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COMPLETE, SEMI-PROGRAMMED
TEACHING INSTRUCTIONS
FOR THE USE OF

ELEMENTARY *SIMPLEX* MATH SLIDE RULE

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PICKETT

Price $1.00

FOREWORD

The Pickett ELEMENTARY SIMPLEX MATH Slide Rule brings to the teachers of second grades and higher, a simple and effective tool for use in the teaching of basic mathematics. Here, on this specially created rule, the student physically experiences the relationship of numbers, becomes acquainted with exponential notation, sees how addition and subtraction work, watches the interplay of negative and positive numbers, learns multiplication and division. It provides an easily acquired and fundamental understanding of mathematics.

Through the use of the ELEMENTARY SIMPLEX MATH Slide Rule, for instruction in basic mathematics, or as a slide rule trainer, the student also learns basic slide rule operation. The rapidly increasing use of the slide rule by students of mathematics, sciences and other subjects in secondary schools and colleges is evidence of its true importance. It is recognized that the use of the slide rule speeds learning and gives any student a valued extension of his abilities in his work.

The text of this manual is specially written in simple, easy-to-understand, primary level terms for the lower level student. It is semi-programmed in nature, designed both for self instruction and classroom work, and complements regular teaching methods. Teachers as well as students will almost certainly observe a greater and more facile understanding and ability with mathematics through the use of this new Pickett ELEMENTARY SIMPLEX MATH Slide Rule.

We are proud to offer this new slide rule which motivates students, widens their understanding of basic mathematics, and encourages student progress.

John W Pickett

John W. Pickett

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7. To find 2 + 6, move the slide so that 0 on Y is under ________ on X.

8. Above +6 on ________ find +8 on X. +2

9. To find 1 + 9, set the slide so that 0 on Y is under ________ Y
on X.

10. Above +9 on Y find ________ on X. +1

11. To see why this works, set 0 on Y under +4 on X. Think of +10
this as a marking off of a length of 4 inches from 0 on X.
Now find +3 on Y. Think of this as marking off a length of ________ on Y.

12. Now how far from 0 on X is the +4 on Y? 3 inches

13. You have found 4 + 3 by adding a length of 3 to a length of 4. 7 inches
The total length is measured on the scale named ________.

14. To find 3 + 5, you mark off 3 on the X scale. You do this by X
setting ________ of Y under it.

15. Next you find the length for 5 on the ________ scale. 0

16. You read the combined length above the 5 on the ________ Y
scale.

17. You have now done some examples which show how a slide X
works for addition of "whole numbers" or integers. Next we will do examples like 2.7 + 4.6. How many smaller parts are shown between 0 and +1 on the X scale?

10

18. How many smaller parts are shown between +1 and +2 on the X scale?

19. The shorter marks between the numerals 10
on the X scale stand for tenths. The mark for +2.1 is the first short mark beyond the mark for ________.

20. The seventh short mark beyond +2 is the mark for ________. +2

21. The mark for 4.6 is between the mark for +4 and ________. +2.7

22. The mark for +4.6 is the ________ short mark beyond the +5
mark for +4.

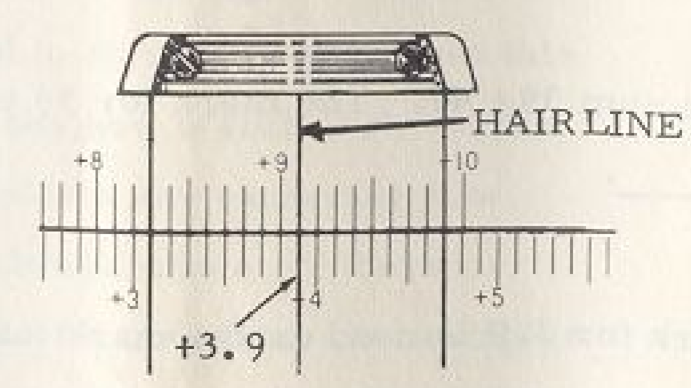
23. To find 2.7 + 4.6, first set 0 of the Y scale under ________ sixth
of the X scale.

24. Next locate +4.6 on the ________ scale. +2.7

25. Above +4.6 read the sum of +7.3 on the ________ scale. Y

26. To find 5.2 + 3.9, move ________ on the Y scale under 5.2 X
on the X scale.

27. Move the hairline of the runner over 3.9 on the Y scale. Under the hairline read the sum ________ on the X scale. 0



9.1

INTRODUCTION

This instruction manual has been written to accompany the Pickett Elementary Basic Math Simplex Slide Rule. It is in programmed style. The text is organized by numbered "frames". Near the end of each frame a blank space __________ is left. The student is to decide what response will correctly fill the blank.

At the bottom of each frame there is a line ruled across the page. The student is expected to keep the part of the page below this line covered with a piece of paper or cardboard until he has made his response. Then he may move the paper down and look at the correct response below the line and in the right-hand margin.

If his response is correct, he goes on to the next frame. If it is not correct, he studies the frame or his work to see where he went wrong.

Responses may be written in the space at the right of the frame if desired, and then compared with the correct response below. For some frames, scratch paper and pencil may be useful.

It will not do much if any harm if a student sees the correct response before he has given an answer. He will learn from doing so. Above all, he must want to learn about the slide rule. He fools no one but himself if he goes through the instruction guide without making the effort to really learn.

Portions of this manual may be too difficult for some students, especially if they are very young. The work gets more difficult with each section covered. If a section seems very difficult, it is probably best not to continue. It can be studied later when the student is more mature.

Needless to say, the student is expected to have a slide rule at hand as he works through the frames. In most frames, he should make the settings described and follow the procedures outlined.

When working with the slide rule, he should hold firmly near the middle with the thumb and first two fingers of one hand (usually the left). He moves the slide or the indicator with the other hand. He should not pinch the body of the rule too tightly, however, because then the slide may bend. With a little practice, the physical manipulation of the rule is easily learned.

HOW TO ADD

1. The slide rule is a tool. For example, a slide rule helps if you want to do multiplication. It also helps in many other kinds of problems. A slide rule looks something like an ordinary ruler. It has scales or "number lines" marked on it. One of these scales is named by the letter X. The mark in the middle of the X-scale is named __________.

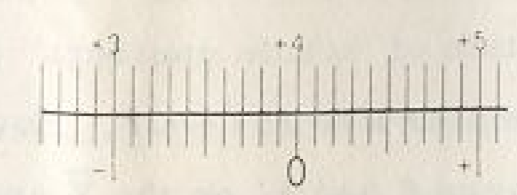
2. The part of the X scale to the right of 0 is divided into 10 smaller parts. The first of these dimension marks is labeled +1. This is read "positive one". The last division mark shown is named __________. — 0 read "zero"

3. The part of the X scale to the left of 0 is also divided into 10 smaller parts. The first of these division marks is labelled -1. This is read "negative one". The last division mark going toward the left is named __________. — +10 (positive ten)

4. The scale named with the letter $\overline{Y}$ is on the slide. It is just like the $\overline{X}$ scale. The first mark on this scale, starting at the left end, is named __________. — -10 (negative ten)

5. The mark in the middle of the $\overline{Y}$ scale is named __________. — -10 (negative ten)

6. Now you are ready to do a very easy addition with the slide rule. We will find 4 + 3. — 0 (zero)
Move the slide so that 0 of the $\overline{Y}$ scale is under +4 of the $\overline{X}$ scale.
Next find +3 on the $\overline{Y}$ scale.
Above the +3 on the $\overline{Y}$ scale the mark on the $\overline{X}$ scale is named __________.



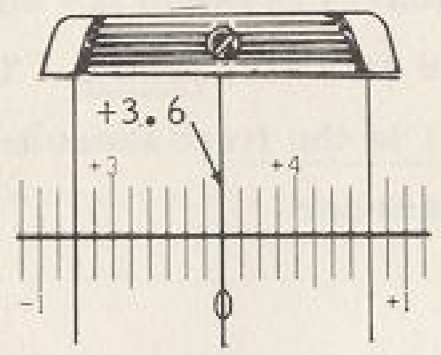
+7

28. For practice, find the sums below by using the slide rule.

a) 0.8 + 6.7 b) 5.4 + 3.8

c) 2.6 + 7.2 d) 4.7 + 3.3

29. You also can find the sums of larger numbers, for example, 36 + 28. To do this, you think of +10 when you see +1 ten. Think of +2 as standing for +20. Now what number does +3 stand for?



a) 7.5
b) 9.2
c) 9.8
d) 8.0

30. When you read the scales this way, you will find 36 between +30 and __________. +30

31. The mark for 36 is the same as the mark for 3.6, but now you think of it as standing for the number __________. +40

32. Set 0 on the $\overline{Y}$ scale under 36 on the __________ scale. 36

33. Move the hairline over the mark for 28 on the __________ scale. $\overline{X}$

34. The mark on the $\overline{X}$ scale under the hairline is the mark for __________. $\overline{Y}$

35. Find the sum 39 + 47. The mark for 39 is between +3 and __________. 64

36. The mark for 3.9 is used as the mark for __________. +4

37. Under 39 on the $\overline{X}$ scale set __________ on $\overline{Y}$. 39

38. Move the hairline over 47 on $\overline{Y}$. The mark on the $\overline{X}$ scale under the hairline is the mark for __________. 0

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39. For practice, find the sums below by using the slide rule.

