

Tolerance Notes

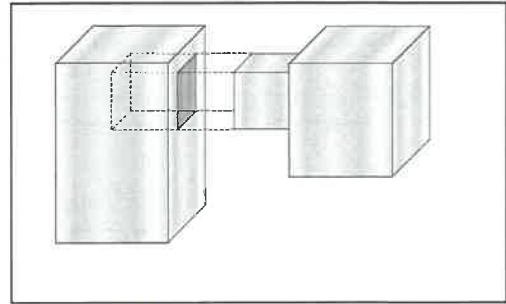
Tolerance is the Measurement variation allowed so that an item is acceptable (still the right size) for its

intended purpose. When building or making an object,

a range of sizes is often

acceptable. For example, if you are drilling a hole in a piece of wood to fit a bolt through, the hole needs to be large enough for the bolt to fit through without hammering it through and damaging the wood but small enough that the nut will sit flush on the surface. This

range of values is called the tolerance.



Note Tolerance and uncertainty are not the same! Uncertainty shows the

margin of error in a measured value. Tolerance shows the range of acceptable values for a measurement.

The tolerance is determined as follows:

subtract the minimum acceptable value from the maximum value

Nominal value or target value is found by:

add the minimum and maximum values together then divide by 2 - this is the value

half way between min and max

Ex 1

- Find the tolerance and nominal value of the following
- State the tolerance using nominal value form

a. minimum value: 56.5 lbs maximum value 65.4 lbs

$$\text{tolerance} = 65.4 - 56.5 = 8.9 \text{ lbs}$$

$$\text{nominal value} = \frac{65.4 + 56.5}{2} = 60.95 \text{ lbs}$$

$$\frac{1}{2} \text{ of tolerance } 8.9 \div 2 = 4.45 \text{ lbs}$$

$$60.95 \text{ lbs} \pm 4.45 \text{ lbs}$$

b. minimum value $18\frac{1}{4}"$ maximum value $18\frac{3}{4}"$

$$\text{tolerance} = 18\frac{3}{4}" - 18\frac{1}{4}" = \frac{2}{4} = \frac{1}{2}"$$

 $\frac{1}{2}$ of tolerance

$$\text{Nominal value} = \frac{18.75 + 18.25}{2} = 18.5" = 18\frac{1}{2}"$$

$$\frac{1}{2} \div 2 = \frac{1}{4}"$$

Show you know

$$18\frac{1}{2}" \pm \frac{1}{4}"$$

Find the tolerance and nominal value of the following and state it in the nominal value form.

a. Maximum = 25.75 mm

minimum = 25.25 mm

$$25.75 - 25.25 = 0.5 \text{ mm}$$

$$\frac{1}{2} \div 2 = 0.25 \text{ mm}$$

$$n = \frac{25.75 + 25.25}{2} = 25.5 \text{ mm}$$

$$25.5 \text{ mm} \pm 0.25 \text{ mm}$$

b. Maximum = 22°C

minimum = 16°C

$$19^{\circ}\text{C} \pm 3^{\circ}\text{C}$$

Ex 2. Finding the minimum and maximum

1. Write the maximum and minimum values represented by each of the following dimensions

a. $350^{\circ}\text{F} \pm 15.5^{\circ}\text{F}$

$$\text{max: } 350^{\circ}\text{F} + 15.5^{\circ}\text{F} = 365.5^{\circ}\text{F}$$

$$\text{min: } 350^{\circ}\text{F} - 15.5^{\circ}\text{F} = 334.5^{\circ}\text{F}$$

