

3.3 Accuracy and Precision Notes

In everyday life, people often use the words "precise" and "accurate" to mean the same thing. In mathematics and the trades, however, they have different meanings.

Accuracy refers to the exactness of measurement.

To be accurate, a measured value must be as close to the real value as possible. If you measure something accurately, someone should be able to repeat the same measurement and get the same value.

When taking measurements, it is important to think about the appropriateness of the unit of measurement. For example, you would not need to know the distance between 2 cities in millimetres. The kilometre would be a much more appropriate unit of measure.

Examples:

Explain if the following measurements would give an accurate measure and if the measuring device is appropriate. State why or why not.

Using the length of stride to mark off a soccer field.

- Not very accurate - stride varies from person to person & step to step
- But reasonable length to use, so could use for an estimate

Using a meter stick to calculate the distance between 2 cities.

- Not a reasonable device
 - more accurate than strides, but not very accurate because there is some error every time the meter stick is moved
- Using a ruler marked in millimetres to measure the thickness of a book
- accurate and reasonable with an appropriate scale

Precision

Precision is the smallest unit of measurement on the measuring device being used. For example, if your ruler has millimetres, that is as precise as you can measure. Precision is determined by the limitations of the measuring device.

Because of the limited precision of a measuring device, there is always 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 6cm, you have to say that it is 6cm 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 the precision of the measuring device

$$\text{Value} \pm \text{uncertainty}$$

$$6 \text{ cm} \pm 0.5 \text{ cm}$$

State the precision and uncertainty of the following examples.

Ex 1. An oven's temperature can be set in 5°C increments. Bob sets the oven at 425°C

- a. What is the precision and uncertainty of the oven?

$$\text{precision} = 5^{\circ}\text{C}$$

$$\text{uncertainty} = 5^{\circ}\text{C} \div 2 = 2.5^{\circ}\text{C}$$

- b. Write the oven's temperature in the form Measured value $\pm$ uncertainty

$$425^{\circ}\text{C} \pm 2.5^{\circ}\text{C}$$

- c. What is the range (minimum and maximum) of the oven's possible temperature?

$$\text{max: } 425^{\circ}\text{C} + 2.5^{\circ}\text{C} = 427.5^{\circ}\text{C}$$

$$\text{min: } 425^{\circ}\text{C} - 2.5^{\circ}\text{C} = 422.5^{\circ}\text{C}$$

Show you know

Genevieve is mixing juice in a jug marked in quarter-litres. She measures the amount of juice in a jug to be approximately 2.5L

- a. What is the precision of the jug's scale?

$$\frac{1}{4} = 0.25\text{L}$$

- b. What is the uncertainty in the scale of the jug?

$$0.25 \div 2 = 0.125\text{L}$$

- c. Write the measurement of juice in the jug in the form: Measured value $\pm$ uncertainty

$$2.5\text{L} \pm 0.125\text{L}$$

- d. What is the range of volume (in litres) that could be in the jug?

$$\text{max } 2.5 + 0.125 = 2.625\text{L}$$

$$\text{min } 2.5 - 0.125 = 2.375\text{L}$$

range

$$2.375\text{L} \text{ to } 2.625\text{L}$$

Uncertainties when 2 objects are being added or subtracted

When adding and subtracting measurements that each have an uncertainty, the combined value will also have an uncertainty. The uncertainty of the final amount is the sum of the measured uncertainties.

You always add uncertainties!**Ex. 1**

Shelby wants to install new cupboards in her kitchen. The space available in her kitchen is 230 cm wide, measure to the nearest centimetre. She plans to buy prebuilt cupboards from IKEA. The sizes available are 70cm, 95cm, and 65cm wide. If Shelby were to buy one of each size of the cupboards, can she safely assume that they will fit the available space? Why or why not?

Solution $p = 1\text{cm}$ $1 \div 2 = 0.5\text{cm}$

- a. Write the lengths of each cupboard in the form: measured value $\pm$ uncertainty

$$70\text{cm} \pm 0.5\text{cm}, 95\text{cm} \pm 0.5\text{cm}, 65\text{cm} \pm 0.5\text{cm}$$

- b. What is the total length of the 3 cupboards in the form: measured value $\pm$ uncertainty

$$70 + 95 + 65 = 230 \text{ cm}$$

$$0.5 + 0.5 + 0.5 = 1.5 \text{ cm}$$

$$230 \text{ cm} \pm 1.5 \text{ cm}$$

- c. What is the min and max length of the 3 cupboards combined (range)

$$\text{max: } 230 + 1.5 = 231.5 \text{ cm}$$

$$\text{min: } 230 - 1.5 = 228.5 \text{ cm}$$

$$\text{range } 228.5 \text{ cm} - 231.5 \text{ cm}$$

Show you know

Bob is a carpenter. He is installing sheets of plywood as a subfloor. He measures 2 sheets to be 2.25m and 1.30 meters using a tape measure marked in centimeters.

225cm 130cm

- a. Write the lengths of each sheet of plywood in the form: measured value $\pm$ uncertainty

$$1 \text{ cm} \div 2 = 0.5 \text{ cm}$$

$$225 \text{ cm} \pm 0.5 \text{ cm}$$

$$130 \text{ cm} \pm 0.5 \text{ cm}$$

- b. What is the total length of 2 sheets of plywood in the form: measured value $\pm$ uncertainty

$$225 \text{ cm} + 130 \text{ cm} = 355 \text{ cm}$$

$$0.5 \text{ cm} + 0.5 \text{ cm} = 1 \text{ cm}$$

$$355 \text{ cm} \pm 1 \text{ cm}$$

- c. What is the min and max length of the 2 sheets combined (range)

$$\text{max: } 355 \text{ cm} + 1 \text{ cm} = 356 \text{ cm}$$

$$\text{min: } 355 \text{ cm} - 1 \text{ cm} = 354 \text{ cm}$$

$$354 \text{ cm} - 356 \text{ cm}$$