amount of PbO_2 formed was not great enough to be estimated. The test was continued at frequent intervals for more than a month, so that it seems that no serious corrosion of the frames could take place in less than fifteen or twenty years of use.

At 15 cents per kilowatt-hour for electrical energy, 660 liters H and 330 liters O would cost about 80 cents, counting 4 volts per cell of generator. This is sufficient to run a strong lime light for three hours. Counting oxygen only as of value, its cost would be \$2.40 per kiloliter (about 8 cents per cubic foot). It seems, therefore, with a generator efficiency of $1.45 \div 4 = 36$ per cent, that the electrolytic generation of H and O for laboratory purposes is not only the most convenient, but perhaps also the cheapest method of production.

AN APPARATUS FOR ILLUSTRATING THE LAWS OF FALLING BODIES.

BY H. M. RANDALL AND W. A. MARKEY.

THE problem of uniformly accelerated motion as illustrated by falling bodies has always been a difficult one for laboratory experiment. The piece of apparatus here described was devised for the purpose of obtaining the necessary data from a practically freely falling body, and is simple both in idea and in manipulation.

The apparatus is shown in the accompanying figure and will be seen to possess considerable stability, the top and the base being of cast iron held rigidly together by three pieces of steel shafting. The falling body is quite heavy, and consists of three iron plates, but one shown in the figure, twenty inches in length, soldered to triangular end pieces. Through the centers of these triangular ends passes the guiding rod AB . One of the faces of the falling body is furnished with a wide rubber band E , which holds in position a strip of stiff paper CD . The body is held in suspension at about the height shown in figure by a thread RS . This thread is so tied to the rod R , which projects from the base of the falling body, that it passes over the forward surface of the paper very near its outer edge. The thread is furnished by the spool G , which can be clamped in any position by the thumb screw on its top.

A heavy brass wheel W is carefully mounted in an iron frame which turns about the shaft as an axis. The wheel is furnished with a knife edge made from a stout knitting needle. This knife K projects about a sixteenth of an inch beyond the circumference of the wheel. The rod M is so clamped to the shafting that it arrests the motion of the iron frame when turned toward the suspended body at such a point that the circum-

ference of the wheel just escapes the outer edge of the paper strip. The knife is then adjusted so that if the wheel was rotated it would touch the paper just before it would cut the thread.

The wheel, drawn back from paper, is set in rapid rotation, in the direction indicated by the arrow, by a heavy cord wound around the upper part of its axle. It is then brought opposite the paper. The knife cuts the thread and at the same time makes a fine cut upon the forward surface of the paper, about an eighth of an inch long, so that the first line is made the instant the body begins to fall. With each succeeding rotation of the wheel the knife makes a fine cut on the edge of the paper. The distances between the cut lines are evidently the distances the body has fallen during the corresponding revolutions of the wheel or units of time. Since the rotation of the wheel, while the body is falling its own length, may be regarded as practically uniform, these units of time are considered equal. The number of records obtained on a strip of paper eighteen inches long varies from six to fifteen, according to the velocity of the wheel.

The body strikes on a pad on the tripod. The paper is taken from under the rubber band, and the distances between the lines are measured. As the knife edge is very sharp, the lines are fine and permit very accurate measurement. The rod *L* is so adjusted that it just touches the back side of the iron plate upon which the paper is fastened, thus preventing any rotation of the falling body that might be caused by the knife.

The apparatus is being used at present in the laboratory, and the results obtained are uniformly good. The following tables express the results obtained in two experiments, the unit of length being the thirty-second part of an inch.

Measured acceleration.	Computed acceleration.	Difference.	Measured S' .	Computed S' .	Difference.	Measured S .	Computed S .	Difference.
	17.54	+0.05	8.9	8.77	+0.13	8.9	8.77	+0.13
17.4	17.54	-0.15	26.2	26.31	-0.11	35.1	35.08	-0.02
17.5	17.54	-0.05	43.7	43.85	-0.5	78.8	78.93	-0.13
17.6	17.54	+0.05	61.3	61.39	-0.09	140.1	140.32	-0.22
17.6	17.54	+0.05	78.9	78.93	-0.03	219.0	219.25	-0.25
17.6	17.54	+0.05	96.5	96.47	+0.03	315.5	315.72	-0.22
17.7	17.54	+0.15	114.2	114.01	+0.09	429.7	427.73	-0.03
17.5	17.54	-0.05	131.7	131.55	+0.15	561.4	561.28	+0.12

18.0	17.76	+0.24	9.0	8.88	+0.12	9.0	8.88	+0.02
17.6	17.76	-0.16	26.6	26.64	-0.04	35.6	35.52	+0.08
17.7	17.76	-0.06	44.3	44.40	-0.1	79.97	79.92	+0.05
17.9	17.76	+0.14	62.2	62.16	+0.04	142.1	142.08	+0.02
18.0	17.76	+0.24	80.2	79.92	+0.28	222.3	222.0	+0.3
17.7	17.76	-0.06	97.9	97.88	+0.02	320.2	319.68	+0.52
17.6	17.76	-0.16	115.5	115.44	+0.06	435.7	435.12	+0.58
17.8	17.76	+0.04	133.3	133.2	+0.1	569.0	568.32	+0.68

The distances the body has fallen during the succeeding units of time are measured and placed in the column headed "Measured S' ." Subtracting each distance from the succeeding distance, the values in the first column are obtained, which are the measured accelerations and should be uniform. The average of these accelerations is taken as the computed acceleration in the second column. The third column contains the difference between the measured and computed accelerations. The fifth column contains the distances the body should fall during the succeeding units of time, according to the formula $S' = \frac{1}{2}a(2t - 1)$, where a is the average acceleration. The sixth column contains the difference between the measured and the computed values. The seventh column contains the total distances the body has fallen in the corresponding units of time. The eighth shows the distances the body should have fallen according to the formula $S = \frac{1}{2}at^2$, where a is the average acceleration. The ninth column contains the difference between the measured and the computed values of the total spaces.