THE

BOY'S PLAYBOOK OF SCIENCE:

INCLUDING THE

Various Manipulations and Arrangements

OF

CHEMICAL AND PHILOSOPHICAL APPARATUS REQUIRED FOR THE SUCCESSFUL PERFORMANCE OF SCIENTIFIC EXPERIMENTS,

IN ILLUSTRATION OF THE ELEMENTARY BRANCHES OF CHEMISTRY AND NATURAL PHILOSOPHY.

BY

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TO

PROFESSOR LYON PLAYFAIR, C.B., F.R.S.

PROFESSOR OF CHEMISTRY IN THE UNIVERSITY OF EDINBURGH.

DEAR SIR,

I DEDICATE these pages to your Children, whom I often had the pleasure of seeing at the Polytechnic during my direction of that Institution. I do so as a mark of respect and appreciation of your talent and zeal, and of your public-spirited advocacy of the Claims of Science in this great and commercial country.

Without making you responsible in any way for the shortcomings of this humble work on Elementary Science, allow me to subscribe myself,

Dear Sir,

Yours most respectfully,

JOHN HENRY PEPPER.

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Seventh Experiment.

One of those toys called "The Squeaking Toy" affords another and ridiculous example of the effect of hydrogen on sound, when it is used in a jar containing this gas. (Fig. 114.)

Fig. 114. The squeaking toy, used in a jar of hydrogen.

Eighth Experiment.

An accordion played in a large receptacle containing hydrogen gas demonstrates still more clearly what would be the effect of an orchestra shut up in a room containing a mixture of a considerable portion of hydrogen with air, as the former, like nitrogen, is not a poison, and only kills in the absence of oxygen gas.

Ninth Experiment.

Some very amusing experiments with balloons have been devised by Mr. Darby, the eminent firework manufacturer, by which they are made to carry signals of three kinds, and thus the motive or ascending power may be utilized to a certain extent.

Mr. Darby's attention was first directed to the manufacture of a good, serviceable, and cheap balloon, which he made of paper, cut with mathematical precision; the gores or divisions being made equal, and when pasted together, strengthened by the insertion of a string at the juncture; so that the skeleton of the balloon was made of string, the whole terminating in the neck, which was further stiffened with calico, and completed when required by a good coating of boiled oil. These balloons are about nine feet high and five feet in diameter in the widest part, exactly like a pear, and tapering to the neck in the most graceful and elegant manner. They retain the hydrogen gas remarkably well for many hours, and do not leak, in consequence of the paper of which they are made being well selected and all holes stopped, and also from the circumstance of the pressure being so well distributed over the interior by the almost mathematical precision with which they are cut, and the careful preparation of the paper with proper varnish. One of their greatest recommendations is cheapness; for whilst a gold-beater's skin balloon of the same size would cost about 5*l.*, these can be furnished at 5*s.* each in large quantities.

A balloon required to carry one or more persons must be constructed of the best materials, and cannot be too carefully made; it is therefore a somewhat costly affair, and as much as 200*l.*, 500*l.*, and even 1000*l.* have been expended in the construction of these aerial chariots.

The chief points requiring attention are:—first, the quality of the silk; secondly, the precision and scrupulous nicety required in cutting

out and joining the gores; thirdly, the application of a good varnish to fill up the pores of the silk, which must be insoluble in water, and sufficiently elastic not to crack.

The usual material is Indian silk (termed Corah silk), at from 2*s.* to 2*s.* 6*d.* per yard.

The *gores* or parts with which the balloon is constructed require, as before stated, great attention; it being a common saying amongst aeronauts, "*that a cobweb will hold the gas if properly shaped,*" the object being to diffuse the pressure equally over the whole bag or balloon.

The varnish with which the silk is rendered air-tight can be made according to the private recipe of Mr. Graham, an aeronaut, who states that he uses for this purpose two gallons of linseed oil (boiled), two ditto (raw), and four ounces of beeswax; the whole being simmered together for one hour, answers remarkably well, and the varnish is tough and not liable to crack.

For repairing holes in a balloon, Mr. Graham recommends a cement composed of two pounds of black resin and one pound of tallow, melted together, and applied on pieces of varnished silk to the apertures.

