

Chapter 3

MULTIPLICATION AND DIVISION (C AND D SCALES)

3.1 Slide rule adds and subtracts lengths

The slide rule is an instrument which is designed to add or subtract lengths. If these lengths are proportional to the logarithms of numbers, it follows that adding such lengths corresponds to multiplying numbers, whereas subtracting the lengths corresponds to dividing numbers. The C and D scales are the basic scales used in these operations.

3.2 Multiplication of two numbers

The mechanics of multiplication may be illustrated by the following examples:

Example 1: $2 \times 4 = ?$ (Figure 3.1)

1. Set left index of C opposite 2 on D.
2. Move hairline over 4 on C.
3. Under hairline read "8" on D.

Essentially, we have performed the multiplication by adding logarithms:

$$\log 2 + \log 4 = \log(2 \cdot 4) = \log 8$$

More properly, we should state that the lengths which are added or subtracted are proportional to the *mantissas* of the logarithms. Thus, the slide rule combines the mantissas only and does not account for the characteristic. This is why the slide rule fails to locate the decimal point.

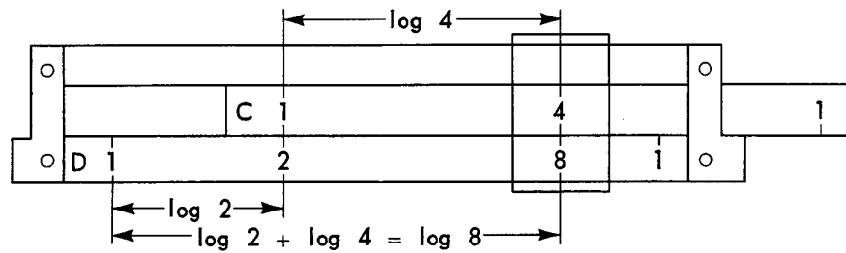


Figure 3.1

Example 2: $16 \times 3 = ?$ (Figure 3.2)

1. Set left index of C opposite 16 on D.
2. Move HL (hairline) over 3 on C.
3. Under HL read "480" on D. Answer is **48**.

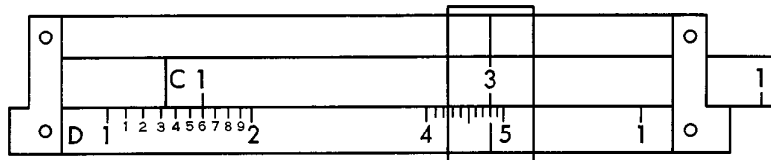


Figure 3.2

Example 3: $20.3 \times 3.86 = ?$

1. Set left index of C opposite 203 on D.
2. Move HL over 386 on C.
3. Under HL read "784" on D.

Rounding off: $20.3 \times 3.86 \approx 20 \times 4 = 80$. Answer must be **78.4**.

Example 4: $1765 \times .0000422 = ?$

1. Set left index of C opposite 1765 on D.
2. Move HL over 422 on C.
3. Under HL read "745" on D.

Shifting decimal points and rounding off:

$1765 \times .0000422 = 1.765 \times .0422 \approx 2 \times .04 = .08$. Answer must be **.0745**.

Example 5: 18.35% of 276 is ?

This corresponds to the product 0.1835×276 .

1. Set left index of C opposite 1835 on D.

2. Move HL over 276 on C.
3. Under HL read "506" on D.

Rounding off: $0.1835 \times 276 \approx 0.2 \times 300 = 60$. Answer must be **50.6**.

The foregoing examples illustrate the general procedure:

To multiply two numbers:

1. Disregard the decimal point and set the index of C over one of the numbers on D.
2. Move HL over the other number on C.
3. Under HL read answer on D.
4. Locate decimal point in answer.

Exercise 3-1

- | | |
|-----------------------------|-----------------------------------|
| 1. $1.8 \times 3.6 =$ | 11. 17.7% of 234 = |
| 2. $2.4 \times 2.2 =$ "528" | 12. $2.07 \times 3.26 =$ "675" |
| 3. $1.4 \times 5.8 =$ | 13. $10.75 \times 6.42 =$ |
| 4. $15 \times 4.7 =$ "705" | 14. 23.4% of 26.3 = "615" |
| 5. $28 \times 3.7 =$ | 15. 29.6% of 308 = |
| 6. $2.2 \times 35 =$ "770" | 16. $1.245 \times 14.7 =$ "1830" |
| 7. $1.4 \times 5.2 =$ | 17. $284 \times 1855 =$ |
| 8. 11% of 175 = "1925" | 18. $196 \times .0000207 =$ "406" |
| 9. $28 \times 3.3 =$ | 19. $1145 \times .000641 =$ |
| 10. $14 \times 2.6 =$ "364" | 20. $.000143 \times 463 =$ "662" |

3.3 Either index may be used

Consider the product 5×0.4 . If the left index of C is set opposite 5 on D, it is found that the number 4 is on the part of the C scale that projects beyond the right index of the D scale; thus it is impossible to read the answer on D. (Figure 3.3).

