AIRCRAFT TECHNICAL BOOK COMPANY

CAT-A

AVIATION MAINTENANCE TECHNICIAN CERTIFICATION SERIES

MATHEMATICS

1

COMPLIANT WITH EASA

EASA PART 66/147

EASA 2023-989 COMPLIANT

REVISION LOG

Update notices for this book will be available online at www.actechbooks.com/revisions.html
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VERSION	EFFECTIVE DATE	DESCRIPTION OF REVISION(S)
001	2016.01	Module creation and release.
002	2020.02	Format update and appearance update.
002.1	2019.10	Cubic feet to cubic meters multiplier changed from 2.831 to 0.028 317. Inclusion of Measurement Standards for clarification.
003	2024.09	Regulatory update for EASA 2023-989 compliance.

Module was reorganized based upon the EASA 2023-989 subject criteria.
Many figures colorized.
Submodule review questions added.

MATHEMATICS

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$$\frac{6}{10} = \frac{6+2}{10+2} = \frac{3}{5}$$

MIXED NUMBERS

A mixed number is a combination of a whole number and a fraction. Each of the following are examples of mixed numbers:

$3\frac{4}{5}$, $2\frac{7}{8}$, $6\frac{5}{7}$

Mixed numbers can be written as improper fractions.

Example:
The number $3\frac{4}{5}$ represents 3 full parts and four fifths.
Three full parts is equivalent to 15 fifths.

So:

$$3\frac{4}{5} = \frac{15}{5} + \frac{4}{5} = \frac{15+4}{5} = \frac{19}{5}$$

ADDITION AND SUBTRACTION OF FRACTIONS

As previosuly stated, in order to add or subtract fractions, we use a common denominator.

Example:
Find the value of:

$$\frac{1}{5} + \frac{1}{6} + \frac{3}{10}$$

Solution:
The LCD in this case is 30 (list the multiples of 5, 6 and 10 if necessary).

Change each fraction so that its denominator is 30:

$$\frac{1}{5} = \frac{1\times 6}{5\times 6} = \frac{6}{30}$$
$$\frac{1}{6} = \frac{1\times 5}{6\times 5} = \frac{5}{30}$$
$$\frac{3}{10} = \frac{3\times 3}{10\times 3} = \frac{9}{30}$$

So the question becomes:

$$\frac{6}{30} + \frac{5}{30} + \frac{9}{30} = \frac{6+5+9}{30} = \frac{20}{30}$$

It's good practice to reduce the fraction as far as possible.

So our final step is:

$$\frac{20}{30} = \frac{20+10}{30+10} = \frac{2}{3}$$

Example:
Find the value of:

$$\frac{3}{5} + \frac{2}{7} + \frac{9}{2}$$

Solution:

The LCD of 2, 5 and 7 is 70

Writing each fraction with 70 as its denominator gives:

$$\frac{3}{5} = \frac{3\times 14}{5\times 14} = \frac{42}{70}$$
$$\frac{9}{2} = \frac{9\times 35}{2\times 35} = \frac{315}{70}$$
$$\frac{2}{7} = \frac{2\times 10}{7\times 10} = \frac{20}{70}$$

So the question becomes:

$$\frac{42}{70} + \frac{20}{70} + \frac{315}{70} = \frac{42+20+315}{70} = \frac{377}{70}$$

The next example involves both addition and subtraction.

Example:
Find the value of:

$$\frac{4}{5} + \frac{7}{3} - \frac{6}{15}$$

And reduce the answer it to its lowest form.

Solution:
The LCD is 15.

$$\frac{4}{5} = \frac{4\times 3}{5\times 3} = \frac{12}{15}$$
$$\frac{7}{3} = \frac{7\times 5}{3\times 5} = \frac{35}{15}$$

Now we calculate:

$$\frac{12}{15} + \frac{35}{15} - \frac{6}{15} = \frac{41}{15}$$

Note that $\frac{41}{15}$ is an improper fraction and since 15 divides in to 41 twice with 11 over, we can write:

$$\frac{41}{15} = 2\frac{11}{15}$$

MULTIPLICATION OF FRACTIONS

There is a very simple rule for multiplying fractions: multiply the numerators and multiply the denominators. An example will show how easy this process is.

Example:
Find the value of:

$$\frac{2}{5} \times \frac{3}{7}$$

Solution:

$$\frac{2}{5} \times \frac{3}{7} = \frac{2\times 3}{5\times 7} = \frac{6}{35}$$

Example:
Perform the following operation:

$$\frac{4}{7} \times \frac{5}{9}$$

Solution:

$$\frac{4}{7} \times \frac{5}{9} = \frac{4 \times 5}{7 \times 9} = \frac{20}{63}$$

DIVISION OF FRACTIONS

To divide fractions, multiply by the reciprocal of the lower fraction.

