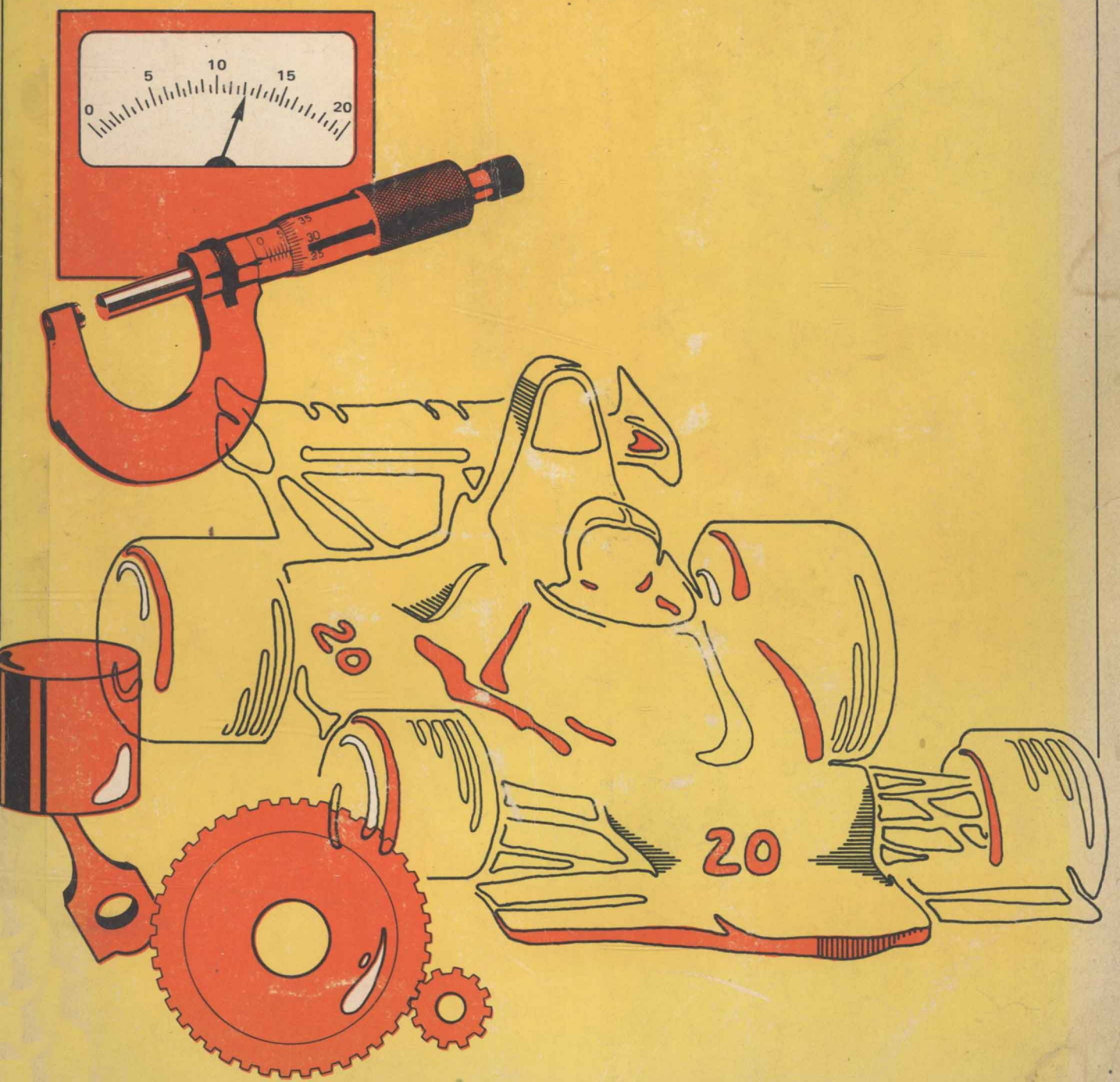
MATHEMATICS FOR AUTO MECHANICS

T.G. Hendrix
C.S. La Fevor



