SIMPLE EXPERIMENTS IN PHYSICS.

BY GEO. M. HOPKINS.

The descent of a falling body along an inclined plane is governed by the same law that controls the fall of free, unimpeded bodies, *i. e.*, "the spaces traversed are proportional to the squares of the times of descent." This law does not apply to the descent of a body along any curved path. A body descending a concave path will be accelerated at the beginning of its fall. A body descending a convex path will start slowly, and will be accelerated at the end of its travel.

Three cases are here considered: First, that of a body rolling down an inclined plane; second, that of a body descending a concave circular curve; and third, that of a body descending a cycloidal curve. In the case of the inclined plane, if the body falls two feet the first second, it will fall four feet the next second, eight feet the third second, and so on. In the case of the concave circular curve, the fall of the body will be accelerated rapidly at the start, and the body will reach the point of stopping quicker than the body on the inclined plane, although it travels over a longer distance. In the case of the cycloidal curve, the body acquires a high velocity at once, as its path at the beginning is practically vertical. This curve has been called the curve of swiftest descent, as a falling body passes over it from the point of starting to the point of stopping in less time than upon any other path, excepting, of course, the vertical.

The cycloid has another property, in virtue of which it has been called the isochronal curve. A body will roll down this curve from any point in its length to the point of stopping in exactly the same time, no matter where it is started. For example, if it requires a second of time for a ball to roll from the upper to the lower end of the curve, it will also take one second for a ball to roll from the center of the curve to its lower end.

Apparatus for illustrating these principles is shown in Fig. 1. It does not differ much from the ordinary apparatus used for the same purpose. It is, however, made entirely of wire, and is arranged to fold, so that it occupies little space when not in use. The inclined plane and curves, down which the balls roll, are all of substantially the same construction. The rails of the tracks are formed of one-eighth inch brass wire. These rails are connected by curved cross pieces having ends bent at right angles and soldered to the under surface of the rails. The lower ends of the rails are connected by angled wires with a cross bar, A, which is bent forward, then upward, to receive the board B, forming the stop for the balls. The upper ends of the rails are connected by angled wires with a cross bar, C, which receives the loops of the wire leg, D. To the leg is jointed a brace which hooks over one of the cross pieces of the middle track.

To the upper cross bar are soldered wire eyes, supporting a wire bent so as to form three cranks for supporting the balls, and releasing them all together. The rods of which the tracks are formed are about three feet long. The cycloid track is made first, the others being cut off to match. A method of laying out the cycloid curve is shown in Fig. 2. At the end of the base line, A D, draw the line, C D, perpendicular to A D. Describe a generating semicircle (in this case of nine inch radius) tangent to A D, at D. Draw the line, E C, parallel to the base line. Divide the semicircle into any number of equal parts—six for example—and lay off on A D and E C distances C 1, 1' 2', etc., equal to the divisions of the semicircle; draw chords, D 1, D 2, etc. From points 1', 2', 3', etc., on the line, C E, with radii equal to the generating semicircle (9 inches), describe arcs. From points 1', 2', 3', 4', 5', on the line, D A, and with radii equal successively to the chords, D 1, D 2, D 3, D 4, D 5, describe arcs cutting the preceding, and the intersections will be the points of the curve required. Through these points the curve is drawn and the wires for the cycloid track are bent so as to conform to this curve. The track, when completed, must sustain the same relation to a horizontal line as the curve in the diagram sustains to the base line, A D.

Another method of describing a cycloid is to fix a pencil in the edge of a disk and roll the disk on a level surface, without slipping, with the pencil in contact with a smooth board or a piece of paper, the curve being started with the pencil at the lowest point or in contact with the base line.

A ball is supported at the upper end of each track by the cranked wire, and when the three balls are liberated simultaneously by quickly turning up the cranked wire, it will be found that the ball on the cycloid reaches the point of stopping first, the ball on the circular curve coming next, the ball on the inclined plane being slowest of all.

