Lesson 7: Ptarget Practice (Wkbk pg. 24)

Please indicate which of the following situations is caused by low precision and which indicates an accuracy problem.

1) You have sores all over your face because you keep missing your mouth with your fork.

The fact that the sores are all over the face indicates a precision problem. If they were in the same spot, say above the mouth and to the right, that would indicate an accuracy problem.

2) You show up late to a dentist appointment because your watch is set 4 minutes slow.

Your watch is inaccurate.

3) A certain balance reports a 10-gram weight standard to be 11 grams in each of three measurements.

The balance is inaccurate.

4) Every time you bake brownies, they come out different because you don't use a measuring cup or a timer.

This is a precision problem because the result is always different. If there is an accuracy problem it is unclear from the information given.

5) You miss the basketball hoop in all directions because you position yourself differently before taking each shot.

The statements "in all directions" and "you position yourself differently..." indicate a precision problem. If the misses were consistently in the same direction after positioning yourself identically, an accuracy problem would be indicated.

6) According to your bathroom scale, you always weigh 25 pounds less than you do on the scale in the doctor's office.

This is an accuracy problem. I'd say, it must be a problem with the doctor's scale!

Lesson 8: It's True, But Is It Significant? (Wkbk pg. 27)

The diagrams on the following page represent a number of measuring devices. Please read them and report their readings to the correct number of decimal places.

1) single-beam balance

I get 66.6. Any measurement from 66.5 to 66.7 is acceptable.

2) pressure gauge

8 PSI.

3) buret

I get 9.23. Any measurement between 9.21 and 9.24 is acceptable.

4) metric ruler

My lower measurement was 4.54 cm. Any reading between 4.53 and 4.56 would be acceptable. My upper reading was 6.10 cm. The acceptable range is 6.08 to 6.11. The lower number should be correctly subtracted from the upper one to get the result. My readings gave an answer of 1.56 cm. Theirs must be accurate in the first decimal place and should be close to mine in the second decimal place.

Lesson 9: Show Your Significance (Wkbk pg. 29)

1) Based on the principles we just covered, give the number of significant figures in each of the following numbers. Assume a good scientist wrote them. If you can't tell how many figures are significant, say so and say why.

0.003 - *Only the 3 is significant. See item #2 of the lesson summary, page 31 of the textbook, for details.*

0.030 - *The 3 is significant. If the zero were not significant it would have been omitted Therefore, it must be significant too. (See item #3 for details.) There are two significant figures.*

0.300 - *The 3 is significant and so are the last two zeros (by the same reasoning used in the previous problem). There are three significant figures.*

3 - *There is only one figure and it is significant.*

33 - *There are two significant figures.*

300 - *We know that the three is significant, but we cannot tell about the two zeros unless we know how they were obtained. Since we do not have that information, we cannot decide.*

30.0003 - *All these digits are significant. (See item #4 in the textbook for details.)*

2) Tell which of the following quantities are known with absolute precision and which are rounded.

60 sec = 1 min

There are, without a doubt, precisely 60 seconds in one minute by definition. This is known with absolute precision.

12 in = 1 ft

This is known with absolute precision.

454 g = 1 lb

This is a rounded approximation. It cannot be a perfect number since these two quantities are from different measuring systems.

3785 ml = 1 gal

This is a rounded approximation.

$\pi = 3.141$

This is a rounded approximation of a mathematical constant.

the number of teeth in a well-formed adult human who has had no loss of teeth

This is a discrete, counted quantity that is known to be equal to 36. Its precision is absolute.

Lesson 10: Don't Multiply Your Lack of Significance (Wkbk pg. 33)

Please express the following products and quotients in the correct number of significant figures. The first value shown after the equal sign is roughly what the calculator gives us. The number at the right is the correct answer when rounded to the proper number of significant digits.

1) $0.75 / 4.85 = 0.154639$ 0.15

0.75 has only two significant figures, so the answer is also limited to two significant figures. The answer, when appropriately rounded, is 0.15.

2) $90.1 \times 83.72 = 7{,}543.172$ 7,540

3) $937 / 5.9 = 158.813$ 160

The correct answer has two significant digits. Because its third digit (8) is greater than 5, the second digit was rounded up from 5 to 6.

4) $6{,}240 \times 97.08 = 605{,}779.2$ 605,800

5) $0.032 \times 0.315 = 0.01008$ 0.010

6) $2{,}303.054 \div 6{,}744 = 0.3414967$ 0.3415

7) The formula for the circumference (c) of a circle is $c = 2\pi r$. Calculate $c : r = 0.8695$ mm, keeping the highest possible number of significant figures in your answer. (The colon is read as "such that" or "given that.")