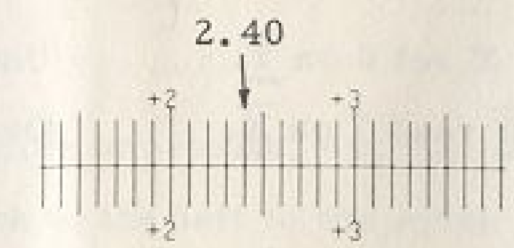
a) 63 + 24 b) 46 + 54

c) 7 + 85 d) 20 + 67

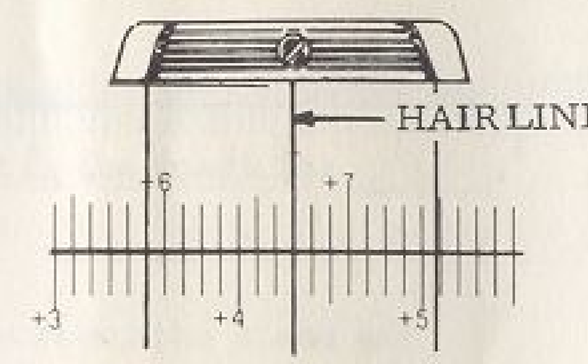
40. You can find a number close to the sum of still larger numbers, for example, 240 + 432. To do this, think of +2 as standing for 200. Now what number does +3 stand for?

a) 87
b) 100
c) 92
d) 87

41. When you read the scales this way, you will read 240 where you read 24 or __________ before. +300



42. Set 0 of the $\overline{Y}$ scale under 240 of the $\overline{X}$ scale. Move the hairline to 430 of the $\overline{Y}$ scale. Now 432 is between the mark for 430 and the mark for 440. Is there a small space between these marks? 2.4



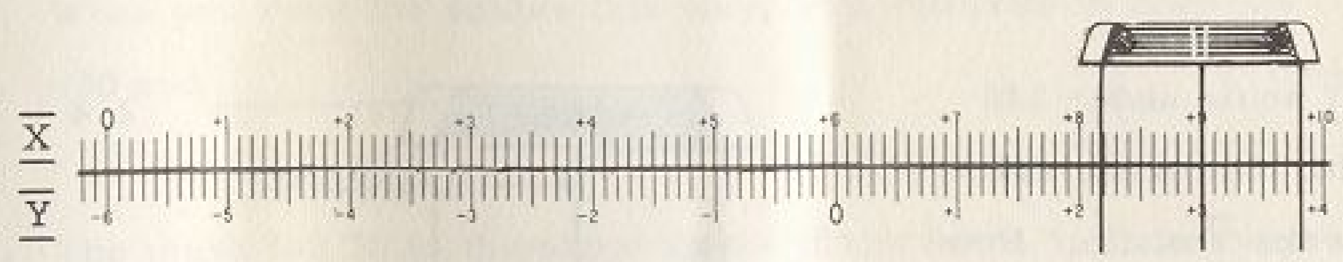
43. To set 432 move the hairline just a little farther to the right. Under the hairline read the sum of 240 + 432 on the $\overline{X}$ scale. The sum is __________. Yes

44. Later you will become more expert in placing the hairline between two marks. All you need to do now is know that this is possible and useful. Now you see how a slide rule works for addition. Notice that we did not do any examples like 4.2 + 37.6. The numbers were always whole numbers or expressed to tenths, for example. Do not try to do examples like this one with the slide rule. However, when you study multiplication, examples like 4.2 x 37.6 will be easy. 672

HOW TO SUBTRACT

45. Subtraction is the "opposite" or inverse of addition. With a slide rule, this means we work "backwards" from addition. Set your rule to find 4 + 3 = 7.

Addition	Subtraction
4 + 3 = 7	7 - 3 = 4
Under 4 on X set 0 on $\overline{Y}$.	Under 7 on X set 3 on $\overline{Y}$.
Over 3 on $\overline{Y}$ read 7 on $\overline{X}$.	Over 0 on $\overline{Y}$ read ___ on $\overline{X}$.



4

46. Find 9 - 3. Set the slide so +3 on $\overline{Y}$ is under +9 on $\overline{X}$. Over 0 on $\overline{Y}$ read __________ on $\overline{X}$.

47. Find 6 - 4. Set 4 on $\overline{Y}$ under +6 on $\overline{X}$. Over 0 on $\overline{Y}$ read +2 on __________. +6

48. The answer in addition is always read on the __________ scale. $\overline{X}$

49. The answer in subtraction is always read on the __________ scale. $\overline{X}$

50. For practice, find the following by using a slide rule. $\overline{X}$

a) 73 - 45 b) 91 - 76

c) 5.9 - 2.7 d) 650 - 490

a) 28
b) 15
c) 3.2
d) 160

51. Now you will learn to add positive and negative numbers with a slide rule. Notice the numerals for the negatives -1, -2, -3, . . . , -10 on the $\overline{X}$ scale. One of the meanings sometimes given to these numbers has to do with temperatures below zero. Then -5 means 5 degrees below zero. There are many other useful meanings of the negative numbers. The mark on a thermometer for 8 degrees below zero is named __________.

52. The short mark for -0.1, or "negative one-tenth," is just to the left of 0. The next short mark to the left is the mark for __________. -8

53. The short mark for -1.1 is just to the left of the mark for -1. The next short mark to the left is the mark for ______. -0.2 or -.2

54. Reading to the left the next three short marks stand for __________. -1.2

55. We will find the sum (+7) + (-3). Under +7 on the $\overline{X}$ scale, set 0 on $\overline{Y}$. The number named on $\overline{X}$ over -3 on $\overline{Y}$ is __________. -1.3, -1.4, -1.5

56. Find (+5) + (-8). Under +5 on $\overline{X}$ set 0 on $\overline{Y}$. Over -8 on $\overline{Y}$ read __________ on $\overline{X}$. +4

57. Find (-3) + (-4). Under -3 on $\overline{X}$ set 0 on $\overline{Y}$. Over -4 on $\overline{Y}$ read __________ on $\overline{X}$. -3

58. Find (-5) + (+9). Under -5 on $\overline{X}$ set 0 on $\overline{Y}$. Over +9 on $\overline{Y}$ read ________ on $\overline{X}$. -7

59. Find (-6.3) + (+7.8). Under -6.3 on $\overline{X}$ set 0 on $\overline{Y}$. Over +7.8 on $\overline{Y}$ find __________ on $\overline{X}$. +4

+1.5

60. Find (-4.7) + (-3.6).

61. Find (+28) + (-59). -8.3

62. Now you will do some subtraction of positive and negative numbers with the slide rule. Find (+3) - (-5). Under (+3) on $\overline{X}$ set (-5) on $\overline{Y}$. Over 0 on $\overline{Y}$ read ________ on $\overline{X}$. -3.1

63. Find 3 - 5. This is the same as (+3) - (+5). Under (+3) on X set (+5) on Y. Over 0 on Y read ________ on X. +8

64. Find (-3) - (+7). Under (-3) on X set (+7) on Y. Over 0 on Y read ________ on X. -2

65. You see that with a slide rule you do addition and subtraction with negative numbers just like you did for positive numbers or ordinary "whole numbers". Do the following for more practice. -10

a) (+3.6) - (-4.8) b) (-42) - (-37)
c) (-2.5) - (3.8) d) (-21) - (-45)

66. Here are some addition and subtraction examples for more practice.

a) +8.4
b) -5
c) -6.3
d) +24

a) (+4.1) + (-3.3) b) (-56) - (25) c) (-8.2) + (+8.2)
d) (-28) - (-19) e) (-1.6) - (2.4) f) (+13) + (-18)
g) (-46) - (+24) h) (+2.5) + (-.6) i) (-250) + (+430)
j) (-250) - (+430)

a) -.8
b) -81
c) 0
d) -9
e) -4.0
f) -5
g) -70
h) +1.9
i) +180
j) -680

READING THE C and D SCALES

67. The scales named C and D are used for multiplication. They are just alike. First you must learn to read them. Begin with the numeral 1 at the left end. Set the hairline over 1 of the D scale. Now move it toward the right until it is over -4 on the X scale. Then the numeral on the D scale now under the hairline is ________.

68. Now move the hairline farther to the right until it is over 3 on the D scale. Is the hairline now almost half way across the slide rule? 2

69. Now move it toward the right again till it passes over 4, then 5, then 6, etc. What number comes after 9 in counting? Yes

70. If you read the numerals on the D scale as 1, 2, 3, etc., you should read the 1 at the right end as ________. 10

71. Now begin again at the left end of the D scale. This time read the "1" as 10. When the hairline is over "2", read the "2" as "20". How should you now read the other numerals on the scale? 10

72. If the "1" at the left end is read as "10", you should read the "1" at the right end as ________. 30, 40, etc.

73. You see that the same mark (or numeral) may be used for different numbers. For example, the mark for 2 is also the mark for 20, for 200, for 2,000, etc. The mark for 3 is also the mark for ________. 100

30, 300,
3,000, etc.

74. The mark for 2 is also the mark for .2, for .02, for .002, etc. The mark for 3 is also the mark for __________.

75. The mark at the left end of the D scale is called the left index. The mark at the right end of the D scale is called the right __________.

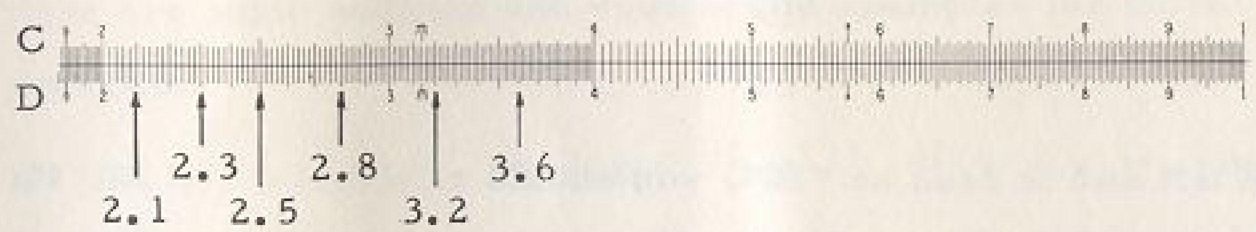
.3, .03, .003, etc.

