SIMPLE EXPERIMENTS IN PHYSICS.

BY GEO. M. HOPKINS.

The behavior of gases under certain conditions is of peculiar interest to the student of physics, since it involves actions which cannot be seen and which require purely mental effort for their comprehension. There are simple ways of demonstrating that certain actions do occur, but the exact mode of their occurrence is left to reason or conjecture.

In some of the following experiments molecular action proceeds with astonishing rapidity. One of the best examples of this rapid action is the absorption of gases by charcoal.

To illustrate absorption according to the usual method, a piece of recently heated charcoal is floated upon mercury and a test tube filled with carbonic acid gas or ammonia gas is inverted over it and quickly plunged into the mercury. The absorption begins immediately and quickly forms a partial vacuum, which causes the mercury to rise in the tube.

When a quantity of mercury is not available, the experiment may be performed very satisfactorily in the manner illustrated by Fig. 2. A glass tube, closed at one end by a cork in which is inserted a short piece of smaller tube, is plunged open end downward into a tumbler partly filled with water. To a flask or bottle is fitted a cork in which is inserted a small glass tube, and the two small tubes are connected by a short piece of flexible rubber tubing. The flask is filled with carbonic acid gas,* and corked. One or two small pieces

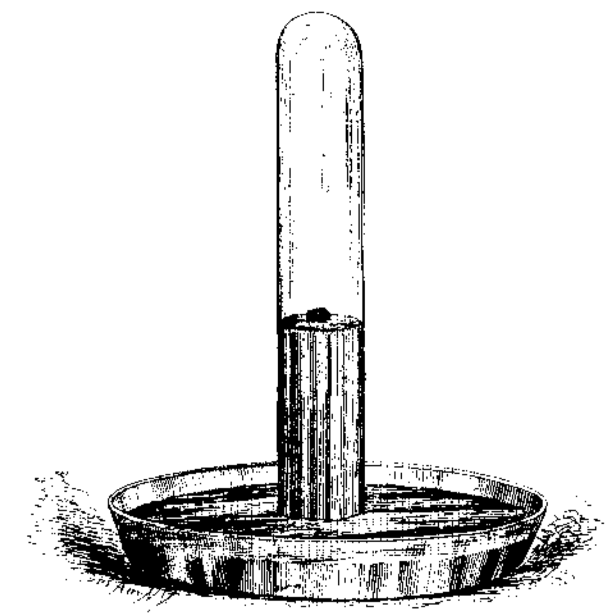


Fig. 1.—ABSORPTION OF GASES BY CHARCOAL.

of fine charcoal are heated strongly in a closed vessel, such as a covered crucible, or upon the top of a stove. The cork of the flask is removed, and the charcoal is dropped in and the cork replaced. If there are no leaks, the absorption of the gas by the charcoal will be immediately shown by the rise of the water in the tube in the tumbler. The coal will absorb 35 times its bulk of the gas. In the case of ammonia the volume of gas absorbed reaches 90 times the bulk of the charcoal. As the gases which are most easily condensed to a liquid state are those which are absorbed with the greatest facility, it is fair to presume that the gases absorbed by the charcoal are in a liquid state. The well known purifying property of charcoal and

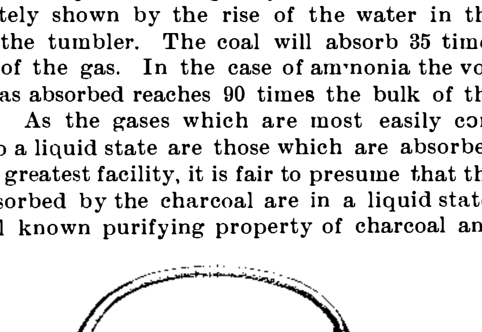


Fig. 2.—ABSORPTION OF CARBONIC ACID GAS BY CHARCOAL.

other porous substances is referred to their absorptive power.

THE DIFFUSION OF GASES.