The 2 is a constant of unlimited precision. Pi can be expressed to any number of decimal places we wish. It is r that decides the amount of precision in our answer. It has four significant figures. So we calculate:

$$c = 2 \times 3.1415 \times 0.8695 = 5.463$$

Notice that I used one more digit of pi than I had in r. This assures me that I won't introduce error into my calculation by rounding pi. My answer has four significant figures, just like r.

8) The formula for the area (A) of a circle is $A = \pi r^2$. Calculate the area of "the unit circle" (the circle having a radius that, by definition, is equal to 1). What factor controls the precision of your answer? (That is, what factor determines how many significant digits your answer can have?)

The calculation of the area is as follows:

$$A = 3.1415 \times 1^2 = 3.1415$$

Because the radius is 1 by definition, its precision is unlimited. The only factor controlling the precision of our answer is the precision with which pi is given.

9) Convert 32.2 g/in² to *y* mg/cm². Express your answer in the correct number of significant digits.

We set this problem up just like problems in previous lessons:

$$y\,\frac{\text{mg}}{\text{cm}^2} = \frac{32.2\,\text{g}}{\text{in}^2} \cdot \frac{1{,}000\,\text{mg}}{\text{g}} \cdot \frac{0.1550\,\text{in}^2}{\text{cm}^2}$$

$$y = 4{,}990$$

The precision of the answer is controlled by the 32.2 g/cm² measurement. The precision of the value 1,000 is absolute. The second conversion factor is expressed in four significant digits, so it does not reduce the number of significant digits in the result. The calculator reads 4,991. Rounded to three significant figures, the correct answer is 4,990.

Lesson 11: Adding and Subtracting with Precision (Wkbk pg. 35)

Perform the following additions and subtractions, showing your answers in the correct number of significant figures.

1)
$$\begin{array}{r} 97.31 \\ -2.617 \\ \hline 94.693 \end{array}$$
94.69

First, just do the math, then round to the correct number of significant figures. In this problem, we can only show precision in the hundredths place because that's the least precision shown in either of the two measured values. The correct, rounded value is shown to the right.

2)
$$\begin{array}{r} 1.8997 \\ +5{,}530.8 \\ \hline 5{,}532.6997 \end{array}$$
5,532.7

3)
$$\begin{array}{r} 709.4 \\ -251 \\ \hline 458.4 \end{array}$$
458

4) Assume that the zero is not significant.

$$\begin{array}{r} 8{,}410 \\ +5{,}488 \\ \hline 13{,}898 \end{array}$$
13,900

5) Assume that the zero is significant.

$$\begin{array}{r} 210 \\ -513 \\ \hline -303 \end{array}$$
-303

Lesson 12: Numbers Great and Small (Wkbk pg. 37)

Exercises I

Practice by converting these to standard form. I've done the first one for you:

$10^8 = 100{,}000{,}000$

$10^5 = 100{,}000$

$10^{10} = 10{,}000{,}000{,}000$

$10^2 = 100$

$10^{14} = 100{,}000{,}000{,}000{,}000$

$10^{30} = 1{,}000{,}000{,}000{,}000{,}000{,}000{,}000{,}000{,}000{,}000{,}000$

Exercises II

When the exponent is negative, begin with the decimal point to the right of the 1 and move it the correct number of decimal places to the left.

$10^{-8} = 0.00000001$

$10^{-5} = 0.00001$

$10^{-10} = 0.0000000001$

$10^{-2} = 0.01$

$10^{-14} = 0.00000000000001$

$10^{-30} = 0.000000000000000000000000000001$

Exercises III

Express the following as some multiple of an exponent of ten. Once again, I've done the first one for you:

$200{,}000{,}000 = 2 \times 10^{8}$

$300{,}000 = 3 \times 10^{5}$

$40{,}000{,}000{,}000 = 4 \times 10^{10}$

$500 = 5 \times 10^{2}$

$600{,}000{,}000{,}000{,}000 = 6 \times 10^{14}$

$7{,}000{,}000{,}000{,}000{,}000{,}000{,}000{,}000 = 7 \times 10^{27}$

Exercises IV

Now convert these shorthand numbers to longhand.

$3 \times 10^{10} = 30{,}000{,}000{,}000$

$4 \times 10^{3} = 4{,}000$

$5 \times 10^{12} = 5{,}000{,}000{,}000{,}000$

$6 \times 10^{0} = 6$

$7 \times 10^{16} = 70{,}000{,}000{,}000{,}000{,}000$

$8 \times 10^{28} = 80{,}000{,}000{,}000{,}000{,}000{,}000{,}000{,}000{,}000$

Exercises V

To shorthand.