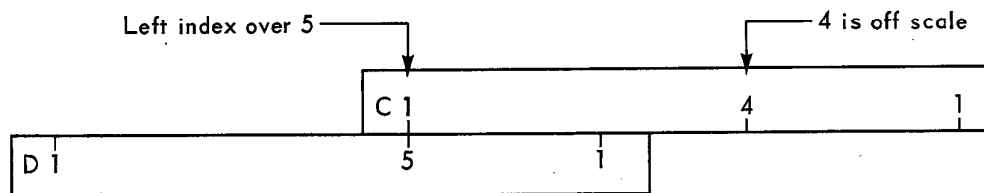


Figure 3.3

If we could somehow extend the D scale for another cycle, the answer would be located on this "extended" scale as shown in Figure 3.4.

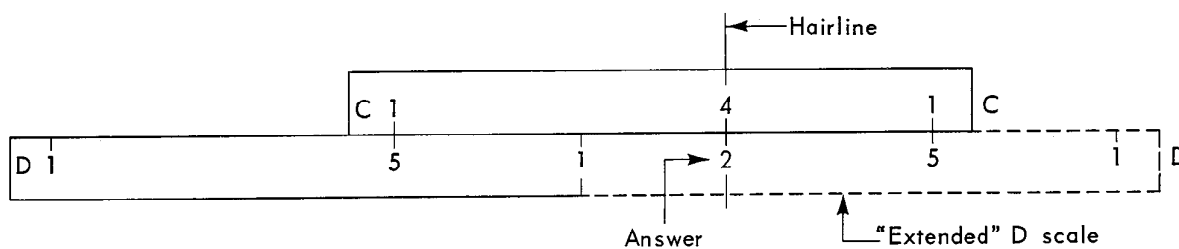


Figure 3.4

Now in Figure 3.4, note that the right index of C is opposite 5 on the "extended" scale. It is clear that the same multiplication may be accomplished by setting the *right* index of C opposite 5 on D, moving the hairline over 4 on C, and reading the result on D. This equivalent operation is illustrated in Figure 3.5.

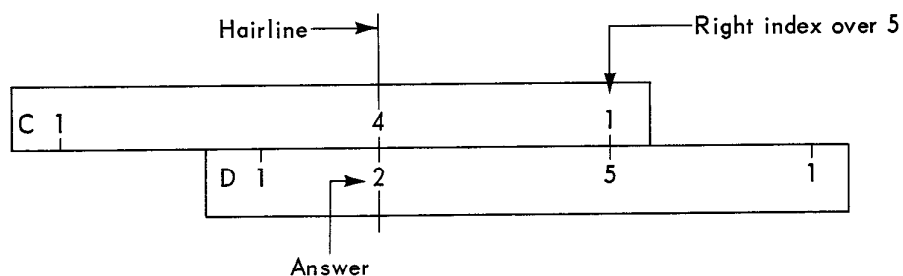


Figure 3.5

We summarize with the following statement:

When multiplying two numbers, make the first setting with *either* the *left* or *right* index of C, whichever one will ensure that the answer can be read on the D scale.

Example 1: $9 \times .04 = ?$ (Figure 3.6)

1. Set right index of C opposite 9 on D.
2. Move HL over 4 on C.
3. Under HL read "360" on D. Answer is **0.36**.

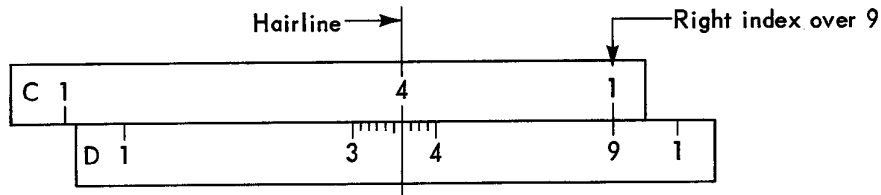


Figure 3.6

Example 2: $5.43 \times 3.26 = ?$

Again, the right index must be used.

1. Set right index of C opposite 543 on D.
2. Move HL over 326 on C.
3. Under HL read "1770" on D.

By inspection, answer must be **17.70**.