The tendency of gases to mix or diffuse one into the other is very strong. A simple experiment exemplifying this tendency is illustrated by Figs. 3 and 4. A clean, dry porous cell, such as is used in galvanic batteries, is closed by a cork in which is inserted a small glass tube. A piece of barometer tube six or eight inches long is connected by rubber tubing with the tube of the porous cell. The end of the barometer tube is plunged into water and the porous cell is introduced into a vessel * filled with hydrogen or illuminating

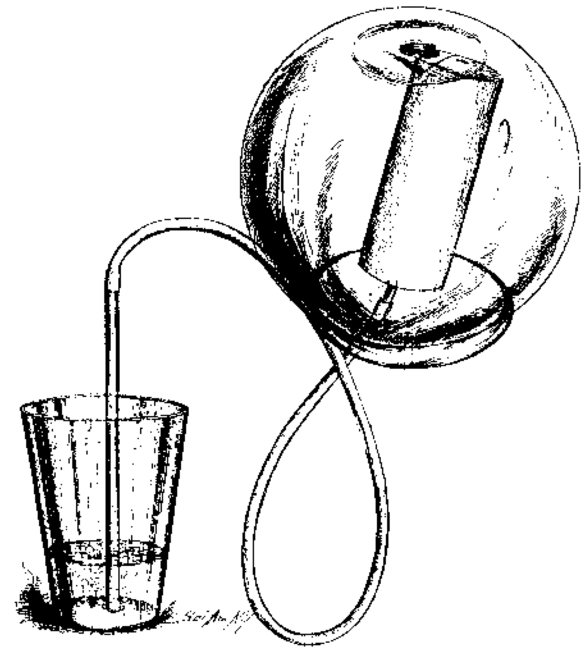


Fig. 3.—THE DIFFUSION OF GASES—ENDOSMOSE.

gas. The gas enters the porous cell so much more rapidly than the air can escape through the pores of the cell that a pressure is created which causes the air to escape through the tube and bubble up through the water.

When the porous cell is removed from the glass globe, the reverse of what has been described occurs, the gas passing outward with much greater rapidity than the air can pass in, thereby producing a partial vacuum, which causes the water to rise to *a* in the glass tube. These are examples respectively of endosmose and exosmose. In these experiments it is of vital importance to have tight joints, as the slightest leak will insure failure. The corks should fit tightly, and where they are not to be removed, they should be carefully sealed.

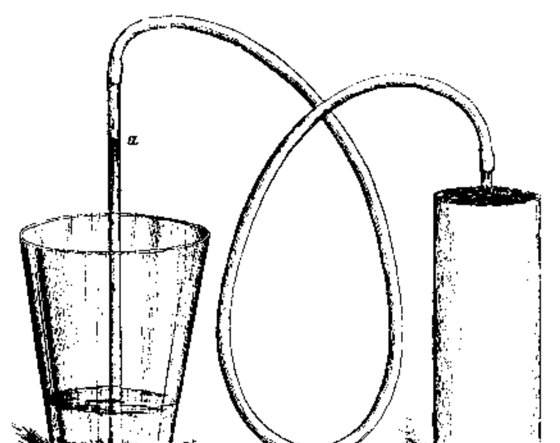


Fig. 4.—EXOSMOSE.

* Carbonic acid gas for this and subsequent experiments may be readily prepared by dissolving a small quantity of carbonate of soda (say 1 oz.) in water, in a tall glass or earthen vessel, then slowly adding a few drops of sulphuric acid. The gas will quickly fill the vessel to overflowing. The carbonic acid gas being much heavier than air, may be readily poured into the flask.

* An ordinary fish globe answers admirably as a gas-containing vessel for this and similar experiments. It is readily filled with illuminating gas by placing it for a few minutes in an inverted position over a burner through which gas is flowing.

Electric Street Cars.

The New York papers a short time ago contained stories concerning an electric shock which Mrs. Lizzie Pfeifer sustained while riding on the electric road from East New York to Jamaica. A gentleman who investigated the case made this report :

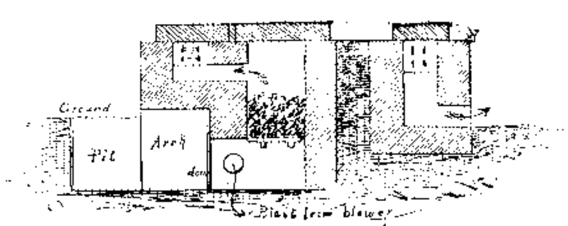
"The electrical circuit from the power station consists of two bare copper wires directly over the tracks, supported by cross wires from ordinary telegraph poles on the sides of the street. These copper wires are connected directly with the dynamo at the power station, and are about fifteen feet above the surface of the street. Two flexible insulated wires run from the motor on each car to two wheels or trolleys resting on the overhead conductors. As the car moves, the trolleys are drawn after it, keeping the motor in constant connection with the dynamo. The current comes from the dynamo through the positive conductor or overhead wire, passes from the trolley down through the motor, up to the other trolley, and back through the negative conductor to the dynamo.

