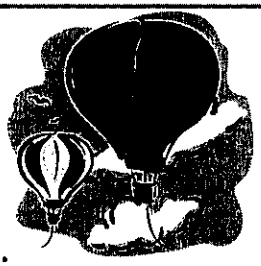
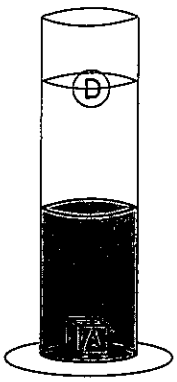
Density



$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

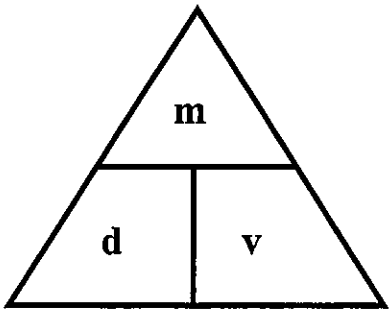


Overview:

Density is an identifying property of matter. By calculating the density of an object, especially minerals, it greatly assists in the identification of the object. Density is the mass per unit volume.

The Equation:

The density equation involves three variables: *v*, *m*, and *d*. When given any two variables, the third variable can be found. This can be shown by the "Density Triangle".



From this triangle if one needs the equation for density, cover *d* and the answer is shown, m/v. The same procedure is used for mass: $m = (d)(v)$ and volume: $v = m/d$. The unit for density is g/cm^3, which is the same as g/cc and g/mL.

If the density question involves a density graph, select any volume value, and from this value move directly to the graphed density line. At the intersection point move directly to the mass axis and read the mass value. Substitute these values into the density equation to arrive at the answer. At times, the density value can change, especially with gases, with changes in volume due to temperature or pressure changes. Remember, if volume increases while mass remains the same, the density decreases. This is why a hot air balloon rises. This is an inverse relationship: $\downarrow d = \frac{m}{\uparrow v}$

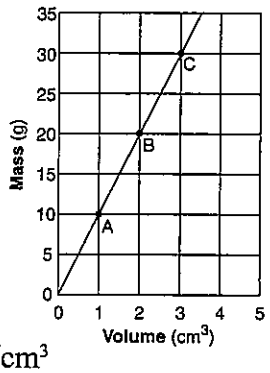
Additional information:

- Normally, solids are denser than liquids, while gases are the least dense.
- The exception to this above rule is water. The solid phase, ice, is less dense than that of the liquid phase.
- As water changes to ice, the volume increases causing the density to decrease.
- Any object with a density value less than 1 g/cm^3 will float when placed in water. An object with a density value higher than 1 g/cm^3 will sink when placed in water.
- The same substance will have the same density regardless of size.

1. A rock sample has a mass of 16 grams and a volume of 8 cubic centimeters. When the rock is cut in half, what is the volume and density of each piece?

(1) 8 cm^3 and 0.5 g/cm^3
(2) 8 cm^3 and 1.0 g/cm^3
(3) 4 cm^3 and 2.0 g/cm^3
(4) 4 cm^3 and 4.0 g/cm^3 1_____

2. The accompanying graph shows the relationship between mass and volume for three samples, *A*, *B*, and *C*, of a given material. What is the density of this material?



(1) 1.0 g/cm^3
(2) 5.0 g/cm^3
(3) 10.0 g/cm^3
(4) 20.0 g/cm^3 2_____

Note that question 3 has only three choices.

3. As air on the surface of Earth warms, the density of the air

(1) decreases
(2) increases
(3) remains the same 3_____

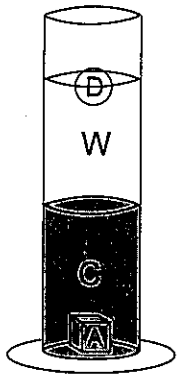
4. If the mass of a spinel crystal is 9.5 grams, what is the volume of this spinel crystal?

Table 1

Gemstone Mineral	Composition	Hardness	Average Density (g/cm^3)
emerald	$Be_3Al_2(Si_6O_{18})$	7.5–8	2.7
sapphire	Al_2O_3	9	4.0
spinel	$MgAl_2O_4$	8	3.8
zircon	$ZrSiO_4$	7.5	4.7

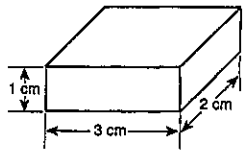
(1) 0.4 cm^3
(2) 2.5 cm^3
(3) 5.7 cm^3
(4) 36.1 cm^3 4_____

5. Liquid *W* was added to the graduated cylinder containing liquid *C*. Objects *A* and *D* were then dropped into the cylinder. Which statement is correct?



(1) Liquid *W* is denser than liquid *C* and object *D*.
(2) Liquid *C* is denser than liquid *W* and object *A*.
(3) Liquid *C* is less dense than object *A*, but more dense than liquid *W* and object *D*.
(4) Object *A* is denser than liquid *C*, but not as dense as liquid *W* and object *D*. 5_____

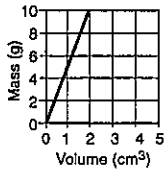
6. The diagram below represents a solid object with a density of 3 grams per cubic centimeter. What is the mass of this object?

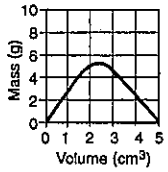


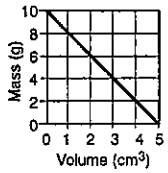
(Not drawn to scale)

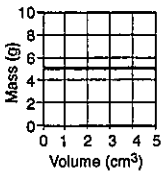
(1) 0.5 g (3) 18 g
(2) 2 g (4) 36 g 6_____

7. Which graph best represents the relationship between mass and volume of a material that has a density of 5 grams per cubic centimeter?

(1)


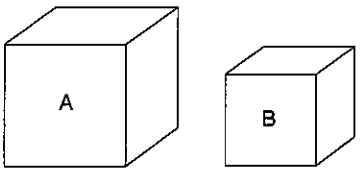
(2)


(3)


(4)


7_____

Base your answers to questions 8, 9, and 10 on the diagrams below, and your knowledge of Earth science. The diagrams represent two different solid, uniform materials cut into cubes *A* and *B*.



Mass of A = 320 g
Volume of A = 64 cm³

Density of B = 3 g/cm³
Volume of B = 27 cm³

(Not drawn to scale)

8. What is the density of cube *A*?

(1) 0.2 g/cm³
(2) 5.0 g/cm³
(3) 12.8 g/cm³
(4) 64.0 g/cm³ 8_____

9. What is the mass of cube *B*?

(1) 3 g (3) 27 g
(2) 9 g (4) 81 g 9_____

Note that question 10 has only three choices.

10. Assume cube *B* was broken into many irregularly shaped pieces. Compared to the density of the entire cube, the density of one of the pieces would be

(1) less
(2) greater
(3) the same 10_____

11. Explain how heat would change the density of a parcel of air.

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