In preparing for the mathematics section of your college entrance examination, it is most important to overcome any fear of mathematics. The level of this examination extends no further than relatively simple geometry. Most problems can be solved using only arithmetic. By reading this chapter carefully, following the sample problems, and then working on the practice problems in each section, you can review important concepts and vocabulary, as well as familiarize yourself with various types of questions. Since arithmetic is basic to any further work in mathematics, this chapter is extremely important and should not be treated lightly. By doing these problems carefully and reading the worked-out solutions, you can build the confidence needed to do well.

1. ADDITION OF WHOLE NUMBERS

In the process of addition, the numbers to be added are called *addends*. The answer is called the *sum*. In writing an addition problem, put one number underneath the other, being careful to keep columns straight with the units' digits one below the other. If you find a sum by adding from top to bottom, you can check it by adding from bottom to top.

Example:

Find the sum of 403, 37, 8314, and 5.

Solution:

$$\begin{array}{r} 403 \\ 37 \\ 8314 \\ +\quad 5 \\ \hline 8759 \end{array}$$

Exercise 1

1. Find the sum of 360, 4352, 87, and 205.

   (A) 5013
   (B) 5004
   (C) 5003
   (D) 6004
   (E) 6013

2. Find the sum of 4321, 2143, 1234, and 3412.

   (A) 12,110
   (B) 11,011
   (C) 11,101
   (D) 11,111
   (E) 11,110

3. Add 56 + 321 + 8 + 42.

   (A) 427
   (B) 437
   (C) 517
   (D) 417
   (E) 527

4. Add 99 + 88 + 77 + 66 + 55.

   (A) 384
   (B) 485
   (C) 385
   (D) 375
   (E) 376

5. Add 1212 + 2323 + 3434 + 4545 + 5656.

   (A) 17,171
   (B) 17,170
   (C) 17,160
   (D) 17,280
   (E) 17,270

2. SUBTRACTION OF WHOLE NUMBERS

The number from which we subtract is called the *minuend*. The number which we take away is called the *subtrahend*. The answer in subtraction is called the *difference*.

If 5 is subtracted from 11, the minuend is 11, the subtrahend is 5, and the difference is 6.

Since we cannot subtract a larger number from a smaller one, we often must borrow in performing a subtraction. Remember that when we borrow, because of our base 10 number system, we reduce the digit to the left by 1, but increase the right-hand digit by 10.

Example:

$$\begin{array}{r} 54 \\ -\ 38 \\ \hline \end{array}$$

Since we cannot subtract 8 from 4, we borrow 1 from 5 and change the 4 to 14. We are really borrowing 1 from the tens column and, therefore, add 10 to the ones column. Then we can subtract.

Solution:

$$\begin{array}{r} 4\ {}^{1}4 \\ -\ 3\ \ 8 \\ \hline 1\ \ 6 \end{array}$$

Sometimes we must borrow across several columns.

Example:

$$\begin{array}{r} 503 \\ -\ 267 \\ \hline \end{array}$$

We cannot subtract 7 from 3 and cannot borrow from 0. Therefore we reduce the 5 by one and make the 0 into a 10. Then we can borrow 1 from the 10, making it a 9. This makes the 3 into 13.

Solution:

$$\begin{array}{r} 4\ {}^{1}0\ 3 \\ -\ 2\ \ 6\ 7 \\ \hline \end{array} \qquad \begin{array}{r} 4\ 9\ {}^{1}3 \\ -\ 2\ 6\ \ 7 \\ \hline 2\ 3\ \ 6 \end{array}$$

Exercise 2

1. Subtract 803 from 952.
   (A) 248
   (B) 148
   (C) 249
   (D) 149
   (E) 147

2. From the sum of 837 and 415, subtract 1035.
   (A) 217
   (B) 216
   (C) 326
   (D) 227
   (E) 226

3. From 1872 subtract the sum of 76 and 43.
   (A) 1754
   (B) 1838
   (C) 1753
   (D) 1839
   (E) 1905

4. Find the difference between 732 and 237.
   (A) 496
   (B) 495
   (C) 486
   (D) 405
   (E) 497

5. By how much does the sum of 612 and 315 exceed the sum of 451 and 283?
   (A) 294
   (B) 1661
   (C) 293
   (D) 197
   (E) 193

3. MULTIPLICATION OF WHOLE NUMBERS

The answer to a multiplication problem is called the *product*. The numbers being multiplied are called factors of the product.