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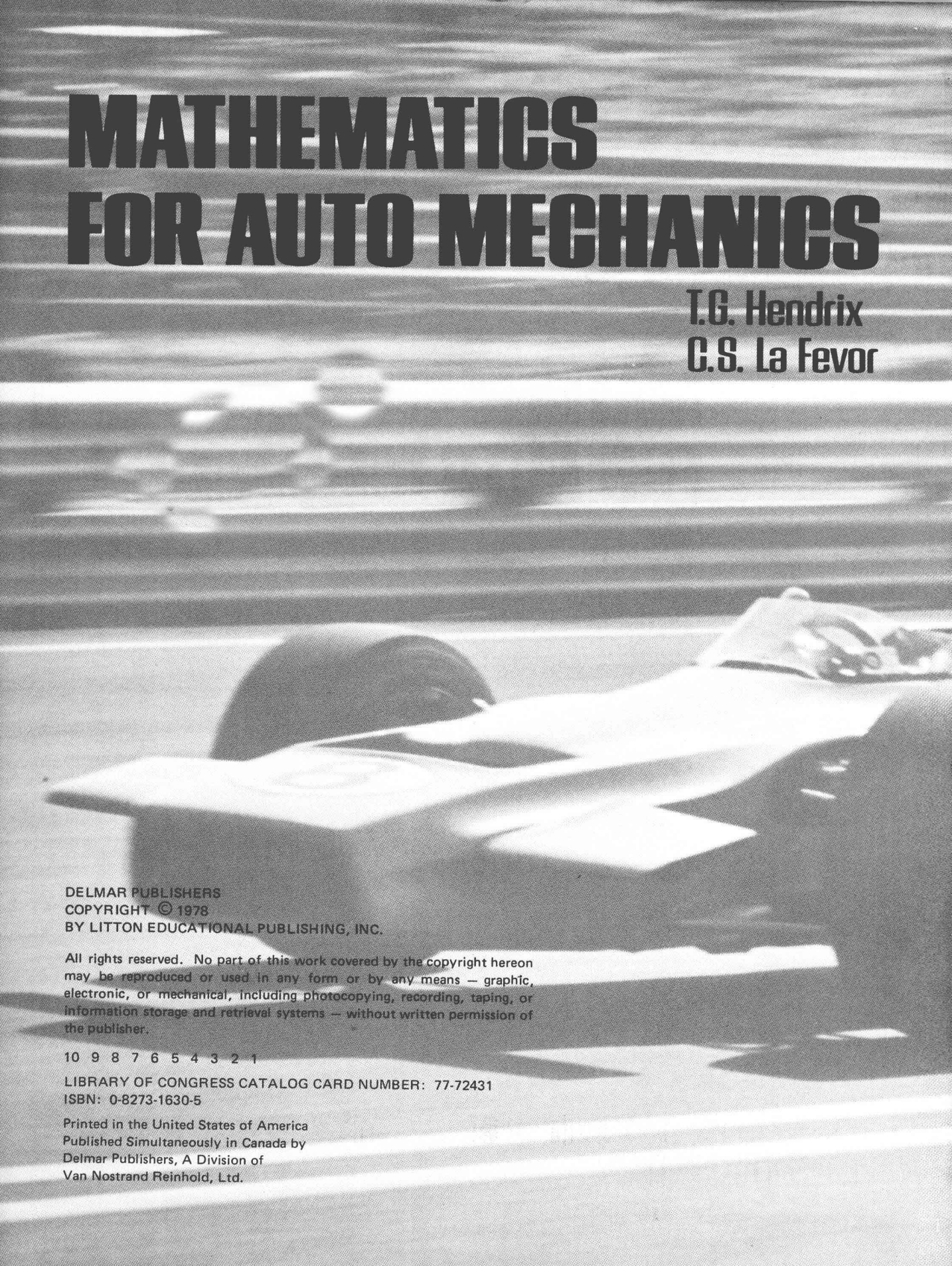

