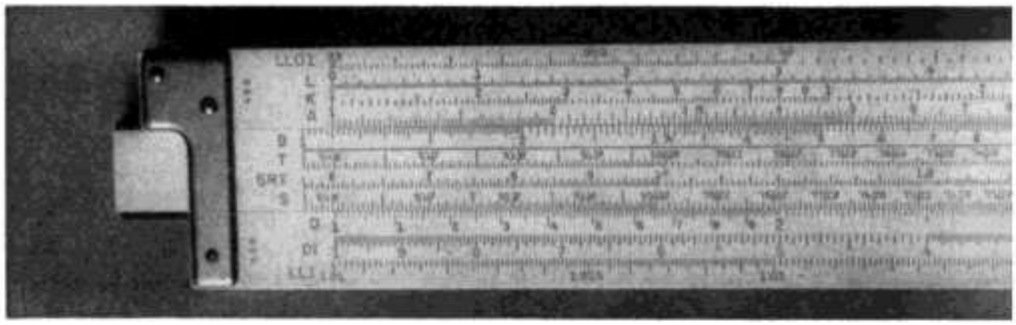

FIG. 6.19. Slide-rule scales set to show same relative accuracy of 1 to 10 at all parts of the scales.

is 0.1/1, or 1/10. Note that 2 on the A scale is opposite 2.2 on the B scale, a relative accuracy again of 0.2/2, or 1/10; and we also have 3 opposite 3.3, 5 opposite 5.5, and 8 opposite 8.8, for example.

Thus it is seen that the *relative accuracy* of the *logarithmic* scale is constant and is *independent of the reading*, but the relative accuracy of the arithmetic scale is *less for small readings than for large ones.*

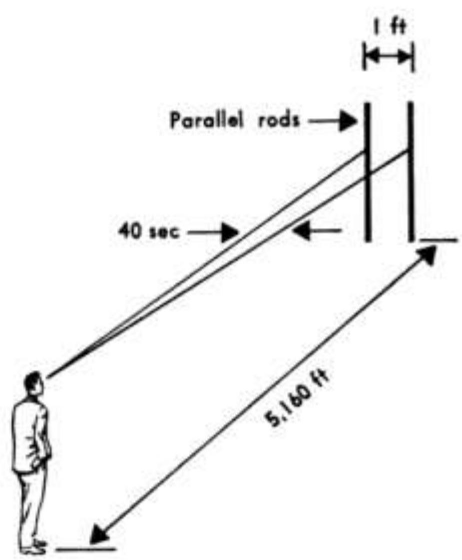

FIG. 6.20.

The ability to read a scale accurately depends upon accurate estimates of a fraction of a subdivision and also upon the resolving power of the human eye. This particular property of the eye can be described by its ability to distinguish parallel lines which are very close together. Measurements have indicated that the eye can resolve parallel lines down to an angle of about 40 seconds, below which the lines merge together and are indistinguishable (Fig. 6.20). The student may test the resolving power of his own eyes by using the chart in Fig. 6.21. The parallel lines in this chart are drawn 0.05 in. apart. If they can be distinguished by the human eye from 21.5 ft away from the chart, the angle of resolution is 40 seconds. Not everyone has this high a degree

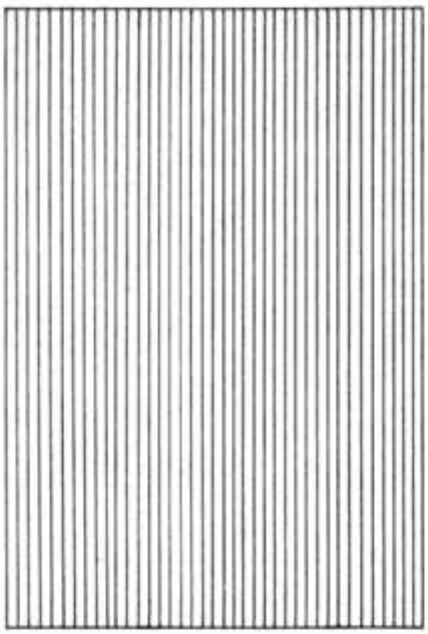

FIG. 6.21. Chart for determining the resolving power of the human eye.

