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ABSTRACT

This module is the second in a series of 12 learning modules designed to teach occupational mathematics. Blocks of informative material and rules are followed by examples and practice problems. The solutions to the practice problems are found at the end of the module. Specific topics covered include rounding off, precision of measurement, and the concept of least precise measurement. (YLB)

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# Module 2--ROUNDING DECIMAL NUMBERS TO A DESIGNATED PRECISION

Rounding off a decimal number means rewriting the number in a shorter form to represent an approximation of the number. The symbol used for values that are approximately equal, but not exactly equal is ≈. In measuring the length of an object, it could be measured to the nearest 1 mm, the nearest 0.1 mm, the nearest 0.01 mm or even closer. Measurements are never exact. The precision with which the technician needs a measurement depends upon the particular application. The measurement a person records is a number which has been read only as close as needed and therefore, represents a rounded off value.

The number pi = π = 3.141592653589793238..... is a never ending decimal. It is necessary to round it off somewhere. Various possibilities include:

nearest unit.....π ≈ 3
nearest tenth.....π ≈ 3.1
nearest hundredth.....π ≈ 3.14
nearest thousandth..... ...π ≈ 3.142
nearest ten-thousandth.....π ≈ 3.1416

The proper value to select depends upon the demand for precision.

The process called rounding off will follow the commonly used steps in what is called the rule-of-5. For example, when the number 748.537 is rounded to the units place, it is written as 749. Rounded to the nearest tenths, 748.537 becomes 748.5, and rounding to the nearest hundredth makes it 748.54. The following is the usual rule-of-5 for rounding a number written out in detail.

## RULE FOR ROUNDING DECIMAL NUMBERS
## ROUNDING TO TEN OR HIGHER PLACE

To round a number to a particular place value, called the rounding place, that is in the ten (10) place or greater

1. If the digit immediately to the right of the rounding place is less than 5 (0,1,2,3,4), then
   (a) do not change the digit in the rounding place or any digits to the left of it.
   (b) replace, with zeros, all the digits to the right of the rounding place until the decimal point location is reached.
   (c) do not write the decimal point.
   (d) drop all digits which were to the right of the decimal point (do not replace them with zeros).

2. If the digit immediately to the right of the rounding place is 5 or greater (5,6,7,8,9), then
   (a) add 1 (one) to the digit in the rounding place. When adding 1 to a 9 digit, add the 1 to the two digit number which ends in that 9. This has the effect of changing the 9 into 0 and the digit to its left will become 1 greater.
   (b) replace, with zeros, all the digits to the right of the rounding place until the decimal point location is reached.
   (c) do not write the decimal point.
   (d) drop all digits which were to the right of the decimal point (do not replace them with zero).

To round a number to a particular place value that is in the units place or to the right of the decimal point:

3. If the digit immediately to the right of the rounding place is less than 5 (0,1,2,3,4), then
   (a) do not change the digit in the rounding place or any digits to the left of it.
   (b) drop all the digits to the right of the rounding place.
   (c) do not replace dropped digits with zeros.

4. If the digit immediately to the right of the rounding place is 5 or greater (5,6,7,8,9), then
   (a) add 1 (one) to the digit in the rounding place. When adding 1 to a 9 digit, add the 1 to the two digit number which ends in that 9. This has the effect of changing the 9 into 0 and the digit to its left will become 1 greater.
   (b) drop all the digits to the right of the rounding place.
   (c) do not replace dropped digits with zeros.

**EXAMPLE 1:** Round each number in the left-hand column to the place value (precision) indicated in each column heading.

| decimal | ten | unit | tenth | hundredth | thousandth |
|---|---|---|---|---|---|
| 275.8103 | 280 | 276 | 275.8 | 275.81 | 275.810 |
| 43.9618 | 40 | 44 | 44.0 | 43.96 | 43.962 |
| 27.8205 | 30 | 28 | 27.8 | 27.82 | 27.821 |
| 7.0261 | 10 | 7 | 7.0 | 7.03 | 7.026 |

A special case arose when 7.0261 was rounded to the nearest ten. The original tens digit is considered to be 0 so that 7.0261 = 07.0261. Since the digit immediately to the right of the ten digit is 7 (5 or more), then the tens digit of 0 is to be increased by 1 to form 10. Rounding 7.0261 to the nearest ten produced 10.

**PRACTICE PROBLEMS:** Round each number in the left-hand column to the place value indicated in each column heading.

| | Decimal | hundred | ten | unit | tenth |
|---|---|---|---|---|---|
| 1. | 685.31 | | | | |
| 2. | 1728.47 | | | | |
| 3. | 475.296 | | | | |
| 4. | 88.972 | | | | |

Round each number in the left-hand column to the place value indicated in each column heading.

| | Decimal | tenth | hundredth | thousandth | ten-thousandth |
|---|---|---|---|---|---|
| 5. | 1.70862 | | | | |
| 6. | 0.39491 | | | | |
| 7. | 3.06177 | | | | |
| 8. | 6.07939 | | | | |
| 9. | 0.17316 | | | | |
| 10. | 0.05592 | | | | |

A ruler, caliper and micrometer are three different devices used to make a length measurement. The biggest difference in these three instruments is the precision with which you are able to determine size. A person trained to use these might record the following for the measurement of the length of a pin.

| | | | |
|---|---|---|---|
| ruler,metric | 17 mm | ruler,English | 0.7 in. |
| caliper,metric | 17.3 mm | caliper,English | 0.68 in. |
| micrometer,metric | 17.274 mm | micrometer,English | 0.6801 in. |

The **PRECISION** of each measurement is the place value of the last digit recorded by the measuring instrument and the unit of measure used by the instrument.