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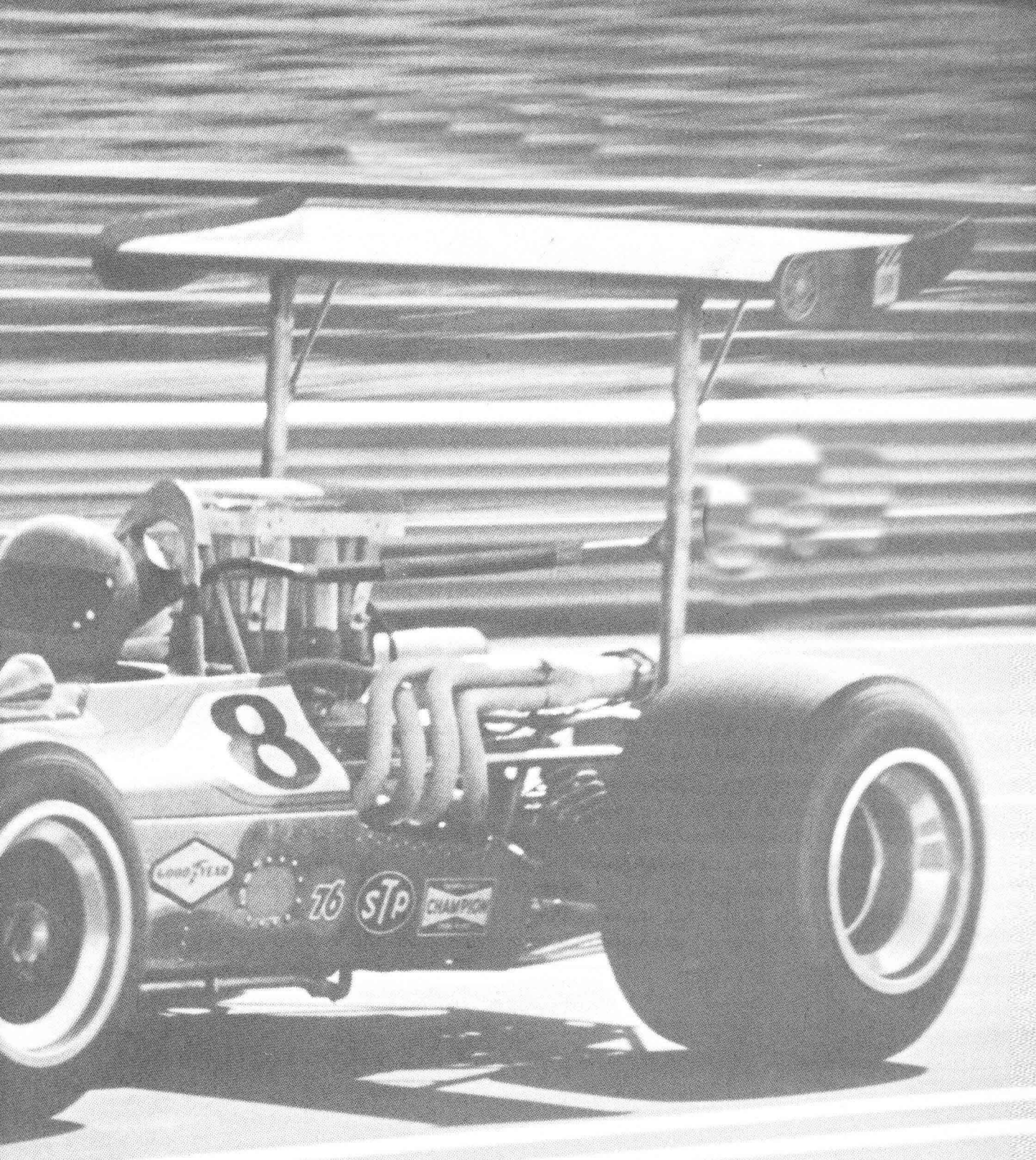

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Preface

Mathematical skills serve as the foundation for many occupations. Basic facts and operations with whole numbers, common fractions, decimal fractions, and systems of measurement underlie the technology in all fields of specialization. A student pursuing a career in the automotive industry must develop many skills on many different levels. Each of these skills is extremely important to the consumer the automotive mechanic serves. MATHEMATICS FOR AUTO MECHANICS fills the need for mathematical learning experiences, which, in turn, motivate the student.