76. Place the hairline over the left index on the D scale. Notice the small numeral 1 under the glass on the right side. Also notice that the space between 1 and 2 is separated into ten parts. The marks have little numerals below them. The little "1" is read as 1.1. The mark for the small numeral 2 not under the glass is read as 1.2. Moving to the right, we read 1.3, 1.4, _____, _____, _____, _____, _____.

index

77. Now you are near the mark that is under the larger numeral 2, which now can be read as 2.0. Notice the space between 2 and 3 is again separated into ten parts by little marks. However, these marks do not have numerals shown. They can be read as 2.1, 2.2, 2.3, _____, _____, _____, _____, _____, _____.

1.5, 1.6, 1.7, 1.8, 1.9

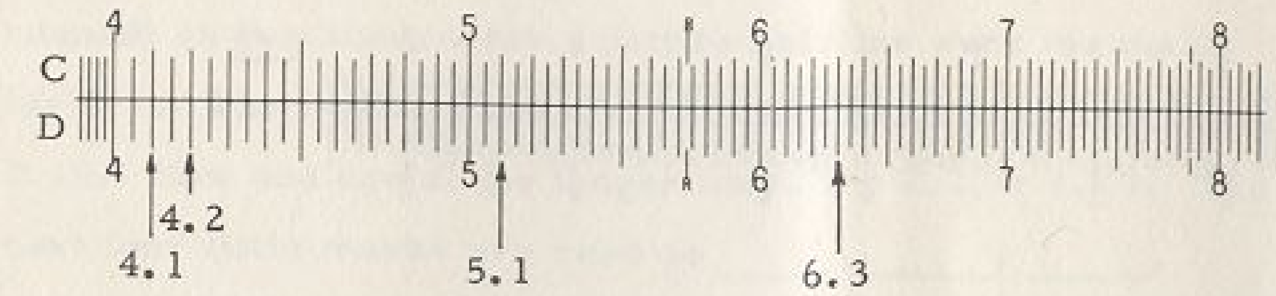


78. The space between the numerals 3 and 4 is also separated into ten parts. These marks can be read as 3.1, 3.2, 3.3, _____, _____, _____, _____, _____, _____.

2.4, 2.5, 2.6, 2.7, 2.8, 2.9

3.4, 3.5, 3.6, 3.7 3.8, 3.9

79. Notice the part of the D scale to the right of the numeral 4. The space between 4 and 5 is separated into ten parts.



The spaces between 5 and 6, between 6 and 7, etc., are also separated into ten parts. Between 4 and 5, these marks can be read as 4.1, 4.2, 4.3, etc. Between 5 and 6 these marks can be read as _____, _____, _____, etc.

80. Between 7 and 8 these marks can be read as _____, _____, _____, etc.

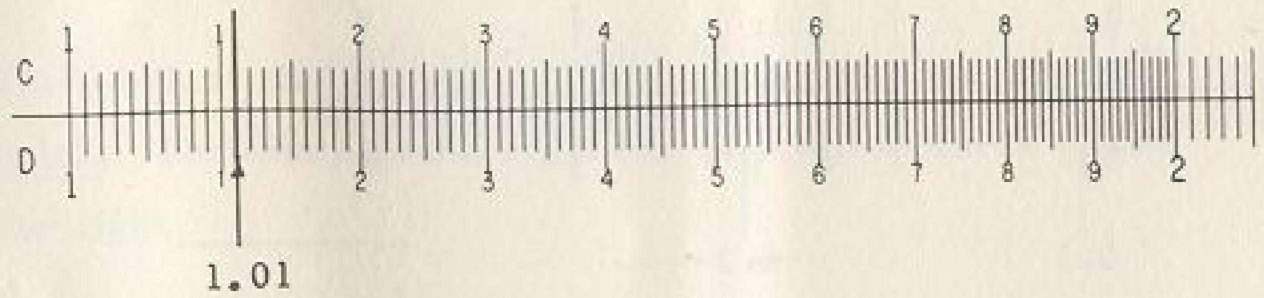
5.1, 5.2, 5.3

81. You see that between any two of the large numerals you can read "to tenths." Between 1 and 2 there is enough room on the D scale to show small numerals for the "tenth" marks. Between 2 and 3, and between all the other larger numerals, there is not enough room to show numerals for the "tenths". You must look at the scale and count the larger marks. This is like counting "fourths of an inch" on an ordinary foot ruler. As you become more familiar with the rule, you will learn to do this at a glance. You can now read two digits of a numeral; for example, 4.7. How many digits are in the numeral 1.11?

7.1, 7.2, 7.3

three

82. Next you will learn to read three digit numerals. Begin by setting the hairline over the mark for 1.1.



Now move the hairline over the first short mark to the right of 1.1. This is the mark for 1.11. Notice the space between 1.1 and 1.2 is separated into ten small parts. The little marks are read 1.11, 1.12, 1.13, _____, _____, _____, etc.

83. Begin at 1.7, and read the next four little marks to the right. They are read _____, _____, _____, _____.

1.14, 1.15, 1.16

84. Between 1 and 1.1 the reading is tricky. The short mark at the right of 1 is the mark for 1.01. The next three short marks are for _____, _____, _____.

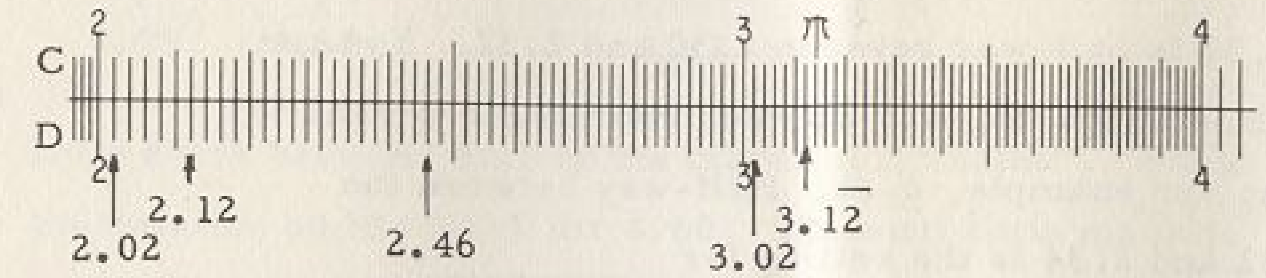
1.71, 1.72, 1.73, 1.74

85. Between the large numerals 1 and 2 on the D scale there is a little mark that can be read as 'hundredths'. The mark for 1.41 is the first short mark to the right of the longer mark for 1.4, or 1.40. The mark for 1.63 is the _____ short mark to the right of the longer mark for 1.6 or 1.60.

1.02, 1.03, 1.04

third

86. The distance between the marks for 2.0 and 2.1 is too short to have marks that separate it into ten parts. The little marks separate it into <u>five</u> parts. Then each part can be counted as <u>two</u> hundredths. Set the hairline over the mark for 2.1. The little marks are now read as 2.12, 2.14, 2.16, 2.18. Now you are at the longer mark for 2.2 or 2.20. The next four little marks are read as _____, _____, _____, _____.



87. Between 2.0 and 2.1 the reading is tricky. The little mark just to the right of the 2 is read as __________.

2.22, 2.24, 2.26, 2.28

88. The next four marks are read as _____, _____, _____, _____.

2.02

89. The four little marks just to the right of 3 are read as _____, _____, _____, _____.

2.04, 2.06, 2.08, 2.10

90. The second little mark to the right of 3.4 is read as _____.

3.02, 3.04, 3.06, 3.08

91. The third little mark to the right of 3.7 is read as _____.

3.44

92. The first little mark after 3.5 is _____.

3.76

93. The fourth short mark after 3.9 is _____.

3.52

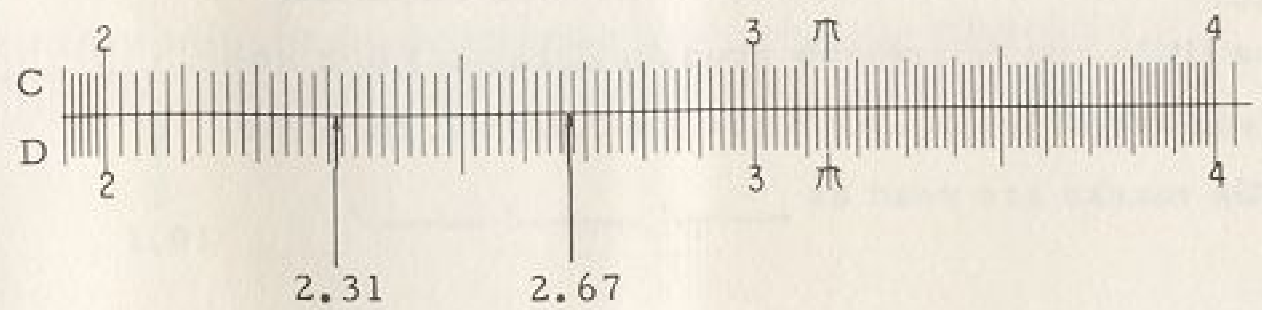
94. The number 2.56 is set as the third short mark after 2.5. The number 2.74 is set as the __________ short mark after 2.7.

3.98

second

95. The number 3.88 is set as the ________ mark after 3.8.

96. There is no mark for 2.31. fourth



The number 2.31 is half-way between 2.30 and 2.32. You can place the hairline about half-way between two marks to read to one-hundredth; for example, 2.31. Half-way between the marks for 2.32 and 2.34 is the setting for ________.