The actual cost of a balloon will be understood from information also derived from Mr. Graham. His celebrated "Victoria Balloon," which has passed through so many hairbreadth escapes, was sixty-five feet high, and thirty-eight feet in diameter in the broadest part; and the following articles were used in its construction:—

	£	*s.*	*d.*
1400 yards of Corah silk, at 2*s.* 6*d.* per yard . .	175	0	0
The netting weighed 70 lbs.	20	0	0
Extra ropes weighed 20 lbs. at 2*s.* per lb. . . .	2	0	0
The car weighed 25 lbs.	7	0	0
Varnish, wages, &c.	16	0	0
	£220	0	0

Thirty-eight thousand cubic feet of coal gas were required to fill this balloon, charged by one company 20*l.*, by others from 9*l.* to 10*l.*; and eight men were required to hold the inflated baggy monster.

Such a balloon as described above is a mere soap bubble when compared with the "New Aerial Ship" now building in the vicinity of New York; the details are so practical and interesting, that we quote nearly the whole account of this mammoth or Great Eastern amongst balloons, as given in the *New York Times*.

"An experiment in scientific ballooning, greater than has yet been undertaken, is about to be tried in this city. The project of crossing the Atlantic Ocean with an air-ship, long talked of, but never accomplished, has taken a shape so definite that the apparatus is already prepared and the aeronaut ready to undertake his task.

"The work has been conducted quietly, in the immediate vicinity of New York, since the opening of spring. The new air-ship, which has

been christened the City of New York, is so nearly completed, that but few essentials of detail are wanting to enable the projectors to bring it visibly before the public.

"The aeronaut in charge is Mr. T. S. C. Lowe, a New Hampshire man, who has made thirty-six balloon ascensions.

"The dimensions of the City of New York so far exceed those of any balloon previously constructed, that the bare fact of its existence is notable. Briefly, for so large a subject, the following are the dimensions:—Greatest diameter, 130 feet; transverse diameter, 104 feet; height, from valve to boat, 350 feet; weight, with outfit, 3½ tons; lifting power (aggregate), 22½ tons; capacity of gas envelope, 725,000 cubic feet.

"The City of New York, therefore, is nearly five times larger than the largest balloon ever before built. Its form is that of the usual perpendicular gas-receiver, with basket and lifeboat attached.

"Six thousand yards of twilled cloth have been used in the construction of the envelope. Reduced to feet, the actual measurement of this material is 54,000 feet—or nearly 11 miles. Seventeen of Wheeler and Wilson's sewing machines have been employed to connect the pieces, and the upper extremity of the envelope, intended to receive the gas-valve, is of triple thickness, strengthened with heavy brown linen, and sewed in triple seams. The pressure being greatest at this point, extraordinary power of resistance is requisite. It is asserted that 100 women, sewing constantly for two years, could not have accomplished this work, which measures by miles. The material is stout and the stitching stouter.

"The varnish applied to this envelope is a composition the secret of which rests with Mr. Lowe. Three or four coatings are applied, in order to prevent leakage of the gas.

"The netting which surrounds the envelope is a stout cord, manufactured from flax expressly for the purpose. Its aggregate strength is equal to a resistance of 160 tons, each cord being capable of sustaining a weight of 400 lbs. or 500 lbs.

"The basket which is to be suspended immediately below the balloon is made of rattan, is 20 feet in circumference and 4 feet deep. Its form is circular, and it is surrounded by canvas. This car will carry the aeronauts. It is warmed by a lime-stove, an invention of Mr. O. A. Gager, by whom it was presented to Mr. Lowe. A lime-stove is a new feature in air voyages. It is claimed that it will furnish heat without fire, and is intended for a warming apparatus only. The stove is 1½ feet high, and 2 feet square. Mr. Lowe states that he is so well convinced of the utility of this contrivance, that he conceives it to be possible to ascend to a region where water will freeze, and yet keep himself from freezing. This is to be tested.

"Dropping below the basket is a metallic lifeboat, in which is placed an Ericsson engine. Captain Ericsson's invention is therefore to be tried in mid-air. Its particular purpose is the control of a propeller, rigged upon the principle of the screw, by which it is proposed to obtain

a regulating power. The application of the mechanical power is ingeniously devised. The propeller is fixed in the bow of the lifeboat, projecting at an angle of about forty-five degrees. From a wheel at the extremity twenty fans radiate. Each of these fans is 5 feet in length, widening gradually from the point of contact with the screw to the extremity, where the width of each is 1½ feet. Mr. Lowe claims that by the application of these mechanical contrivances his air-ship can be readily raised or lowered, to seek different currents of air; that they will give him ample steerage way, and that they will prevent the rotatory motion of the machine. In applying the principle of the fan, he does not claim any new discovery, but simply a practical development of the theory advanced by other acronauts, and partially reduced to practice by Charles Green, the celebrated English aeronaut.