Example:
Divide ⅞ by ⅓:

$$\left(\frac{7}{8} + \frac{4}{3}\right) = \left(\frac{7}{8} \times \frac{3}{4}\right) = \left(\frac{7 \times 3}{8 \times 4}\right) = \frac{21}{32}$$

ADDITION OF MIXED NUMBERS

To add mixed numbers, add the whole numbers together. Then add the fractions together by finding a common denominator. The final step is to add the sum of the whole numbers to the sum of the fractions for the final result. Note the following example uses feet as the unit of measurement which can commonly result in the use of fractions. 1 foot is equal to 30.49 centimeters.

Example:
The cargo area behind the rear seat of a small airplane can handle solids that are 4¾ feet long. If the rear seats are removed, then 2⅓ feet is added to the cargo area. What is the total length of the cargo area when the rear seats are removed?

$$4\frac{3}{4} + 2\frac{1}{3} = (4 + 2) + \left(\frac{3}{4} \times \frac{1}{3}\right) = 6 + \left(\frac{9}{12} \times \frac{4}{12}\right)$$

$$= 6\frac{13}{12} = 7\frac{1}{12} \leftarrow \text{feet of cargo room}$$

SUBTRACTION OF MIXED NUMBERS

To subtract mixed numbers, find a common denominator for the fractions. Subtract the fractions from each other (*it may be necessary to borrow from the larger whole number when subtracting the fractions*). Subtract the whole numbers from each other. The final step is to combine the final whole number with the final fraction. Note the following example uses inches as the unit of measurement which can commonly result in the use of fractions. 1 inch is equal to 2.54 centimeters.

Example:
What is the length of the grip of the bolt shown in **Figure 1-5**? The overall length of the bolt is 3½ inches, the shank length is 3⅛ inches, and the threaded portion is 15⁄16 inches long. To find the grip, subtract the length of the threaded portion from the length of the shank.

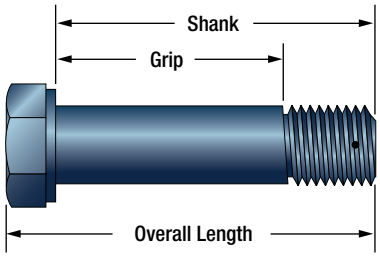

Figure 1-5. Bolt dimensions.

To subtract, start with the fractions. A common denominator must be used. 16 is the LCD. So the problem becomes:

$$3\frac{2}{16} - 1\frac{5}{16} = \text{grip length in inches}$$

Borrowing will be necessary because 5⁄16 is larger than 2⁄16. From the whole number 3, borrow 1, which is actually 16⁄16. After borrowing, the first mixed number is expressed as 2 18⁄16 and the equation is now as follows:

$$2\frac{18}{16} - 1\frac{5}{16} = \text{grip length in inches}$$

Again, to subtract, start with the fractions:

$$\frac{18}{16} - \frac{5}{16} = \frac{13}{16}$$

Then, subtract the whole numbers:

$$2 - 1 = 1$$

Therefore, the grip length of the bolt is 1 13⁄16 inches.

Note that the value for the overall length of the bolt was given in the example, but it was not needed to solve the problem. This type of information is sometimes referred to as a "distractor" because it distracts from the information needed to solve the problem.

THE DECIMAL NUMBER SYSTEM

ORIGIN AND DEFINITION

The number system that we use every day is called the *decimal system*. The prefix in the word decimal is a Latin root for the word "ten." The decimal system probably had its origin in the fact that we have ten fingers (or digits). The decimal system has ten digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. It is a base 10 system and has been in use for over 5 000 years. A decimal is a number with a decimal point. For example, 0.515, .10, and 462.625 are all decimal numbers. Like whole numbers, decimal numbers also have place value. The place values are based on powers of 10, as shown in **Figure 1-6**.

ADDITION OF DECIMAL NUMBERS

To add decimal numbers, they must first be arranged so that the decimal points are aligned vertically and according to place value. That is, adding tenths with tenths, ones with ones, hundreds with hundreds, and so forth.

Example:
Find the total resistance for the circuit diagram in **Figure 1-7**. The total resistance of a series circuit is equal to the sum of the individual resistances. To find the total resistance, R_T, the individual resistances are added together.

$$R_T = R_1 + R_2 + R_3$$
$$R_T = 2.34 + 37.5 + .09$$

Arrange the resistance values in a vertical column so that the decimal points are aligned and then add.