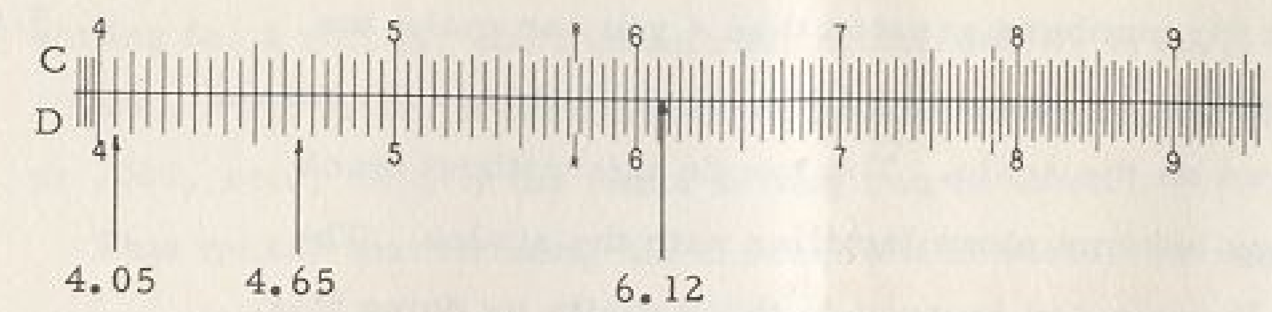
97. Half-way between the marks for 2.00 and 2.02 is the setting for ________. 2.33

98. Do not worry about the "reading between the marks" not being quite accurate. The slide rule is used as a tool by many engineers and scientists. It gives answers that are good enough for them, even if the answers are not exact. You can learn to get readings that are exact enough for many purposes. The setting for 3.55 is half-way between the marks for _____ and _____. 2.01

99. The setting for 3.99 is half-way between the setting for _____ and _____. 3.54, 3.56

3.98, 4.00

100. Now you can see how to read the D scale and the C scale to three digits when the number is between 2 and 4. Next you will see how to read when the number is greater than 4. Between 4 and 5 there is not enough room to show marks for hundredths that can be "counted by twos". There is only one



little mark between each of the marks for "tenths". Place the hairline on the mark for 4.60. The next little mark is for 4.65. The little marks are "counted by five hundredths". The little mark between 4.30 and 4.40 is the mark for _____.

101. The little mark to the right of 4 is read as _____. 4.35

102. The little mark to the right of 5 is read as _____. 4.05

103. The next mark after 5.05 is for _____. 5.05

104. The next mark after 5.10 is for _____. 5.10

105. The setting for 7.55 is over the little mark between _____ and _____. 5.15

106. To place the hairline for a number like 6.12 you have to set it in the space between the marks for 6.10 and 6.15. It is about half-way between 6.10 and 6.15 (see figure for Frame 100). The setting for 6.11 will be just a little to the right of 6.10. The setting for 6.16 will be just a little to the right of _____. 7.50, 7.60

6.15

107. The setting for 5.63 will be about half-way between _____ and _____.

108. The setting for 5.64 will be just a little to the left of _____. 5.60, 5.65

109. You see that for numbers greater than 4 you can make the reading or setting by imagining little marks between the marks that are shown on the scale. You can do this without much trouble as you become more familiar with the scales. The C scale and D scale can be read to three digits by doing this. (Between 1 and 2 you can sometimes even read to four digits, but these readings are not as accurate). 5.65

Between 1 and 2 you have marks for hundredths. Between 2 and 4, how many marks must you imagine are between each mark shown when you read to hundredths?

110. Between 4 and 10, how many marks must you imagine are between each mark shown when you read to hundredths? one

111. Now you will learn to read the scales when the large numerals 1, 2, 3, etc., are thought of as 10, 20, 30, etc. If 1 at the left index is read as 10, and 2 is read as 20, then 1.1 is read as 11. Now instead of 1.2 you would read _____. four

112. Instead of 1.5, you would read _____. 12

113. Instead of 1.21, you would read _____. 15

114. Instead of 2.46, you would read _____. 12.1

115. You can see that the same marks or settings can be used for a number and 10 times that number. If 1 at the left index is read as 100, and 2 is read as 200, then 1.36 is read as 136. Now instead of 1.27, you would read _____. 24.6

127

116. Instead of 2.46, you would read _____.

117. Instead of 8.92, you would read _____. 246

118. The same settings are used on the D scale for a number and 100 times that number. In the same way, we can use the same setting for a number and that number multiplied by 1,000, 10,000, etc. Also, if the number is multiplied by .1, or .01, or .001, etc., exactly the same setting can be used. 892

This means that in using the C scale and D scale, we can pay no attention to where the decimal point stands in the numeral. The setting for 456,000 is the same as the setting for 4.56. The setting for .000456 is the same as the setting for _____.

119. The setting for 7,980 is the same as the setting for _____. 4.56

120. The setting for .0825 is the same as the setting for _____. 7.98

121. Of course, you have to pay attention to where the decimal point is sometime. You will learn how to do this in a later section of this book. 8.25

122. In an example like 2 x 3 = 6, the numbers 2 and 3 are factors, and 2 x 3 or 6, is the product. The factors in 4 x 5 are _____ and _____.

123. The product of 4 x 5 is _____. 4, 5

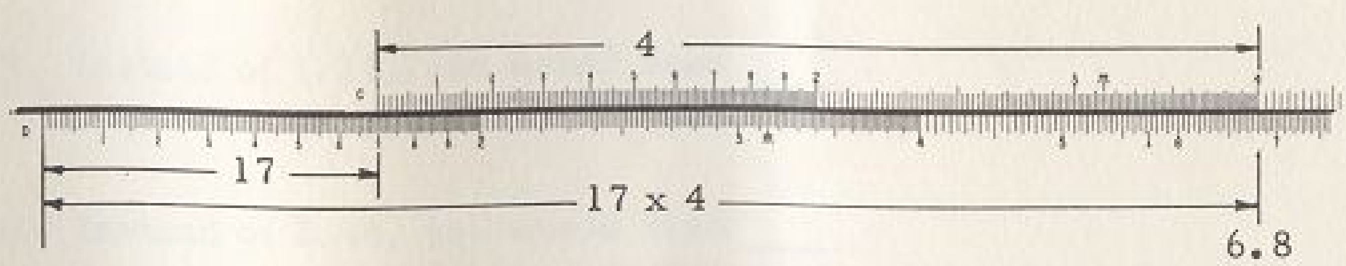
124. To see how multiplication is done with a slide rule, we will do 2 x 3. Move the slide so that the left index 1 of the C scale is over 2 of the D scale. Under 3 of the C scale, on the D scale read _____. 20

125. Find 17 x 4. Move the slide so that the left index 1 of the C scale is over 17 of the D scale. Under 4 of the C scale, on the D scale read _____. 6

126. To multiply, you begin by setting the index 1 of the C scale over one of the factors on the _____ scale. 68

127. Then find the other factor on the C scale, and use the hairline to read the product on the _____ scale. D

128. Multiplication with the C and D scales is much like addition with the X and Y scales. To do addition, you add two lengths. D



In multiplication you also add two "lengths", but the scales are made so the numbers are multiplied. There is one "length" for each factor. In the setting shown above, the "length" for 17 is "measured" on the _____ scale.

D

129. The "length" for 4 is "measured" on the _____ scale.

130. The total length is measured by the _____ scale. C

131. The number corresponding to this length is _____. D

132. You can also set the 1 of the C scale over 4 of the D scale. 68
Then under 17 of the _____ scale, read 68 on the D scale.

133. Find 2.4 x 6.3. Set the left index 1 of C over 24 on D. Now C
63 on C is "outside the rule", and you cannot read the product on D. When this happens, you should use the right-hand index. Set the right-hand index 1 over 63 on D. Under 24 on C read on D the digits of the product _____.

134. The decimal point in a product can often be placed by "common 151
sense" or estimating. 2.4 is a little more than 2 and 6.3 is a little more than 6. The product will be a little more than 12, but not as much as 100. Then the product must be _____.

135. The exact product is 15.12, so there is a slight error in this 15.1
answer. It is only about one-tenth of 1 per cent. In most problems the error is a very small per cent. How many pennies would there be in $10?

136. The error is about the same as losing one penny out of 1,000 1,000
pennies. Now we will find 237 x 346. Set 1 on C over 237 on D. Under 346 of C find the digits of the product _____.

137. Now we will find where to put the decimal point. 237 is near 820
200; and 346 is near 300. But 200 x 300 is easy. It is _____.

60,000

138. To find 200 x 300, we can multiply 2 x 3 and count the zeros in 200 and 300. The numerals of the product are a 6 followed by 4 zeros. We now know the answer is "near" 60,000. It is not 6, or 60, or 600, or even 6,000. Neither is it as large as 600,000. It must be 82 followed by _____ zeros.

139. In another section you will learn a more scientific way of placing the decimal point. For now, we can say the product of 237 x 346 is _____. 3

140. Here are some multiplication examples for practice. 82,000

a) 15 x 37	b) 9.54 x 16.7
c) 753 x 89.1	d) 21.5 x 37.9
e) 280 x 34	f) 7.4 x 6.7
g) 114 x 5.3	h) 34.2 x 4.87
i) 275 x 46	j) 98 x 93

a) 555
b) 159
c) 67,110
d) 815
e) 9,520
f) 49.6
g) 604
h) 166
i) 1,265
j) 9,110

HOW TO DIVIDE

141. Division is the "opposite" or inverse of multiplication. With a slide rule, this means we work "backwards" from multiplication. Set your rule to find 2 x 3 = 6.

Multiplication	Division
2 x 3 = 6	$6 \div 3 = 2$
Over 2 on D set 1 of C Under 3 on C read 6 on D.	Over 6 on D set 3 on C Under 1 on C read _____ on D.

142. Find $8 \div 4$. Over 8 on D set 4 on C. Under 1 of C read _____ on D. 2

143. Find $9 \div 4.5$. Over 9 on D set 4.5 on C. Under 1 of C read _____ on D. 2

144. Notice these examples may be written in the form: 2

$\frac{6}{3} = \frac{8}{4} = \frac{9}{4.5} = \frac{2}{1}$.

