

Uncertainty

Your device limits the amount of certainty you have in your measurement. The less *precision* your device has, the larger the *margin of error*.

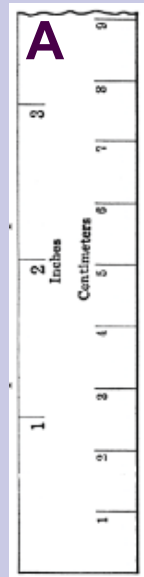
Unless the device says otherwise, the margin of error is half of the amount of the unit of measurement.



The gas container measurement goes up 1 gallon at a time so the margin of error is 0.5 gallon.

With which ruler can you make the most precise measurement?

Which ruler has a higher margin of error?



What is the margin of error for each ruler?

For ruler A:

$1/2$ inch or $1/2$ centimeter

For ruler B:

$1/16$ inch or $1/2$ millimeter

Tolerance



Tolerance tells you how precise you have to be in what you're measuring.

A tolerance can be written with a plus or minus after the number.
eg. "32 inches \pm 1/8 inch."

tolerance

- the total amount that a measurement is allowed to vary

F.Y.I.

$\pm \frac{1}{4}$ " is read, "plus or minus one-quarter inch."

On the Job 3**Tolerance**

A clothing manufacturer allows for a certain **tolerance** when making their products. Men's pants are sold in whole-inch sizes by their waist measurement and, often, by their inseam measurement as well. The company allows for a tolerance of $\pm \frac{1}{4}$ " when labelling their products.



- What is the tolerance for the waist measurement of a pair of pants?
- What are the maximum and minimum allowable waist measurements that can be labelled as 32-inch waist pants?

Solution

- The tolerance in the waist measurement is $\frac{1}{4}$ ".
- A pair of pants that has a waist measurement from $31 \frac{3}{4}$ " to $32 \frac{1}{4}$ " can be labelled as 32". For example, pants with a waist measurement that is greater than $32 \frac{1}{4}$ " will have to be re sewn and pants with a waist measurement of $32 \frac{3}{4}$ " will be labelled as 33".

Your Turn

The same manufacturer allows a tolerance for the neck measurement of a men's shirt of $\pm \frac{1}{8}$ ". Their men's shirts are sold in $\frac{1}{2}$ -inch increments of the neck measurement, for example, $14 \frac{1}{2}$ ", 15", $15 \frac{1}{2}$ ", 16", and so on.



- What is the tolerance for the neck measurement of a men's shirt?
- What are the maximum and minimum allowable measurements that can be sold as a men's shirt with a 15-inch neck?

Try It

- Determine the maximum and minimum allowable measurements.
 - $22'' \pm \frac{1}{4}''$
 - $45\text{ }^\circ\text{C} \pm 1^\circ$
 - $350\text{ }^\circ\text{F} \pm 10^\circ$
 - $1\text{ m} \pm 1\text{ cm}$
 - $1\text{ m} \pm 1\text{ mm}$
 - $5\text{ lb} \pm 0.2\text{ lb}$
- For each part of #1, what is the tolerance?

Answers

- maximum: $22\frac{1}{4}''$, minimum: $21\frac{3}{4}''$
 - maximum: $46\text{ }^\circ\text{C}$, minimum: $44\text{ }^\circ\text{C}$
 - maximum: $360\text{ }^\circ\text{F}$, minimum: $340\text{ }^\circ\text{F}$
 - maximum: 1.01 m , minimum: 0.99 m
 - maximum: 1.001 m , minimum: 0.999 m
 - maximum: 5.2 lb , minimum: 4.8 lb

- $\pm\frac{1}{4}''$
 - $\pm 1^\circ\text{C}$
 - $\pm 10^\circ\text{F}$
 - $\pm 1\text{ cm}$
 - $\pm 1\text{ mm}$
 - $\pm 0.2\text{ lb}$

- Determine the tolerance if the maximum and minimum allowable measurements for a 100-g product are 95 g and 105 g.

$$3. \pm 5\text{ g}$$

- A meat thermometer is accurate to $\pm 2^\circ$. What range of temperatures could the interior temperature of the burger be?



$$4. 158\text{ }^\circ\text{F to } 162\text{ }^\circ\text{F}$$

5. A machine shop that manufactures nuts and bolts allows a tolerance of ± 0.01 mm.

- a) What are the maximum and minimum diameters of a 6-mm bolt?
- b) The corresponding nut has an inside diameter of 6.1 mm, ± 0.01 mm. What are the maximum and minimum allowable inside diameters of the nut?



- c) What is the greatest possible difference between the diameter of the bolt and the nut? Explain.
- d) What is the least possible difference between the diameter of the bolt and the nut?
- e) Explain why the nut cannot be manufactured with an inside diameter of 6 mm.

Answers

5. a) maximum: 6.01 mm, minimum: 5.99 mm
- b) maximum: 6.11 mm, minimum: 6.09 mm
- c) 0.12 mm; The greatest possible distance is the difference between the maximum diameter of the nut and the minimum diameter of the bolt.
- d) 0.08 mm
- e) Example: To ensure that the bolt fits inside the nut, the inside diameter of the nut must be greater than the diameter of the bolt.

6. Most breakfast cereals are sold by mass, not by volume. A 350-g package is allowed to have a tolerance of ± 3 g. What is the acceptable range of masses for a cereal package?



6. 347 g to 353 g

8. The information on a package of carrot seeds says that the carrots, under normal growing conditions, will grow to a length of 6 inches to 8 inches.
- What do you think is the average length of the carrots? Explain.
 - Express the likely length of each carrot using the \pm symbol.



8. a) 7 inches; the middle of the given range of lengths
b) $7'' \pm 1''$