Density

Density is a measure of how **tightly packed** a material is.

*High density objects are **heavy** even if they are **small**.*
Low density objects weigh very little even if they are large.

Density is calculated using:

$$\boldsymbol{density = \frac{mass}{volume}}$$

(divide the mass in grams by the volume in cm^3)*

**Note: For most practical purposes, mass and weight mean the same thing.*

An apple and a lead cannonball are roughly the same size (**volume**), but the lead ball **weighs** 20 times more.

Lead is <u>more dense</u> than Apple

*If two objects are roughly the same **volume**, the **heaviest** is the **most dense**.*

A 4 by 8 sheet of expanded polystyrene (EP) **weighs** roughly the same as a brick, but is about 9 times the size (**volume**).

E.P. is <u>less dense</u> than Brick

*If two objects are roughly the same **weight**, the **smallest** is the **most dense**.*

1. Below each object, guess if it would float or sink.

This effectively compares the density to water (which is $1\ g/cm^3$)

Aluminium bike frame

Oak table top

Expanded polystyrene sheet

Anchor chain link

Ice sculpture

2. Put the objects above in order, from low to high density.

Just make an intelligent guess – no need to do any calculations yet.

Low density *High density*

Density Calculations 1

Calculate the density for each using $density = \frac{mass}{volume}$ then put them in order.

Just divide mass by volume. Eg, brick density: $4000 \div 2000 = 2g/cm^3$

Brick

Volume: $2000cm^3$
Mass: $4000g$

Density:

g/cm^3

Pane of glass

Volume: $4000cm^3$
Mass: $10{,}400g$

Density:

g/cm^3

Gold bar

Volume: $52cm^3$
Mass: $1003.6g$

Density:

g/cm^3

Granite counter

Volume: $15{,}000cm^3$
Mass: $36{,}750g$

Density:

g/cm^3

Oak table top

Volume: $30{,}000cm^3$
Mass: $23{,}100g$

Density:

g/cm^3

Apple

Volume: $150cm^3$
Mass: $90g$

Density:

g/cm^3

Concrete slab

Volume: $18{,}000cm^3$
Mass: $43{,}200g$

Density:

g/cm^3

Density Calculations 2

Calculate the density for each using $density = \frac{mass}{volume}$ then put them in order.

Just divide mass by volume. Eg, lead density: $2034 \div 180 = 11.3 g/cm^3$

Lead Cannonball

Volume: $180 cm^3$
Mass: $2034 g$

Density:

g/cm^3

Anchor chain link

Volume: $12{,}500 cm^3$
Mass: $97{,}500 g$

Density:

g/cm^3

Ice sculpture

Volume: $80{,}000 cm^3$
Mass: $73{,}600 g$

Density:

g/cm^3

Expanded polystyrene

Volume: $90{,}000 cm^3$
Mass: $3600 g$

Density:

g/cm^3

Aluminium bike frame

Volume: $570 cm^3$
Mass: $1539 g$

Density:

g/cm^3

Elephant's femur

Volume: $8000 cm^3$
Mass: $15{,}200 g$

Density:

g/cm^3

Density SOLUTIONS

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Low density objects weigh very little even if they are large.

Density is calculated using:

$$density = \frac{mass}{volume}$$

(divide the mass in grams by the volume in cm^3)*

**Note: For most practical purposes, mass and weight mean the same thing.*

…

1. Below each object, guess if it would float or sink.

This effectively compares the density to water (which is $1\ g/cm^3$)

Aluminium bike frame

Sink*

Oak table top

Float

Expanded polystyrene sheet

Float

Anchor chain link

Sink

Ice sculpture

Float

* The aluminium material is more dense than water, so it would sink unless the frame was sealed to form hollow tubes.

2. Put the objects above in order, from low to high density.

Just make an intelligent guess – no need to do any calculations yet.

Expanded polystyrene sheet

Oak table top

Ice sculpture

Aluminium bike frame*

Anchor chain link

Low density *High density*

* If the frame were sealed, the bike frame would be less dense overall than the aluminium material itself. This might mean it would be less dense than oak.

Density Calculations 1 SOLUTIONS

Brick

Volume: $2000cm^3$
Mass: $4000g$

Density:

$\boldsymbol{2g/cm^3}$

Pane of glass

Volume: $4000cm^3$
Mass: $10{,}400g$

Density:

$\boldsymbol{2.6g/cm^3}$

Gold bar

Volume: $52cm^3$
Mass: $1003.6g$

Density:

$\boldsymbol{19.3g/cm^3}$

Granite counter

Volume: $15{,}000cm^3$
Mass: $36{,}750g$

Density:

$\boldsymbol{2.45g/cm^3}$

Oak table top

Volume: $30{,}000cm^3$
Mass: $23{,}100g$

Density:

$\boldsymbol{0.77g/cm^3}$

Apple

Volume: $150cm^3$
Mass: $90g$

Density:

$\boldsymbol{0.6g/cm^3}$

Concrete slab

Volume: $18{,}000cm^3$
Mass: $43{,}200g$

Density:

$\boldsymbol{2.4g/cm^3}$

In order, from least to most dense: **Sheet 1:** Apple, Oak, Brick, Concrete, Granite, Glass, Gold

Both sheets together:

Polystyrene, Apple, Oak, Ice, Bone, Brick, Concrete, Granite, Glass, Bike, Chain, Lead, Gold

Density Calculations 2 SOLUTIONS

Lead Cannonball

Volume: $180cm^3$
Mass: $2034g$

Density:

$\mathbf{11.3g/cm^3}$

Anchor chain link

Volume: $12500cm^3$
Mass: $97500g$

Density:

$\mathbf{7,8g/cm^3}$

Ice sculpture

Volume: $80000cm^3$
Mass: $73600g$

Density:

$\mathbf{0.92g/cm^3}$

Expanded polystyrene

Volume: $90{,}000cm^3$
Mass: $3600g$

Density:

$\mathbf{0.04g/cm^3}$

Aluminium bike frame

Volume: $570cm^3$
Mass: $1539g$

Density:

$\mathbf{2.7g/cm^3}$

Elephant's femur

Volume: $8000cm^3$
Mass: $15200g$

Density:

$\mathbf{1.9g/cm^3}$

In order, from least to most dense: **Sheet 2:** Polystyrene, Ice, Bone, Bike, Chain, Lead

Both sheets together:

Polystyrene, Apple, Oak, Ice, Bone, Brick, Concrete, Granite, Glass, Bike, Chain, Lead, Gold