With only one setting of the slide you can read many proportions. For example, this same setting also gives:

On D: / On C: $\frac{30}{15} = \frac{36}{18} = \frac{48}{24} = \frac{80}{40} = \frac{72}{36} = \frac{2}{1}$.

Now try to work a harder example. Find $68 \div 44$. Over 68 on D set 44 on C. Under 1 of C read _____ on D. You can place the decimal point in the answer by noticing that $68 \div 44$ is more than 1 and not as much as 2, because 2 x 44 = 88.

145. Find $56.7 \div 2.48$. Over 56.7 on D set 2.48 on C. Under 1 of C read _____ on D. You can place the decimal point by noticing that the example is roughly the same as $50 \div 2$, or 25. 1.545

22.8

146. Next find 87,342 ÷ 38.29. First, you set 874 on D, because you can set only 3 digits on the D scale. This is the same as "rounding off" the number to 87,400. Next, set 38.3 on the C scale over the 874 on the D scale. Under 1 of the C scale, read 228 on the D scale. Now to place the decimal point in the answer, think of the numbers in the example. 87,432 is near 88,000, and 38.29 is near 40.

But $\frac{88,000}{40} = \frac{8800}{4} = \frac{2200}{1}$. So the answer is __________.

147. In another section you will learn a more scientific method of placing the decimal point. For now, find 28 ÷ 65. Over 28 on D set 6.5 on C. Under the right-hand index 1 of C find _____ on D. To place the decimal point, think of this example as 30 ÷ 60 or 1/2 or .5. 2,280

148. Notice that you can always read the result in division under either the left-hand index or the right-hand index. You never need to move the slide because the answer is on a part of the scale "outside the rule." Here are some examples for practice. .431

a) 47 ÷ 29 b) 83 ÷ 7

c) 75 ÷ 92 d) 69 ÷ 79

e) 137 ÷ 51.3 f) 152 ÷ 56.7

g) 490 ÷ 23 h) 17.3 ÷ 2.31

i) 924 ÷ 26.3 j) 847 ÷ 31.6

a) 1.62
b) 11.9
c) .815
d) .873
e) 2.67
f) 2.68
g) 21.3
h) 7.49
i) 35.1
j) 26.8

PROPORTION and PERCENT

149. In Frame 144, there were some examples of proportions. You can solve proportions easily with a slide rule. For example, find the number n in the proportion.

$$\frac{3}{14} = \frac{7.5}{n} .$$

Over 3 on D set 14 on C. Over 7.5 on D read _____ on C.

150. The same example can be done by another setting. Set 3 of C over 14 of D. Under 7.5 of C read _____ on D. 35

151. Solve the proportion 35.

$$\frac{39}{23} = \frac{n}{56} .$$

Set 39 of C over 23 on D. Over 56 on D read _____ on C.

152. You can see that with this setting the numerals on the scales appear in the same position as they do in the written form: 95.

On C	39	n
On D	23	56

Solve the proportion:

$$\frac{26}{19} = \frac{89}{n} .$$

Here the number n is _____.

153. You can use proportion to find per cents. A team won 5 of the 8 games it played. What per cent is this? You need to solve: 65

$$\frac{5}{8} = \frac{n}{100}$$

Over 5 on D set 8 on C. Under 1 (that is, 100) on C read _____ on D.

62.5

154. A student did 42 examples and got 37 of them right. What per cent was this? You need to solve:

$$\frac{37}{42} = \frac{n}{100}$$

Over 42 on D set 37 on C. Under 1 of C read _____ on D.

155. What is 35 per cent of 54? You need to solve: 88

$$\frac{35}{100} = \frac{n}{54}$$

Over 35 on D set 1 (that is, 100), on C. Under 54 on C read _____ on D.

156. The number 62 is 25 per cent of what number? You need to solve: 18.9

$$\frac{25}{100} = \frac{62}{n}$$

Over 25 on D set 100 on C. Over 62 on D read _____ on C.

157. Here are some proportion examples for practice. 248.

a) $\frac{8}{5} = \frac{2}{n}$ b) $\frac{14}{17} = \frac{35}{n}$

c) $\frac{12}{7} = \frac{23}{n}$ d) $\frac{18}{91} = \frac{13}{n}$

e) $\frac{n}{42.5} = \frac{13.2}{1.87}$ f) $\frac{90.5}{n} = \frac{3.42}{1.54}$

g) $\frac{9}{14} = \frac{n}{100}$ h) $\frac{24}{29} = \frac{n}{100}$

i) $\frac{163}{205} = \frac{350}{n}$ j) $\frac{488}{450} = \frac{n}{100}$

a) 1.25
b) 42.5
c) 13.4
d) 65.7
e) 300
f) 40.7
g) 64.3
h) 82.7
i) 440
j) 108.5

SCIENTIFIC NOTATION — TO SIMPLIFY THE SIZE OF NUMBERS

158. Scientists have a special way of writing numerals. You will learn some of the advantages of this way of writing as you study more mathematics and science. Just now, you will first learn how to write numerals this way. Then you will learn how to use this way to place the decimal point in difficult examples.

The numeral system in common use is the decimal system. It uses ten basic symbols to write the numeral for any number. These symbols are 0, 1, 2, 3, etc., to _____.

159. Notice the scale named D* (read D star) on the body of the slide rule. Place the hairline over 0 on the $\overline{X}$ scale. Then the mark on the D* scale under the hairline is named _____. 9

160. Move the hairline to +1 of the $\overline{X}$ scale. Now the mark on the D* scale named 10^1 (read "10 to the first power") is under the hairline. $10^1 = 10$. When the hairline is over +2 on $\overline{X}$, it is also over 10^2 (read "10 to the second power,") or (10 squared), on _____. 1

161. 10^2 means 10 x 10 or 100. When the hairline is over 10^3 (read "10 to the third power") or (read "10 cube") it is also over _____ on $\overline{X}$. C*

162. 10^3 means 10 x 10 x 10 or 1,000. When the hairline is over +4 on $\overline{X}$, it is also over _____ on D*. +3

163. 10^4 means _____. 10^4

10 x 10 x 10 x 10
or 10,000

164. 10^7 means 10 x 10 x 10 x 10 x 10 x 10 x 10. This is 10 used as a factor 7 times. Then 10^9 means 10 used as a factor _____ times.

165. When the hairline is over 10^9 on D*, it is also over _____ on $\overline{X}$. — 9

166. The number which tells how many times 10 is used as a factor is called an <u>exponent</u>. For 10^5 the exponent is _____. — +9

167. What can the number 8 in 10^8 be called? — 5

168. The number 10 used as a factor is called the <u>base</u>. The number named by a base and an exponent is called the <u>power</u>. 10,000 or 10^4, is the "4th power" of 10. The number 1,000 or 10^3 is called 3rd __________. — exponent

169. The number 10^6, or 1,000,000 is called the __________ power of 10. — power of 10

170. For the ninth power of 10 the exponent is _____. — sixth

171. Using the base 10 and an exponent, the number 10 x 10 x 10 x 10 x 10 x 10 x 10 can be written __________. — 9

172. Using the base 10, the exponent of 10 x 10 x 10 x 10 x 10 is __________. — 10^7

173. Using base 10 and an exponent, the number 10 x 10 x 10 x 10 x 10 can be written __________. — 5

10^5

174. Notice the numerals as you read on D* from the right-hand end toward the left. Also notice the exponents just above on $\overline{X}$.

10 , 9 , 8 , 7 , 6 , 5 , 4 , 3 , 2 , 1 , 0

10^{10}, 10^9, 10^8, 10^7, 10^6, 10^5, 10^4, 10^3, 10^2, 10^1, 1

To keep the same pattern, we agree that below 0 on $\overline{X}$ we should have 10^0 on D*. But in mathematics 10^0 is 1. When the hairline is over 0 on $\overline{X}$, it is also over _____ on D*.

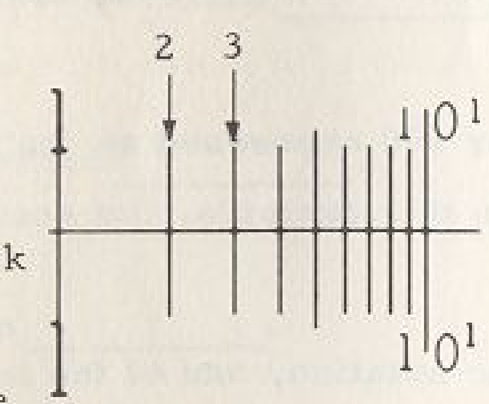
175. The number 328 is equal to 3.28 x 100 or 3.28 x 10^2. Also, the number 463 is equal to 4.63 x __________. — 1 or 10^0

176. The number 671 = _____ x 10^2. — 100 or 10^2

177. Numbers expressed as 6.71 x 10^2 are in <u>scientific notation</u>. This notation is much used in science and mathematics. When expressed in scientific notation, the number 149 is written __________. — 6.71

178. The number 9,826 in scientific notation is 9.826 x 1,000 or 9.826 x __________. — 1.49 x 10^2

179. You can use a slide rule which has a D* scale to help express numbers in scientific notation. Place the hairline over 1 on D*. The next short mark to the right on this scale represents 2. Move the hairline over this mark. The next short mark represents 3. The next two marks represent _____ and _____. — 10^3



ON D*

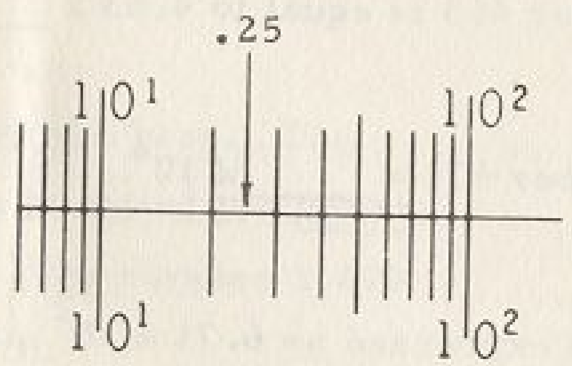
180. The marks to the <u>right</u> of the mark for 5 until you get to 10^1 stand for _____, _____, _____, _____. — 4, 5

6, 7, 8, 9

181. Notice the shorter marks between 10^1 and 10^2 or 100. Now you must count them by tens. The first mark to the right of 10^1 is the mark for 20. The next mark to the right stands for the number ____.