Exercise 3-2

- | | |
|------------------------------|----------------------------------|
| 1. $6.5 \times 4.2 =$ | 11. $0.74 \times 367 =$ |
| 2. $5.6 \times 5.7 =$ "319" | 12. $6.90 \times 22.4 =$ "1546" |
| 3. $8.4 \times 7.6 =$ | 13. $485 \times 2.53 =$ |
| 4. $93 \times 1.7 =$ "1581" | 14. $65.4 \times 0.392 =$ "256" |
| 5. $4.6 \times 3.2 =$ | 15. $8360 \times .0206 =$ |
| 6. 37% of 475 = "1758" | 16. $7.14 \times 64.0 =$ "457" |
| 7. 56% of 26.7 = | 17. $46.5 \times 31.2 =$ |
| 8. 43% of 3240 = "1393" | 18. $.00945 \times 50.6 =$ "478" |
| 9. $6.25 \times 3.40 =$ | 19. $.000486 \times 366 =$ |
| 10. $56 \times 40.7 =$ "228" | 20. $408 \times 71.2 =$ "290" |

3.4 Excessive extension of slide should be avoided

In multiplying two numbers, there is always a choice as to the order in which they are multiplied. Often, if the numbers are multiplied in one way the slide will extend far out of the body, whereas if the order is reversed this will not be the case. It is good practice in all slide rule operations to try to keep at least one half of the slide within the body.

Example 1: $38.4 \times .01245 = ?$

Note that if the left index of C is set opposite 384 on D, the slide extends far to the right; hence, it is better to begin by setting the index opposite 1245:

1. Set left index of C opposite 1245 on D.
2. Move HL over 384 on C.
3. Under HL read "478" on D. Answer is **0.478**.

Example 2: $2.43 \times 8.16 = ?$

Here, the right index of C must be used, and the smaller extension of the slide occurs when the right index is set opposite 8.16:

1. Set right index of C opposite 816 on D.
2. Move HL over 243 on C.
3. Under HL read "1983" on D. Answer is **19.83**.

Exercise 3-3

- | | |
|--------------------------------|---------------------------------|
| 1. $1.6 \times 23 =$ | 11. $8.2 \times 4.06 =$ |
| 2. $3.7 \times 12 =$ "444" | 12. $71.2 \times 6.44 =$ "459" |
| 3. $2.1 \times 25 =$ | 13. $21 \times 63 =$ |
| 4. $43 \times 10.2 =$ "439" | 14. $185 \times 0.74 =$ "1369" |
| 5. $5.6 \times 11 =$ | 15. $4.66 \times 14.3 =$ |
| 6. $6.3 \times 13 =$ "819" | 16. $7.24 \times 10.65 =$ "771" |
| 7. $230 \times 3.2 =$ | 17. $27.5 \times 61 =$ |
| 8. $15 \times 19 =$ "285" | 18. $4.2 \times 83.6 =$ "351" |
| 9. $27 \times 32 =$ | 19. $35.1 \times 0.22 =$ |
| 10. $5.6 \times 3.24 =$ "1814" | 20. $55 \times 3.7 =$ "204" |

- | | |
|----------------------------------|---------------------------------------|
| 21. $7.6 \times 10.45 =$ | 46. $5020 \times .00318 =$ "1596" |
| 22. $43 \times 2.07 =$ "890" | 47. $750 \times .0222 =$ |
| 23. $0.634 \times 824 =$ | 48. $1085 \times 0.986 =$ "1070" |
| 24. $12 \times 26.1 =$ "313" | 49. $.0784 \times .001135 =$ |
| 25. $36.2 \times 0.209 =$ | 50. $436 \times 2160 =$ "942" |
| 26. $2.57 \times 42.6 =$ "1095" | 51. $34,600 \times .000375 =$ |
| 27. $3.75 \times 92.5 =$ | 52. $.00643 \times .00912 =$ "586" |
| 28. $9.38 \times 18.8 =$ "1763" | 53. $92.2 \times 1250 =$ |
| 29. $32.6 \times 3.15 =$ | 54. $.000254 \times 412,000 =$ "1046" |
| 30. $25.3 \times 9.06 =$ "229" | 55. $34.2 \times .00664 =$ |
| 31. $2.84 \times 56.7 =$ | 56. $20.7 \times 87.4 =$ "1809" |
| 32. $3150 \times 2.70 =$ "851" | 57. $.00417 \times .0505 =$ |
| 33. $7.33 \times 11.85 =$ | 58. $63,200 \times .0001095 =$ "692" |
| 34. $30.4 \times 7.56 =$ "230" | 59. $.0759 \times .0759 =$ |
| 35. $0.466 \times 50.2 =$ | 60. $(195)^2 =$ "380" |
| 36. $15.45 \times 8.05 =$ "1244" | 61. $.000612 \times 56.7 =$ |
| 37. $623 \times 0.124 =$ | 62. 24.2% of $83.6 =$ "202" |
| 38. $5.77 \times 5.77 =$ "333" | 63. 11.55% of $4310 =$ |
| 39. $21.8 \times 21.8 =$ | 64. 75.2% of $.0905 =$ "681" |
| 40. $2.56 \times .00304 =$ "778" | 65. 43.6% of $7.62 =$ |
| 41. $.0245 \times 432 =$ | 66. 2.07% of $520 =$ "1076" |
| 42. $1015 \times .00726 =$ "737" | 67. 33.3% of $1545 =$ |
| 43. $6.32 \times .00124 =$ | 68. 123% of $.0842 =$ "1036" |
| 44. $362 \times 243 =$ "880" | 69. 3.05% of $23,400 =$ |
| 45. $175 \times 63.4 =$ | 70. 0.62% of $835 =$ "518" |