MATHEMATICS FOR AUTO MECHANICS is intended for use in an introductory course. This text is organized following the logic of developmental mathematics. Thus, the instructor is able to select materials that fulfill the students' needs. Care has been taken to insure that the student learns mathematical principles which hold true throughout the students' technical studies. To accomplish this, drill and practice exercises immediately follow the presentation of a mathematical concept. Verbal problems provide practical applications in the field of auto mechanics. The student is clearly introduced to new terms because each new term is italicized and defined on the first usage. For quick reference, important rules are marked with the symbol ▲ .

All reading material is prepared at a controlled reading level and is accompanied by many illustrations. To enable the student to refer back to prior work, space is provided for the computation of many problems. Space is available for all answers. Safety reminders and caution notices are set off from the text to emphasize their importance to the auto mechanic.

Sections in algebra, geometry, and trigonometry are included for optional use by the instructor. These units include many basic facts and relationships which enable the student to achieve a better understanding of more advanced mathematical applications as they relate to automotive equipment. The material is geared to the automotive field, especially in the area of steering geometry, with special emphasis on the mathematics involved in the alignment of an automobile. The Appendix

contains only those charts which are necessary for the use of this text. Other charts are provided in the text material.

For the convenience of the instructor, the Instructor's Guide includes all answers, some complete solutions, helpful hints, nine tests to be used to measure periodic achievement, and a final comprehensive test. All tests may be reproduced by the teacher for classroom use.

The authors have many years of combined experience as academic mathematics teachers, as well as vocational mathematics instructors. Currently they are teaching mathematics courses at McMinnville Area Vocational-Technical School, McMinnville, Tennessee. Automotive instructors at the same institution have reviewed this material. Consultant, G. Moore, Aims Community College, Greeley, Colorado, has also made many contributions to this text.

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MERCHANDISING MATHEMATICS

To the Teacher

MATHEMATICS FOR AUTO MECHANICS is the result of our teaching experience and research in the field of mathematics related to auto mechanics. This text is written from the approach of first understanding the mathematical concept, then making the application. The topics of this text range from basic arithmetic essentials to practical computation to the fundamentals of geometry and trigonometry. With this text, prerequisites are unnecessary as each unit is based on previous units. Every effort has been made to present examples, illustrations, and problems meaningful to the student and of value for self-instruction and classwork.

The Instructor's Guide provides solutions and answers for all problems. We developed a series of ten tests (with answers) to accompany this text, with the last test being a comprehensive final. These tests can be used to determine existing skills as well as acquired skills.

We have always been critical of errors in textbooks. Although every attempt has been made to prevent errors in this text, we realize they occur. Therefore, corrections, suggestions, and constructive criticism from the users of this text are appreciated.

T. G. Hendrix

C. S. LaFevor

To the Student

MATHEMATICS FOR AUTO MECHANICS is a textbook on practical mathematics as applied to auto mechanics. An understanding of mathematics gives the auto mechanic better insight into automotive theory and principles which are mathematically based. Our approach in this text is to present the mathematical concept first, then make the application. Each unit is based on the previous unit, thus it is important to study each topic, and then check your understanding by completing the exercise.

We know that students, too, can be helpful critics of a text. We welcome your suggestions and comments. We hope this text can give you a better understanding of both mathematics and auto mechanics.

T. G. Hendrix

C. S. LaFevor

Contents

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SECTION 2 PERCENT; POWERS AND ROOTS; RATIO AND PROPORTION

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SECTION 1
Arithmetic

Unit 1
Basic Operations with Whole Numbers

OBJECTIVES

After studying this unit the student should be able to

- Identify the place values of whole numbers.
- Read and write whole numbers.
- Round whole numbers.
- Perform the operations of addition, subtraction, multiplication, and division with whole numbers.
- Identify prime and composite numbers.
- Make practical applications of whole numbers.

The system of whole numbers uses only ten digits. These ten digits – 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0 – are the symbols used to represent numbers that are needed daily.

PLACE VALUE OF WHOLE NUMBERS

The *value* (worth) of a whole number is determined by the position of its digits. The values of 39 and 93 are not the same although both contain the same digits. The number system has an assigned *place value* for each position. The place values must be known in order to read and write any number.

Fig. 1-1 Figures are added every day.