182. Count the marks over to 10^2 or 100 in this way. The next one is 40. The following five marks are for ____, ____, ____, ____, ____. 30

183. The D* scale is an example of a non-uniform scale. The marks between 1 and 10^1 get closer together as you move to the right. There is not enough space between the mark for 10 and the mark for 20 to put in all the marks for 11, 12, 13, etc. You can imagine they are there. The space between the mark for 20 and the mark for 30 represents 21, 22, 23, etc. The setting for 25, for example, is a little more than half-way between the mark for 20 and ______. 50, 60, 70, 80, 90



184. The number 25 in scientific notation is 2.5×10^1. In scientific notation the number is always expressed as the product of two factors. In this example, the factors are 2.5 and ______. 30

185. The number 700 expressed as the product of two factors is 7×100. In this example, the second factor is ______. 10^1 or 10

186. In scientific notation, one of the factors is always a power of ten. For example, $360 = 3.60 \times 100$, or 3.60×10^2. In this example, the power of ten is the ______. 100 or 10^2

second

187. In scientific notation, the factor that is not a power of ten always is expressed so that the decimal point is at the right of the first digit. For example, we write $275 = 2.75 \times 10^2$. The first digit of 275 is the numeral ______.

188. The number 8.3 expressed in scientific notation is 8.3×10^0 or $8.3 \times$ ______. 2

189. The number 830 expressed in scientific notation is 8.30×10____. 1

190. You can use an easy way to express a number in scientific notation. For example, try 8,520. First, write 8.52. Then count the number of digits in 8,520 between the first digit and the decimal point. There are 3 digits. Then finish by writing a times sign and 10^3 after the 8.52. Thus 2

$8,\underline{520} = 8.52 \times 10^3$

3 places — the exponent

When 956,000 is expressed in scientific notation, the exponent of 10 is ____.

191. Expressed in scientific notation, 956,000 becomes ______. 5

192. In scientific notation, 1,000,000 is written ______. 9.56×10^5

193. In scientific notation, 3,784 is written ______. 1×10^6

3.784×10^3

194. Notice the following pattern.

$100,000 = 1 \times 10^5$

$10,000 = 1 \times 10^4$

$1,000 = 1 \times 10^3$

$100 = 1 \times 10^2$

$10 = 1 \times 10^1$

$1 = 1 \times 10^0$

$.1 = 1 \times 10^{-1}$

$.01 = 1 \times 10^{-2}$

$.001 = 1 \times 10^{-3}$

$.0001 = 1 \times 10^{-4}$

etc.

The number .00001 written in scientific notation is ________.

195. When numbers less than 1 are written in scientific notation, the exponent of 10 is a negative number. For example, $.034 = 3.4 \times 10^{-2}$. You can find the exponent of 10 by counting. Begin at the right of the first digit and count the digits to the decimal point. — 1×10^{-5}

Begin
.034

In this example, the count is 2. You are counting toward the left. Then the exponent of 10 is $^{-2}$. The exponent of 10 for .0056 is ________.

196. Expressed in scientific notation, .0056 becomes ________. — -3

197. Notice that if you count toward the right, the exponent of 10 is a positive number. For example, in 8,347 — 5.6×10^{-3}

Begin here
8,347.

the count is 3 toward the right. In scientific notation, 8,347 is written ________.

$8.347 \times 10^{+3}$

198. Here are some examples for practice. Write each numeral in scientific notation.

a) 430,000 b) .000043
c) 26.5 d) .62
e) 723.5 f) 2.7
g) 94,600 h) .00137
i) .0006 j) 20,000,000

a) 4.3×10^5
b) 4.3×10^{-5}
c) 2.65×10^2
d) 6.2×10^{-1}
e) 7.235×10^3
f) 2.7×10^0
g) 9.46×10^4
h) 1.37×10^{-3}
i) $6. \times 10^{-4}$
j) 2×10^7

PLACING THE DECIMAL POINT

199. You can use scientific notation to help place the decimal point. First, you must learn to multiply numbers written in scientific notation. Here is an easy example.

$2,000 \times 300.$

In scientific notation, this is

$2 \times 10^3 \times 3 \times 10^2.$

Changing the order of the factors, you get

$2 \times 3 \times 10^3 \times 10^2$

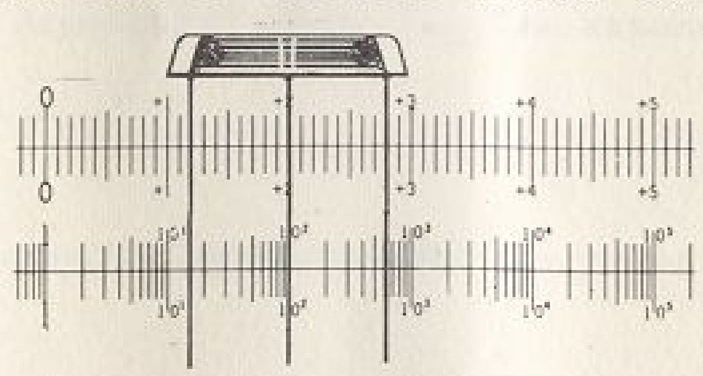
This is $6 \times 10 \times 10 \times 10 \times 10 \times 10.$

Written in scientific notation, this becomes ______________.

200. To multiply powers of ten, like $10^3 \times 10^2$, you can add the exponents and use the sum as an exponent of 10, $10^3 \times 10^2 = 10^5$. In $10^4 \times 10^3$, the exponent of 10 in the product is _____. — 6×10^5 or 600,000

201. $10^4 \times 10^3 = 10^7 = 10,000,000$. This is the numeral 1 followed by 7 zeros. In the example $10^2 \times 10^6$, the exponent of 10 is _____. — 7

202. You can do examples like these on the slide rule. For example, place the hairline over 10^2 on the D* scale. On the X scale — 8



just above you find +2. The numbers for the X scale are the exponents for the D* scale. The numeral +5 on X is just above 10 ____ on the D* scale.

5

203. Remember, to multiply powers of ten you can add the exponents. The X and Y scales are used for addition. In an example like $10^2 \times 10^6$, you want to add +2 and +6. Set 0 on the Y scale under +2 on the X scale. Over +6 on the Y scale read +8 on X. Below +8 read 10^8 on D*. For the example $10^3 \times 10^6$, set 0 of Y under +3 of X (10^3 of D*). Over +6 of Y read +9 on X, or read __________ on D*.

204. Products of powers of ten are easy when both exponents are positive numbers. They are harder if one (or both) of the exponents is a negative number. However, you can use the slide rule here too. For example, find $10^2 \times 10^{-5}$. Set 0 of Y under +2 of X (or 10^2 of D*). Under $^{-5}$ of Y, read -3 on X, or __________ on D*. — 10^9

205. Remember that $10^2 = 100$ and $10^{-5} = .00001$, so you have multiplied $100 \times .00001$. You get 10^{-3} or .001 as the answer. Now find $200 \times .00003$. First, write the example in scientific notation. — 10^{-3}

$2 \times 10^2 \times 3 \times 10^{-5}.$

Next change the order of the factors:

$2 \times 3 \times 10^2 \times 10^{-5}.$

This can be written: 6×10 _____.

206. The result in ordinary notation is __________. — -3

207. Now try a harder example. Find — .006

$.0024 \times .000196$

This is $2.4 \times 10^{-3} \times 1.96 \times 10^{-4}$, or

$2.4 \times 1.96 \times 10^{-3} \times 10^{-4}.$

First multiply 2.4×1.96 using the C and D scales. The product is __________.

4.70

208. Next, find $10^{-3} \times 10^{-4}$. Set 0 of Y under -3 on X. Over -4 on Y read _____ on D*.

209. Now you have 4.70×10^{-7}. Start at the decimal point and count toward the left, writing 6 zeros in front of the 4. 10^{-7}

Begin

.000000470

Then you have 7 digits to the left of the original decimal point. The answer is __________.

210. Find .0048 x 73,000. This can be written: .000,000,47

$4.8 \times 10^{-3} \times 7.3 \times 10^{4}$, or

$4.8 \times 7.3 \times 10^{-3} \times 10^{4}$.

First, multiply 4.8 x 7.3. The product is __________.

211. Next, find $10^{-3} \times 10^{4}$. Set 0 of Y under -3 of X. Over +4 on Y, read _____ on D*. 35.0

212. Then the answer is 35×10^{1}, or __________. 10^{1}

213. There is another way to think of the answer. 350

Notice 35 = 3.5 x 10, so 35 x 10 = 3.5 x 10 x 10, or 3.5×10^{2}, which is _____.

214. You can use scientific notation to place the decimal point in division. Here is an easy example. 600,000 ÷ 300. Written in scientific notation, this becomes $6 \times 10^{5} \div 3 \times 10^{2}$, or $\frac{6 \times 10^{5}}{3 \times 10^{2}}$. First, divide 6 by 3; the result is 2. Next, you must divide 10^{5} by 10^{2}. 350

$$\frac{10 \times 10 \times 10 \times \cancel{10} \times \cancel{10}}{\cancel{10} \times \cancel{10}}$$

Dividing by the two tens, you see you will then have the product of three tens, or 10^{3}. The answer is 2×10^{3}, or written in ordinary notation __________.