The last digit of the metric caliper reading is the 3 of 17.3 mm. This 3 is in the tenths or 0.1 place value position. The precision of the 17.3 mm caliper reading is stated as 0.1 mm.

An English caliper reading for length of the same pin is 0.68 in. The last digit 8 of 0.68 in. is in the hundredths or 0.01 place value position. The precision of the 0.68 in. English caliper reading is stated as 0.01 in.

**EXAMPLE 2:** The precision of the measurements given for the pin length by the various types of instruments is summarized in the table.

| Type of Device | Metric Measure | Metric Precision | English Measure | English Precision |
|---|---|---|---|---|
| ruler | 17 mm | 1 mm | 0.7 in. | 0.1 in. |
| caliper | 17.3 mm | 0.1 mm | 0.68 in. | 0.01 in. |
| micrometer | 17.274 mm | 0.001 mm | 0.6801 in. | 0.0001 in. |

As one learns production skills of machining, it is necessary to match the quality demanded of the craftsmanship to the precision of the measurements required to meet those quality standards.

**PRACTICE PROBLEMS:** State the precision of the following measurements. Do not forget to include the unit of measurement with your number value.

| | | | |
|---|---|---|---|
| 11. | 2.4 in. | 12. | 6.08 mm |
| 13. | 1.931 in. | 14. | 12.280 mm |
| 15. | 7.09 in. | 16. | 91 mm |
| 17. | 91.0 mm | 18. | 91.000 mm |
| 19. | 0.81 in. | 20. | 0.810 in. |

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The English length of pin measurements of Example 2 show that different instruments have different precisions. The least precise English measure is achieved by the English ruler as 0.7 in., while the most precise English measure is 0.6801 in. obtained by the English micrometer.

> The LEAST PRECISE of two or more measurements is the measure whose last recorded digit is farthest left (higher place value).

**EXAMPLE 3:** The diameter of a pin has been recorded as 0.25 in. and as 0.248 in. What is the precision of each measurement and which measurement is the least precise?

**Solution:**

0.25 in. has precision 0.01 in.
0.248 in. has precision 0.001 in.
The least precise is 0.25 in.

**EXAMPLE 4:** The thickness of a steel plate has been recorded as 9.78 mm, 9.780 mm and as 9.8 mm. What is the precision of each measurement and which measurement is the least precise?

**Solution:**

9.78 mm has precision 0.01 mm
9.780 mm has precision 0.001 mm
9.8 mm has precision 0.1 mm
The least precise is the 9.8 mm.

**PRACTICE PROBLEMS:** Identify the least precise of each set of measurements:

21. 2.181 in., 2.18 in., 2.1814 in.

22. 7.23 mm, 7.2346 mm, 7.2 mm, 7.235 mm.

23. 1230 mm, 1200 mm, 1232.1 mm, 1232 mm

24. 6.26 in., 6 in., 6.3 in., 6.277 in.

25. 4.00 in., 4.0 in., 4.000 in., 4 in.

The width of 3 separate steel plates are recorded below. Identify the least precise of each set of measurements.

26. 0.3 in., 2.56 in., 1.772 in.

27. 12.3 mm, 10.44 mm, 13 mm

28. 6.002 mm, 10.92 mm, 15.8 mm.

29. 14.125 in., 3.25 in., 0.875 in.

30. 9.40 mm, 27.900 mm, 316.0 mm

## SOLUTIONS TO PRACTICE PROBLEMS--MODULE 2

| | Decimal | hundred | ten | unit | tenth |
|---|---|---|---|---|---|
| 1. | 685.31 | 700 | 690 | 685 | 685.3 |
| 2. | 1728.47 | 1700 | 1730 | 1728 | 1728.5 |
| 3. | 475.296 | 500 | 480 | 475 | 475.3 |
| 4. | 88.972 | 100 | 90 | 89 | 89.0 |

| | Decimal | tenth | hundredth | thousandth | ten-thousandth |
|---|---|---|---|---|---|
| 5. | 1.70862 | 1.7 | 1.71 | 1.709 | 1.7086 |
| 6. | 0.39491 | 0.4 | 0.39 | 0.395 | 0.3949 |
| 7. | 3.06177 | 3.1 | 3.06 | 3.062 | 3.0618 |
| 8. | 6.07939 | 6.1 | 6.08 | 6.079 | 6.0794 |
| 9. | 0.17316 | 0.2 | 0.17 | 0.173 | 0.1732 |
| 10. | 0.05592 | 0.1 | 0.06 | 0.056 | 0.0559 |

| | | | | | |
|---|---|---|---|---|---|
| 11. | 0.1 in. | 12. | 0.01 mm | 13. | 0.001 in. |
| 14. | 0.001 mm | 15. | 0.01 in. | 16. | 1 mm |
| 17. | 0.1 mm | 18. | 0.001 mm | 19. | 0.01 in. |
| 20. | 0.001 in. | 21. | 2.18 in. | 22. | 7.2 mm |
| 23. | 1200 mm | 24. | 6 in. | 25. | 4 in. |
| 26. | 0.3 in. | 27. | 13 mm | 28. | 15.8 mm |
| 29. | 3.25 in. | 30. | 316.0 mm | | |

# END

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