If two cycloidal tracks be placed side by side, it will be found by trial that a ball started from the middle or at any point between the ends of one of the tracks will reach the point of stopping no sooner than the ball started at the top of the other track. In fact, if the tracks are accurately made, both balls, if started simultaneously, will reach the bottom at the same time.

The centrifugal railway shown in Fig. 3 is made in the same manner as the tracks already described. Two wires are bent into spiral loops around 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 wire feet are attached to complete the apparatus. No particular rule is required for the construction of the centrifugal railway. The only precaution necessary is to see that the height of the higher end of the railway is to the height of the circular part in a greater ratio than 5 to 4.

A ball started at the higher end of the railway follows the track to the opposite end, and at one point in its travel it is held by centrifugal force against the under side of the track in opposition to the force of gravity.

In Fig. 4 is shown a spiral railway upon which a ball rolls down upon a track consisting of two rails arranged vertically one over the other. The track is formed of two wires bent spirally and connected by curved cross pieces, as in the cases already described. The upper convolution of the spiral is twisted so that the ball may start on a horizontal track. During the descent of the twisted portion of the track, the ball acquires sufficient momentum to cause it to follow the vertical track, being held outwardly against the rails by centrifugal force. The descent of the ball is accelerated. The spiral railway represented in the engraving is two feet high, six inches in diameter, the rails being ¾ inch apart.

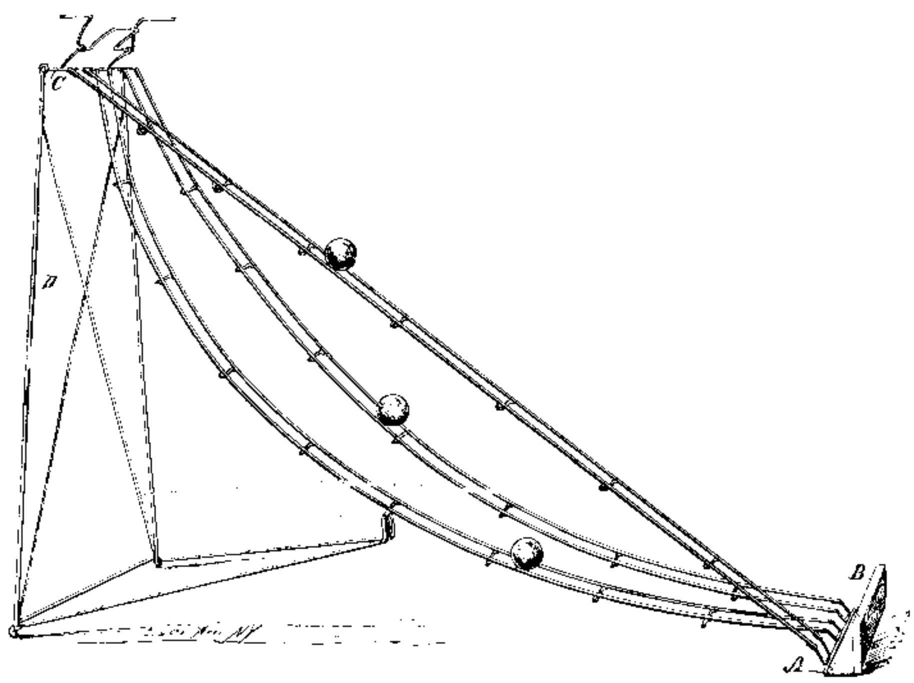
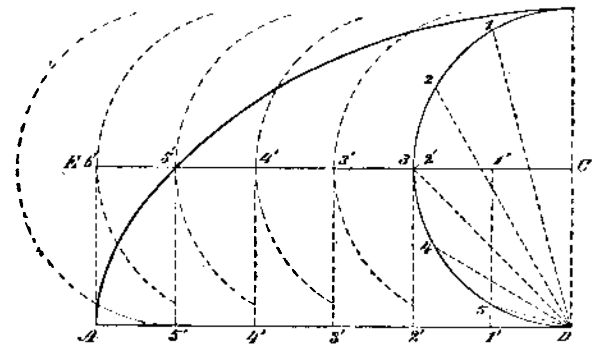


Fig. 1.—SWIFTEST DESCENT APPARATUS.



g. 2.—METHOD OF DESCRIBING THE CYCLOID.