"Mr. Lowe contends that the application of machinery to aerial navigation has been long enough a mere theory. He proposes to reduce the theory to practice, and see what will come of it. It is estimated that the raising and lowering power of the machinery will be equal to a weight of 300 lbs., the fans being so adjusted as to admit of very rapid motion upward or downward. As the loss of three or four pounds only is sufficient to enable a balloon to rise rapidly, and as the escape of a very small portion of the gas suffices to reduce its altitude, Mr. Lowe regards this systematic regulator as quite sufficient to enable him to control his movements and to keep at any altitude he desires. It is his intention to ascend to a height of three or four miles at the start, but this altitude will not be permanently sustained. He prefers, he says, to keep within a respectable distance of mundane things, where 'he can see folks.' It is to be hoped his machinery will perform all that he anticipates from it. It is a novel affair throughout, and a variety of new applications remain to be tested. Mr. Lowe, expressing the utmost confidence in all the appointments of his apparatus, assured us that he would certainly go, and, as certainly, would go into the ocean, or deliver a copy of Monday's *Times* in London on the following Wednesday. He proposes to effect a landing in England or France, and will take a course north of east. A due easterly course would land him in Spain, but to that course he objects. He hopes to make the trip from this city to London in forty-eight hours, certainly in sixty-four hours. He scouts the idea of danger, goes about his preparations deliberately, and promises himself a good time. As the upper currents, setting due east, will not permit his return by the same route, he proposes to pack up the City of New York, and take the first steamer for home.

"The air-ship will carry weight. Its cubical contents of 725,000 feet of gas suffice to lift a weight of 22½ tons. With outfit complete its own weight will be 3½ tons. With this weight 19 tons of lifting power remain, and there is accordingly room for as many passengers as will care to take the venture. We understand, however, that the company is limited to eight or ten. Mr. Lowe provides sand for ballast, regards his chances of salvation as exceedingly favourable,

places implicit faith in the strength of his netting, the power of his machinery, and the buoyancy of his lifeboat, and altogether considers himself secure from the hazard of disaster. If he accomplish his voyage in safety, he will have done more than any air navigator has yet ventured to undertake. If he fail, the enterprise sinks the snug sum of 20,000 dollars. Wealthy men who are his backers, sharing his own enthusiasm, declare failure impossible, and invite a patient public to wait and see."

A night ascent witnessed at any of the public gardens is certainly a stirring scene, particularly if the wind is rather high. On approaching the balloon, swayed to and fro by the breeze, it seems almost capable of crushing the bold individual who would venture beneath it; seen as a large dark mass in the yet dimly-lighted square, it appears to be incapable of control; when the inflation is completed, the aeronaut, all importance, seats himself in the car, and blue lights, with other fireworks, display the victim who is to make a "last ascent," or perhaps *descent*. Finally the word is given, the ropes are cast off, and the bulky chariot rises majestically to the sound of the National Anthem. The crowd see no more, but the next day's *Times* reports the end of the aerial journey.

Balloons can never be of any permanent value as means of locomotion until they can be steered; and this is a problem, the solution of which is something like *perpetual motion*. In the first place, a balloon of any size exposes an enormous surface to the pressure and force of the winds; and when we consider that they move at the rate of from three to eighty miles per hour, it will be understood that the fabric of the balloon itself must give way in any attempt to tear, work, or pull it against such a force. Secondly and lastly, the power has not yet been created which will do all this without the inconvenience of being so *heavy* that the steering engine fixes the balloon steadily to the earth by its obstinate gravity. When engines of power are constructed without the aeronaut's obstacle of weight—when balloons are made of thin copper or sheet-iron, then we may possibly hear of the voyage of the good ship *Aerial*, bound for any place, and quite independent of dock, port, and the host of dues (*quere*), which the sea-going ships have to disburse. It is, however, gratifying to the zeal and perseverance of those who dream of aerial navigation, to know that a balloon is not quite useless; and here we may return to the consideration of Mr. Darby's signals, which are of various kinds, and intended to appeal to the senses by night as well as by day; and first, by *audible sounds*. Such means have long been recognised, from the ancient float and bell of the "Inchcape Rock," to the painful minute-gun at sea, or the shrill railway whistle and detonating signals employed to prevent the horrors of a collision between two trains. The signal sounds are produced by the explosion of shells capable of yielding a report equal to that of a six-pounder cannon, and they are constructed in a very simple manner. A ball, composed of wood or copper, and made up by screwing together the two hemispheres, is attached to a shaft or tail of cane or lance-wood, properly feathered like an arrow; at the side opposite to that of the arrow—viz., at its antipodes, is placed a slight protuberance

