

CHAPTER I.

PROPERTIES OF BODIES.

Extension, impenetrability, divisibility, porosity, compressibility, elasticity, inertia, and gravity are general properties common to all bodies, whether solid, liquid, or gaseous, while some bodies possess specific properties, such as solidity, density, tenacity, malleability, color, hardness.

EXTENSION AND IMPENETRABILITY.

To all matter must be attributed two essential qualities: first, that in virtue of which it occupies space, and which is

FIG. 1.



A Hatful of Cotton in a Tumblerful of Alcohol.

known as extension, and, second, that which allows only one particle or atom of matter to occupy a given space, the

of loose cotton without causing the alcohol to overflow.*
The success of the experiment depends upon the slow intro-

FIG. 2.



Solution of Sugar in Water.

tion of the cotton, allowing the alcohol to invest the
ers, before they are fairly plunged beneath the surface
ne alcohol.

In this experiment the penetration of the alcohol is only
arent; the fibers displace some of the alcohol, but the
ntity is so small as not to be observable. If the cotton
e compressed to the smallest possible volume, it would
ound to occupy but very little space. So small a body

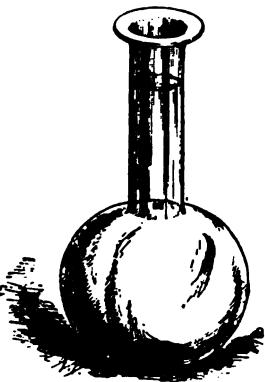
* See also chapter on projection.

without increasing its bulk.

Here the physicist is forced to acknowledge that either water is penetrated or its atoms are so disposed as to give the sugar between them, possibly in the same way scuttle filled with coal might contain also a bucketful of oil. This latter view is adhered to. The atom or ultimate particle is held to be impenetrable.

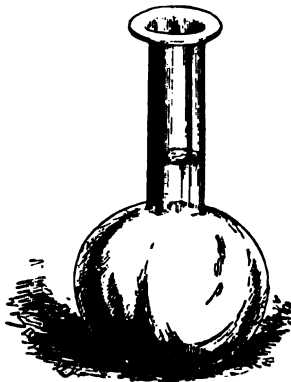
In the case of the mixture of water and alcohol, or water

FIG. 3.



Representing Volume of Unmixed Alcohol and Water.

FIG. 4.



Reduction of Volume of Alcohol and Water Mixture.

When sulphuric acid, a curious phenomenon is presented. If you mix equal volumes of alcohol and water for example. Equal volumes of alcohol and water, when mixed, occupy less space than when separate. If the sum of the volumes of the two separate liquids is 100, the volume of the mixture will be only 94. In the case of the mixture of sulphuric acid and water, the difference is greater.

An easy way to perform this experiment is to fill a narrow-necked flask up to a line which may conveniently be marked

that the molecules of the two liquids accommodate themselves to each other in such a manner as to reduce the porosity and thus diminish the volume of the mixture.

DIVISIBILITY.

The property of a body which admits of separating into distinct parts, and which is known as divisibility, is possessed by all matter. An example of extreme divisibility is found in the coloring of a pail of water with a minute particle of aniline.

POROSITY.

There are two kinds of pores, viz., physical or intermolecular pores and sensible pores. In the case of the former, the interspaces are so small that the molecules are within each other's influence and may attract or repel each other. Expansion by heat, contraction by reduction of temperature, and reduction of volume by compression are among examples of phenomena rendered possible by the existence of physical pores.

Sensible pores are small cavities or spaces, across which intermolecular forces are unable to act.

The experiment illustrated by Fig. 5 shows the existence of sensible pores. In the neck of an Argand chimney is inserted a plug of Malacca wood, which is sealed around the periphery with wax or paraffine. In the top of the chimney is inserted a stopper, through which projects a short glass tube, having its upper end bent over or capped with a small test tube. To the outer end of the glass tube is applied a rubber tube. When the chimney is in an inverted position as shown in the engraving, a quantity of mercury is placed in the larger part of the chimney, and the air is partly exhausted from the chimney, by applying the mouth to the

direction of these pieces of wood.

Wood, vegetable, and animal tissues, sponge, pumice
stone, and many other substances have sensible pores that

FIG. 5.



Mercurial Shower.

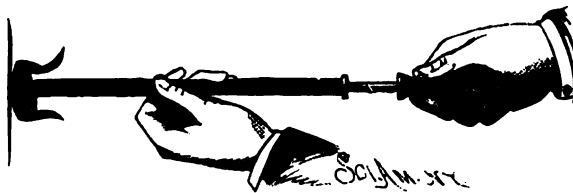
readily be seen. Physical pores cannot be seen even
the aid of the most powerful microscope; but their
presence is proved by the fact that all bodies may be com-
pressed or diminished in volume.

Sensible pores play an important part in the operations
of nature, especially in the vegetable and animal kingdoms.

ed in volume, by pressure, without losing weight, is known as compressibility. This property is possessed in the greatest degree by gases, which may be reduced by compression to from one-tenth to one-hundredth their original volume.

The simplest piece of apparatus for showing the compression of a gas is a well-made toy popgun, such for example as that shown in Fig. 6. By closing the mouth of this by means of a piece of sheet metal or mica, and oiling

FIG. 6



The Popgun used as a Pneumatic Syringe.

piston well with a heavy oil, to prevent the escape of air from the barrel, it may readily be shown that the air contained by the barrel may be greatly reduced in volume by simply pushing in the piston.

