

Table of Contents

NONFICTION

Introduction to Economics	4
Mass, Volume and Density	10
The Systems of the Human Body: Part I	14
The Systems of the Human Body: Part II	18
What Is Sound?	22

ESSAYS/SPEECHES

Excerpts From <i>Common Sense</i>	28
The Gettysburg Address.	32
Moving Pictures Evoke Concern, 1922	35

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Mass, Volume and Density

The three mathematical concepts of mass, volume and density are all used to describe different characteristics of objects.

Mass

Mass is the amount of matter in a given object. It is the total number of subatomic particles – protons, electrons and neutrons – that the object contains. The measurement of mass is expressed in grams. Although mass and weight appear very similar, they are not the same thing. Weight is the mass of an object multiplied by the pull of Earth's gravity on the object. Consider this scenario: As you may know, you weigh less on the Moon than you do on Earth. But your mass remains exactly the same whether you are on the Moon or on the Earth. The difference in your weight is attributed to the strength of the Earth's gravitational pull. When you are on Earth, the gravitational pull is, not surprisingly, stronger. When you travel far from the Earth to the Moon, the strength of the Earth's gravitational pull is weakened and, therefore, you weigh less. The Moon's gravitational pull is so small that it does not make much difference.

Volume

Volume measures the space an object occupies and is expressed in cubic centimetres. Every object occupies a certain amount of space within the universe. The volume of regularly shaped objects, such as cubes, spheres and cones can be determined by formulas. For example, to find the volume of a cube, you multiply the lengths of the three sides (height, depth and width). Therefore, if a cube has a height of 2 centimetres, a width of 2 centimetres and a depth of 2 centimetres, then its volume is 8 cubic centimetres.

The volume of irregularly shaped objects is more difficult to determine. The theory of water displacement often is used in these situations. Do you know how water displacement works? First, you put water into a container and mark the level of the water. Then, the object is placed in the water, which causes the water level to rise. The new water level is marked. The volume of the irregularly shaped object is determined by the difference between the original water level and the water level when the object was in the container of water.



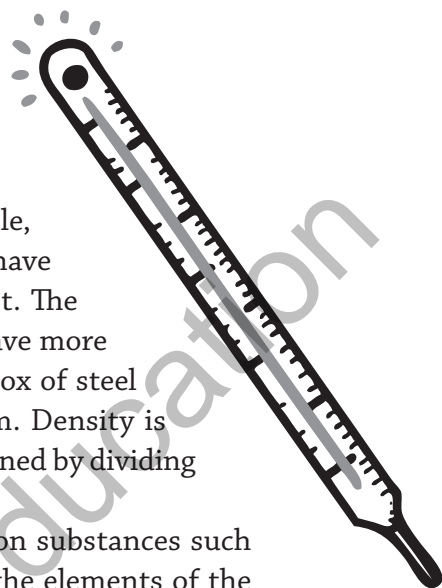
Density

Density is the relationship between the mass of an object and the object's volume. In other words, density describes how much stuff is in how much space or how compact the matter in an object is. For example, a box made of steel and a box made of Styrofoam may have the same volume, but their densities will be different. The box of steel will contain more matter and therefore have more mass than the box of Styrofoam. Consequently, the box of steel will have a higher density than the box of Styrofoam. Density is expressed in grams per cubic centimetre and is determined by dividing an object's mass by its volume.

Scientists have determined the density of common substances such as air, water, ice, aluminium, gold, lead and most of the elements of the periodic table. By figuring out the density of an object, you can determine what the object is made from. But you must be careful because density can be changed by changing the pressure and/or temperature of an object. Increasing the pressure on an object will always increase the density because it will compact the particles closer together. Increasing the temperature of an object generally will decrease the density with a few exceptions, such as water.

Legend of Archimedes

Mass, volume and density have been studied since ancient times. The Legend of Archimedes is one of the earliest examples of the use of water displacement. Archimedes was tasked with determining if the King's goldsmith was stealing gold while he was making the King's crown. The King suspected the goldsmith of keeping the gold for himself and replacing it with a much cheaper metal in the crown. Archimedes was puzzled about how best to determine if this was the case. While taking a bath, Archimedes noticed that the water level rose when he sat in the water. He realised that his density could be determined by the amount of water that his body displaced. He decided to compare the displacement of water caused by the amount of gold that should have been used in the crown with the displacement of water caused by the actual crown. By using the theory of water displacement, he would be able to determine the goldsmith's guilt or innocence. Upon this discovery, legend has it that Archimedes went running through the streets screaming, "Eureka! Eureka!"



