________ it is on Earth. (greater than, less than, or equal to what)
5. T or F: The density of a particular piece of matter is a clue to its identity.
6. T or F: Volume = density/mass

CONCEPT REVIEW

1. A tanker ship is rammed by an iceberg and leaks. The oil it carried has a density of 0.92 g/ml. Which life forms will be most affected: those that live near the surface or bottom dwellers? ____________________ How can the mess be cleaned up?
   ____
2. An alien with about your mass visits Earth from his home planet, which is 1.6 times more massive than Earth. Do you think you should pick a fight with him? Why or why not?
   ____
3. When the air heats up from the burner in a hot air balloon, what happens to the volume of the balloon? What happens to the density of the air inside? How do you know?
   ____
   ____
4. The alien in question 2 above says he weighs 75 gurkas on Earth. How many gurkas does he weigh at home? __________