2,000

215. To divide powers of ten, like $10^{5} \div 10^{2}$, we can <u>subtract</u> the exponent of the division from the exponent of the dividend, and use the difference as the exponent of 10 in the answer.

For example, $10^{5} \div 10^{2} = 10^{5-2} = 10^{3}$.

In $10^{9} \div 10^{5}$, the exponent of 10 in the quotient is _____.

216. In $\frac{10^{8}}{10^{2}}$ the exponent of 10 in the quotient is _____. 4

217. You can do examples like these on the slide rule. You do the subtraction with the X and Y scales. For example, find $10^{7} \div 10^{3}$. Set the hairline over +7 on the X scale. Set the slide so that +3 on Y is under the +7 on X. Over 0 on Y read +4 on X, or _____ on D*. 6

218. When one (or both) of the exponents is negative, the problem is a little harder. However, if you use a slide rule the problem is easy. Find $10^{3} \div 10^{-4}$. Under +3 of X set -4 of Y. Over 0 of Y read _____ on X. 10^{4}

219. Then $10^{3} \div 10^{-4} = 10^{7}$, or in ordinary notation, 1,000 ÷ .0001 = __________. +7

220. Now you can do a harder example. Find .0067 ÷ .032. Write the example in scientific notation. 10,000,000

$$\frac{6.7 \times 10^{-3}}{3.2 \times 10^{-2}}$$

First, divide 6.7 by 3.2 using the C and D scales. The answer is _____.

221. Next, divide $10^{-3} \div 10^{-2}$ using the X and Y scales. Under -3 on X set -2 on Y. Over 0 on X read -1 on X, or _____ on D*. 2.09

10^{-1}

222. Now you have 2.09×10^{-1}. So the final answer is ____.

223. Find $4,200 \div .088$ — .209

In scientific notation, this is

$$\frac{4.2 \times 10^{3}}{8.8 \times 10^{-2}}$$

First, find the quotient of $4.2 \div 8.8$. The result is ____.

224. Next find $10^{3} \div 10^{-2}$. The result is ____. — .477

225. Now you have $.477 \times 10^{5}$. But .477 is not in scientific notation. Changed to scientific notation, it is ________. — 10^{5}

226. Then you have $4.77 \times 10^{-1} \times 10^{5}$. — 4.77×10^{1}

But $10^{-1} \times 10^{5} = 10$ ____.

227. Then in ordinary notation the answer is ________. — 4

228. Here are some more examples for practice. — 47,700

a) $3,240 \times .00039$
b) $.00146 \div 32.8$
c) $2,650 \times .00047$
d) $8,570 \div .0219$
e) $.43 \times .0027$
f) $7,630 \div .0198$
g) $.000478 \times .0069$
h) $.00231 \div 41.3$

a) 1.264
b) .000,044,5
c) 1.245
d) 391,000
e) .001161
f) 385,000
g) .000,003,3
h) .000,055,9

229. Notice the scale named CI on the slide. It is an ordinary C scale but the numbers increase from right to left, instead of left to right. Place the hairline over the right-hand index. If this is read as 1, the left-hand index is read as 10. A small arrow beside the numerals (for example, ‹2, ‹3) will remind you that the CI scale is reversed or "inverted". Place the hairline over 2 on the CI scale. Then the numeral under the hairline on the C scale is ____.

230. Two numbers whose product is 1 are reciprocals. For example, 2 and 1/2 are reciprocals, because $2 \times \frac{1}{2} = 1$. But 1/2 can also be written as .5. So $2 \times .5 = 1$, and 2 and .5 are reciprocals. The reciprocal of 4 is ________. — 5

231. Each number represented on the CI scale is the reciprocal of the number represented just below it on the C scale. Place the hairline over 4 on the C scale. The corresponding reciprocal on CI is ____. — 1/4 or .25

232. Find the reciprocal of 47. Set the hairline over 47 on C. On CI read the reciprocal as ________. — .25

233. Did you have the decimal point correctly placed? Remember, the reciprocal of 47 is $\frac{1}{47}$, because $47 \times \frac{1}{47} = 1$. — .0213

But $\frac{1}{47} = \frac{1 \times 2}{47 \times 2}$. This shows the reciprocal is about $\frac{2}{100}$ or .02. You can also use scientific notation to find the decimal point. The reciprocal of 60 is ________.

.0167

234. Instead of multiplying by a factor, you can divide by the reciprocal of the factor. For example, $7 \times 8 = 7 \div (1/8)$. Suppose that you try to do 7 x 8 on the slide rule by setting the left index of C over 7 on D. Then 8 on C is far "outside the rule". You must move the slide so that the right-hand index of C is over 7 on D. Now, move the hairline to 8 on C. The answer on D is 56.

You can avoid moving the slide "end-for-end" in examples like this by using the CI scale. Let's do 7 x 8 again. This time, move 8 on CI over 7 on D. Under 1 of CI (or C) read _____ on D. You only had to move the slide once this way.

235. Find 53 x 7.9. Notice that if you move the slide to set 1 over either of these numbers, the stick will stick far outside the rule. Place the hairline over 79 on D. Move the slide so 53 on CI is under the hairline. Then under the index of CI read _____ on D. 56

236. Find 84 x 3.1. The answer is _____. 418.

237. The CI scale has other uses. Perhaps you will learn some of them when you study slide rules that have many useful scales that are not on a simple rule. 260

SQUARES OF NUMBERS and SQUARE ROOTS

238. Notice the scale named A **above** the D scale. Place the hairline over 2 of the D scale. Then on the A scale you can read 4 or 2 x 2. Under 3 of D you can read 9 or 3 x 3 on A. The number 9 is the square of 3. The square of 3 can also be written 3^2.

If the left-hand 1 of A is read as 1, the numeral 1 (just to the right of 9) is read 10. **The numerals on A at the right are** now read as 20, 30, 40, etc. The right-hand index of A is then 100.

Place the hairline over 4 on D. The reading under the hairline on A is _____.

239. Find 5^2. Set the hairline over 5 on D. On A, read _____. 16

240. Find 16^2. Set the hairline over 16 on D. On A, read _____. 25

241. Find 48^2. Set the hairline over 48 on D. On A, read _____. 256

242. If you find the square of a one-digit number (like 3 or 7), the square will have either one or two digits. If it is read on the left-hand half of the A scale, it has one digit. $3^2 = 9$. If it is read on the right-hand half of A, it will have two digits. 7^2 will be read on the right half and has _____ digits. 2300.

243. If you find the square of a two-digit number (like 16 or 48), it will have either three or four digits. It will have three digits if it is read from the left-hand half of A. Example: $16^2 = 256$. If it is read from the right-hand half of A it will have _____ digits. 2

4

244. The square of a three-digit number which is read from the left half of A will have _____ digits.

245. The square of 137 is _____. 5

246. The square of a three-digit number which is read from the right half of A will have _____ digits. 18,800

247. The square of 631 is __________. 6

248. You can find the square of any number by remembering how the left-right pattern goes. The squares read from the left half of the A scale have an odd number of digits. The squares read from the right half of the A scale have an even number of digits. 398,000

You can also think of finding squares by ordinary multiplication and using scientific notation to locate the decimal point.

For example $(.37)^2 = .37 \times .37$

Then $3.7 \times 10^{-1} \times 3.7 \times 10^{-1} =$

$3.7 \times 3.7 \times 10^{-1} \times 10^{-1}$

But 3.7×3.7 or $(3.7)^2$ is _____.

249. Then written in scientific notation, $13.7 = 1.37 \times 10^1$. 13.7

Therefore, $(3.7)^2 = 1.37 \times 10^1 \times 10^{-1} \times 10^{-1}$

This is $1.37 \times 10^0 \times 10^{-1}$, or 1.37×10^{-1}.

The answer is _____.

250. Here are some more examples for practice. .137

a) 1.91^2 b) $(19.1)^2$

c) $(5.74)^2$ d) $(48.2)^2$

e) $(.32)^2$ f) 254^2

a) 3.65
b) 365
c) 32.9
d) 2,320
e) .1024
f) 64,500

251. You know that 5 x 5 = 25. Here 5 is one of the two equal factors of 25. The number 25 is the square root of 25. The square root of 16 is _____.

252. You can find square roots easily with the slide rule. The symbol for square root is $\sqrt{}$. Find $\sqrt{9}$. Set the hairline over 9 on the left half of the A scale. Read _____ on the D scale. 4

253. Finding square roots is the opposite of finding squares. You begin on the A scale and end on the D scale. Find $\sqrt{25}$. Since 25 is a 2 digit number, you use the right-hand half of the A scale. Set the hairline over 25 and on D read _____. 3

254. Find $\sqrt{361}$. Since 361 has three digits, it is an "odd-digit number". Use the left-hand half of the A scale. Set 361 on A. Above on D read _____. 5

255. You know the decimal point comes after the 9 in 19 because it takes a two-digit number (19) to have a three digit square (361). Find $\sqrt{4900}$. Set the hairline over 49 on the right-hand half of A. On D, read the square root as _____. 19.

256. You know the answer is 70 and not 7 or 700 because it takes a two-digit number (70) to have a four-digit square (4900). Find $\sqrt{6.4}$. Use the left half of A. Set 6.4 on A, read _____ on D. 70

2.53

257. You see that you can use your knowledge about squares to help you find square roots. If you forget how the scales are related, choose a simple example. You see 3 is on D, and 9 is on A. The number is on D, the square is on _____.

258. If the number is on A, the square root is on _____. A

259. In difficult examples, use scientific notation to help. For D
example, find $\sqrt{.00075}$. Written in scientific notation, .00075 becomes 7.5×10^{-4}. Now you can find $\sqrt{7.5}$ and $\sqrt{10^{-4}}$. First, use A and D to find $\sqrt{7.5}$, which is _____.