containing a minute bulb of glass filled with oil of vitriol, and surrounded with a mixture of chlorate of potash and sugar, the whole being protected with gutta-percha, and communicating by a touch-hole with the interior, which is of course filled with gunpowder. These shells are attached to a circular framework by a strong whipcord, which passes to a central fuse, and are detached one after the other as the slow fuse (made hollow on the principle of the argand lamp) burns steadily away. Directly a shell falls to the ground, the little bulb containing the oil of vitriol breaks, and the acid coming in contact with the chlorate of potash and sugar, causes the mixture to take fire, when the gunpowder explodes. During the siege of Sebastopol many similar mines were prepared by the Russians in the earth, so that when an unfortunate soldier trod upon the spot, the concealed mine blew up and seriously injured him; such petty warfare is as bad as shooting sentries, and a cruel application of science, that unnecessarily increases the miseries of war without producing those grand results for which the truly great captains, Wellington and Napoleon, only warred. (Fig. 115.)

The bill distributor consists of a long piece of wood, to which are

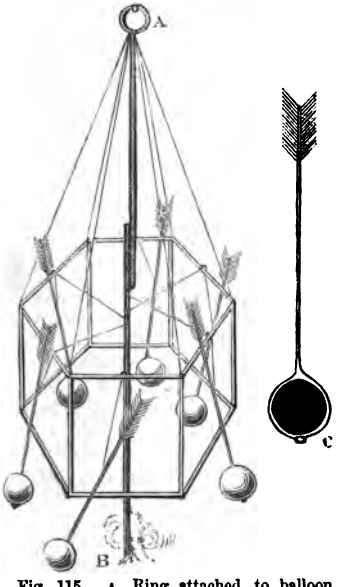

Fig. 115. A. Ring attached to balloon, carrying an hexagonal framework with six shells. B. Hollow fuse, which burns slowly up to the strings, and detaches each shell in succession. C. Section of shell. The shaded portion represents the gunpowder.

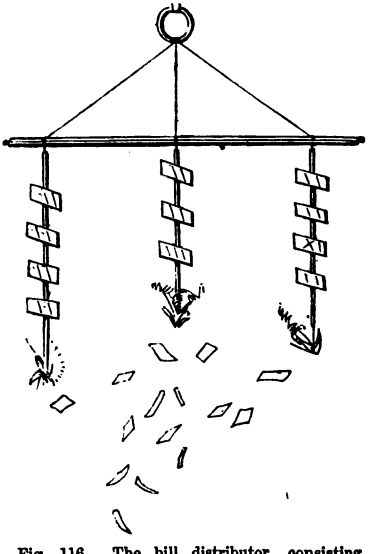

Fig. 116. The bill distributor, consisting of three hollow fuses, with bills attached in packets.

attached a number of hollow fuses, with packets of bills, protected from being burned or singed by a thin tin plate; 10,000 or 20,000 bills can thus be delivered, and the wind assists in scattering them, whilst the balloon travels over a distance of many miles. It must be recollected that in each case the shells and the bills are detached by the string burning away as the fire creeps up from the fuse. (Fig. 116.)

Another most ingenious arrangement, also prepared by Mr. Darby, is termed by the inventor, the "Land and Water Signal," and may be thus described:—A short hollow ball of gutta-percha, or other convenient material, five or six inches in diameter, and filled with printed bills, or the information, whatever it may be, that is required to be sent, is attached to a cap to which a red flag, having the words "*Open the shell,*" and four cross sticks, canes, or whalebones with bits of cork at equal distances, are fitted. The whole is connected by a string to the fuse as before described. These signals are adapted for land and water: in either case they fall upright, and in consequence of the sticks projecting out they float well in the water, and can be seen by a telescope at a distance of three miles. (Fig. 117.) Many of these signals were sent away by Mr. Darby from Vauxhall; one was picked up at Harwich, another at Brighton, a third at Croydon; in the latter case it was found by a cottager, who, fearing gunpowder and combustibles, did not examine the shell, but having mentioned the circumstance to a gentleman living near him, they agreed to cut it open; and intelligence of their arrival, in this and the other cases, was politely forwarded to Mr. Darby at Vauxhall Gardens.