READING AND WRITING WHOLE NUMBERS

When whole numbers are read or written in words, place values are identified so

Billions			Millions			Thousands			Units		
hundred billions	ten billions	billions	hundred millions	ten millions	millions	hundred thousands	ten thousands	thousands	hundreds	tens	ones or units
2	7	4,	5	4	9,	1	8	3,	7	6	5

Fig. 1-2 Place value chart

that a number has only one meaning. In a number of four or more digits, a comma is used to separate each group of three digits, counting from the right to the left. A large number is then more easily read. A hyphen (-) is used with two-word numbers from twenty-one to ninety-nine. The word 'and' is not used in whole numbers.

Examples:

Write the numerical symbol for each of the following:

thirty-five 35
seven hundred twelve 712
nine hundred fifty-eight 958
nine thousand, two hundred five 9,205
five million, twenty-four thousand, seven 5,024,007
two hundred seven thousand, three hundred 207,300
ninety billion, one hundred thousand 90,000,100,000
fifteen hundred 1,500
one thousand, five hundred 1,500

Exercise 1-1

Write the following whole numbers in words:

1. 27 _____
2. 921 _____
3. 2,030 _____

4. 27,541 _____
5. 7,296 _____
6. 292,000 _____
7. 6,705,500 _____
8. 706 _____
9. 59,002,911 _____
10. 60,000 _____
11. 1,300 _____
12. 16,000,200,000 _____

Write the numerical symbols for each of the following:

13. twelve hundred _____
14. fifty-nine _____
15. three hundred twenty-four _____
16. seven thousand, twelve _____
17. sixty-two thousand, one hundred _____
18. one hundred fifty-six thousand, eighty _____
19. sixteen billion, forty-six thousand _____
20. two hundred two thousand, two hundred _____
21. thirty-one thousand, four hundred twenty _____
22. seven billion _____
23. nine hundred eighteen _____
24. twenty-four hundred twenty-four _____

ROUNDING WHOLE NUMBERS

Numbers are rounded in order to give an approximate value. For example, if 5,618 is rounded to the nearest thousand, then one can tell whether 5,618 is closer to 5,000 or 6,000.

First, locate the place value to which the number is being rounded. The digits to the left of the indicated place value remain the same. Write a zero for each digit to the right of the indicated place. Second, determine whether the first digit replaced by a zero is more or less than 5. If it is less than 5, the digit in the indicated place remains the same. If it is 5 or more, then increase the digit in the required place by 1.

Note: This is the most common method of rounding numbers. It is the method which is used throughout this text.

Following are some examples of rounding whole numbers. In each example, the place to which the number is being rounded is underlined.

Examples:

521 rounded to the nearest ten (52̲1) 520
1,695 rounded to the nearest hundred (1,6̲95) 1,700
831 rounded to the nearest hundred (8̲31) 800
17,925 rounded to the nearest thousand (17̲,925) 18,000
199,506 rounded to the nearest thousand (199̲,506) . . 200,000

Exercise 1-2

Round each of the following to the nearest indicated place value.

Ten:

1. 39 _____
2. 42 _____
3. 365 _____
4. 1,854 _____

Hundred:

5. 204 _____
6. 396 _____
7. 5,099 _____
8. 4,444 _____

Thousand:

9. 2,694 _____
10. 9,999 _____
11. 23,099 _____
12. 156,230 _____

Ten thousand:

13. 265,660 _____
14. 390,261 _____

Million:

15. 39,000,999 _____
16. 1,146,890 _____

ADDITION OF WHOLE NUMBERS

The *plus sign* (+) indicates the operation of addition. In an addition problem, the numbers added are called *addends.* The answer is called the *sum.*

To add whole numbers, write the numbers with units under units, tens under tens, etc. Add each column of numbers starting with the units column. If the sum of any column is ten or more, write the last digit under the column that is being added, and add (carry) the other number to the next column to the left.

The sum in addition can be checked. One method finds the sum of each column according to its place value. Then all of these are totaled. Another method of

checking addition is to add the numbers in the reverse order because addition can be performed in any order with the same result. Both methods are illustrated in the following examples.

Examples:

Add and check.

