4. The handle of a jack-screw is 28 in., the pitch is $\frac{1}{4}$ in., the weight of head is 20 lbs., and the weight is 3,500 lbs. What is the force that would balance this weight, if there were no friction?

5. If the reading on the balance when the weight is slowly lifted is 25 lbs., and when the weight is slowly lowered is 15 lbs., what is the force? What is the friction?

Lesson XV

Record the weather conditions.

What were the results of your experiments at home with the jack-screw?

Going up Hill.—We all know that it is harder to pull a weight up hill than to pull it on the level. Let us answer the question. "How much harder is it?" This is somewhat hard to answer experimentally without the proper apparatus, so we will state the law first and then test it by experiment. If the road rises 1 foot in 10, then the increased force is $\frac{1}{10}$ of the weight. If the grade is 1 ft. in 20 ft., then the increased force is $\frac{1}{20}$ of the weight, etc. So that if a team of horses is drawing a load of 1 ton (2,000 lbs.), including the wagon, then it would take a pull of $\frac{1}{10} \times 2{,}000$, or 200 lbs. more to pull the wagon up a grade of 1 foot in 10 ft. than on the level. Similarly, if the grade is 1 foot in 20 ft., the pull would be $\frac{1}{20} \times 2{,}000$, or 100 lbs. more on the grade than on the level.

The Law is:

$$\text{Increase of Pull} = \frac{\text{Rise}}{\text{Length of Incline}} \times \text{Weight.}$$

Let us test this law by experiment. We will use a small board with a weight on it to represent the wagon and its load, and a larger board to represent the road.