3.5 Division

Division is the inverse of multiplication, and is illustrated by the following examples:

Example 1: $\frac{6}{3} = ?$ (Figure 3.7).

1. Move HL over 6 on D.
2. Slide 3 on C under HL.
3. Opposite left index of C read "200" on D. Answer is **2**.

Analysing this operation, it is clear that we have simply found the number which must multiply 3 to give 6. Also from Figure 3.7, it can be seen that the answer is located at $(\log 6 - \log 3)$; hence, we have essentially performed the division by subtracting logarithms:

$$\log 6 - \log 3 = \log(6 \div 3) = \log 2$$

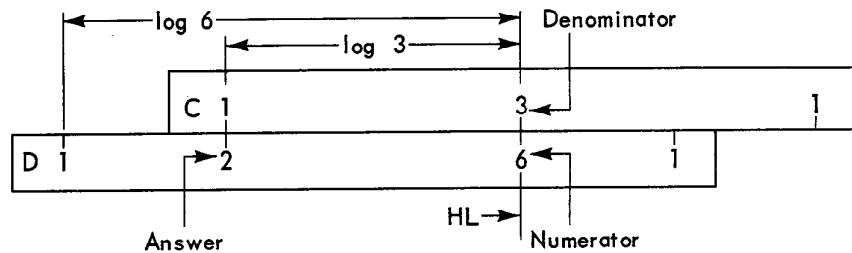


Figure 3.7

Note especially that the hairline is first moved over the *numerator* on *D*, the denominator is then pushed under the hairline on *C*, and the answer appears opposite the *C* index on *D*.

Example 2: $\frac{3}{5} = ?$ (Figure 3.8).

1. Move HL over 3 on D.
2. Slide 5 on C under HL.
3. Opposite right index of C read "600" on D. Answer is **0.6**.

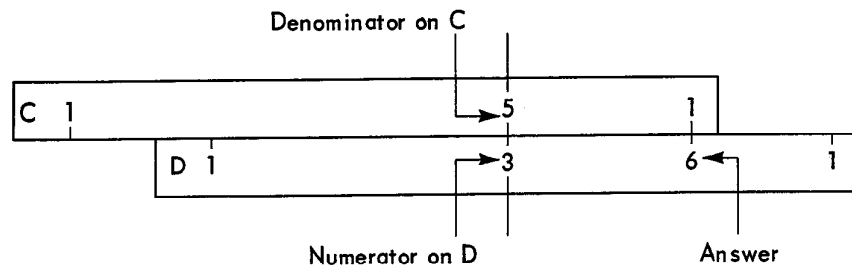


Figure 3.8

Example 3: $\frac{5.74}{3420} = ?$

1. Move HL over 574 on D.
2. Slide 342 on C under HL.
3. Opposite left index of C read "1678" on D.

Write: $\frac{5.74}{3420} = \frac{.00574}{3.42} \approx \frac{.006}{3} = .002$. Answer must be **.001678**.

Example 4: $312 \div 4.75 = ?$

1. Move HL over 312 on D.
2. Slide 475 on C under HL.
3. Opposite right index of C read "657" on D. Answer is **65.7**.

The procedure may be summarized:

To divide two numbers:

1. Disregard the decimal points, and move the hairline over the *numerator* on the *D scale*.
2. Move the slide so that the *denominator* on the *C scale* is under the hairline.
3. Read the answer on D opposite the right or left index of C, whichever is on scale.
4. Locate the decimal point in the answer.

