Sig Figs and Scientific Notation
Warm Up 8-21

1. How many grams are in 20kg?

2. How many ml are in 12hl?

3. How many dl are in 357dal?

4. How many inches are in 1 mile? (1 mile = 5280ft)
Accuracy vs Precision

**Accuracy** is how correct something is, or how close to the true value

If you imagine a dart board, this is like **hitting the bullseye** (or close to it) every time.
Accuracy vs Precision

Precision is how close your measurements are to each other, or how consistent something is.

With the dart board, this is like almost hitting the same spot every time (even if that spot is not close to the goal/bullseye).
Match the Following:

1) Low Accuracy and High Precision
2) Low Accuracy and Low Precision
3) High Accuracy and High Precision
4) High Accuracy and Low Precision

A  B  C  D
Quick Check

Each of five students used the same ruler to measure the length of the same pencil. These data resulted: 15.33 cm, 15.34 cm, 15.33 cm, 15.33 cm, 15.34 cm. The actual length of the pencil was 15.85 cm.

Describe whether accuracy and precision are each good or poor for these measurements.
Scientific Notation

• **Scientific Notation** allows us to display massive and tiny numbers in a universal simple way.

Instead of writing 4,000,000
we would write $4.0 \times 10^6$

All we are doing is **moving the decimal to the right of the first non-zero number**

We then write $x 10^{\text{the number of places we moved the decimal}}$

On a **BIG number**, we move the **decimal left** and the **exponent is positive**
On a **LITTLE number**, we move the **decimal right** and the **exponent is negative**
Scientific Notation

Example:
Write 5,000,000,000 in scientific notation

Now we write $5.0 \times 10^9$ because we moved the decimal 9 places to the left
Scientific Notation

Example:
Write 0.0005723 in scientific notation

0.0005723

Now we write $5.723 \times 10^{-4}$ because we moved the decimal 4 places to the right
# Scientific Notation Practice

Practice writing these in Scientific Notation:

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>300</td>
<td>$3 \times 10^2$</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>420</td>
<td>$4.2 \times 10^2$</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.34</td>
<td>$3.4 \times 10^{-1}$</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.00034</td>
<td>$3.4 \times 10^{-4}$</td>
<td></td>
</tr>
</tbody>
</table>

Practice writing these in from Scientific Notation:

<p>| | | | |</p>
<table>
<thead>
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<tbody>
<tr>
<td>5</td>
<td>$8.2 \times 10^2$</td>
<td>820</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>$9.63 \times 10^{-5}$</td>
<td>0.0000963</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>$7.22 \times 10^5$</td>
<td>722000</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>$1.23456 \times 10^{-4}$</td>
<td>0.000123456</td>
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Scientific Notation

• **Addition/Subtraction**: all values must have the same exponent before they can be added or subtracted

• **Multiplication**: multiply the values and add the exponents

• **Division**: divide the values and subtract the exponents
Scientific Notation

• Addition/Subtraction:
  \((n \times 10^a) + (m \times 10^a) = (n + m) \times 10^a\)
  \((n \times 10^a) - (m \times 10^a) = (n - m) \times 10^a\)

• Multiplication:
  \((n \times 10^a) \times (m \times 10^b) = (n \times m) \times 10^{a+b}\)

• Division:
  \(\frac{n \times 10^a}{m \times 10^b} = \frac{n}{m} \times 10^{a-b}\)
Significant Figures (Sig Figs)

**Significant Figures** express the accuracy of a measurement.

They are how many ‘important’ numbers to include in an answer/measurement

You want to count these for a calculation/measurement so you know how many decimal places/non zero numbers to include
Counting Significant Figures Rules

1. **Non-zero** digits are always significant
   - 12,345 (five sig figs)

2. **Sandwich Zeros** (between nonzero) are **always** significant
   - 10,003 (five sig figs)

3. **Leading Zeros** (before nonzero) are **never** significant
   - 0.00023 (two sig figs)

4. **Trailing Zeros** (after nonzero) are only significant after a decimal
   - 13,400 (three sig figs)
   - 3.23000 (six sig figs)
- Non-zero: Significant
- Zero: Leading NOT Significant, Trailing NOT After Decimal Significant
- Sandwich: Significant
- After Decimal: Significant
- NOT After Decimal: Not Significant
Counting Significant Figures

How many significant figures are in the numbers below?

1) 3.0045  5 sig figs
2) 0.0047   2 sig figs
3) 1.0047   5 sig figs
4) 4.20000  6 sig figs
5) 420000   2 sig figs
Calculations and Significant Figures

**ALWAYS round your answer to the LOWEST number of Sig Figs!**

1) $0.0456 \times 0.7 = 0.03192$  
   3 sig figs 1 sig fig  
   0.03

2) $1.002 \times 0.33 = 0.33066$  
   4 sig figs 2 sig figs  
   0.33
Significant Figures and Lab Equipment

For any laboratory measurement that is not a digital read, you can only estimate 1 decimal point beyond the markings.

On the graduated cylinder to the left, it is marked at each 1mL.

Imagine the line to the left, it is about ¼ of the way between 20 and 21mL.

You would be tempted to estimate 20.25, but you can only estimate 1 decimal beyond what is marked so you would have to say 20.3mL.