$0.0000000002 = 2 \times 10^{-10}$

$0.7 = 7 \times 10^{-1}$

$0.000003 = 3 \times 10^{-6}$

$0.004 = 4 \times 10^{-3}$

$0.0000007 = 7 \times 10^{-7}$

$0.0000000000006 = 6 \times 10^{-13}$

$0.0000000000000000000000000000004 = 4 \times 10^{-32}$

Exercises VI

Now do the reverse:

$5 \times 10^{-9} = 0.000000005$

$7 \times 10^{-7} = 0.0000007$

$4 \times 10^{-8} = 0.00000004$

$8 \times 10^{-3} = 0.008$

$6 \times 10^{-5} = 0.00006$

$2 \times 10^{-33} = 0.000000000000000000000000000000002$

$9 \times 10^{-17} = 0.00000000000000009$

Exercises VII

I'll give you the number and tell you the power of ten. You put the decimal point in the correct place. Include only significant digits unless you need placeholder zeros.

1)

$647{,}500{,}000 = \underline{6.475} \times 10^{8}$

$\underline{647.5} \times 10^{6}$

2)

$58{,}300{,}000{,}000 = \underline{5.83} \times 10^{10}$

$\underline{0.583} \times 10^{11}$

3)

$8{,}580{,}000 = \underline{8.58} \times 10^{6}$

$\underline{85.8} \times 10^{5}$

4)

$12{,}225{,}000{,}000{,}000 = \underline{1.2225} \times 10^{13}$

$\underline{12225} \times 10^{9}$

5)

$2{,}017{,}000{,}000 = \underline{2.017} \times 10^{9}$

$\underline{201700} \times 10^{4}$

Lesson 13: Scientifically Speaking (Wkbk pg. 40)

Exercises I

Let's be sure you get plenty of practice! Please express all the following in scientific notation. Assume placeholder zeros to be non-significant.

1) 9,873,400,000,000	9.8734×10^{12}
2) 0.790840	7.90840×10^{-1}
3) 24,240	2.424×10^{4}
4) 0.00000874	8.74×10^{-6}
5) 0.000000005	5×10^{-9}
6) 1,074,980,000	1.07498×10^{9}
7) 56,000,000,000,000,000	5.6×10^{16}
8) 0.662	6.62×10^{-1}
9) 19,500,000	1.95×10^{7}
10) 0.0000000005979	5.979×10^{-10}
11) 6,982	6.982×10^{3}
12) 0.023	2.3×10^{-2}
13) 740,100,000,000,000,000,000,000	7.401×10^{23}
14) 0.00000000000000000000001596	1.596×10^{-24}

Exercises II

Please practice performing math operations on numbers written in scientific notation. Give your answer in the correct number of significant figures.

1) 5.31×10^{8} times 9.759×10^{1}

5.18×10^{10}

2) 9.9×10^{5} times 5.49×10^{-3}

5.4×10^{3}

3) 6.63×10^{0} times 3.51×10^{0}

2.33×10^{1}

4) 6.620×10^{6} times -9.929×10^{7}

-6.573×10^{14}

5) 5.953×10^{20} divided by 7.734×10^{7}

7.697×10^{12}

6) 4.012×10^{3} divided by 1.95×10^{-5}

2.06×10^{8}

7) 5.979×10^{0} divided by 9.69×10^{8}

6.17×10^{-9}

The student's answers should be just as they appear here, with no additional digits, and with each digit shown being precisely the same.

To solve addition and subtraction problems, the numbers should be written out in standard notation. The addition and subtraction can then be readily performed. Afterward, the number of significant digits is adjusted .

8) 2.66×10^2 plus 2.42×10^4

266
+ 24,200
24,466 2.45×10^4

9) 7.49×10^6 plus 0.159×10^9

7,490,000
+ 159,000,000
166,490,000 1.66×10^8

10) 5.106×10^6 plus 2.06×10^{-1}

5,106,000
+ 0.206
5,106,000.206 5.106×10^6

11) 9.92×10^9 plus -7.595×10^8

9,920,000,000
- 759,500,000
9,160,500,000 9.16×10^9

12) 3.205×10^7 minus 7.734×10^7

32,050,000
-77,340,000
-45,290,000 -4.529×10^7

13) 4.0×10^1 minus -2.31×10^2

40
+231
271 2.71×10^2

14) 9.555×10^0 minus -9.7×10^{-1}

9.555
+0.97
10.525 1.053×10^1

Once again, every digit in the student's answers should be identical to those shown here.

Lesson 14: How Difficult Is Difficult? (Wkbk pg. 44)

There were no exercises in today's lesson.

Lesson 15: The Problem with Words (Wkbk pg. 51)

There were no exercises in today's lesson.