MASS, VOLUME AND DENSITY

Main Idea, Theme or Concept

C3 Theme/Concept: What is the main idea of the Legend of Archimedes? Justify your answer.

Inference

C2 What inferences can be made about the relationship among mass, volume and density? Use evidence from the text to support your answer.

Literary Elements

C1 How would you characterise Archimedes? Support your answer with details from the text.

Excerpts From Common Sense

By Thomas Paine

... I have heard it asserted by some, that as America hath flourished under her former connection with Great Britain, that the same connection is necessary towards her future happiness, and will always have the same effect ... We may as well assert, that because a child has thrived upon milk, that it is never to have meat; or that the first twenty years of our lives is to become a precedent for the next twenty. But even this is admitting more than is true, for I answer roundly, that America would have flourished as much, and probably much more, had no European power had any thing to do with her. The commerce by which she hath enriched herself are the necessaries of life, and will always have a market while eating is the custom of Europe ...

But Britain is the parent country, say some. Then the more shame upon her conduct. Even brutes do not devour their young; nor savages make war upon their families; wherefore the assertion, if true, turns to her reproach; but it happens not to be true, or only partly so ... Europe, and not England, is the parent country of America. This new world hath been the asylum for the persecuted lovers of civil and religious liberty from every part of Europe ...

I challenge the warmest advocate for reconciliation to show a single advantage that this continent can reap, by being connected with Great Britain. I repeat the challenge, not a single advantage is derived. Our corn will fetch its price in any market in Europe, and our imported goods must be paid for, buy them where we will.

But the injuries and disadvantages we sustain by that connection are without number; and our duty to mankind at large, as well as to ourselves, instruct us to renounce the alliance: Because, any submission to, or dependence on Great Britain, tends directly to involve this continent in European wars and quarrels; and sets us at variance with nations, who would otherwise seek our friendship, and against whom, we have neither anger nor complaint. As Europe is our market for trade, we ought to form no partial connection with any part of it ...

As to government matters, it is not in the powers of Britain to do this continent justice: The business of it will soon be too weighty, and intricate, to be managed with any tolerable degree of convenience, by a power, so distant from us, and so very ignorant of us; for if they cannot conquer us, they cannot

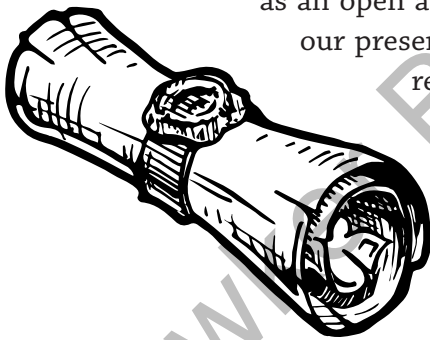


govern us. To be always running three or four thousand miles with a tale or a petition, waiting four or five months for an answer, which when obtained requires five or six more to explain it in, will in a few years be looked upon as folly and childishness – there was a time when it was proper, and there is a proper time for it to cease.

Small islands not capable of protecting themselves are the proper objects for kingdoms to take under their care; but there is something very absurd in supposing a continent to be perpetually governed by an island. In no instance hath nature made the satellite larger than its primary planet, and as England and America, with respect to each other, reverses the common order of nature, it is evident they belong to different systems: England to Europe – America to itself ...

A government of our own is our natural right: And when a man seriously reflects on the precariousness of human affairs, he will become convinced, that it is infinitely wiser and safer, to form a constitution of our own in a cool deliberate manner, while we have it in our power, than to trust such an interesting event to time and chance ...

However strange it may appear to some, or however unwilling they may be to think so, matters not, but many strong and striking reasons may be given, to show, that nothing can settle our affairs as expeditiously as an open and determined declaration for independence ... Under our present denomination of British subjects we can neither be received nor heard abroad: The custom of all courts is against us, and will be so, until, by an independence, we take rank with other nations.



EXCERPTS FROM COMMON SENSE

Generalisations

B3 What generalisations can you make about independence based on your list?

Classifications

B2 Classify your list into categories.

Details

B1 List the ways in which Paine thinks America should exert her independence.