When multiplying by a number containing two or more digits, place value is extremely important when writing partial products. When we multiply 537 by 72, for example, we multiply first by 2 and then by 7. However, when we multiply by 7, we are really multiplying by 70 and therefore leave a 0 at the extreme right before we proceed with the multiplication.

Example:

$$\begin{array}{r} 537 \\ \times\ \ 72 \\ \hline 1074 \\ +\ \ 37590 \\ \hline 38664 \end{array}$$

If we multiply by a three-digit number, we leave one zero on the right when multiplying by the tens digit and two zeros on the right when multiplying by the hundreds digit.

Example:

$$\begin{array}{r} 372 \\ \times\ 461 \\ \hline 372 \\ 22320 \\ +\ \ 148800 \\ \hline 171492 \end{array}$$

Exercise 3

Find the following products.

1. 526 multiplied by 317
   (A) 156,742
   (B) 165,742
   (C) 166,742
   (D) 166,748
   (E) 166,708

2. 8347 multiplied by 62
   (A) 517,514
   (B) 517,414
   (C) 517,504
   (D) 517,114
   (E) 617,114

3. 705 multiplied by 89
   (A) 11,985
   (B) 52,745
   (C) 62,705
   (D) 62,745
   (E) 15,121

4. 437 multiplied by 607
   (A) 265,259
   (B) 265,219
   (C) 265,359
   (D) 265,059
   (E) 262,059

5. 798 multiplied by 450
   (A) 358,600
   (B) 359,100
   (C) 71,820
   (D) 358,100
   (E) 360,820

4. DIVISION OF WHOLE NUMBERS

The number being divided is called the *dividend*. The number we are dividing by is called the *divisor*. The answer to the division is called the *quotient*. When we divide 18 by 6, 18 is the dividend, 6 is the divisor, and 3 is the quotient. If the quotient is not an integer, we have a *remainder*. The remainder when 20 is divided by 6 is 2, because 6 will divide 18 evenly, leaving a remainder of 2. The quotient in this case is $6\frac{2}{6}$. Remember that in writing the fractional part of a quotient involving a remainder, the remainder becomes the numerator and the divisor the denominator.

When dividing by a single-digit divisor, no long division procedures are needed. Simply carry the remainder of each step over to the next digit and continue.

Example:

$$\begin{array}{r} 9\ \ 7\ \ 2\ \ 4 \\ 6\overline{)5\ 8^4\ 3^1\ 4^2\ 4} \end{array}$$

Exercise 4

1. Divide 391 by 23.
   (A) 170
   (B) 16
   (C) 17
   (D) 18
   (E) 180
2. Divide 49,523,436 by 9.
   (A) 5,502,605
   (B) 5,502,514
   (C) 5,502,604
   (D) 5,502,614
   (E) 5,502,603
3. Find the remainder when 4832 is divided by 15.
   (A) 1
   (B) 2
   (C) 3
   (D) 4
   (E) 5
4. Divide 42,098 by 7.
   (A) 6014
   (B) 6015
   (C) 6019
   (D) 6011
   (E) 6010
5. Which of the following is the quotient of 333,180 and 617?
   (A) 541
   (B) 542
   (C) 549
   (D) 540
   (E) 545

5. ADDITION OR SUBTRACTION OF DECIMALS

The most important thing to watch for in adding or subtracting decimals is to keep all decimal points underneath one another. The proper placement of the decimal point in the answer will be in line with all the decimal points above.

Example:

Find the sum of 8.4, .37, and 2.641

Solution:

$$\begin{array}{r} 8.4 \\ .37 \\ +\ 2.641 \\ \hline 11.411 \end{array}$$

Example:

From 48.3 subtract 27.56

Solution:

$$\begin{array}{r} 4\overset{7}{\cancel{8}}.\overset{12}{\cancel{3}}\overset{1}{0} \\ -\ 27.56 \\ \hline 20.74 \end{array}$$

In subtraction, the upper decimal must have as many decimal places as the lower, so we must fill in zeros where needed.

