a length a little less than the width of the coil. This keeps it in a more uniform field. Aluminum wire, *a*, wound around the ends of the needle serves as a counterpoise and a pointer. The suspension, *s*, is made by untwisting a silk thread and separating a strand equal to half a dozen fibers, or less. Though the free length of the fibers is but $\frac{1}{2}$ cm., there is plenty of sensitiveness with a great gain in mechanical steadiness.

For some experiments a shunt is desirable; *e. g.*, such an experiment as connecting batteries in series and in parallel and comparing the deflections with different resistances in circuit. The instrument can be adapted to lecture-table work by bending the pointer at a right angle at the end and bringing it down in front of a suitable scale.

The galvanometer will stand very hard usage for one of its sensitiveness. Twice during the past summer it has been wrapped in a newspaper and sent 300 miles in a heavily loaded trunk, each time coming out of the ordeal all ready for use.

SOME IMPROVEMENTS IN APPARATUS FOR EXPERIMENTS IN ACCELERATED MOTION.

BY E. E. BURNS,

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IN SCHOOL SCIENCE (Vol. I., p. 202) a new form of the Atwood machine is described by Mr. H. W. Hawkes. This machine appears to me to be the best yet devised for experiments in accelerated motion. Its cost, however, will prevent its immediate adoption in some schools. These schools must be content, for a time, at least, with a simpler form of the experiment. I believe that I have succeeded in eliminating from the inclined plane form of the accelerated motion experiment the sources of error pointed out by Mr. Hawkes. I believe, moreover, that by direct experimental determination of velocity the pupils will obtain a clearer conception of the meaning of velocity than if this quantity is determined by a process of calculation.

Before taking up the experiment in accelerated motion, the pupil has learned that the velocity of a moving body at a given

instant is the distance the body would move during the next unit of time if the rate of motion were to remain unchanged. This will be the condition if, at the given instant, the body starts to move on a horizontal plane where the friction is too small to retard the motion perceptibly. The use of the horizontal plane in this experiment is due to Prof. Snow, of the University of Wisconsin. I have only adapted the experiment to the laboratory.

The inclined track is made by nailing strips of zinc to the sides of a board sixteen feet long and one inch thick, so that the strips project half an inch beyond the edge of the board. The horizontal track is made in the same way, except that one end of the board is beveled and the zinc strips are not fastened at the beveled end. This beveled end is fitted between the zinc strips of the inclined track and the zinc strips of the horizontal track are held in place by means of a table clamp and two strips of wood. A pendulum indicating seconds by means of a telegraph sounder is used.

The error due to the difficulty in starting the ball at the instant of the tick is eliminated in the following manner: A piece of platinum wire fastened to the arm of the telegraph sounder is bent at right angles and dips into a cup of mercury. Through this cup of mercury connection is made with a current which excites an electromagnet at the upper end of the track. A steel sphere one and one-half inches in diameter is held in place by the electromagnet. When the switch of the sounder is closed the first tick breaks the contact at the mercury cup and releases the sphere. To insure the instant release of the sphere a piece of paper should be placed between it and the magnet.

The difficulty of perceiving the coincidence of two dissimilar sensations is obviated by using a second telegraph sounder. This sounder and battery are connected by means of flexible wire cord with a lead push-button which is fastened to a block of wood and held in the groove. I found that this device added greatly to the accuracy of the results, showing that the coincidence of two sensations can be perceived much more accurately when the sensations are similar. The reason for making the push-button of lead is that the circuit remains closed when the ball strikes and only

one tick is heard. By means of a rubber band to deaden the sound the double click of the pendulum sounder is reduced to a single click.

The results obtained with this apparatus are not so accurate as those obtained with the Hawkes-Atwood machine, but they are sufficiently accurate to illustrate the laws of accelerated motion, and, so far as my experience goes, this is more than can be said of the old form of the inclined plane experiment. The following results were obtained by my pupils after the improvements were made in the apparatus:

	d	d	d	v	v
	t=1.	t=2.	t=3.	t=1.	t=2.
	29.7	124.6	276.7	64.8	118.4
	29.3	121.9	276.8	58.5	117.0
	30.3	117.0	253.0	61.8	121.5
	31.5	126.6	265.0	65.3	124.1
	31.5	127.9	279.6	65.7	122.2
Means.	30.46	123.6	270.2	63.2	120.6

These results were obtained by ten pupils working in twos, and are all of the results that I have to show, as the improvements were made somewhat late in the year. It will be seen that the velocities which were determined experimentally agree quite well with the theoretical values.

ELEMENTARY EXPERIMENTS IN OBSERVATIONAL ASTRONOMY

BY GEORGE W. MYERS.

(Concluded from page 228.)

EXPERIMENT XL.

To draw the celestial equator at a given epoch.

This can be best done by means of the spherical blackboard fitted with the precessional circles.

Set the pole pins into the sockets corresponding to the epoch. Then with crayon, or camel's-hair brush moistened with water-color, held against the O° of the meridian and touching the globe,