ELASTICITY.*

When a body resumes its original form or volume after distortion or compression, it possesses the property of elasticity, and is therefore known as an elastic body. Elasticity may be shown by pressure, by bending, by torsion or twisting, or by tension or stretching. Gases and liquids are perfectly elastic. When compressed and afterward allowed to

* See also chapter on expansion.

tested for any permanent set, was found to have returned to exactly its original shape. Elasticity by flexure bending is seen in various springs, such as carriage springs, gun-lock springs, etc.

The elasticity of torsion is exhibited by door springs of various forms, spiral springs, and by twisted threads of cotton, linen, and other material. The elasticity of tension is seen in the strings of all stringed musical instruments, and also in soft rubber in its various forms.

REST, MOTION, AND FORCE.

A body is said to be at rest when its position is not being changed, but this statement needs some qualification, since rest known to us is only relative. All bodies with which we are acquainted are continually changing their position either in relation to adjacent objects or along with adjacent objects relatively to distant objects. For example: a bowl is said to be at rest when it maintains its position relative to the earth's surface, but since the earth itself is not at rest, it is evident that whatever is fixed on the face of the earth is not be at rest.

On the other hand, if the boulder were rolling down a hill, it would be changing its position relative to the earth's surface as well as to all other objects, and would therefore be said to be in motion; but a body may be apparently in motion while in reality absolutely at rest. If we were to suppose a body projected from the earth into space with a velocity equal to that of the earth, but in a direction opposite that of the earth's motion and uninfluenced by heavenly bodies, the body, although having apparently a velocity relative to the earth, would be absolutely at rest.

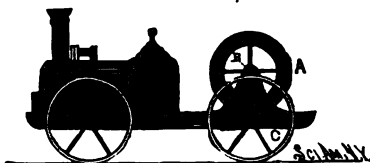
INERTIA.

No body is of itself able to change from a state of rest to a state of motion, neither can a body in motion change its direction or pass unaided to a state of rest. That which causes or tends to cause a body to pass from a state of rest to a state of motion, or accelerates or retards the motion of a body, or changes its direction, is known as Force. The capability of matter to change from rest to motion, or the reverse, is a negative property known as Inertia.

the top is an example of persistent rotation due to inertia. To inertia is due the action of projectiles, hammers, presses, also the hydraulic ram.

The property of inertia, the storage of power, the transmission of power by friction, and the conversion of rotary into linear motion are illustrated by the toy locomotive shown in the annexed engraving. The flywheel, A, is mounted on a shaft, B, which rests on supporting and driving wheels, C. The wheel, A, is spun by means of a handle in the same manner as a top. By virtue of its inertia, the wheel, A, tends to continue its rotary motion.

FIG. 7



Inertia Locomotive.

If unaffected by outside influences, it would run on forever; but the friction of the bearings and of the air and other causes combine to stop it to rest.

The power imparted to and stored in the wheel, A, is put out in turning the wheels, C, overcoming friction, and propelling the machine forward.

FRICITION.

The resistance caused by the moving of one body in contact with another is known as friction. No perfectly smooth surface can be produced, all surfaces having minute projections or roughnesses, so that when the surfaces of any two bodies are moved in contact with each other, the projections of one body engage the projections of the other, thus offering resistance to the free motion of the bodies. When the surfaces are covered with a lubricant, the inequalities are filled and smoothed over and the friction is reduced.

FIG. 8.



Centrifugal Railway.

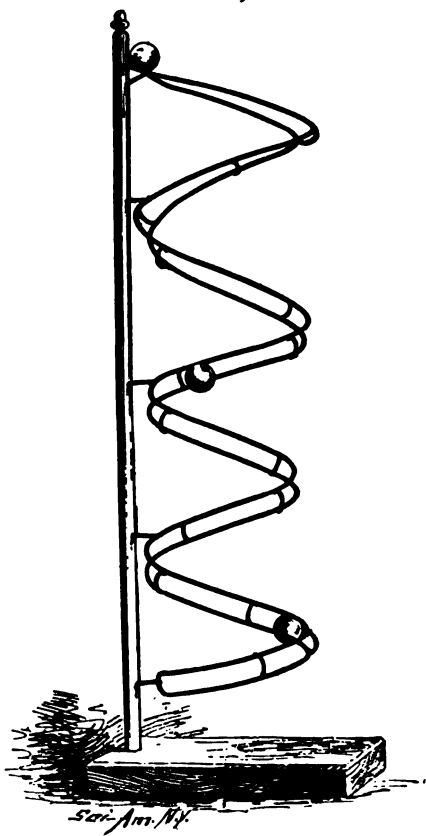
many kinds of machinery are provided with roller or ball bearings, thus substituting rolling for rubbing surfaces. An example of bearings of this kind is found in the pedals and axles of bicycles and tricycles, which are provided with bearings

centrifugal force. When a body moving in a circular path is released, it does not fly off radially out on a line tangent to the circular path. The fact that a body traveling in a circular path, when released from all constraint, will move in a straight line, proves that the normal path of a moving body is a straight line. The centrifugal railway represented in Fig. 9 shows with what force a restrained body tends to fly from a circular path.

This railway is made in the same manner as the swiftest descent apparatus described on another page. Two wires are bent into spiral loops and a cylinder, and the extremities are curved upwardly as shown. The two curved wires are connected together by

curved wire cross pieces fastened by soldering, and two wires are attached to complete the apparatus. No particular is required for the construction of the centrifugal

FIG. 9.



Spiral Railway.