Apprenticeship Math 12

NOTES: Accuracy, Precision and Uncertainty

Name: _____

Date: Oct. 1

Accuracy

Accuracy is how close a measured value is to the actual value.

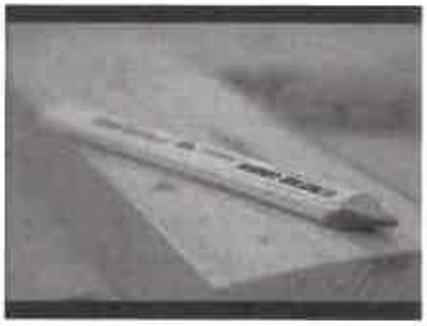
Accuracy will change depending on the measuring device used and how closely it can be read. Something to keep in mind is that two tape measures made by two different companies may show measurements slightly differently.

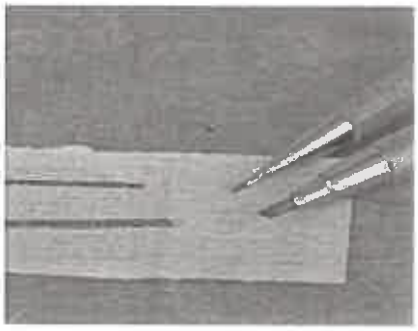
Using stride length to measure the length of the main hallway in a school would be NOT ACCURATE because stride length changes from person to person

Using a standard ruler to measure a pencil would be ACCURATE as we are using a standart tool that has small enough units

Did you know?

A carpenter's pencil and and a cabinet maker's (more exact) pencil are different as the accuracies of their respective work are at different tolerance levels.





Precision

Precision is how close the measured value are to each other.

High Accuracy
Low Precision

- close to bullseye
- far from each other

Low Accuracy
High Precision

- far from bullseye
- close to each other

High Accuracy
High Precision

- close to bullseye
- close to each other

Bias

It's not enough to be accurate and precise. You also need to be aware that your measuring equipment does not introduce errors. For example, the scale that you use to weigh ball bearings might not be calibrated properly so all measurements made with that scale will not be accurate if even if the measurements are close.

Precision and Uncertainty

Like accuracy, precision is related to exactness but it is determined by the limitations of the measuring instrument.

Precision is the smallest unit of measurement on the measuring device being used. A measurement made with a ruler marked in millimetres would be more precise than a measurement made with a ruler marked in centimetres.

Because of the limited precision of a measuring device, there is always some uncertainty when taking measurements.

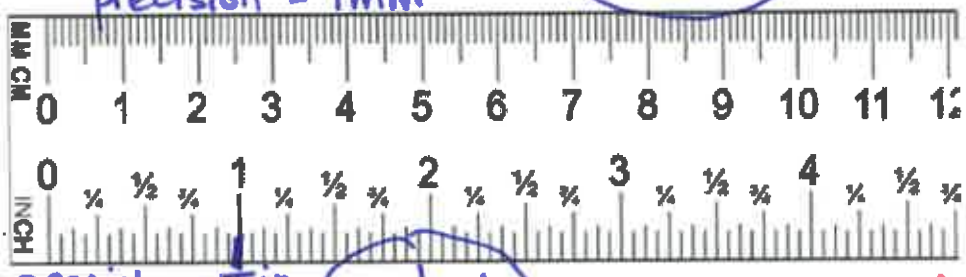
For example, if you are measuring a box with a ruler marked in centimetres and the box is slightly less than 6 cm, you have to say that it is 6 cm long. You cannot give a more precise measure than this because of the units of the measuring device.

It is often necessary to record how much uncertainty exists in a measurement.

Unless otherwise stated, uncertainty is given as half of the precision of the measuring device. For the box example above, the length would be 6 cm with a precision of 1 cm and an uncertainty of 0.5 cm

For example, the uncertainty for the following ruler is ±0.5 mm. ($\frac{1}{2} \times 1$ mm)

precision = 1 mm



precision = $\frac{1}{16}$ in

The uncertainty in inches is ± $\frac{1}{32}$ in. ($\frac{1}{2} \times \frac{1}{16}$ in)

If what you are creating needs to be more certain, use a measuring device that is more exact. This will reduce your level of uncertainty, provided that you are accurate in your reading of the device!

Examples

State the precision and uncertainy of the following:

a. A ruler marked in millimetres is used to measure the pencil as shown.

precision 1 mm

uncertainty ± 0.5 mm

b. An odometer records distance travelled to the nearest kilometer.

precision 1 km

uncertainty ± 0.5 km

c. The outside temperature was recorded to 12°C using the thermometer shown.

precision 1 °C

uncertainty ± 0.5 °C

d. Harpreet says it took him about 5 hours to drive from Vancouver to Kamloops, B.C.

precision 1 hour

uncertainty ± 0.5 hour

OR (± 30 min)

*always

When adding or subtracting measurements that have uncertainty, we need to ADD the uncertainties.

(even when subtracting measurements)

Example

44 mm ± 0.5 mm added to 30 mm ± 0.5 mm.

$44\text{mm} \pm 0.5\text{mm}$
$+\ 30\text{mm} \pm 0.5\text{mm}$
$74\text{mm} \pm 1\text{mm}$

43.5mm to 44.5mm
29.5mm to 30.5mm
73mm to 75mm

Example

Marcie is a carpenter. She is installing sheets of plywood as subflooring on a balcony. She has measured two of the sheets to be 2.25 m and 1.30 m long, using a tape measure marked in centimetres.

precision = 1cm
uncertainty = ± 0.5cm

a) Write the lengths of each sheet of plywood in the form: *measured value* ± *measurement uncertainty*.

$2.25\text{m} \pm 0.5\text{cm} \Rightarrow 225\text{cm} \pm 0.5\text{cm}$
$1.30\text{m} \pm 0.5\text{cm} \Rightarrow 130\text{cm} \pm 0.5\text{cm}$

b) What is the total length, including uncertainty, of the two sheets if they are placed end to end?

$225\text{cm} \pm 0.5\text{cm}$
$+\ 130\text{cm} \pm 0.5\text{cm}$
$355\text{cm} \pm 1\text{cm}$

somewhere between 354 cm and 356 cm.

c) Marcie needs to shorten the 2.25-m piece of plywood. She cuts a 30-cm section from the end. What is the new length of this sheet, including uncertainty?

$225 \pm 0.5\text{cm}$
$-\ 30 \pm 0.5\text{cm}$
$195 \pm 1\text{cm}$

add uncertainty!

somewhere between 194cm and 196 cm