260. Now $10^{-2} \times 10^{-2} = 10^{-4}$. That is, one of the two equal factors 2.74
of 10^{-4} is 10^{-2}. So $\sqrt{10^{-4}} = 10^{-2}$.

Then 2.74×10^{-2} = __________.

261. The exponent of the square root of a power of ten is just half .0274
the exponent of the power. For example, if the power is 10^{-4}, the exponent of the square root is 10^{-2}.

To find the square root it is necessary to write the exponent as an "even" number. For example, suppose you want to find $\sqrt{.0075}$. In scientific notation, $.0075 = 7.5 \times 10^{-3}$. The exponent of 10 is not "even", or divisible by 2. You can change it so that exponent is even, but then you have to change the other factor too. For example,

$$.0075 \text{ is } \quad \frac{75}{10,000} = \frac{75}{10^4} = 75 \times 10^{-4}.$$

Now you have 75 instead of 7.5, and 10^{-4} instead of 10^{-3}. You can find $\sqrt{75}$, which is _____.

262. Next find $\sqrt{10^{-4}} = 10^{-2}$. So $\sqrt{.0075} = 8.66 \times 10^{-2}$, or 8.66
in ordinary notation __________.

.0866

263. Here are some more examples for practice.

a) $\sqrt{7.3}$ b) $\sqrt{73}$

c) $\sqrt{450}$ d) $\sqrt{841}$

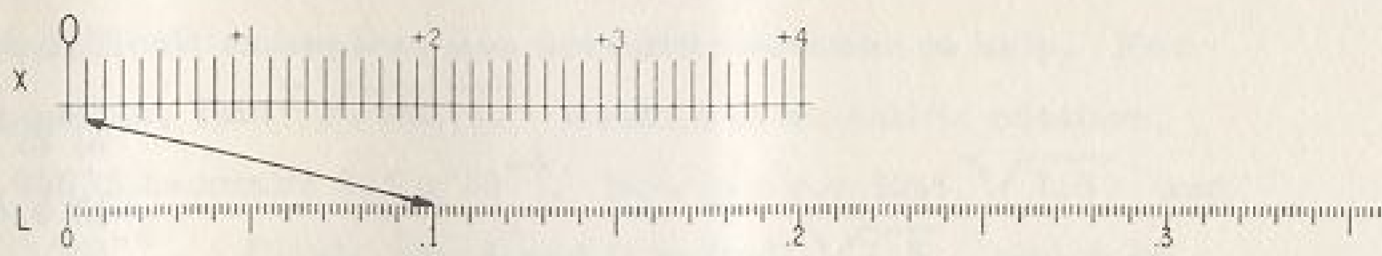
e) $\sqrt{3000}$ f) $\sqrt{3.73}$

g) $\sqrt{.006}$ h) $\sqrt{.062}$

a) 2.7
b) 8.54
c) 21.2
d) 29
e) 54.8
f) 1.93
g) .0775
h) .249

THE L SCALE and LOGARITHMS

264. Notice the scale named L at the bottom of the rule. It is a uniform scale, similar to the X scale and Y scale. In fact, it is like the part of the X scale between 0 and +1, except that it has been magnified or stretched 20 times. The small numeral .1 corresponds to the first little mark after the 0 on X.



The L scale is made to read with the C and D scale. Now you can see that the D scale corresponds to the section of D* between 1 and 10^1, but the D scale is 20 times as long.

You could use the D* to get answers with the decimal point all taken care of. But the answers will not be accurate to much more than one digit. By magnifying the D* scale 20 times, and only using one section between 0 and 1, as is done with the C and D scales, you can read to 3 digits, but you have to place the decimal point by some other method.

The L scale is named L because it is used to get logarithms, which are really just exponents of 10. Set the hairline over 2 of D. Then the hairline is over .301 of L. Now, $2 = 10^{.301}$. Find the logarithm, or exponent of 10 for which the power is 3. Set the hairline over 3 of D. On L, read _____.

265. Now you know that $3 = 10^{.477}$. .477

Do not try to think of this as .477 factors of 10.

But the rules for exponents work all right for numbers expressed this way. For example, $2 \times 3 = 10^{.301} \times 10^{.477}$.

Now we add .301 and .477. The sum is _____.

.778

266. If you place the hairline over .778 of L, you can read 6 on D, and $2 \times 3 = 6$.

On a slide rule, we multiply by adding logarithms, or exponents.

Logarithms have many uses. You can learn more about them in high school. If you do, then the way a slide rule is made and the reason it works can be explained.

PICKETT
ALL-METAL SLIDE RULES

THESE ARE THE REASONS FOR PICKETT PREFERENCE

1) ALL-METAL CONSTRUCTION Pickett Slide Rules are dimensionally stable. Regardless of heat or cold, dry or damp, they never warp or stick. Smooth operation is assured in all climatic conditions.

2) EYE-SAVER "5600" YELLOW COLOR The exclusive Pickett yellow-green finish makes it easy to read scales, even in bright sunlight. Eye-fatigue is sharply reduced and visual accuracy improves. White finish is also available on most models.

3) MICRO-DIVIDED SCALES Precision to ±2 microns (.000157 inch) makes Pickett All-Metal Slide Rules "The World's Most Accurate."

4) FUNCTIONAL SCALE GROUPING Scales are positioned so as to provide quick solutions to problems through a minimum of steps or operations. Trig scales are always on the slide; extended Log Log scales are on one side; extended root scales $\sqrt{}$ and $\sqrt[3]{}$ are on upper bar for most efficient use.

5) SYNCHRO-SCALE DESIGN Mated scales are "back-to-back" so the eyes more easily focus on the correct scale. This convenient arrangement aids quick reference and easy reading.

6) EZE-SLIDER TENSION SPRINGS Spring tension is maintained at both ends to assure smooth operation in any climate throughout the length of the slide rule, with minimum adjustment.

7) NYLON CURSORS End-bearing cursors always function smoothly. The special Tyril plastic window has a super-sharp hairline, is extremely durable and provides clear, distortion-free reading.

8) TOP GRAIN LEATHER CASES The 10-inch slide rule cases have a formed plastic protective liner; the 6-inch slide rule cases have a leather jacketed spring steel pocket clip and E-Z-Out pull tab. All of these are Pickett innovations that enhance the value of treated, select leathers.

HOW TO ADJUST YOUR SLIDE RULE

Each rule is accurately adjusted before it leaves the factory. However, handling during shipment, dropping the rule, or a series of jars may loosen the adjusting screws and throw the scales out of alignment. Follow these simple directions for slide rule adjustment.

CURSOR WINDOW HAIRLINE ADJUSTMENT

Line up the hairline on one side of the rule at a time.

1. Lay rule on flat surface and loosen adjusting screws in end plates.
2. Line up C index with D index. Then align DF (or A) index with CF (or B) index.
3. Tighten screws in end plates.
4. Loosen cursor window screws. Slip a narrow strip of thin cardboard (or 3 or 4 narrow strips of paper) under center of window.
5. Align hairline with D and DF (or D and A) indices, and tighten cursor window screws. Check to see that *window surfaces do not touch or rub against rule surfaces.*

Note: The narrow strip of cardboard under the window will prevent possible distortion or "bowing in" of the window when screws are tightened. "Bowing in" may cause rubbing of window against rule surface with resultant wear or scratches.

Line up hairline on reverse side of rule.

1. Loosen all 6 cursor window screws.
2. Place narrow strip of thin cardboard under window to prevent "Bowing in" when screws are tightened.
3. Align hairline and indices on first side of rule, then turn rule over carefully to avoid moving cursor.
4. Align hairline with indices and tighten cursor screws.
5. Check to see that window surfaces do not touch surfaces of rule during operation.

SLIDER TENSION ADJUSTMENT • Loosen adjustment screws on end brackets; regulate tension of slider, tighten the screws using care not to misalign the scales. The adjustment needed may be a fraction of a thousandth of an inch, and several tries may be necessary to get perfect slider action.

SCALE LINE-UP ADJUSTMENTS • (1) Move slider until indices of C and D scales coincide. (2) Move cursor to one end. (3) Place rule on flat surface with face uppermost. (4) Loosen end plate adjusting screw slightly. (5) Adjust upper portion of rule until graduations on DF scale coincide with corresponding graduations on CF scale. (6) Tighten screws in end plates.

REPLACEABLE ADJUSTING SCREWS • All Pickett All-Metal rules are equipped with Telescopic Adjusting Screws. In adjusting your rule, if you should strip the threads on one of the Adjusting Screws, simply "push out" the female portion of the screw and replace with a new screw obtainable from your dealer, or from the factory. We do not recommend replacing only the male or female portion of the screw.

HOW TO KEEP YOUR SLIDE RULE IN CONDITION

OPERATION • Always hold your rule between thumb and forefinger at the ENDS of the rule. This will insure free, smooth movement of the slider. Holding your rule at the center tends to bind the slider and hinder its free movement.

CLEANING • Wash surface of the rule with a non-abrasive soap and water when cleaning the scales.

LUBRICATION • The metal edges of your slide rule will require lubrication from time to time. To lubricate, put a *little* white petroleum jelly (White Vaseline) on the edges and move the slider back and forth several times. Wipe off any excess lubricant. *Do not use ordinary oil as it may eventually discolor rule surfaces.*

LEATHER CASE CARE • Your Leather Slide Rule Case is made of the finest top-grain, genuine California Saddle Leather. This leather is slow-tanned using the natural tanbark from the rare Lithocarpus Oak which grows only in California. It polishes more and more with use and age.

To clean your case and to keep the leather pliable and in perfect condition, rub in a good harness soap such as Propert's Harness Soap.

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