Exercise 5

1. From the sum of .65, 4.2, 17.63, and 8, subtract 12.7.
   (A) 9.78
   (B) 17.68
   (C) 17.78
   (D) 17.79
   (E) 18.78

2. Find the sum of .837, .12, 52.3, and .354.
   (A) 53.503
   (B) 53.611
   (C) 53.601
   (D) 54.601
   (E) 54.611

3. From 561.8 subtract 34.75.
   (A) 537.05
   (B) 537.15
   (C) 527.15
   (D) 527.04
   (E) 527.05

4. From 53.72 subtract the sum of 4.81 and 17.5.
   (A) 31.86
   (B) 31.41
   (C) 41.03
   (D) 66.41
   (E) 41.86

5. Find the difference between 100 and 52.18.
   (A) 37.82
   (B) 47.18
   (C) 47.92
   (D) 47.82
   (E) 37.92

6. MULTIPLICATION OF DECIMALS

In multiplying decimals, we proceed as we do with integers, using the decimal points only as an indication of where to place a decimal point in the product. The number of decimal places in the product is equal to the sum of the number of decimal places in the numbers being multiplied.

Example:

Multiply .375 by .42

Solution:

$$\begin{array}{r} .375 \\ \times\ \ .42 \\ \hline 750 \\ +\ \ 15000 \\ \hline .15750 \end{array}$$

Since the first number being multiplied contains three decimal places and the second number contains two decimal places, the product will contain five decimal places.

To multiply a decimal by 10, 100, 1000, etc., we need only to move the decimal point to the right the proper number of places. In multiplying by 10, move one place to the right (10 has one zero), by 100 move two places to the right (100 has two zeros), by 1000 move three places to the right (1000 has three zeros), and so forth.

Example:

The product of .837 and 100 is 83.7

Exercise 6

Find the following products.

1. 437 × .24 =
   - (A) 1.0488
   - (B) 10.488
   - (C) 104.88
   - (D) 1048.8
   - (E) 10,488
2. 5.06 × .7 =
   - (A) .3542
   - (B) .392
   - (C) 3.92
   - (D) 3.542
   - (E) 35.42
3. 83 × 1.5 =
   - (A) 12.45
   - (B) 49.8
   - (C) 498
   - (D) 124.5
   - (E) 1.245
4. .7314 × 100 =
   - (A) .007314
   - (B) .07314
   - (C) 7.314
   - (D) 73.14
   - (E) 731.4
5. .0008 × 4.3 =
   - (A) .000344
   - (B) .00344
   - (C) .0344
   - (D) 0.344
   - (E) 3.44

7. DIVISION OF DECIMALS

When dividing by a decimal, always change the decimal to a whole number by moving the decimal point to the end of the divisor. Count the number of places you have moved the decimal point and move the dividend's decimal point the same number of places. The decimal point in the quotient will be directly above the one in the dividend.

Example:

Divide 2.592 by .06

Solution:

$$.06\overset{43.2}{\overline{)2.592}}$$

To divide a decimal by 10, 100, 1000, etc., we move the decimal point the proper number of places to the *left*. The number of places to be moved is always equal to the number of zeros in the divisor.

Example:

Divide 43.7 by 1000

Solution:

The decimal point must be moved three places (there are three zeros in 1000) to the left. Therefore, our quotient is .0437

Sometimes division can be done in fraction form. Always remember to move the decimal point to the end of the divisor (denominator) and then the same number of places in the dividend (numerator).

Example:

Divide: $\frac{.0175}{.05} = \frac{1.75}{5} = .35$

Exercise 7

1. Divide 4.3 by 100.
   (A) .0043
   (B) 0.043
   (C) 0.43
   (D) 43
   (E) 430

2. Find the quotient when 4.371 is divided by .3.
   (A) 0.1457
   (B) 1.457
   (C) 14.57
   (D) 145.7
   (E) 1457

3. Divide .64 by .4.
   (A) .0016
   (B) 0.016
   (C) 0.16
   (D) 1.6
   (E) 16

4. Find $.12 \div \frac{2}{.5}$.
   (A) 4.8
   (B) 48
   (C) .03
   (D) 0.3
   (E) 3

5. Find $\frac{10.2}{.03} \div \frac{1.7}{.1}$.
   (A) .02
   (B) 0.2
   (C) 2
   (D) 20
   (E) 200

8. THE LAWS OF ARITHMETIC

Addition and multiplication are *commutative* operations, as the order in which we add or multiply does not change an answer.

Example:

$$4 + 7 = 7 + 4$$
$$5 \bullet 3 = 3 \bullet 5$$

Subtraction and division are not commutative, as changing the order does change the answer.