1. 138 + 896 + 219

	Check: (Sum of place value totals)
138 addend	23 sum of value of units column
896 addend	130 sum of value of tens column
+ 219 addend	+ 1,100 sum of value of hundreds column
1,253 sum	1,253 sum

2. 1,065 + 117 + 93

	Check: (Sum in reverse order)
1,065	93
117	117
+ 93	+ 1,065
1,275	1,275

Exercise 1-3

Add and check.

1. 5
6
+ 7

2. 76
21
+ 60

3. 300
761
+ 28

4. 30
189
+ 22

5. 6,811
41
392
+ 6,706

6. 2,389
3,716
2,000
+ 7,020

7. 63,500
4,821
9,008
+ 6,121

8. 23,666
729
506,100
+ 2,987

9. 297 + 20 + 512 = _____

10. 69,712 + 54 + 308 = _____

11. 29 + 75 + 601 + 336 = _____

12. 279,842 + 69,711 = _____

SUBTRACTION OF WHOLE NUMBERS

The *minus sign* (–) indicates the operation of subtraction. The number from which a value is subtracted is called the *minuend*. The value subtracted is called the *subtrahend*. The answer is called *remainder* or difference.

To subtract two whole numbers, write the larger number first. Under the larger number write the smaller number, with units under units, tens under tens, etc. Subtract each column starting at the units column. If any number in the subtrahend is larger than the corresponding number in the minuend, it will be necessary to regroup. When a number is regrouped, it is expressed in different but equal terms. For example, 25 = 2 tens plus 5 units or 20 + 5. Twenty-five may also be written as 1 ten plus 15 units or 10 + 15.

A subtraction can be checked by adding the remainder to the subtrahend. This sum equals the minuend.

Examples:

Subtract and check.

1. 987 - 502

	Check:
987 minuend	502
- 502 subtrahend	+ 485
485 remainder or difference	987

2. 641 - 29

		Check:
641	becomes 6 3 (11)	29
- 29	- 2 9	+ 612
	6 1 2	641

The one is smaller than nine. Therefore, one ten from the tens place is written as ten units in the units place.

3. Take 277 from 3,000.

		Check:
3,000	becomes 2,9 9 (10)	277
- 277	- 2 7 7	+ 2,723
	2,7 2 3	3,000

Exercise 1-4

Subtract and check.

1. 15
   - 7

2. 40
   - 23

3. 165
   - 105

4. 703
   - 256

5. 5,631
   - 287

6. 6,080
   - 4,902

7. 5,000
   - 4,298

8. 1,008
   - 285

9. Subtract 59 from 100. _____

10. Take 206 from 897. _____

11. From 2,000 take 999. _____

12. 9,096 - 798 = _____

MULTIPLICATION OF WHOLE NUMBERS

The *times sign* (X) is the symbol of multiplication. The number that is multiplied is called the *multiplicand*. The number by which a value is multiplied is called the *multiplier*. Both numbers may be called *factors*. The answer in multiplication is the *product*.

To multiply whole numbers, write the numbers with units under units, tens under tens, etc. Multiply the number in the units place of the multiplier by the number in each place of the multiplicand. When the product of any two numbers is 10 or more only the last digit of the product is recorded. The other numbers are added (carried) to the next product.

When multiplying by numbers with more than one digit, partial products are obtained. The location of the partial product is determined by the place of the number in the multiplier. Write the partial products under each other and add them. When several numbers are to be multiplied, multiply the product of the first two numbers by the third number, and this product by the fourth number, etc.

A product can be checked by interchanging the multiplicand and multiplier because multiplication can be performed in any order. Another method is to divide the product by the multiplier. The result is the multiplicand. Both methods are illustrated in the examples.

Examples:

Multiply and check.

1. 35 X 26

```
  35  multiplicand
X 26  multiplier
 210  partial product
  70  partial product
 910  product
```

Check: (by interchanging)

```
  26
X 35
 130
  78
 910
```

2. 259 X 206

```
  259
X 206
1 554
0 00
51 8
53,354
```

Check: (by division)

```
        259
206 ) 53,354
      41 2
      12 15
      10 30
       1 854
       1 854
```

Excercise 1-5

Multiply and check.

1. 8 X 7
2. 12 X 6
3. 14 X 20
4. 56 X 23