WARD'S™

Chapter 27.1
Planet
Formation

"Solar Stew" Investigating Planet Densities

Student Study and Analysis Sheets

36 H 0745

Introduction

Protons, neutrons, and electrons are the building blocks of all matter. These particles make up atoms, which, in turn, make up matter. Matter can be classified as **elements** (one kind of atom), **compounds** (two or more kinds of atoms chemically bonded) and **mixtures** (two or more substances physically combined). **Matter** can be defined as anything that takes up space (volume) and has mass. Everything around us is matter, but there are many, many types of matter. One type of matter can be distinguished from another by a set of physical properties that are characteristic for that material. A **physical property** is a characteristic of a type of matter that can be observed or measured without changing the chemical composition of the substance. Examples of these properties include state (solid, liquid, or gas), color, odor, melting/freezing point, boiling/condensation point, and density. Water, for example, is a colorless, odorless liquid that boils at 100°C, freezes at 0°C, and has a density of 1 g/ml.

Density is defined as the ratio of the mass of a substance to its volume, and is measured in g/cm^3 for solids. But what does that really mean? A steel sphere will feel heavier than an aluminum sphere of the same size. In this example, the volume of both spheres is the same; however, the steel sphere contains more mass. Density depends on the kind of atoms a substance contains and also how tightly the atoms are packed together. Steel, for example, contains iron, which has an atomic mass that is more than twice that of aluminum. It is a heavier element, so the density of steel will be greater than that of aluminum for a given volume.

Density for a regularly shaped object, like a cube, block, or cylinder, can be found by obtaining the mass of the object using a balance, and by measuring the dimensions of the object to determine the volume. Once the mass (m) and volume (V) are determined, the density (D) can be calculated as follows:

$D = m/V = g/cm^3$ (for solids) or g/ml (for liquids)

OBSERVATIONS AND DATA

DATA TABLE 1

SUBSTANCE	MASS (g)	VOLUME (cm^3)	DENSITY (g/cm^3)
acrylic			
chalcocite			
clay			
cork			
iron			
magnetite			
pine wood			
rubber			
sphalerite			

DATA TABLE 2

PLANETARY DATA

PLANET	DENSITY (g/cm^3)	"STEW" INGREDIENT	ACTUAL PLANET COMPOSITION
Mercury	5.4		Silicates, iron
Venus	5.2		Silicates, iron
Earth	5.5		Silicates, iron
Mars	3.9		Silicates, iron
Jupiter	1.3		Hydrogen, helium
Saturn	0.7		Hydrogen, helium
Uranus	1.3		Hydrogen, helium, methane
Neptune	1.8		Hydrogen, helium, methane
Pluto	1.1 (?)		Methane, rock, ice (?)

Questions

1. What happens to the overall density of the planets as one travels outward from the sun? Why do you think this is so?

2. Which two substances were NOT used for the planetary densities?

3. Which was the heavier of the two substances NOT used? Where is this substance found in the solar system? Explain your answer in terms of the nebular theory.

4. Use the nebular theory to state what happens to the lighter materials in the solar system, as represented by the less dense of the two substances referred to in Question #2.

5. The mass of Jupiter is 1.9×10^{30}g. The mass for Earth is 5.98×10^{27}g. In the space provided, use this data and the information from DATA TABLE 2 to calculate the volume for Jupiter and Earth. Show all work; don't forget the units.

6. Using your data from Question #5, how many Earths would fit into Jupiter?

7. Using the mass data from Question #5, how many Earths would it take to equal the mass of Jupiter?

8. With a density of 1.3 g/cm^3 for Jupiter, calculate what its volume WOULD be if it had the mass of Earth. How many times the size of Earth would this planet be?