"It is evident that to receive a shock one must be in contact, either direct or through wires, with both overhead conductors at the same time. It is absolutely impossible to receive a shock unless this condition be fulfilled. The motor is on the front of the car, inclosed in a cab, and separated from the rest of the car by a partition. A person sitting in the body of the car could in no conceivable way come in contact with the two overhead wires, and of course could not receive an electric shock. A person in the motor cab might touch the two bare ends of the wires running down from the trolleys, and so complete the circuit through his or her body, receiving a part or the whole of the current ; but it is not alleged that Mrs. Pfeifer was in the motor cab, where passengers are not allowed.

"The trolleys on this road are poorly constructed, in consequence of which they sometimes fall from the wires. This is annoying to passengers, but is simply a nuisance, not a source of danger. The fall of the trolley breaks the circuit, and the current is cut off from the motor. No accidental shock can result under such circumstances. It is said that Mrs. Pfeifer was in a highly nervous condition, resulting from a recent surgical operation. The trolley fell, and she was greatly alarmed. On the repetition of the accident she fainted, and was carried from the car in an unconscious condition. She was attended for two hours by one of the employes, who gave me the foregoing information. I have no doubt as to the substantial accuracy of these facts, as the conditions made it impossible for her to receive an electric shock. To the ignorant, electricity possesses many terrors, but it is subject to well defined laws, and a more general understanding of these laws would remove many unreasonable prejudices. The current used on the Jamaica road has a potential of 500 volts. Such a current would produce an unpleasant but by no means fatal shock. The precautions are such, however, that an accidental shock is almost impossible. The lesson conveyed by this accident is not that electric motors and their actuating currents are dangerous to life and limb, but that electric railways should be equipped with trolleys that would not fall off to the alarm of nervous passengers. Such trolleys are in use on many electric railways of all systems in this country."—*Western Electrician.*

TIRE FURNACE.

The following sketch shows a good tire furnace with a set of tires in place. The tire chamber is circular, with a fire and flue entering on one side below the tires and the exit on the other side, also below the tires.

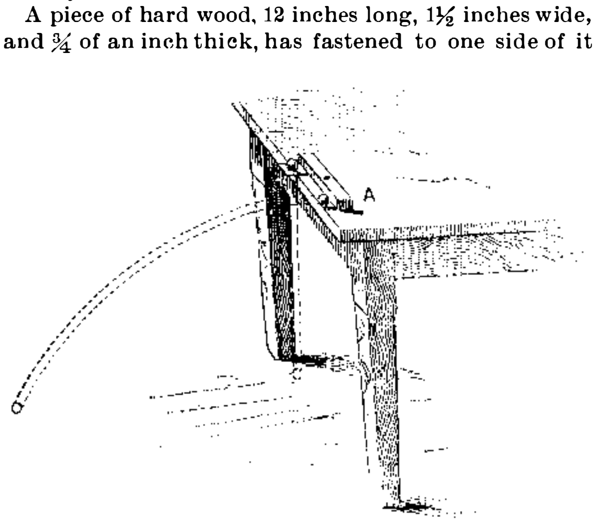


The chamber and furnace covered with fire brick slabs. The whole furnace and chamber should also be made of fire brick. Use coal, as in the sketch. If it is desired to use wood, leave out the grate and door, and arrange the furnace to fire directly under the tire chamber. Extend the exit flue to a short chimney and use natural draught.

SIMPLE APPARATUS FOR ILLUSTRATING NEWTON'S SECOND LAW.

In this journal for March 3 there is described an apparatus for illustrating Newton's second law. The following simple arrangement will project and drop a ball at, practically, the same instant, with equal facility :

A piece of hard wood, 12 inches long, 1½ inches wide, and ¾ of an inch thick, has fastened to one side of it



APPARATUS FOR ILLUSTRATING NEWTON'S LAW.

near the end a piece of tin, 3 inches long and 1½ inches wide, so that one-half of the tin will project edgewise from the stick. Through a hole in the center, fasten the stick loosely, by means of a wood screw, one-half inch from the edge of a table—the tin downward and projecting one inch over the edge of the table. Place a marble on the end of the tin, and another on the table against the opposite end of the stick. The sketch will illustrate the plan. If the end, A, be now struck a smart blow with a hammer, the desired illustration will evidently follow.

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