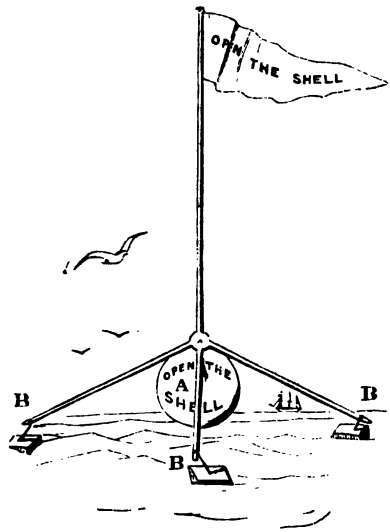

Fig. 117. The land and water signal, which remains upright on land, or floats on the surface of water. A. The water-tight gutta-percha shell, containing the message or information. B B B. Sticks of cane to keep the flag in an upright position; at the ends are attached cork bungs.

Balloons, like a great many other clever inventions, have been despised by military men as new-fangled expedients, toys, which may do very well to please the gaping public, but are and must be useless in the field. Over and over again it has been suggested that a balloon corps for observation should be attached to the British army, but the scheme has

been rejected, although the expense of a few yards of silk and the generation of hydrogen gas would be a mere bagatelle as compared with the transport and use of a single 32-pounder cannon. The antiquated notions of octogenarian generals have, however, received a great shock in the fact that the Emperor Napoleon III. was enabled, by the assistance of a captive balloon, to watch the movements and dispositions of the Austrian troops; and with the aid of the information so obtained, he made his preparations, and was rewarded by the victory of Solferino; and as soon as the battle was over Napoleon III. occupied at Cavriana the very room and ate the dinner prepared for his adversary, the Emperor Francis Joseph.

Over and over again the most excellent histories have been written of aerostation, but they all tend to one truth, and that is, the great danger and risk of such excursions; and to enable our readers to form their own judgment, a chronological list of some of the most celebrated aeronauts, &c., is appended.

1675. Bernair attempted to fly—*killed.*
1678. Besnier attempted to fly.
1772. L'Abbé Desforges announced an aerial chariot.
1783. Montgolfier constructed the first air balloon.
„ Roberts *frères*, first gas balloon, destroyed by the peasantry of Geneva, who imagined it to be an evil spirit or the moon.
1784. Madame Thiblé, the first lady who was ever up in the clouds; she ascended 13,500 feet.
„ Duke de Chartres, afterwards *Egalité* Orleans, travelled 135 miles in five hours in a balloon.
„ Testu de Brissy, equestrian ascent.
„ D'Achille, Desgranges, and Chalfour—Montgolfier balloon.
„ Bacqueville attempted a flight with wings.
„ Lunardi—gas balloon.
„ Rambaud—Montgolfier balloon, which was burnt.
„ Andreani—Montgolfier balloon.
1785. General Money—gas balloon, fell into the water, and not rescued for six hours.
„ Thompson, in crossing the Irish Channel, was run into with the bowsprit of a ship whilst going at the rate of twenty miles per hour.
„ Brioschi—gas balloon ascended too high and burst the balloon; the hurt he received ultimately caused his *death.*
„ A Venetian nobleman and his wife—gas balloon—*killed.*
„ Pilatre de Rozier and M. Romain—gas balloon took fire—both *killed.*
1806. Mosment—gas balloon—*killed.*
„ Olivari—Montgolfier balloon—*killed.*
1808. Degher attempted a flight with wings.
1812. Bittorf—Montgolfier balloon—*killed.*
1819. Blanchard, Madame—gas balloon—*killed.*

1819. Gay Lussac—gas balloon, ascended 23,040 feet above the level of the sea. Barometer 12·95 inches; thermometer 14·9 Fah.
„ Gay Lussac and Biot—gas balloon for the benefit of science. Both philosophers returned safely to the earth.
1824. Sadler—gas balloon—*killed.*
„ Sheldon—gas balloon.
„ Harris—gas balloon—*killed.*
1836. Cocking—parachute from gas balloon—*killed.*
1847. Godard—Montgolfier balloon fell into and extricated from the Seine.
1850. Poitevin, a successful French aeronaut.
„ Gale, Lieut.—gas balloon—*killed.*
„ Bixio and Barral—gas balloon.
„ Graham, Mr. and Mrs.—gas balloon.—Serious accident ascending near the Great Exhibition in Hyde Park.
„ Green, the most successful living aeronaut of the present time.

Of the 41 persons enumerated, 14 were killed, and nearly all the aeronauts met with accidents which might have proved fatal.

Fig. 118. Flying machine (*theoretical*).