Notice that there is only one order in which division may be performed using the C and D scales and, unlike multiplication, there is no possibility of the answer being off scale. However, there are certain combinations which will result in excessive slide extension. For example, if 11 is divided by 9, the slide must be moved almost entirely out of the body. As will be shown later, this may be avoided by using the inverted or folded scale.

Exercise 3-4

1. $\frac{62}{28} =$

3. $\frac{84}{25} =$

5. $\frac{13}{21} =$

2. $\frac{47}{19} =$ "247"

4. $\frac{364}{142} =$ "256"

6. $\frac{66}{145} =$ "455"

7. $\frac{1075}{240} =$

20. $\frac{30.9}{5.24} = \text{"590"}$

33. $\frac{82.4}{524} =$

8. $\frac{520}{45} = \text{"1155"}$

21. $\frac{1255}{63.1} =$

34. $\frac{9.46}{102} = \text{"927"}$

9. $\frac{17.6}{4.2} =$

22. $\frac{420}{312} = \text{"1346"}$

35. $\frac{395}{48.2} =$

10. $\frac{82.7}{31.6} = \text{"262"}$

23. $\frac{5640}{2.03} =$

36. $\frac{26.2}{0.124} = \text{"211"}$

11. $\frac{143.5}{54} =$

24. $\frac{67.7}{7.22} = \text{"938"}$

37. $\frac{3.14}{16.4} =$

12. $\frac{12.45}{3.26} = \text{"382"}$

25. $\frac{105.7}{82.4} =$

38. $\frac{295}{3600} = \text{"819"}$

13. $\frac{282}{12} =$

26. $\frac{62.7}{2.54} = \text{"247"}$

39. $\frac{32.4}{.0288} =$

14. $\frac{36}{4.1} = \text{"878"}$

27. $\frac{1945}{364} =$

40. $\frac{7.59}{248} = \text{"306"}$

15. $\frac{756}{204} =$

28. $\frac{29.2}{11.43} = \text{"255"}$

41. $\frac{920}{1436} =$

16. $\frac{20.4}{5.66} = \text{"360"}$

29. $\frac{71.9}{27.4} =$

42. $\frac{3.24}{56,500} = \text{"573"}$

17. $\frac{38.4}{12.1} =$

30. $\frac{9.98}{5.04} = \text{"1980"}$

43. $\frac{.00421}{2.17} =$

18. $\frac{902}{23.1} = \text{"390"}$

31. $\frac{1}{175} =$

44. $\frac{754}{.00233} = \text{"323"}$

19. $\frac{82.4}{27.4} =$

32. $\frac{.01}{76.6} = \text{"1305"}$

45. $\frac{24.6}{.0824} =$

46. $\frac{368}{28.2} = \text{"1305"}$

50. $\frac{62,700}{382} = \text{"1641"}$

47. $\frac{1045}{54,200} =$

51. $\frac{.00944}{543} =$

48. $\frac{.000411}{.0613} = \text{"671"}$

52. $\frac{237}{472,000} = \text{"502"}$

49. $\frac{7240}{39.2} =$

53. $164.5 \div 3.14 =$

54. $100 \div 3750 = \text{"267"}$

55. $28.2 \div .000466 =$

56. $3.99 \div 46.2 = \text{"863"}$

57. $783 \div 9020 =$

58. $\frac{1}{49.2} = \text{"203"}$

59. $\frac{.0504}{1675} =$

60. $\frac{72,100}{.0234} = \text{"308"}$

61. $\frac{3.14}{3620} =$

62. $\frac{1000}{0.461} = \text{"217"}$

63. $\frac{27.9}{0.123} =$

64. $\frac{49,200}{32.1} = \text{"1533"}$

65. $\frac{.00723}{.0211} =$

66. $\frac{4300}{.0182} = \text{"236"}$

67. $\frac{74,600}{25.2} =$

68. $\frac{.00207}{.000523} = \text{"396"}$

69. $\frac{74.5}{4300} =$

70. $\frac{2.43}{.00071} = \text{"342"}$

71. $\frac{5640}{0.920} =$

72. $\frac{293}{.0823} = \text{"356"}$

73. $\frac{0.411}{.00624} =$

74. $\frac{9430}{.0912} = \text{"1034"}$

75. $\frac{.00593}{2.66} =$

76. 4.67 is 35% of _____

77. 34.5 is 71.4% of _____

78. 16.25 is _____% of 23.4

79. .0744 is _____% of .0913

80. 234 is 123% of _____

81. 1.345 is _____% of 12.68

82. 57.4 is _____% of 41.6

83. 6430 is 74.2% of _____

84. 307,000 is 0.214% of _____

85. .0062 is _____% of 37.6