Distance at which lines can be resolved, feet	Angle of resolution, seconds
21.5	40
19.1	45
17.2	50
14.3	60
12.3	70

of resolving power. A table of distances and corresponding angles of resolution is included in Fig. 6.21.

One interesting application of the angle of resolution can be made to reading the scales on the engineer's 10-in. slide rule. Some students

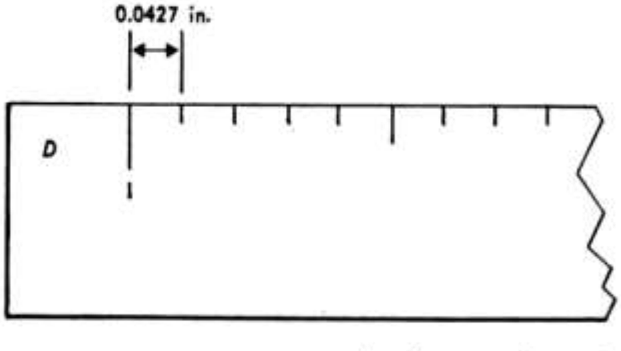

FIG. 6.22.

attempt to read values on the scales to an accuracy which far exceeds the resolving power of the eye. If we assume that the slide rule is held about 12 in. from the eyes, an angle of 40 seconds subtends an arc of about 0.0023 in. at that distance. The first division on the D scale of the 10-in. slide rule (Fig. 6.22) is 0.0427 in. wide so that reading the tenths of this division falls well within the realm of possibility. The student must estimate between imaginary lines approximately 0.004 in. apart with an eye that could distinguish them if they were closer together than that.

However, to read to four significant figures in the middle or right-hand portion of the scale is not possible. For example, suppose a student should attempt to read the position shown in Fig. 6.23 as 40.83, and this sometimes happens. Between 40.50 and 41.00, if we consider four significant figures, there are 50 imaginary subdivisions, and each of these is approximately 0.001 in. apart. Thus our student has picked out the 33d imaginary subdivision among a group of 50 which are only one-thousandth of an inch apart. This is obviously impossible, and students

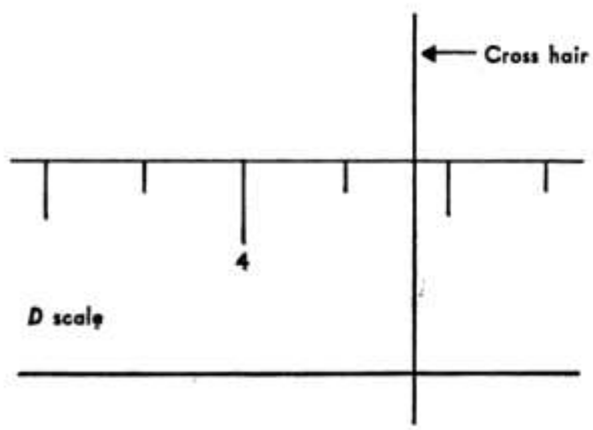

FIG. 6.23.

should not expect in general to obtain more than three-place accuracy with the slide rule. Exceptions would be for readings close to the left end of the scales and on certain of the log log scales.

Suggested references

Fred H. Rhodes and Herbert F. Johnson, "Technical Report Writing," McGraw-Hill Book Company, Inc., New York, 1941, chapter VIII, Mathematical Analysis of Experimental Errors, p. 51. A brief discussion of random errors, least squares, standard deviation, maximum probable error, and weighted averages.

M. Rossweiler and J. M. Harris, "Mathematics and Measurement," Row, Peterson, & Company, Evanston, Ill., 1955.