

For the REVIEW.] **NATURE LESSONS.****Pop-Gun Airs.**

Coming suddenly on the play-ground, as I often do, I noticed one of the boys with his hand up to his face, evidently making an effort to conceal the pain of a slap or a blow.

"Well, Arthur," said I, "who has been hurting you, and how did it happen?"

"It was Jack," said he, "but he didn't want to hurt me."

Said Jack, "It was only a pop-gun. I didn't think a little squirt of air could throw a cork so hard as to hurt a person." And he showed me a tube about twelve inches long, with a smooth bore of a little over a half an inch in diameter, into which was inserted a neatly fitting and oiled piston having a broad head on the other end for the convenience of pushing or striking the piston in. An ordinary cork was fitted into the other end to serve as the bullet to be propelled by the compressed air when the piston was forced in. The tighter the cork was fitted into the end of the tube the greater the force with which the piston had to be driven before the cork flew, but when it flew under such circumstances the shot was a "rouser," and it was one of these which hit Arthur on the cheek, although he was at a considerable distance.

Jack looked as if he were to be punished in some way or other, but I said, "I am glad to see that Arthur does not think you wanted to hurt him. It was an accident; but if Arthur gets over the accident easily, I shall be glad you made your gun and brought it here, for we shall have a lesson this afternoon on the pop-gun, and it may be a useful piece of apparatus for several object lessons." Then I walked away, while I heard the word passed around, "Nature lesson on the pop-gun to-day; did you hear?"

**LESSON I.**

TEACHER.—This is a very good air-gun for our purposes; it is so simple. We can see exactly how it is made and how it acts. There is the tube, the piston and the cork. And when I put the cork in one end and the piston into the other end, there is how long a column of air between the two? Measure.

SCHOLAR (measuring).—About twelve inches.

T.—And the cork which fits into the tube is a little over three-fourths of an inch in diameter, and appears to have a surface of about the half of a square inch. Now, after I put the cork in I want to be able to push the piston in half-way, and, as the piston rod is very nearly as stout as the bore of the tube, I bore a hole through it and put this neat nail through it, so that the

piston can be driven only six inches. Now, from our previous lessons you know how the pressure of air is shown and measured. How much is that pressure generally pretty near?

S.—Very nearly fifteen pounds to the square inch.

T.—What is the pressure of the air on the face of the cork in the tube, then?

S.—About seven and a-half pounds.

T.—Why does not the cork move, then?

S.—Because there is the same pressure on the outside as on the inside.

T.—Very well. I am now going to press the tube with the cork in it down suddenly and strongly against the piston, which I support on the desk. (The cork flies out with a loud report. Applause).

T.—When the piston was suddenly thrust in half-ways, what was the condition of the enclosed air?

S.—It was compressed into one-half its first bulk.

T.—On which side of the cork was there the greatest pressure just before it flew?

S.—On the inside — a great deal more.

T.—Well, I may tell you just now, although we must prove it again, that it has been proved that when you compress any gas into one-half of its bulk its pressure becomes twice as great. What was the pressure on the half a square inch of cork after the piston was thrust in half-way, then?

S.—It must have been about fifteen pounds, acting against the seven-and-a-half-pound air pressure on the outside.

T.—Correct. And the difference caused the cork to fly. But can I put the cork in so tight that it will not fly out when I press the piston in half-way? Let us try. (The cork does not fly.) What have you to say now?

S.—The cork was pressed in so tight that seven-and-a-half-pounds pressure would not push it out.

T.—How can we prove that?

S.—Let the tube be kept firmly upright in the hand while a slender rod is made to rest on it in the tube with a weight of about seven-and-a-half pounds on it. I think that would prove the point.

T.—Well, let us try it. (The cork bears up the seven pound weight.) Now let me put the cork in as lightly as when it flies. Should the seven-pound-and-a-half weight press it out now if placed on the slender rod resting on the cork?

S.—I think it should, if the theory is true, that pressing into half the bulk doubles the pressure. (The experiment tried, and the cork is pressed out.)

T.—It looks, then, as if the law is true. What should the pressure be were I to press the piston in six inches, then another three inches?