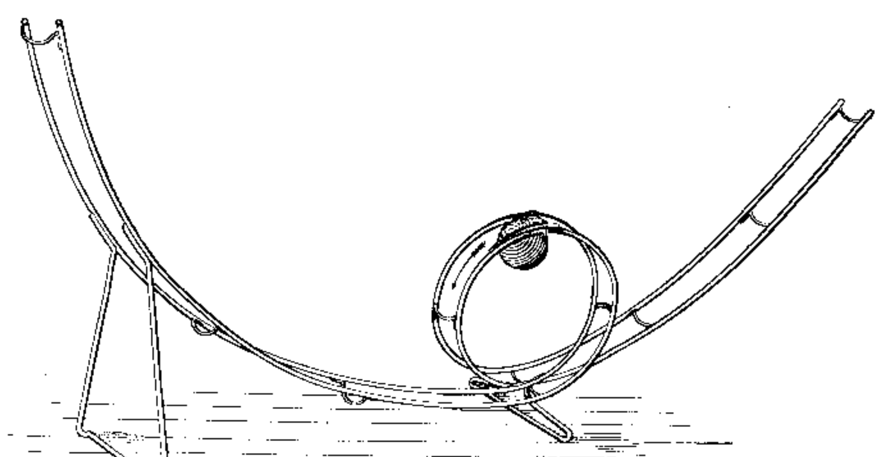


Fig. 3.—CENTRIFUGAL RAILWAY.

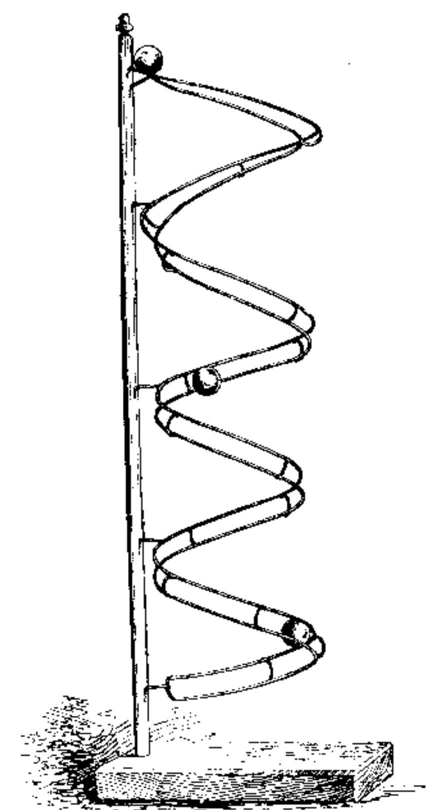


Fig. 4.—SPIRAL RAILWAY.

Detection of Gas Leakage.

Dr. Bunte's method for detecting gas leakage by means of palladium paper has been rendered still more delicate by Herr Schaufflers, who uses, to every three parts of chloride of palladium, one part of chloride of gold. The increase of sensitiveness may be partly due to catalytic action, that is, to the mere presence of the gold, perhaps to the action of traces of acetylene upon the gold solution. The solution used for making the paper contains ⅜ per cent of chloride of palladium and ⅛ per cent of chloride of gold. One pint costs about 9s., and will steep filter paper enough for 8,000 to 11,000 tests. The main sources of error are tobacco smoke, stoves, and smoky chimneys, which let carbonic oxide into the room, the vapor of fusel oil, onion smell, mercury vapor, and sulphureted hydrogen.

ACCORDING to Prof. Sargent, the strongest wood in the United States is that of the nutmeg hickory of the Arkansas region, and the weakest is the West Indian birch. The most elastic is the tamarack, the white or shellbark hickory standing far below it. The least elastic, and the lowest in specific gravity, is the wood of the *Ficus aurea*. The highest specific gravity, upon which in general depends value as fuel, is attained by the bluewood of Texas.