Example:

$$5 - 3 \neq 3 - 5$$
$$20 \div 5 \neq 5 \div 20$$

Addition and multiplication are *associative*, as we may group in any manner and arrive at the same answer.

Example:

$$(3 + 4) + 5 = 3 + (4 + 5)$$
$$(3 \bullet 4) \bullet 5 = 3 \bullet (4 \bullet 5)$$

Subtraction and division are not associative, as regrouping changes an answer.

Example:

$$(5 - 4) - 3 \neq 5 - (4 - 3)$$
$$(100 \div 20) \div 5 \neq 100 \div (20 \div 5)$$

Multiplication is *distributive* over addition. If a sum is to be multiplied by a number, we may multiply each addend by the given number and add the results. This will give the same answer as if we had added first and then multiplied.

Example:

3(5 + 2 + 4) is either 15 + 6 + 12 or 3(11).

The *identity for addition* is 0 since any number plus 0, or 0 plus any number, is equal to the given number.

The *identity for multiplication* is 1 since any number times 1, or 1 times any number, is equal to the given number.

There are no identity elements for subtraction or division. Although $5 - 0 = 5$, $0 - 5 \neq 5$. Although $8 \div 1 = 8$, $1 \div 8 \neq 8$.

When several operations are involved in a single problem, parentheses are usually included to make the order of operations clear. If there are no parentheses, multiplication and division are always performed prior to addition and subtraction.

Example:

Find $5 \bullet 4 + 6 \div 2 - 16 \div 4$

Solution:

The + and – signs indicate where groupings should begin and end. If we were to insert parentheses to clarify operations, we would have $(5 \cdot 4) + (6 \div 2) - (16 \div 4)$, giving $20 + 3 - 4 = 19$.

Exercise 8

1. Find $8 + 4 \div 2 + 6 \cdot 3 - 1$.

   (A) 35
   (B) 47
   (C) 43
   (D) 27
   (E) 88

2. $16 \div 4 + 2 \cdot 3 + 2 - 8 \div 2$.

   (A) 6
   (B) 8
   (C) 2
   (D) 4
   (E) 10

3. Match each illustration in the left-hand column with the law it illustrates from the right-hand column.

   a. $475 \cdot 1 = 475$
   b. $75 + 12 = 12 + 75$
   c. $32(12 + 8) = 32(12) + 32(8)$
   d. $378 + 0 = 378$
   e. $(7 \cdot 5) \cdot 2 = 7 \cdot (5 \cdot 2)$

   u. Identity for Addition
   v. Associative Law of Addition
   w. Associative Law of Multiplication
   x. Identity for Multiplication
   y. Distributive Law of Multiplication over Addition
   z. Commutative Law of Addition

9. ESTIMATING ANSWERS

On a competitive examination, where time is an important factor, it is essential that you be able to estimate an answer. Simply round off all answers to the nearest multiples of 10 or 100 and estimate with the results. On multiple-choice tests, this should enable you to pick the correct answer without any time-consuming computation.

Example:

The product of 498 and 103 is approximately

(A) 5000
(B) 500,000
(C) 50,000
(D) 500
(E) 5,000,000

Solution:

498 is about 500. 103 is about 100. Therefore the product is about (500) (100) or 50,000 (just move the decimal point two places to the right when multiplying by 100). Therefore, the correct answer is (C).

Example:

Which of the following is closest to the value of $4831 \cdot \frac{710}{2314}$?

(A) 83
(B) 425
(C) 1600
(D) 3140
(E) 6372

Solution:

Estimating, we have $\left(\frac{(5000)(700)}{2000}\right)$. Dividing numerator and denominator by 1000, we have $\frac{5(700)}{2}$ or $\frac{3500}{2}$, which is about 1750. Therefore, we choose answer (C).

Exercise 9

Choose the answer closest to the exact value of each of the following problems. Use estimation in your solutions. No written computation should be needed. Circle the letter before your answer.

1. $\frac{483+1875}{119}$

(A) 2
(B) 10
(C) 20
(D) 50
(E) 100

2. $\frac{6017 \cdot 312}{364+618}$

(A) 18
(B) 180
(C) 1800
(D) 18,000
(E) 180,000

3. $\frac{783+491}{1532-879}$

(A) .02
(B) .2
(C) 2
(D) 20
(E) 200