b. $18" \pm \frac{1}{8}"$

$$\text{Max: } 18" + \frac{1}{8}" = 18\frac{1}{8}"$$

$$\text{Min: } 18" - \frac{1}{8}" = 17\frac{7}{8}"$$

Show you know

$$\frac{1}{8} \overset{\times 2}{=} \frac{2}{16}$$

a. $8 \frac{5}{16}'' \pm \frac{1}{8}''$

$$\text{max: } 8 \frac{5}{16}'' + \frac{1}{8}'' = 8 \frac{7}{16}''$$

$$\text{min: } 8 \frac{5}{16}'' - \frac{1}{8}'' = 8 \frac{3}{16}''$$

b. $35.75 \text{ lbs} \pm 7.25 \text{ lbs}$

$$\text{max: } 43 \text{ lbs}$$

$$\text{min: } 28.5 \text{ lbs}$$

Ex 3. Mackenzie is making caramel candies. The recipe says to use a candy thermometer to monitor the temperature of the sugar mixture. If it is not heated enough, the candies will not hold their shape, and if it is heated too much, the candies will be too firm. The sugar mixture must be heated to between 245° degrees F and 250° F

a. What is the temperature tolerance of the sugar mixture?

$$250 - 245 = 5^\circ \text{F}$$

b. What is the nominal value and state it using the nominal value form?

$$\text{nom} = \frac{245 + 250}{2} = 247.5^\circ \text{F}$$

$$\frac{1}{2} \text{ of } t = 5 \div 2 = 2.5^\circ \text{F}$$

$$247.5^\circ \text{F} \pm 2.5^\circ \text{F}$$

c. What is the minimum and maximum acceptable temperatures?

$$245^\circ \text{F} \quad 250^\circ \text{F}$$

Show you know

Ex. 1

Bob is drilling a hole and the maximum size it can be is 15 mm and the minimum is 13 mm.

- a. What is the tolerance of the hole?

$$15 - 13 = 2 \text{ mm}$$

- b. What is the nominal value of the hole Bob needs to drill? State it using nominal value form

$$\frac{15 + 13}{2} = 14 \text{ mm}$$

- c. What are the minimum and maximum acceptable sizes?

$$\text{min: } 13 \text{ mm}$$

$$\text{max: } 15 \text{ mm}$$

Ex 3 4 ways of stating Range

Serena is making a new front door for her house. In order to fit properly in the frame, the door width must have a nominal value of 24" and a tolerance of $\frac{1}{8}$ ".

$$\frac{1}{8} \div 2 = \frac{1}{16}$$

- a. What are the maximum and minimum allowable values of the door width?

$$\text{max} = 24" + \frac{1}{16} = 24\frac{1}{16}"$$

$$\text{min} = 24" - \frac{1}{16} = 23\frac{15}{16}"$$

b. State the acceptable sizes in each of the four ways

$$\begin{array}{l} 1) \text{ maximum value} \\ \text{minimum value} \end{array} = \begin{array}{l} 24 \frac{1}{16}'' \\ 23 \frac{15}{16}'' \end{array}$$

$$2) \text{ minimum value } \begin{array}{c} + \text{tolerance} \\ - 0 \end{array} = 23 \frac{15}{16}'' \begin{array}{c} + \frac{1}{8}'' \\ - 0 \end{array}$$

$$3) \text{ maximum value } \begin{array}{c} + 0 \\ - \text{tolerance} \end{array} = 24 \frac{1}{16}'' \begin{array}{c} + 0 \\ - \frac{1}{8}'' \end{array}$$

$$4) \text{ nominal value } \pm \frac{1}{2} \text{ of tolerance} = 24 \pm \frac{1}{16}''$$

Show you know

1. Adam is a tailor. He is sewing a pair of pants for a client. The waist measurement must be between $33 \frac{3}{4}''$ and $34 \frac{1}{4}''$

a. What is the tolerance?

$$34 \frac{1}{4}'' - 33 \frac{3}{4}'' = \frac{1}{2}''$$

- b. Write the dimension in the form: minimum value $\begin{array}{c} + \text{tolerance} \\ - 0 \end{array}$ and maximum value $\begin{array}{c} + 0 \\ - \text{tolerance} \end{array}$

$$33 \frac{3}{4}'' \begin{array}{c} + \frac{1}{2}'' \\ - 0 \end{array}$$

$$34 \frac{1}{4}'' \begin{array}{c} + 0 \\ - \frac{1}{2}'' \end{array}$$

- c. What is the nominal value and the $\pm$ range of the waist measurement?

$$34'' \pm \frac{1}{4}''$$