	Place Value										
	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones	Tenths	Hundredths	Thousandths	Ten Thousandths
1 623 051	1	6	2	3	0	5	1				
0.053 1							0	0	5	3	1
32.4						3	2	4			

Figure 1-6. Decimal place values.

$$\begin{array}{r} 2.34 \\ 37.5 \\ +\ .09 \\ \hline 39.93 \end{array}$$

Therefore, the total resistance, R_T = 39.93 ohms.

SUBTRACTION OF DECIMAL NUMBERS

To subtract decimal numbers, they must first be arranged so that the decimal points are aligned vertically and according to place value. That is, subtracting tenths from tenths, ones from ones, hundreds from hundreds, and so forth.

Example:

Working again with resistance values to be studied in *Module 3*, a series circuit containing two resistors has a total resistance (R_T) of 37.272 ohms. One of the resistors (R_T) has a value of 14.88 ohms. What is the value of the other resistor (R_2)?

$$R_2 = R_T + R_2 = 37.272 - 14.88$$
$$R_2 = 37.272 - 14.88$$

Arrange the decimal numbers in a vertical column so that the decimal points are aligned and then subtract.

$$\begin{array}{r} 37.272 \\ -\ 14.88 \\ \hline 22.392 \end{array}$$

Therefore, the second resistor, R_2 = 22.392 ohms.

MULTIPLICATION OF DECIMAL NUMBERS

To multiply decimal numbers, vertical alignment of the decimal point is not required. Instead, align the numbers to the right in the same way as whole numbers are multiplied (*with no regard to the decimal points or place values*) and then multiply. The last step is to place the decimal point in the correct place in the answer. To do this, "count" the number of decimal places in each of the numbers, add the total, and then "give" that number of decimal places to the result.

Example:

To multiply 0.2 × 6.03, arrange the numbers vertically and align them to the right. Multiply the numbers, ignoring the decimal points for now.

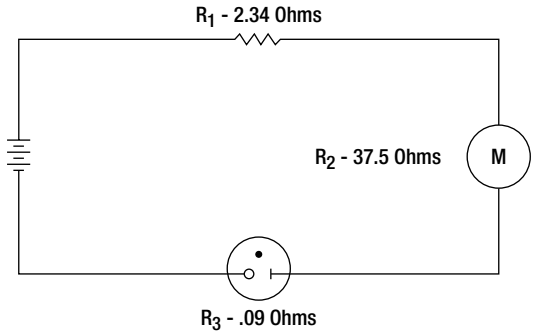

Figure 1-7. Circuit diagram.

$$\begin{array}{r} 6.03 \\ \times\ \ 0.2 \\ \hline 1.206 \end{array} \leftarrow \text{ignore the decimal points}$$

After multiplying the numbers, count the total number of decimal places in both numbers. For this example, 6.03 has 2 decimal places and 0.2 has 1 decimal place. Together there are a total of 3 decimal places. The decimal point for the answer will be placed 3 decimal places from the right. Therefore, the answer is 1.206.

Example:

Using the formula Watts = Amperes × Voltage, what is the wattage of an electric drill that uses 9.45 amperes from a 120 volt source?

$$\text{Watts} = \text{Amperes} \times \text{Voltage}$$
$$\text{Watts} = 9.45 \times 120$$

Place the values to be multiplied vertically and aligned to the right.

$$\begin{array}{r} 9.45 \leftarrow \text{2 decimal places} \\ \times\ \ 120 \leftarrow \text{no decimal places} \\ \hline 000 \\ 1890 \\ 945 \\ \hline 1134.00 \leftarrow \text{2 decimal places} \end{array}$$

After multiplying the numbers, count the total number of decimal places in both numbers. For this example, 9.45 has 2 decimal places and 120 has no decimal place. Together there are 2 decimal places. The decimal point for the answer will be placed 2 decimal places from the right. Therefore, the answer is 1 134.00 watts, or 1 134 watts.

DIVISION OF DECIMAL NUMBERS

Division of decimal numbers is performed the same way as whole numbers, unless the divisor is a decimal.

$$\begin{array}{r} \text{quotient} \\ \text{divisor}\overline{)\text{dividend}} \end{array}$$

When the divisor is a decimal, it must be changed to a whole number before dividing. To do this, move the decimal in the divisor to the right until there are no decimal places. At the same time, move the decimal point in the dividend to the right the same number of places. Then divide. The decimal in the quotient will be placed directly above the decimal in the dividend.